

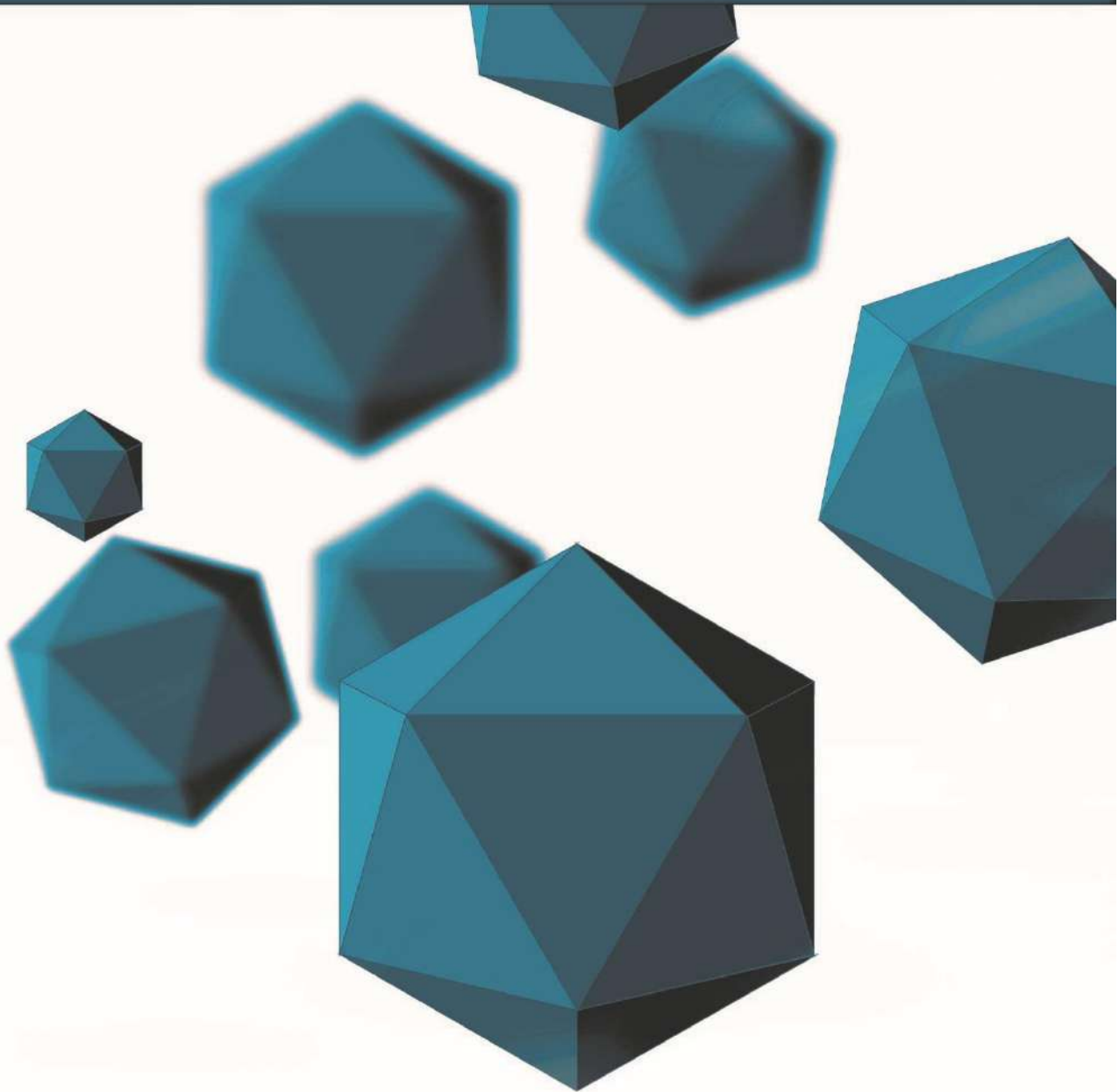
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# FOREWORD

I am pleased to put into the hands of readers Volume-8; Issue-8: 2021 (August, 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**

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September 2021

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***Solid Index versus Impression for transferring the Position of implants in Mandibular total Edentulous Arches: A Clinical study on trueness***

Ana Larisse Carneiro Pereira, Henrique Vieira Melo Segundo, Maria de Fátima Trindade Pinto Campos, Míria Rafaelli Souza Curinga, Ana Clara Soares Paiva Tôres, Adriana da Fonte Porto Carreiro

 DOI: [10.22161/ijaers.88.1](https://doi.org/10.22161/ijaers.88.1)

Page No: 001-007

***Cardiopulmonary resuscitation in patients diagnosed with or suspected of COVID-19: A narrative review of the literature***

Naiade Moreira de Oliveira, Viviane Costa Matos, Jonatas Crispim Magalhães de Oliveira, Diélig Teixeira, Meick Farias Negrão, Priscila de Figueiredo Viana, Dáwilla Ruanny de Almeida Palheta dos Santos, Danielly Guerra de Aguiar, Susi dos Santos Barreto de Souza, Sheyla Cristina Ferreira de Magalhães, Antônio Lourenço da Costa Neto, Marcieli Borba do Nascimento, Gilvana Rodrigues de Oliveira, Jessica Dias Ribeiro, Jaciara da Silva Barroso Martins, Bruna Luiza de Souza Costa, Leudilane Reis da Silva, Milena Oliveira Saldanha Pacífico, Vera Lúcia Queiroz Correa Vieira, Erika Renata Castilho Carvalho Sarraff, Bruna Carolina da Trindade Monteiro da Silva, Tamires De Cassia Silva da Cruz, Rafael Pilad Barata Mussio, Dermison Leão Pereira, Lorena Costa Londres, Lucas Garcia Rodrigues, Mayco Tadeu Vaz Silva, Laydiane Martins Pinto, Fabiana Nascimento Silva, Marcio Almeida Lins, Amanda do Socorro Furtado Silva, Eimar Neri de Oliveira Junior, Simone Batista da Silva dos Santos, Rosilene Ferreira de Sousa, Elen Priscila Garcia Assunção de Castro, Vanessa de Nazaré Mendes Favacho, Sandra Sueli de Medeiros Nunes dos Santos, Dienid Campos Azevedo, Dhyrlee Dennara Magalhães Silva, Samanntha Lara da Silva Anaisse, Gleyce Pinto Girard, Thamyris Abreu Marinho, Danielle Oliveira Maciel, Tatyellen Natasha da Costa Oliveira, Anderson Lineu Siqueta dos Santos, Larissa Pereira de Barros Borges, Emerson Glauber Abreu dos Santos, Elias Costa Monteiro, Rafaela Martins Dourado Gonçalves, Shirley Iara Martins Dourado, Enderson Vasconcelos de Lima, Michelly Lima Braga, Odilene Silva Costa, Vera Lucia Silva de Sousa, Lívia Sayonara de Sousa Nascimento, Glauber Marcelo Dantas Seixas, Raquel Fernandes Costa, Denise Karla de Abreu Silva, Paulo Alaércio Beata, Marcelo Williams Oliveira de Souza, Luana da Silva Rodrigues, Tobias do Rosário Serrão, Zaíne Melo de Oliveira, Iranete Pereira Ribeiro, Patrick Roberto Gomes Abdoral, Larissa Siqueira Rodrigues, Elisângela Claudia de Medeiros Moreira, Elcilane Gomes Silva, Ruan Rodrigues Felicidade, Nádia Maria Machado da Costa, Luís Edilson de Azevedo Ferreira, Ana Sheyla Falcão Modesto, Giovane José de Magalhães Duarte, Wanda Carla Conde Rodrigues, Maguida Patrícia Lacerda Cordeiro Oliveira, Simone Aguiar da Silva Figueira, Jaqueline Cardoso Marcena, Maicon de Araujo Nogueira\*, Djenanne Simonsen Augusto de Carvalho Caetano, Camilo Carvalho Gomes, Anne Caroline Gonçalves Lima, Diego João de Lima Arrais, Elyade Nelly Pires Rocha Camacho, Antonia Margareth Moita Sá

 DOI: [10.22161/ijaers.88.2](https://doi.org/10.22161/ijaers.88.2)

Page No: 011-024

***A Review on Plastic Moulding Manufacturing Process and Parameters***

Shailesh Singh, Sunil Sahai, Manoj Kumar Verma

 DOI: [10.22161/ijaers.88.3](https://doi.org/10.22161/ijaers.88.3)

Page No: 025-033

***Prefabricated Sandwich Panel System in India***


Vaishaliben Ratilal Baldha

 DOI: [10.22161/ijaers.88.4](https://doi.org/10.22161/ijaers.88.4)











Page No: 034-036












***Analysis of Intelligent public Transit Service Models by users: A Literature Review***

Filipe de Castro Quelhas, Prof. Luis Perez Zotes, Leonardo Soares Francisco de Almeida

 DOI: [10.22161/ijaers.88.5](https://doi.org/10.22161/ijaers.88.5)

Page No: 037-051

<p><b><i>Use of VR/AR techniques in Remote Laboratories: a systematic review</i></b> Isabela Nardi da Silva, Karmel Cristina Nardi da Silva, Juarez Bento da Silva, Simone Meister Sommer Bilessimo, Leticia Rocha Machado  DOI: <a href="https://doi.org/10.22161/ijaers.88.6">10.22161/ijaers.88.6</a></p>	<p>Page No: 052-057</p>
<p><b><i>Swarm Intelligence based Fire Fighting Robot</i></b> Savita Jadhav, Shreyas Jadhav  DOI: <a href="https://doi.org/10.22161/ijaers.88.7">10.22161/ijaers.88.7</a></p>	<p>Page No: 058-063</p>
<p><b><i>The Digital Game 'Artesaga' as a Methodological Strategy for Teaching Art History</i></b> Francy Izanny de B. B. Martins, Isaque Barbosa Martins, Joaquim Felipe T. Belchior, Kiev Luiz F. Guedes, Rodrigo Eduardo D. Barbalho, Sandro Sinval de Souza  DOI: <a href="https://doi.org/10.22161/ijaers.88.8">10.22161/ijaers.88.8</a></p>	<p>Page No: 064-069</p>
<p><b><i>Modeling and Decision Making Applied to Agriculture</i></b> Cláudia Brazil Marques, Fabrício Moraes de Almeida, Carlos Alberto Paraguassú-Chaves, Carla Dolezel Trindade, Simão Aznar Filho, Simão Dolezel Aznar, Carlos Alberto Dolezel Trindade, Levi Pereira Granja de Souza, Ricardo Guanabara  DOI: <a href="https://doi.org/10.22161/ijaers.88.9">10.22161/ijaers.88.9</a></p>	<p>Page No: 070-081</p>
<p><b><i>Towards innovation on computer science courses</i></b> Diones Hohemberger, Andréia dos Santos Sachete, Fábio Diniz Rossi  DOI: <a href="https://doi.org/10.22161/ijaers.88.10">10.22161/ijaers.88.10</a></p>	<p>Page No: 082-089</p>
<p><b><i>Public Management Role for the Encouragement of the Entrepreneurial Ecosystem in Imperatriz (Ma) – Brazil</i></b> Sandna Nolêto de Araújo, Marcela Barbosa de Moraes, Antônio Esmerahdson de Pinho da Silva  DOI: <a href="https://doi.org/10.22161/ijaers.88.11">10.22161/ijaers.88.11</a></p>	<p>Page No: 090-103</p>
<p><b><i>What motivated students at the Diana Colaça Education Center to choose the Administration Course and what are their Expectations when Completing the Course? – A Case Study</i></b> Maria Eliane Nunes Freitas, Felipe Neris Torres de Sousa  DOI: <a href="https://doi.org/10.22161/ijaers.88.12">10.22161/ijaers.88.12</a></p>	<p>Page No: 104-113</p>
<p><b><i>Extension Activities of Administration during Pandemic: University of the State of Bahia (2020)</i></b> Aliger dos Santos Pereira, Jader Cristiano Magalhães de Albuquerque, Rosana Cruz Marques da Silva  DOI: <a href="https://doi.org/10.22161/ijaers.88.13">10.22161/ijaers.88.13</a></p>	<p>Page No: 114-119</p>
<p><b><i>Pharmaceutical Conduct Applied to Pharmacies During the Sars Cov2 Pandemic (Covid-19)</i></b> Cristianne Confessor Castilho Lopes, Heliude de Quadros e Silva, Eduardo Barbosa Lopes, Youssef Elias Ammar  DOI: <a href="https://doi.org/10.22161/ijaers.88.14">10.22161/ijaers.88.14</a></p>	<p>Page No: 120-124</p>
<p><b><i>A Obesidade Infantil no Brasil E Sua Prevalência nos Tempos (Pré) Pandêmicos da Covid-19</i></b> Angélica Cristina Castro Soares, Wilder Kleber Fernandes Santana, Richardson Lemos de Oliveira, Hermes Candido de Paula, Priscilla Duarte Soares Correa, Yuri Alexander dos Santos Rôas, Itaécio Felipe Silva, Vítor Diego de Pontes Simões, Edilane Aparecida Alves Canto, Jéssica Ribeiro da Silva, Janaina Kelly da Silva de Souza de Araújo, Allef Algemiro Gawlinski de Ávila  DOI: <a href="https://doi.org/10.22161/ijaers.88.15">10.22161/ijaers.88.15</a></p>	<p>Page No: 125-130</p>
<p><b><i>The influence of the agricultural management systems in the maintenance of the biodiversity in benefit of the Phyto sanity control</i></b></p>	


<p>Edvando Manoel de Souza, Ana Rosa Peixoto, Fábio Del Monte Coccoza, Cristiane Domingos da Paz, Gertrudes Macário de Oliveira, Marcos Antônio Vanderlei Silva, Thiago Francisco de Souza Carneiro Neto</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.16">10.22161/ijaers.88.16</a></p>	Page No: 131-137
<p><b><i>Shipment Delivery and Covid-19: An Indian Context</i></b></p> <p>Mehtab Alam, Shamsh Parveen</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.17">10.22161/ijaers.88.17</a></p>	Page No: 145-154
<p><b><i>Portuguese Sentiment Analysis Applied to a Reality Show using Twitter and NLP in real time</i></b></p> <p>Marta Azevedo, José Pinheiro , Cecília Castro</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.18">10.22161/ijaers.88.18</a></p>	Page No: 155-159
<p><b><i>A review on Silicide based materials for thermoelectric applications</i></b></p> <p>Sarabjeet Singh, Yogesh Chandra Sharma</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.19">10.22161/ijaers.88.19</a></p>	Page No: 160-168
<p><b><i>Platform for Distributed Generation Connection Assessment in Brazilian Electrical Grids</i></b></p> <p>Daniel Szente Fonseca, Anna Giulia Queiroz Costa, Renan Machado Sales, Luiz Henrique Leite Rosa, Cíntia Gonçalves, Marcelo Aparecido Pelegrini</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.20">10.22161/ijaers.88.20</a></p>	Page No: 169-175
<p><b><i>Stabilization at Santinho-Ingleses dunefield, Southern Brazil: What will be the future of sediment input to Ingleses Beach?</i></b></p> <p>Maiara Werner Pinto, Antonio Henrique da Fontoura Klein, Adrián Acevedo, Melisa Menendez</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.21">10.22161/ijaers.88.21</a></p>	Page No: 176-190
<p><b><i>Study of the Chemical Composition and Antimicrobial Action of Dillenia Indica Peel, Fruit and Leaves Extracts</i></b></p> <p>Gabriela Celeguim, Wanderson de Oliveira dos Santos, Ana Claudia Granato, Mônica Hitomi Okura</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.22">10.22161/ijaers.88.22</a></p>	Page No: 191-196
<p><b><i>Breaking Ways, Opening Variants - Cowboy Culture in the City of Andorinha, Brasil</i></b></p> <p>Monica Andrade Souza, Cosme Batista dos Santos</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.23">10.22161/ijaers.88.23</a></p>	Page No: 197-204
<p><b><i>The Occupational Health and Safety Care Policy (PASS): The Case of the SIASS UNIVASF Unit</i></b></p> <p>Ana Carla Mendes Coelho, José Ricardo Costa de Mendonça</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.24">10.22161/ijaers.88.24</a></p>	Page No: 205-210
<p><b><i>Performance Test on Modified Block Ice Crusher Using Double Crusher System in Sorong West Papua</i></b></p> <p>Anifudin, Sugianto Halim, Maimun</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.25">10.22161/ijaers.88.25</a></p>	Page No: 211-215
<p><b><i>Influence of Physical Activity on Side Effects in Women with Breast Neoplasms Undergoing Chemotherapy Treatment</i></b></p> <p>Cristina Albuquerque Douberin, Liniker Scolfild Rodrigues da Silva, Rayanne Beatriz Barros Marinho, Edivaldo Bezerra Mendes Filho, Maria de Fatima Silva Nascimento, Fernanda Barbosa dos Santos, Richelly do Nascimento Pereira</p> <p> DOI: <a href="https://doi.org/10.22161/ijaers.88.26">10.22161/ijaers.88.26</a></p>	Page No: 216-220
<p><b><i>Covid-19 effects on cybersecurity issues</i></b></p> <p>Thiago Jose Ximenes Machado, Luis Borges Gouveia</p>	

 DOI: <a href="https://doi.org/10.22161/ijaers.88.27">10.22161/ijaers.88.27</a>	Page No: 222-229
<p><b><i>Storytelling in the Bean Threshing: A Form of Struggle and Resistance for Tradition and Ancestral Memory</i></b>  Fernanda Ielpo da Cunha, Ana Maria Eugenio da Silva, José Gerardo Vasconcelos, Ana Flávia Ferreira da Silva, José Rogério Santana, Olienai de Oliveira Pinto, Juan Carlos Alvarado Alcócer, Alexandre Oliveira Lima, Sidney Guerra Reginaldo</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.28">10.22161/ijaers.88.28</a>	Page No: 230-237
<p><b><i>A Review of Remote Sensing Applications on Very High-Resolution Imagery Using Deep Learning-Based Semantic Segmentation Techniques</i></b>  Philipe Borba, Edilson de Souza Bias, Nilton Correia da Silva, Henrique Llacer Roig</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.29">10.22161/ijaers.88.29</a>	Page No: 238-255
<p><b><i>The Tax Waiver Impact on Profits and Dividends as an Economic Efficiency Instrument</i></b>  Michael de Alencar Silva, Fabio do Nascimento Siqueira da Silva, Nelson Hein</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.30">10.22161/ijaers.88.30</a>	Page No: 256-267
<p><b><i>Effect of Storage on Quality of Spirulina Snack Bars</i></b>  Doiphode S. S., Mane K. A.</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.31">10.22161/ijaers.88.31</a>	Page No: 268-275
<p><b><i>Remote Sensing for Risk Mitigation in Agricultural Financings: Multitemporal Change Detections in Agricultural Areas using the Delta NIR and Delta NDVI Models</i></b>  Sumaia Resegue Aboud Neta, Edilson de Souza Bias</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.32">10.22161/ijaers.88.32</a>	Page No: 275-297
<p><b><i>Predominant Leadership Style in the 1st Military Police Battalion in the State of Rondônia, Brazil</i></b>  Alexsandro Antonio Lang, Ariadne dos Santos Massaro, Jose Arilson de Souza, Elder Gomes Ramos, Leonardo Severo da Luz Neto, Joelson Agostinho de Pontes, Lucicleia Barreto Queiroz, Carlos Alberto Paraguassú-Chaves</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.33">10.22161/ijaers.88.33</a>	Page No: 298-310
<p><b><i>Interculturality and Meaningful Learning: Indigenous Schooling Education in Natural Sciences Teaching</i></b>  Leonardo Diego Lins, Maíra Cavalcanti Coelho, Karina Amorim Moreira M. Lourenço, Sandra Valéria Silva Lins</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.34">10.22161/ijaers.88.34</a>	Page No: 311-318
<p><b><i>Thermoelectric Effects on MoSi<sub>2</sub> with Finite Element Analysis using COMSOL</i></b>  Sarabjeet Singh, Yogesh Chandra Sharma</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.35">10.22161/ijaers.88.35</a>	Page No: 319-322
<p><b><i>Municipalization of Environmental Licensing: An Analysis of The Identity Territory of Piemonte Norte do Itapicuru - Bahia</i></b>  Thaíse Loiola de Sá, Gina Gouveira Pires de Castro</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.36">10.22161/ijaers.88.36</a>	Page No: 323-334
<p><b><i>Talent retention practices by the view of the Administration university students at Universidade Federal Fluminense (UFF) in Macaé/RJ</i></b>  Fabio do Nascimento Siqueira da Silva, Michael da Silva Alencar, Nelson Hein</p>	
 DOI: <a href="https://doi.org/10.22161/ijaers.88.37">10.22161/ijaers.88.37</a>	



***The Pitaguary Ethnicity Sociobiodiversity and Sustainability Practices in Maracanaú, Ceará, Brazil***

Antônio Roberto Xavier, Bárbara Eleodora Santiago Gomes, Andréa Yumi Sugishita Kanikadan, Rosalina Semedo de Andrade Tavares, José Gerardo Vasconcelos

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***Improving the Voltage Stability of the Nigeria 44- Bus 330KV Power Transmission Network using ANN Based Adaptive STATCOM Device***

E.N. Aneke, E.N.C Okafor, Iyidobi J.C

 DOI: [10.22161/ijaers.88.39](https://doi.org/10.22161/ijaers.88.39)

***Sinusoidal Water Wave Dispersion Equation Formulated Using the Total Velocity Potential Equation***

Syawaluddin Hutahaean

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***Skills and Competencies for Resilience in Manufacturing Systems: A Systematic Literature Review***

Lucas de Carvalho Borella, Flávio Sanson Fogliatto, Margareth Rodrigues de Carvalho Borella

 DOI: [10.22161/ijaers.88.41](https://doi.org/10.22161/ijaers.88.41)

***Antônio Conselheiro and the Arraial De Canudos: A Socio-Anthropological Analysis***

Ronaldo Bitencourt de Oliveira, Kleyton Gualter de Oliveira Silva, Guilherme Ernesto de Andrade Neto, Cleiton Lin Oliveira da Silva, Enos André de Farias, Reginaldo Bitencourt de Oliveira, José Inaldo Valões

 DOI: [10.22161/ijaers.88.42](https://doi.org/10.22161/ijaers.88.42)

***Study of the neutralization of cell multiplication, in vitro, with Botulinum Neurotoxin Type A***

Adriana Novaes Rodrigues, Andressa Duarte

 DOI: [10.22161/ijaers.88.43](https://doi.org/10.22161/ijaers.88.43)

***Productive backyards, solidarity economy and sustainable development in the community of Novas Vidas, Ceará, Brazil***

Alexandre Oliveira Lima, Francisco Antonio de Sousa Rodrigues, Meiriane da Silva Pinheiro, Antônio Roberto Xavier, Marcelo de Oliveira Sindeaux, José Cleilson de Paiva dos Santos, Maria do Rosário de Fátima Portela Cysne, José Rogério Santana

 DOI: [10.22161/ijaers.88.44](https://doi.org/10.22161/ijaers.88.44)

***Design & Development of a Computer Controlled Tensile Strength Testing Machine for Testing of Strings & Fabrics***

Ravi Babu Sharma, Jitendra Kumar Rai

 DOI: [10.22161/ijaers.88.45](https://doi.org/10.22161/ijaers.88.45)

***Sustainable Cultural Afro Brazilian Practices in the Melancias Quilombola Community in Ocara-Ceará- Brazil***

Carlos Mendes Tavares, Meiriane da Silva Pinheiro, Antônio Roberto Xavier, Andrea Yumi Sugishita Kanikadan, José Gerardo Vasconcelos










 DOI: [10.22161/ijaers.88.46](https://doi.org/10.22161/ijaers.88.46)

***Youth Speeches Mediated on the Web Radio About Digital Games and Mental Health***

Karlla da Conceição Bezerra Brito Veras, Raimundo Augusto Martins Torres, Edine Dias Pimentel Gomes, Breno da Silva Albano, Josenice Vasconcelos Martins

 DOI: [10.22161/ijaers.88.47](https://doi.org/10.22161/ijaers.88.47)



	<i>Page No: 418-424</i>
<b><i>Panorama of the use of Intangible Assets and Innovation in Brazilian Fashion Companies</i></b> Caio Martins Nazareth Machado  DOI: <a href="https://doi.org/10.22161/ijaers.88.48">10.22161/ijaers.88.48</a>	<i>Page No: 425-432</i>
<b><i>Cultivar x environment interaction on green ear yield in corn inoculated with Azospirillum brasilense, at low latitude</i></b> Vanderlan Carneiro Dias, Joênes Mucci Peluzio, Maria Dilma de Lima, Guilherme Benko, Alessandra Maria de Lima Naoe, Evandro Reina, Weder Ferreira dos Santos, Layanni Ferreira Sodrê Santos, Flávio Sérgio Affêrri, Wânia Maria Dias Carneiro  DOI: <a href="https://doi.org/10.22161/ijaers.88.49">10.22161/ijaers.88.49</a>	<i>Page No: 433-440</i>
<b><i>Productivity Analysis in Recyclable Materials Sorting Operation - A Case Study at Recifavela Cooperative</i></b> Luís Henrique Rodrigues, Ricardo Reolon Jorge, Kevin Laita Kumamoto  DOI: <a href="https://doi.org/10.22161/ijaers.88.50">10.22161/ijaers.88.50</a>	<i>Page No: 441-453</i>
<b><i>Health Literacy and Relation to Adherence to Pharmacologic Treatment of Patients in Hemodialysis</i></b> Dayani Barbosa dos Santos, Carina Rossoni, Fabiana Meneghetti Dallacosta  DOI: <a href="https://doi.org/10.22161/ijaers.88.51">10.22161/ijaers.88.51</a>	<i>Page No: 454-459</i>
<b><i>Gait based Age Estimation using LeNet-50 inspired Gait-Net</i></b> Tawqeer ul Islam, Lalit Kumar Awasthi, Urvashi Garg  DOI: <a href="https://doi.org/10.22161/ijaers.88.52">10.22161/ijaers.88.52</a>	<i>Page No: 460-469</i>
<b><i>Performance of Rural Credit in the Municipalities of Rondônia, Brazilian Amazon</i></b> Carlos Alberto Paraguassú-Chaves, Fabio Robson Casara Cavalcante, Raimunda Lirineide de Brito, Carla Dolezel Trindade, Simão Aznar Filho, Ana Maria Moraes da Fonseca Cavancante, Fabrício Moraes de Almeida, Simão Dolezel Aznar, Levi Pereira Granja de Souza, Ricardo Guanabar, Carlos Eugenio Pereira  DOI: <a href="https://doi.org/10.22161/ijaers.88.53">10.22161/ijaers.88.53</a>	<i>Page No: 470-483</i>
<b><i>Active Learning with Experiment Whole Numbers in Fifth Grade of Elementary School</i></b> Taruly Tampubolon, Robet Harianja, Holmes Rajagukguk  DOI: <a href="https://doi.org/10.22161/ijaers.88.54">10.22161/ijaers.88.54</a>	<i>Page No: 484-490</i>
<b><i>Applied Study on Visual Identity Configuration Allied to Intellectual Property Protection in Pernambuco: guidelines for designers</i></b> Camila Brito de Vasconcelos, Danielle Silva Simões-Borgiani, Pedro Henrique Sobral de Souza Azevedo Mayrinck, Cintia Raquel Ferreira de Amorim  DOI: <a href="https://doi.org/10.22161/ijaers.88.55">10.22161/ijaers.88.55</a>	<i>Page No: 491-496</i>
<b><i>Apical microleakage evaluation of a new proposal for endodontic sealer associated with hydroxyapatite: an ex vivo study</i></b> Carlos Eduardo Fontana, Beatriz Anjos do Santos, Mariana Xavier Pilla, Letícia Fernandes Sobreira Parreira, Sérgio Luiz Pinheiro  DOI: <a href="https://doi.org/10.22161/ijaers.88.56">10.22161/ijaers.88.56</a>	<i>Page No: 497-503</i>
<b><i>Pharmacological and toxicological aspects of barbatimão (Abarema cochliacarpus (GOMES) Barneby &amp; J.W. Grimes)</i></b> Lilia Silva Santos, Carolina Santos Andrade, Carlas Thays Lima da Silva, Romário Alves Santana, Julita Maria Pereira Borges	

***Social and Institutional Presence of the Presidents of the Americas on social media: An analysis of the Communication on Twitter about COVID-19***

Lucas Dejard, Adriano Madureira dos Santos, Harold Dias de Mello Junior, Rita de Cássia Romeiro Paulino, Karla Figueiredo, Fernando Augusto Ribeiro Costa, Douglas Almeida Vidal, Yomara Pinheiro Pires, Marcos César da Rocha Seruffo

***On a Model of Generalized Pell Numbers***

I. M. Craveiro, E. V. Pereira Spreafico, M. Rachidi

# Solid Index versus Impression for transferring the Position of implants in Mandibular total Edentulous Arches: A Clinical study on trueness

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**Keywords**— *splinting, direct technique, edentulous, dental abutments.*

**Abstract**— *To evaluate the trueness of two techniques for transferring the position of implants, with respect to the angles and distances between them, in completely edentulous arches rehabilitated with 3 and 4 implants. All patients were subjected to 2 impressions techniques: solid index (SI) and conventional impression using the open tray (MC) technique. The cast models were digitized by a laboratory scanner, and the generated STL files were imported into engineering software to measure the axes of the coordinates of the implants and the distances between the implants. The Wilcoxon test was used to identify the differences between the SI and MC groups ( $p < 0.05$ ). The Spearman correlation coefficient was applied to identify the correlation between the coordinate axes and the distances between the implants ( $p < 0.05$ ). When comparing the SI and MC groups, a significant difference was observed in the x-axis of implant #1, for the arches with 3 and 4 implants ( $p < 0.05$ ). As for the distances, a significant difference was observed between implants 1-2 in the arches with 4 implants ( $p < 0.05$ ). No correlation was identified between the two dependent variables. The SI, as well as the MC, must be developed to obtain a passive adjustment framework.*

## I. INTRODUCTION

The passive adjustment of implant-supported fixed total prostheses is a determining factor for their long-term success.<sup>1-4</sup> Biological and mechanical complications, such as progressive marginal bone loss (peri-implantitis), increase or accumulation of biofilm (mucositis), loosening of the abutment screw, fatigue fractures in the prosthetic components<sup>5,6</sup> or the implant, and loss of osseointegration,

may contribute to the inadequate adjustment of the metallic infrastructure with the abutments or implant, to varying extents.<sup>2,4</sup>

The impression techniques and materials,<sup>4,7</sup> impression copings, presence or absence of splinting, as well as the splint material and the number and angulations of the implants<sup>4,8</sup> are factors that affect the transfer precision of the position of the implants to the mold and later to the

plaster model.<sup>4,9</sup> This model, which is used for waxing the metal framework, may still be influenced by the operator's experience, plaster handling, and mold casting technique.<sup>10</sup>

In this context, several impressions techniques have been used for the construction of working models to provide a more precise clinical adjustment of the metal framework. The methods of immobilization of the copings, either by splinting with dental floss followed by acrylic resin,<sup>3,9,10-12</sup> addition silicone,<sup>3</sup> interocclusal registration materials,<sup>3,12</sup> type II plaster,<sup>12</sup> or methods involving rigid materials such as titanium bars<sup>9</sup> and solder index previously projected in 3D on a digitized reference model,<sup>13</sup> produce molds that are more accurate than those obtained by techniques without splinting. Methods for capturing the position of the implants with the solid index proved to be superior to conventional (impression) and digital methods.<sup>13-15</sup>

Numerous in vitro studies have evaluated the influence of impression techniques on the transfer precision of multiple implants,<sup>3,9,10-12</sup> as well as the accuracy and/or precision of digital versus conventional impressions from the axes of the three-dimensional plane.<sup>16-18</sup> However, to our knowledge, studies comparing the clinical data between the two techniques for obtaining the implant positions, using the same splinting material and abutment levels, to evaluate the axes on a three-dimensional plane, the distance between the implants, while comparing arches with four and three implants, have not been reported in the literature. In this cross-sectional clinical study, we proposed to evaluate the accuracy of two techniques for transferring the position of implants, regarding the angle and distance between the implants in total edentulous arches rehabilitated with four and three implants. The null hypothesis is that there is no difference between the solid index (SI) and the transfer impression of the position of the implants in the total edentulous arches rehabilitated with four and three implants respectively.

## II. MATERIALS AND METHODS

This cross-sectional study was carried out at the Dentistry Department of the Federal University of Rio Grande do Norte (UFRN) and was approved by the institution's Ethics and Research Committee (CEP-UFRN) under protocol number 3.673.666. It included 10 and 7 patients with four and three implants, respectively, and cases of implant loss were excluded from the study.

The sample size was obtained from a previous study on the precision of different techniques for transferring implant positions. The results of the study by Paspaspyridakos et al. (2011)<sup>18</sup> for the total 3D displacements of the axes (x, y, and z) obtained an average

of 44  $\mu\text{m}$  and a standard deviation of 17  $\mu\text{m}$  for the technique with splinting and an average of 89  $\mu\text{m}$  and standard deviation of 60  $\mu\text{m}$  for the technique without splinting. A two-tailed hypothesis test with a significance level of 5% and power of 80% resulted in a sample size of 32 implants. Considering the loss of follow-up, the sample size was increased by 20%, resulting in 52 implants. Thus, in total, 61 implants were evaluated for the two dependent variables in this study.

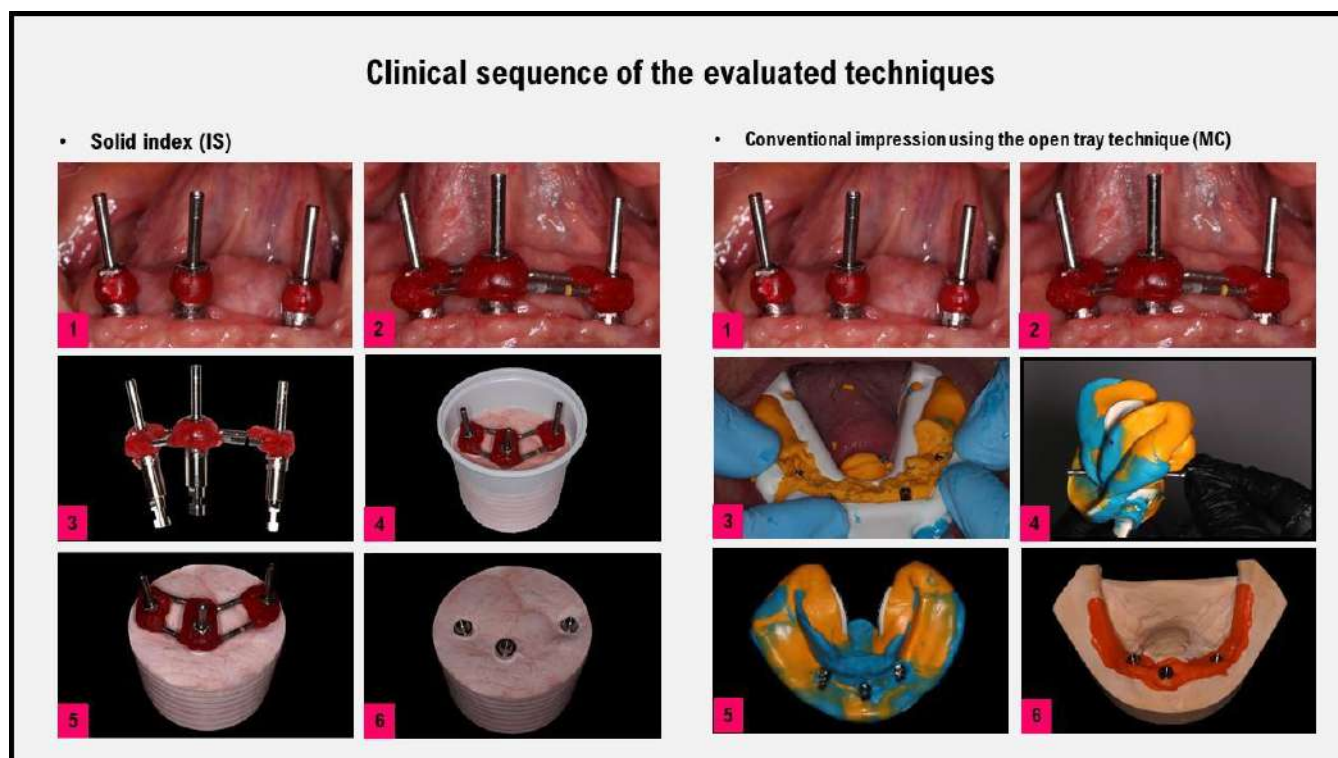
After clinical and radiographic evaluation of the implants, all patients underwent two techniques of obtaining the implant positions: SI (solid index) and conventional impression using the open tray (MC) technique, which was performed by a single operator (Fig. 1).

To make the models corresponding to the two techniques, prior to insertion in the mouth, the copings (Neodent; Straumann) were wrapped with self-curing acrylic resin (GC Pattern resin, GC Corporation, Tokyo, Japan)<sup>19</sup> After polymerization of the resin, the copings were screwed onto the abutments with a torque of 10 Ncm (manufacturer's instruction). Then, the copings were splinted with metallic fragments (tips/drills for dental use) and acrylic resin was used to fix them in place.

At this time, after the resin's polymerization reaction, the copings were unscrewed to obtain the SI models, and then removed from the oral cavity to fix the analogs (Neodent, São Paulo-SP, Brazil) in the copings. This resin pattern was immersed in plaster type IV (Dentsply, Vila Gertrudes, São Paulo, Brazil),<sup>13</sup> and after crystallization, the copings were unscrewed from the model.

To obtain the MC plaster models, a plastic tray was used to transfer the impression of the implant positions. An access window was created to release the abutments in the mouth, and then it was loaded with dense addition silicone (Express XT, 3M, São Paulo, Brazil). The copings were wrapped with low-viscosity addition silicone (Express XT, 3M, São Paulo, Brazil) and, in sequence, the tray loaded with the dense impression material was positioned in the mouth. After the initial setting reaction of the material, the copings were unscrewed and the tray/coping set was removed from the oral cavity. The coping analogs were placed in the mold obtained, in which the space corresponding to the rim was hollowed out with artificial gingiva (Zhermack, Moema, São Paulo, Brazil) and the other anatomical structures were recorded with type IV plaster (Dentsply, Vila Gertrudes, São Paulo, Brazil).

All physical models (MC and SI) were scanned with a laboratory scanner (Zirkozahn® S600 ARTI Scan) by the same operator. For this, scan bodies for abutments (Neodent; Straumann) were screwed over the existing analogs in the models and torqued at 10 Ncm



*Fig. 1: Clinical sequence for performing the evaluated techniques. Index solid: (1) Impression copings positioned on abutments, (2) Copings splinted with metallic fragments, (3) Copings unscrewed and removed from the oral cavity to fix the analogs, (4) Resin pattern immersed in plaster type IV, (5) Removal of the plastic matrix, (6) Copings unscrewed from the model. Conventional impression using the open tray technique: (1) Impression copings positioned on abutments, (2) Copings splinted with metallic fragments, (3) Plastic tray loaded with dense addition silicone and the copings wrapped with low-viscosity addition silicone, (4) Tray/coping set was removed the oral cavity and the coping analogs placed in the mold, (5) Mold, (6) Cast model.*

(manufacturer's instructions). Standard Tessellation Language (STL) files were stored in the scanner software used for the analysis.

Codes regarding the implant positions were standardized for the two dependent variables in this study: For cases rehabilitated with four implants, the following were considered: (1) posterior right, (2) anterior right, (3) anterior left, and (4) posterior left, and for cases with three implants, (1) posterior right, (2) median, and (3) left posterior. Thereafter, six distances (1-2, 2-3, 3-4, 1-4, 1-3, and 2-4) were measured for cases of four implants and three distances for cases with three implants (1-2, 2-3, and 1-3). In both cases, the three axes of the coordinates (x, y, and z) of the implants were evaluated accordingly.

Thereafter, the STL files of the digitized physical models were imported into the GOM Inspect software (GOM GmbH, Germany). Initially, these were overlapped using a three-point alignment, followed by a better fit.<sup>16</sup> In view of the absence of a digital table in the software, the SI model was used to standardize the insertion axis of the models to be evaluated. Therefore, the MC models (real

elements) were superimposed on the SI (nominal elements), and for this, the scan body inputs corresponding to positions 1 and 4 in the cases with four implants and one and three for the cases with three implants were determined as the most suitable planes for the alignment of the files.

Subsequently, cylinders were designed for each scan body and a coordinate system was defined to extract the values corresponding to the x, y, and z axes of each implant, and the end of the upper centroid of each scan body was used to trace the measurement lines between the implants at pre-established distances.

The measurements were performed three times by the same operator (H.V.M.S.), and then checked by a second independent appraiser (A.L.C.P.), at an interval of 3 days, and an average of the measurements was included for data analysis. The data were analyzed using statistical software (IBM SPSS Statistics, v22.0; IBM Corp). The descriptive analysis was based on data presented as median ( $\bar{x}$ ) and quartiles 25 ( $Q^{25}$ ) and 75 ( $Q^{75}$ ). The Wilcoxon non-parametric test was used to verify the statistical difference between the SI and MC groups, as well as between the



rehabilitated arches with four and three implants, assuming a significance of  $p < 0.05$ . The Spearman correlation coefficient was applied to identify the correlation between the coordinate axes and the distances between the implants for cases with four and three implants ( $p < 0.05$ ).

### III. RESULTS

To assess the reliability of the data, the interclass correlation coefficient was applied for each axis (x, y, and z) and distances between the implants were calculated accordingly (Chart 1).

Charts 1: Interclass Correlation Coefficient.

	SI	MC
Distances	1,000	1,000
Axis x	0,999	0,999
Axis y	0,995	0,994
Axis z	0,655	0,997

A total of 40 and 21 implants for the rehabilitated arches with four and three implants, respectively, were evaluated for the coordinate axes (x, y and z), totaling 61 for both the groups.

When analyzing the values corresponding to the x-axis of the arches with four implants (Table 1), a statistically significant difference for implant #1 was observed (right posterior implant), when comparing the SI group with MC ( $p < 0.05$ ). However, in the y and z axes, no statistically significant differences were observed for any of the implant positions in the arch ( $p < 0.05$ ). For the arches rehabilitated with three implants (Table 2), no statistically significant differences were identified for the y and z axes of the two groups, whereas for the x-axis, differences were observed for implant #1 and in the total median value ( $p < 0.05$ ).

Sixty and 21 distances between the implants were evaluated, respectively. For the rehabilitated arches with four and three implants, 60 and 21 distances between the implants were evaluated, totaling 81 distances for the two groups. When observing the distances measured for the cases with four implants (Table 3), the value of the total median of the MC group was greater than that of the SI, with a statistically significant difference ( $p < 0.05$ ). For the arches rehabilitated with three implants (Table 4), there was no statistically significant difference for each distance and the total value per group ( $p < 0.05$ ).

No correlations were observed (Supplementary Material) in either case (four and three implants) between the axes and distances for the implants in the SI and MC groups.

### IV. DISCUSSION

Based on the results, our null hypothesis was rejected. This cross-sectional clinical study analyzed the accuracy of two techniques for transferring the implant positions, regarding the angle and distance between them in total edentulous arches rehabilitated with four and three implants. The impression for transferring the implant positions using the open tray technique (group MC) did not accurately capture the x-axis of implant #1, for cases with four and three implants, when compared to the SI group, as well as the distances between the implants for cases with four implants. No correlations were observed between the two groups for the distances and axes in cases with four and three implants.

The clinical and laboratory phases, necessary for the making of the plaster model, which are used for the closure, casting, and pressing of the implant-supported fixed total prosthesis, can affect the accuracy of transferring the orientation of the implants to the plaster due to movement of the implants and impression copings. The splinting of these is seen as a solution to minimize such movements, with a view to stabilizing them under the tightening torque to the analog of the copings that will be positioned in the mold, thus reducing the rotational freedom of the copings within the impression material.<sup>9</sup> In addition, the sequence of unscrewing the copings to remove the impression tray from the oral cavity can also cause minimal movements and influence the accuracy of the plaster model.<sup>20</sup>

Although splinting techniques have shown excellent results over the years, contrary opinions have been reported in the literature. Some problems can affect the splinting techniques, such as the fracture of the splinting material with copings,<sup>21</sup> because of the polymerization contraction of the acrylic resin, which is the most commonly used material. The solution would be to section the splint and then reconnect it with a small amount of the same material, after a specific time interval, as evidenced by a previous study,<sup>22</sup> which showed that 80% of the polymerization shrinkage occurred in the first 17 minutes.

The standardization of the two techniques of impression from splintering with metallic fragments made excellent results possible, once the evaluated groups presented minimal differences. Previous studies have evaluated the use of metal bars to immobilize copings. Shankar & Doddamani (2020),<sup>9</sup> showed that the immobilization methods using the direct technique with metallic splinting, followed by welding in the mouth, produced the most accurate molds, in comparison to the direct technique of splinting with dental floss and acrylic resin and direct technique without splinting.



Table 1: Median values ( $Q^{25}/Q^{75}$ ) of the axes of the coordinates of the implants for cases with four implants.

IMP	n	x			y			z		
		SI	MC	p	SI	MC	p	SI	MC	p
1	10	5,81100	4,73800	<b>0,006*</b>	7,93600	7,11300	0,653	80,09800	79,35400	0,246
		2,75800/11,80350	3,31050/10,29250		4,77400/10,55000	4,52950/11,20500		75,47750/83,15600	72,85100/82,82850	
2	10	3,07500	3,66600	0,868	6,32800	6,69000	0,906	79,74900	80,00700	0,795
		1,87750/6,99800	1,84400/6,75350		4,64750/10,56200	3,15500/10,74800		77,48200/83,93850	76,90500/85,30400	
3	10	3,61500	3,64300	0,210	6,31500	5,38500	0,981	80,57000	81,62200	0,943
		1,43500/6,99200	2,03750/7,85300		3,05200/10,35050	3,48400/10,00300		76,70550/83,97300	76,40800/85,41700	
4	10	4,12800	4,63100	0,646	5,14350	4,10900	0,333	81,95000	82,79900	0,508
		3,00875/9,74825	1,86525/10,02725		2,96450/9,36075	1,76050/7,62925		73,11700/84,10250	73,47250/85,30500	
All	40	3,86400	4,53300	0,051	6,32800	6,69000	0,906	80,56800	80,24200	0,638
		2,32050/8,05700	2,16100/8,30400		4,02550/9,70350	3,41650/10,59450		76,65900/83,50250	75,80750/85,03200	

Q<sup>25</sup>: Quartile 25; Q<sup>75</sup>: Quartile 75; IMP: implant; 1: right posterior implant; 2: right anterior implant; 3: left anterior implant; 4: left posterior implant; SI: solid index; MC: conventional impression using the open tray technique.

Table 2: Median values ( $Q^{25}/Q^{75}$ ) of the axes of the coordinates of the implants for cases with three implants.

IMP	n	x			y			z		
		SI	MC	p	SI	MC	p	SI	MC	p
1	7	6,410	8,190	<b>0,028*</b>	7,936	6,855	0,612	81,349	79,354	0,091
		3,341-15,082	5,482-17,494		4,707-14,169	3,311-11,231		69,061-85,184	66,564-83,288	
2	7	4,773	6,424	0,499	4,773	6,690	0,866	79,749	80,007	0,091
		3,075-10,003	3,666-11,579		3,075-10,033	3,321-8,130		77,619-83,804	76,571-82,014	
3	7	3,303	3,643	0,176	5,935	3,966	0,866	80,570	85,025	1,000
		1,027-7,882	2,620-8,085		2,824-6,340	3,456-7,486		73,741-86,719	75,727-85,355	
All	21	4,738	6,424	<b>0,006*</b>	5,935	6,690	0,741	80,570	80,242	0,092
		2,922-9,463	3,216-10,368		4,395-7,373	3,416-9,550		74,936-84,431	76,023-85,123	

Q<sup>25</sup>: Quartile 25; Q<sup>75</sup>: Quartile 75; IMP: implant; 1: right posterior implant; 2: median implant; 3: left posterior implant; SI: solid index; MC: conventional impression using the open tray technique.

Table 3: Distances between implants for cases with four implants (Median -  $Q^{25}/Q^{75}$ ).

Distances	n	SI	MC	p
1-2	10	13,52500	13,43100	<b>0,022*</b>
		92,6850/16,19500	9,44300/16,67100	
2-3	10	15,93800	16,13900	0,653
		14,13000/18,93550	12,7400/18,83950	
3-4	10	10,97000	11,16500	0,136
		9,6965/29,36550	9,52300/29,30950	
1-4	10	31,52700	31,68150	0,386
		30,44100/32,78675	30339,25/32743,50	
1-3	10	24,79850	24,84900	0,241
		22,67625/26,97425	22,91575/26,17350	
2-4	10	23,93600	23,95250	0,445
		21,41950/27,42500	21,61425/27,04450	
All	60	19,04300	18,95900	<b>0,003*</b>
		12,88750/27,52800	13,10850/27,39950	

Q<sup>25</sup>: Quartile 25; Q<sup>75</sup>: Quartile 75; 1: right posterior implant; 2: right anterior implant; 3: left anterior implant; 4: left posterior implant; SI: solid index; MC: conventional impression using the open tray technique.

Table 4: Distances between implants for cases with three implants (Median -  $Q^{25}/Q^{75}$ ).

Distances	n	SI	MC	p
1-2	7	17,128	17,106	0,058
		15,903 - 28,419	16,462 - 28,435	
2-3	7	16,521	16,779	0,091
		15,753-16,817	16,361-17,102	
1-3	7	16,654	16,630	0,866
		15,038-19,043	15,130-18,959	
All	21	29,874	29,841	0,176
		27,982-30,298	29,093-30,296	

Q<sup>25</sup>: Quartile 25; Q<sup>75</sup>: Quartile 75; 1: right posterior implant; 2: median implant; 3: left posterior implant; SI: solid index; MC: conventional impression using the open tray technique.

Del Acqua et al. (2010)<sup>23</sup> showed that the working model made from the splinting of copings with metal bars can be the most accurate, in view of the stiffness of the metal in withstanding the distortion forces. Although the authors carried out splinting with metal bars without the use of acrylic resin, as was done in the present study, the fragments were joined to the copings with a small amount of resin at the ends, just enough to keep them stabilized, freeing them from possible failures that may be associated with the section and joining method, as well as the polymerization reaction of the resin.

When evaluating the coordinate axes (x, y, and z), a statistically significant difference for the x-axis of implant #1 in the rehabilitated arches with four and three implants was observed. This difference in the x-axis was reported in previous studies that evaluated impressions performed with and without splinting.<sup>18,24,25</sup> Papaspyridakos et al. (2011),<sup>18</sup> also showed that when evaluating the effect of implant position, it was observed that the x-axis of the posterior implants in the mandible, when the impression was obtained by splinting, presented the greatest deviation, followed by the z and y axes. In view of these previous findings, which are in agreement with the results of this study, another study also pointed out that changes in the x-axis, which corresponds to the horizontal plane, would indicate the construction of smaller metallic infrastructures, that is, with a probable vertical marginal mismatch, or posterior inclination of the implants towards the palate or floor.<sup>26</sup> Therefore, the use of the SI model is even more appropriate than the MC model for the manufacture of metallic infrastructures.

The transfer technique from direct impression did not accurately capture the distances between the implants for the arches with four implants, when compared to the solid index. For the arches with three implants, the impression technique did not influence the results. Studies that evaluated the distances between implants, comparing splinting techniques or conventional impression methods, were unknown by the authors of this study. Rech-Ortega et al. (2019),<sup>27</sup> compared a conventional technique (elastomeric impression material) and a digital one, based on a master model with six implant analogs. The authors concluded that in clinical situations with more than three implants, the conventional method was more accurate than the digital method, while for cases with four implants, the digital method was the most suitable. Therefore, we justify our results for the cases with three and four implants in terms of the distances between the implants. The statistically significant differences found in the distance between the right posterior implant and the right anterior implant (#1-2) for cases with four implants reflects the changes found in the right posterior implant (#1) on the x-axis for the MC group.

The distribution of the implants preserving the maintenance area of the polygon supporting the future prosthesis,<sup>28</sup> contributed to the absence of correlation between the coordinate axes and the distances between the implants, for the arches rehabilitated with four and three implants. Although we are not aware of studies that correlate the number of implants with axes and distances (the opposite also applies), we emphasize that through a negative correlation, that is, as the axes increase, the distance decreases; if the plaster model that presented if this result was used to design a metallic infrastructure, it would probably present a visible vertical and/or horizontal marginal mismatch.

In view of the results, the present study showed that when comparing two techniques for transferring the position of the implants, the plaster model obtained by conventional impression using the open tray technique should be used to obtain information about the soft tissues. However, a solid index must also be developed to obtain information regarding the passive metal framework. Additionally, we compared two numbers of implants, four and three, showing that a reduction in the number of implants made the rehabilitation process more accessible to the population, owing to the reduction in the final cost of treatment.

The limitations of this study included the absence of other splinting materials, impression techniques, and types of implants. Future research should be conducted to include greater numbers of dependent variables and provide clinical responses to simplify the dental treatment.

## V. CONCLUSION

The fabrication of the plaster model through MC using the open tray technique, compared to that of the SI, presented difficulties in capturing the x-axis for cases with four and three implants, but did not exhibit significant differences for the y and z axes. The number of implants influenced the record of the distances, showing that there was no difference between the MC and SI groups for the arches with three implants; however, it did not influence the correlation of the axes with the distances. Therefore, considering the conventional workflow, in addition to the MC plaster model, which provided soft tissue details that are necessary for the laboratory-based steps in the design of the metal framework and veneering the prosthesis, a solid index must be recorded to obtain sufficient details for designing the passive metal framework.

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## **Cardiopulmonary resuscitation in patients diagnosed with or suspected of COVID-19: A narrative review of the literature**

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**Keywords—** Heart arrest. Reanimação cardiopulmonar. Assistência individualizada de saúde. Coronavírus. Equipamentos de proteção. Pandemias.

**Abstract—** Objective: to map the production of knowledge and make considerations about the main updates and recommendations for the management of patients in cardiac arrest, diagnosed or suspected of having COVID-19. Method: narrative literature review. The source of information consisted of relevant publications in the literature carried out in June 2021, based on the narrative synthesis of evidence on the updates contained in the main guidelines and official recommendations published by bodies linked to the Brazilian and international health area: World Organization of Health, International Alliance of Resuscitation Committees, American Heart Association Guidelines (AHA 2020), European Council on Resuscitation, American College of Surgeons Committee on Trauma, National Association of Emergency Medical Technicians, Brazilian Association of Emergency Medicine, the Brazilian Society of Cardiology, Brazilian Association of Intensive Medicine, Brazilian Society of Anesthesiology and official associations and societies representing specialties affiliated with the Brazilian Medical Association, which recommend following practices specifically designed to care for patients diagnosed or suspected of having COVID-19. Results: there is a consensus that it is essential to completely dress the team with Personal Protective Equipment for respiratory isolation of aerosols during the service of cardiopulmonary arrest in this context, even if this delays the cardiopulmonary resuscitation maneuvers. Conclusion: health professionals from the multidisciplinary team involved in CPA care in the context of caring for patients suspected of or with a confirmed diagnosis of COVID-19 are exposed to numerous risks, and a range of challenges, and must follow the established protocol with scientific rigor. In health services, to maximize the effectiveness of CPR maneuvers, without losing sight of the objective of these actions, which is to increase survival, without giving up on preserving the health and integrity of the team and minimizing the risk of contagion by the virus and its spread.

## I. INTRODUCTION



Processes involving decision making to support cardiopulmonary resuscitation (CPR) guidelines need to be individualized in Emergency Departments and Intensive Care Units (ICU), and CPR should always be performed, unless consensus indicates otherwise<sup>1</sup>.

The care of patients who are victims of cardiopulmonary arrest (CPA) in the context of a COVID-19 pandemic has peculiarities that should be highlighted. The following recommendations presented here in narrative form are in line with the recommendations of the Brazilian Association of Emergency Medicine (ABRAMEDE), Brazilian Society of Cardiology (SBC), Brazilian Association of Intensive Medicine (AMIB) and Brazilian Society of Anesthesiology (SBA), associations and official representative societies of specialties affiliated with the Associação Médica Brasileira (AMB), which corroborate in guiding the various assistant teams, in a context of little solid evidence on the subject, maximizing the protection of teams and patients during a CPA<sup>2</sup>.

Coronaviruses represent a family of Ribonucleic Acid (RNA)-type viruses, responsible for infections of the respiratory and intestinal tract in humans. A large part of these viruses have low pathogenicity and high transmissibility, leading to signs and symptoms similar to those of flu, which can be more severe in risk groups, such as children, the elderly and people with chronic diseases, named comorbidities. At the end of 2019, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-Cov-2) was discovered, as this new virus was named by the World Health Organization (WHO), having its origin in the city of Wuhan, China<sup>3,4,5</sup>. Coronavirus Disease 2019 or COVID-19 is a disease with a high rate of transmissibility, which resulted in an epidemic of Severe Acute Respiratory Syndrome (SARS) caused by SARS-Cov-2. Among the most evident and known clinical manifestations so far, it is worth highlighting: high fever, cough, odynophagia and dyspnea. However, patients with pre-existing comorbidities have strong evidence of having the most severe form of the disease<sup>4</sup>.

Coronaviruses are viruses with an RNA structure that cause respiratory infections in a variety of animals, including birds and mammals. Among them, seven coronaviruses are known to cause disease in humans. It is described that in the last 20 years, two of them were responsible for the most violent and impactful SARS epidemics. The SARS epidemic, which emerged in Hong Kong (China) in 2003, with a fatality rate of approximately 10%, and the Middle East Respiratory Syndrome (MERS), which originated in Saudi Arabia in 2012, with a fatality rate of about 30%. Both are part of the list of priority diseases for research and development in the context of emergency<sup>6</sup>.

COVID-19 is a new disease, still little known, and its pathophysiology is not fully understood. What is amply evident is that infected patients may clinically exhibit symptoms very similar to those of SARS-CoV and MERS-CoV infection, with a high probability of developing Acute Respiratory Distress Syndrome (ARDS), which can lead to hospitalization in services urgent and emergency care and in intensive care units (ICU), and can progress to respiratory failure, and therefore, if not managed effectively and early, can progress to cardiorespiratory arrests (CPAs)<sup>4</sup>.

Considering this scenario, in which scientific evidence is broad, varied and not very solid, and is poorly documented or accessible, the Brazilian Association of Emergency Medicine (ABRAMEDE), the Brazilian Society of Cardiology (SBC), the Brazilian Association of Intensive Care Medicine (AMIB) and the Brazilian Society of Anesthesiology (SBA), associations and official representative societies of specialties affiliated with the Brazilian Medical Association (AMB), presented their recommendations, based on evidence available in the literature and reviewed by peers, aiming to optimize the actions to be followed by assistant teams in practices specifically designed to care for patients diagnosed or suspected of COVID-19. In all other cases, it is recommended to maintain the 2015 ILCOR (International Alliance of Resuscitation Committees) guidelines, AHA 2020 (American Heart Association) Guidelines and the Brazilian Society of Cardiology 2019 Cardiopulmonary Resuscitation and Emergency Care Guidelines Update<sup>2</sup>.

Cardiopulmonary resuscitation (CPR) is a procedure considered as the most urgent action among health actions, and it can occur in patients diagnosed with COVID-19 who progress to cardiorespiratory arrest. Therefore, it demands special attention from the team, particularly regarding the increased risk of aerosol formation during external chest compression and ventilation maneuvers, offering a significant risk of contamination for the assistant team<sup>1,7</sup>.

It is described that the appearance of COVID-19 has a global impact, and with it evidence that there are limitations to the full understanding of transmission patterns, risk factors, virus characteristics, pathogenicity, clinical and laboratory repercussions, and its severity, both in the population in general, as well as for health professionals. Health professionals are more vulnerable to transmission, as they provide direct assistance to these patients. Studies show that a significant number of these workers were affected in previous outbreaks of Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), contributing to the spread

of the disease inside and outside the health service environment<sup>4</sup>.

Approximately 12% to 19% of COVID-19 positive patients require hospital admission. Ten to 15% of infected patients are at risk of developing respiratory failure requiring admission to the ICU. Data from the National Health Commission of China showed that in February 2020, in Wuhan, about 15% of patients developed severe pneumonia and 6% required non-invasive or invasive ventilatory support. The AHA and collaborators corroborate that 3% to 6% of these victims progress with a serious condition. Thus, it is essential for health assistants, especially the nursing staff, due to their greater proximity in the care process, to establish surveillance and prevention measures to continuously monitor the early signs of clinical deterioration and preventable deaths from cardiorespiratory arrest<sup>8</sup>.

In the context of severity of this recent infection, cardiorespiratory arrest becomes common<sup>5,9,10,11</sup> due to: hypoxemic respiratory failure secondary to acute respiratory distress syndrome (ARDS), myocardial injury, ventricular arrhythmias, shock, as well as the widening of the QT interval, which in the latter, is one of the possible adverse events caused by the proposed experimental treatment with the combination of the drugs hydroxychloroquine and azithromycin<sup>12</sup>. In view of this new scenario that presents itself, the updating and elaboration of specific protocols and guidelines are necessary for the qualitative confrontation of the disease. Furthermore, with the exponential growth of contamination, it is considered that cases of cardiorespiratory arrest also increase<sup>1,2,8,12,13</sup>.

Transmission occurs through respiratory droplets generated by sputum, coughing, sneezing, speaking and breathing of the infected individual, as well as by Aerosol Generating Health Procedures (PSGA), understanding that not only physicians work in this context, but also other professionals on the team. assistants, we prefer to use the term health procedures as a synonym for medical procedures, which should be highlighted: airway aspiration, orotracheal intubation, bronchoscopy and CPR in all its stages<sup>4</sup>.

Furthermore, the guidelines are not completely clear as to the effective protective measures of these professionals during CPR in patients with COVID-19. In this context, the study is justified by the need to obtain evidence that can support the knowledge to be applied in the care of patients in CPA diagnosed or suspected of COVID-19, and who need CPR maneuvers. In this way, providing greater technical and scientific robustness to the practices of professionals working in these cases, who are at risk of

assistance, contributing to greater professional competence in this situation. Added to this is the importance of studies on COVID-19 in the context of public health, as it is a current issue of a pandemic character that has a scarcity of research carried out in this perspective.

From this perspective, the study aims to map the production of knowledge and make considerations about the main updates and recommendations for the management of patients in cardiopulmonary arrest, diagnosed or suspected of having COVID-19.

## II. METHOD

Narrative literature review. The source of information consisted of relevant publications in the literature carried out in June 2021, from the narrative synthesis of evidence on the main updates for cardiopulmonary resuscitation (CPR) in patients suspected of or with confirmed diagnoses of COVID-19, contained in the main guidelines and official recommendations issued by bodies linked to the Brazilian and international health area, namely: World Health Organization (WHO), International Alliance of Resuscitation Committees (ILCOR), AHA 2020 Guidelines (American Heart Association), European Council of Resuscitation (ERC), American College of Surgeons Committee on Trauma, National Association of Emergency Medical Technicians, Brazilian Association of Emergency Medicine (ABRAMEDE), Brazilian Society of Cardiology (SBC), Brazilian Association of Intensive Care Medicine (AMIB) and the Brazilian Society of Anesthesiology (SBA), associations and official representative societies of and specialties affiliated with Associação Médica Brasileira (AMB), which recommend following practices specifically designed to care for patients diagnosed or suspected of COVID-19.

It is agreed that CPR maneuvers should follow the recommendations and guidelines of specialized agencies and guidelines, and some clear changes related to CPA care in hospital and extra-hospital settings in patients with suspected or confirmed COVID-19 were developed, gathered and published during the pandemic.

The results found especially refer to the existence of extra risks to health professionals, due to possible exposure to bodily fluids, administration of external chest compressions, in addition to several procedures involving the generation of aerosols, such as positive pressure ventilation, airway aspiration and installation of advanced airways<sup>1,5,14</sup>.

The texts found were read, organized and synthesized into two thematic categories, namely: Clinical dimension of care in cardiopulmonary resuscitation in patients

diagnosed with or suspected of COVID-19 and Management and organizational dimension of the multidisciplinary team in the management of diagnosed or suspected patients of COVID-19 in cardiorespiratory arrest requiring CPR and the summary presented below.

### III. RESULTS AND DISCUSSION

#### Clinical dimension of care in cardiopulmonary resuscitation in patients diagnosed with COVID-19 or suspected cases

The European Resuscitation Council (ERC) published its guideline on resuscitation of patients diagnosed with COVID-19 on April 24, 2020, which is also available as an authorized translation in multiple languages on the AHA website.

These guidelines address the peculiar characteristics of healthcare for patients suspected of or diagnosed with COVID-19, but also highlight fundamental self-protection measures for the safety of the patient and the multidisciplinary team. The recommendations are based on a risk assessment carried out by the International Alliance of Resuscitation Committees (ILCOR) based on evidence from the peer-reviewed literature on how high the potential risk of transmitting SARS-CoV-2 to health team, particularly with regard to transmission through aerosols produced during resuscitation measures<sup>14</sup>.

In this context, it is important that all patients suspected or diagnosed with COVID-19, who are at increased risk of acute clinical deterioration or CPA, should be monitored and properly signaled to the Rapid Response Teams (RRT) or teams that potentially can perform early care, avoiding deterioration, cardiorespiratory arrest, sequelae and preventable deaths, following the chain of survival. The use of severity scores and tracking systems and triggering of care codes aimed at these patients allow early detection of evidence of severity and can be a potential tool to optimize the care of eventual CPAs.

The assessment of potential difficulty for laryngoscopy/tracheal intubation must be mandatory when the patient is admitted to the hospital and/or ICUs and must be duly registered in the patient's medical record. Scores such as MACOCHA (Figure 1) or mnemonics such as LEMON (“Look, Evaluate, Mallampati, Obesity/Obstruction and Neck”) can help to determine difficult airway, previous support activation and request for difficult airway equipment. For the level of understanding, the MACOCHA score ranges from 0 (easy) to 12 (very difficult). MACOCHA score > 3 indicates difficult airway<sup>2</sup>.

MACOCHA Score Calculation Worksheet	Points
<b>- Factors related to patient</b>	
Mallampati Score III or IV	5
Obstructive Sleep Apnoea Syndrome	2
Reduced Mobility of Cervical Spine	1
Limited Mouth Opening <3cm	1
<b>- Factors related to pathology</b>	
Coma	1
Severe Hypoxaemia (<80%)	1
<b>- Factor related to operator</b>	
Non Anaesthesiologist	1
<b>Total</b>	<b>12</b>

Sources: De Jong et al. 2014a; 2013b  
**M.** Mallampati score III or IV  
**A.** Apnoea Syndrome (obstructive)  
**C.** Cervical spine limitation  
**O.** Opening mouth <3cm  
**C.** Coma  
**H.** Hypoxia  
**A.** Anaesthesiologist Non trained  
 Coded from 0 to 12  
 0 = easy  
 12 = very difficult

Fig.1: MACOCHA score.

Source: Hurtado et al. 2017<sup>15</sup>.

It is recommended that the rules for decision-making involving resuscitation should remain individualized, however, even if CPA outcomes in these patients are not fully known, mortality remains high, worsening when associated with risk factors such as age and comorbidities, particularly when involving cardiovascular diseases. In the meantime, ensuring effective communication between members of the multidisciplinary team regarding the orders of “no cardiopulmonary resuscitation” (NRCP) established in accordance with family members and in the rounds should be a priority, as well as the adequate documentation of this definition. Likewise, it is essential to follow institutional policies related to palliative and terminal care<sup>2,8</sup>.

Recognition of CRP will occur through the absence of: awareness (non-responsiveness), carotid pulse (absence of carotid or femoral pulse) and normal breathing (apnea or gasping/agonic breathing, present in up to 40 to 60% of CPA cases)<sup>8</sup>.

During all CPA care, the reversible causes (5h and 5t) must be identified and treated, before considering the interruptions of the maneuvers. In the most recent and current publications on COVID-19 there is a special consideration for hypoxia, acidosis and coronary thrombosis. In mechanically ventilated patients, the adoption of protective ventilation strategies is recommended, however cases of pneumothorax were observed and should be strongly considered in any ventilated patient with sudden respiratory worsening<sup>8,16</sup>.

The decision-making processes to initiate or not CPR must continue to be individualized in pre-hospital care services, emergency departments and ICU. One must always take into account the benefits to the patient, the safety and exposure of the team and the potential futility of the maneuvers<sup>2,17,18</sup>. CPR must always be carried out, unless previously defined directives indicate otherwise. Decisions/policies for “no cardiopulmonary resuscitation” (NRCP) must be properly documented and communicated to the team<sup>17</sup>, and, similarly to palliative and terminal care, must follow local and institutional policy<sup>1,2,17</sup>.

CPR should be initiated by chest compressions and the pace assessed quickly to determine the appropriate algorithm to be followed. However, in the presence of shocking rhythms (ventricular fibrillation and pulseless ventricular tachycardia) and a readily available defibrillator, defibrillation should occur as early as possible, even before the start of compressions, since the reestablishment of spontaneous circulation may contraindicate new resuscitation measures. It is noteworthy that, in cardiac arrests caused by COVID-19, 80% present electrical activity without pulse or asystole, which reduces the positive response to maneuvers, with survival and hospital discharge from about 15 to 20%<sup>8,17</sup>.

As mentioned, CPR should be initiated by continuous chest compressions in adults. If the patient does not have an invasive/advanced airway installed (orotracheal tube, supraglottic device), the oxygen mask should be kept with low flow or a towel over the patient's mouth and nose, until the invasive airway is obtained; Chest compression movements can trigger the elimination of aerosols and should be initiated carefully. In children, preferentially perform CPR with compressions and ventilations with a Mask Valve Bag (BVM) coupled to the HEPA filter until the definitive airway is obtained (Figure 2 and Figure 3); since pediatric arrest is most often secondary to respiratory/hypoxic causes and compression-only CPR is known to be less effective in this population<sup>1,7,18</sup>.



Fig.2: Bag-valve-mask device with HEPA filter.

Source: Guimarães et al. 2020<sup>7</sup>.



Fig.3: Intubated patient, with bag-valve-mask and HEPA filter and Patient with supraglottic device with HEPA filter, in addition to occlusion of the oral cavity with a mask.

Source: Guimarães et al. 2020<sup>7</sup>.

The guidelines continue to recommend performing high-quality chest compressions, ensuring: Compression frequency from 100 to 120 compressions/minute; in adults, a depth of at least 5 cm (avoiding compressions deeper than 6 cm); in infants, depth of 1/3 of the anteroposterior diameter of the chest; and in children, 1/3 of the anteroposterior diameter of the chest or at least 5 cm; allow the complete return of the chest after each compression, avoiding leaning on the victim's chest; minimize interruptions in compressions, limiting pauses to a maximum of 10 seconds to perform two breaths or



checking pulse when applying the algorithm. Consider achieving the highest possible chest compression fraction, aiming for a minimum of 60% to 80%; take turns with another rescuer every 2 minutes to avoid tiredness and poor quality compressions; if the patient is in horizontal dorsal decubitus, perform compressions in the center of the chest, in the lower half of the sternum; understanding the particularities about the use of personal protective equipment for aerosolization by professionals, the high physical demand of the maneuvers, their potential for exhaustion and the need to minimize the team present in the resuscitation, the use of mechanical CPR devices is suggested for adults, if available<sup>2,18</sup>.

For suspected or confirmed patients with COVID-19 who are prone (pronated) without an advanced airway, return to supine for CPR is recommended. For those in the prone position with advanced airways, placement in the supine position should be avoided, unless the maneuver is performed without risk of device and circuit avulsion (disconnection), which would generate aerosolization to the environment. Instead, the defibrillator adhesive pads (Figures 4 and 5) should be positioned anteroposteriorly and the CPR should be placed with the hands in a normal position, however, over the region of the T7/10 vertebrae (Figures 6 and 7)<sup>8</sup>.

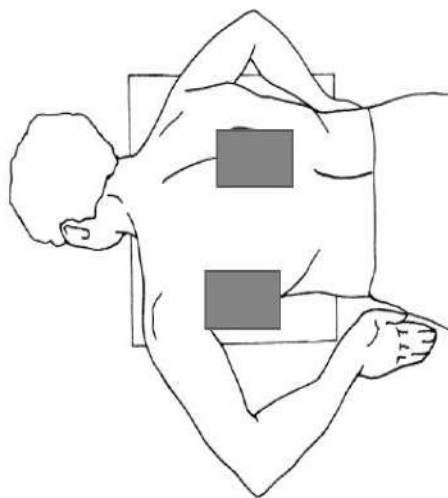


Fig.4: Suggested position of defibrillation paddles in prone patients.

Source: Guimarães et al. 2020<sup>7</sup>.



Fig.5: Suggested paddle position for defibrillation in prone patients.

Source: Timerman et al. 2020<sup>2</sup>.

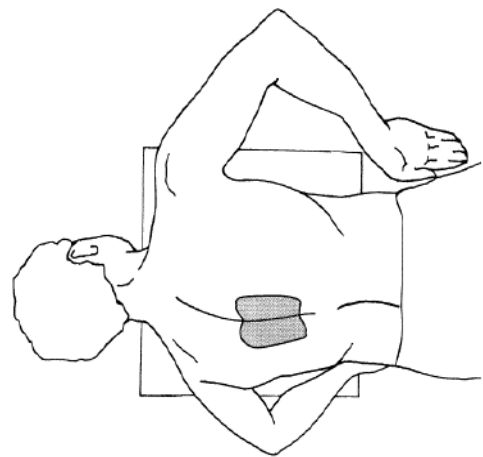


Fig.6: Place of the hands to perform compressions in patients in the prone position.

Source: Timerman et al. 2020<sup>2</sup>.



Fig.7: Place of the hands to perform compressions in patients in the prone position.

Source: Timerman et al. 2020<sup>2</sup>.

If defibrillation equipment is not available, a reasonable alternative is compression-only CPR, keeping the patient with a mask or towel over the mouth. Even with the guidance of some services so that the care of pre-hospital care for CPA, in the absence of a health professional, is performed only with CPR with the hands only ("hands only"), the care described above about sealing the patient's oral cavity for protection from aerosolization remains recommended<sup>1,7,17</sup>.

Studies continue to recommend that monitoring to determine the rhythm/modality of CRP (shocking or non-shocking rhythm) should be carried out as soon as possible, in order not to delay defibrillation when indicated and to establish the appropriate algorithm. Defibrillation at shockable rhythms should not be postponed for airway access or any other procedures. If the patient has an oxygenation face mask before the occurrence of CPA, there is a recommendation to keep it until intubation, but without a high oxygen flow (6-10 liters/minute at most), increasing the risk of generating aerosol. If the patient does not have an airway device, the professional should place a cloth/towel over the victim's mouth and nose and perform continuous external chest compressions<sup>1,2,7,17</sup>.

There is unanimity among specialists that defibrillation of shockable rhythms should not be postponed for airway access or other procedures. After this evaluation and defibrillation of shockable rhythms, intubation should be carried out at the first possible opportunity for a better ventilation/oxygenation pattern, since hypoxia is one of the main causes of CPA in these patients<sup>1,7,8</sup>.

As the orotracheal intubation of critically ill patients diagnosed with Covid-19 related to severe ARDS was associated with episodes of contamination by health professionals, it is recommended that the procedure should be prioritized, in an attempt to promote airway isolation and reduce aerolization and be performed by the most qualified person on the team, aiming to optimize success, preferably in the first attempts. External chest compressions should be discontinued at the time of intubation and the use of a videolaryngoscope should be considered, if available, in an attempt to reduce the exposure of the intubator professional and assistants to aerosol particles generated by the procedure. It is recommended to use waveform capnography as the method of choice to confirm the correct positioning of the endotracheal tube<sup>7,8</sup>.

Manual ventilation with BVM or endotracheal bag-tube should be avoided, due to the high risk of aerosolization and contamination of the assistant team. In situations of extreme need for ventilation with BVM, the

technique for sealing the mask should involve two professionals (Figure 8), using an oropharyngeal cannula<sup>8</sup>.



Fig.8: Manual ventilation with BVM and mask sealing technique involving two professionals.

Source: Machado et al. 2020<sup>8</sup>.

If there is any delay in obtaining an advanced airway (intubation), ventilation with a supraglottic airway or with BVM with a HEPA filter should be considered. It is noteworthy that there is no consistent evidence showing that the use of supraglottic devices generate fewer aerosols than the BVM, there are, however, case reports showing good results and ease of insertion, making it possible to achieve sufficient sealing pressure and that their use can save hands of work, reducing the exposure of the assistant team. It is worth noting that new-generation supraglottic devices provide a conduit for tracheal intubation and that, in this context, mouth-to-mouth and mouth-to-mask ventilation are contraindicated<sup>8</sup>.

When cardiopulmonary arrest occurs in patients already on mechanical ventilation, it is recommended to keep the patient connected to the ventilator, in a closed ventilation circuit, and adjust the parameters as follows: Volume mode, assist-controlled, adjusted to 6 mL/kg the predicted weight of the patient; 100% inspired oxygen fraction; respiratory rate around 10 to 12 breaths/minute and inspiratory time of 1 second; flow trigger: turn off sensitivity; if impossible, change the pressure sensitivity mode and adjust it to the least sensitive way possible (varies according to fan model from 15 to 20 cm H<sub>2</sub>O); positive end-expiratory pressure (PEEP) of zero; adjust alarms for maximum and minimum tidal volume alarms allowed by the equipment; maximum pressure alarms of 60 cm H<sub>2</sub>O and minimum of 1 or 0 cm H<sub>2</sub>O; minute volume alarms must allow the maximum and minimum of each device; the respiratory rate alarm set to the maximum allowed and the apnea time of 60 seconds; the same parameters must be adjusted in children<sup>2,8</sup>.



It is mandatory to continuously assess whether the ventilator is managing to maintain these aforementioned parameters, without self-tripping associated with external chest compression, generating hyperventilation and air trapping with excessive pressures (systematically above 60 cm H<sub>2</sub>O). In children, it may be necessary to disconnect from the ventilator, in this case, a valve bag connected to a HEPA filter must be used; some ventilators available on the market have the “CPR/CPA” function, which automatically adjusts the alarm limits and triggers the parameters aligned above<sup>2,8</sup>.

In mechanical ventilation, it is recommended to install HEPA filters in the ventilatory circuit after the orotracheal tube, and another in the expiratory circuit path (Figure 7); the use of strong straight forceps is important to clamp (Figure 10) the tube when there is a need to change circuits/fans (mask valve bag for the mechanical ventilator circuit, for example), in order to minimize aerosolization; when applying defibrillation, for the safety of the team and the patient, the use of adhesive pads should always be preferred, which do not require the need to disconnect the ventilator to release the shock<sup>2</sup>.

In the case of manual defibrillation paddles, the shock must be released after placing the ventilator in stand-by mode and disconnecting the orotracheal tube from the ventilator always after the HEPA filter, keeping it connected to the tube<sup>1,2,7,8</sup>.

If return of spontaneous circulation is achieved prior to intubation, it is recommended that providers assess the need and potential benefit of intubation with respect to individual care goals. If mechanical ventilation is required, secure the endotracheal tube before disconnecting from the patient. Make sure a closed in-line suction system is connected. At the end of resuscitation attempts, everyone should carefully remove personal protective equipment and hand sanitize. It is recommended that staff watch themselves while removing personal protective equipment to monitor for possible violations of infection control procedures. Equipment must be cleaned, disinfected or disposed of in accordance with hospital protocols; carrying out procedures, communication, personal protective equipment and prevention of transmission COVID-19 are priority actions and focus of care. Any violations of personal protective equipment must be documented, reported and followed up in accordance with local protocols. Keeping a record of the team participating in the resuscitation to facilitate proper monitoring of infection control is necessary and recommended<sup>17</sup>.

Considering recent therapies being tested with chloroquine or hydroxychloroquine and their potential risk to extend the QT interval in up to 17% of cases, it is

essential to consider the risk of severe polymorphic ventricular arrhythmias, with special attention needed for torsades de pointes, and consequent occurrence of cardiorespiratory arrest in shocking rhythms, namely: Ventricular Fibrillation and Pulseless Ventricular Tachycardia. Patients at greatest risk for polymorphic tachycardias in this context are the elderly, females, Covid-19-related myocarditis, heart failure, liver or renal dysfunction, electrolyte disturbances (particularly potassium and magnesium reduction), bradycardia. Thus, it is essential to identify patients who already have arrhythmias, prolonged corrected QT interval (greater than 500ms) with daily ECG monitoring during the use of such drugs<sup>1,2,7,12</sup>.



Fig.9: Positioning the HEPA filter in the expiratory circuit.

Source: Machado et al. 2020<sup>8</sup>.



Fig.10: Endotracheal tube clamped with straight forceps.

Source: Guimarães et al. 2020<sup>7</sup>.

Regarding guidelines in the pre-hospital setting, it is suggested that CPR should not be initiated in suspected or confirmed COVID-19 patients with obvious signs of death; professionals should use standard precaution +

aerosol for the care of suspected or confirmed victims COVID-19; guide the population that, when calling the Emergency Care Service - SAMU 192 (Brazil), they should inform if the victim is suspected of having COVID-19, this will facilitate the prior attire of the care team. It is suggested that the emergency medical service telephone operators and regulators carry out an active search for these patients, inquiring about flu-like symptoms, fever and dyspnea; perform continuous compressions. Mouth-to-mouth ventilation and the use of a pocket mask should not be performed for suspected or confirmed patients COVID-19; considering that most out-of-hospital cardiopulmonary arrests occur at home, in pediatric out-of-hospital CPA, the lay rescuer will most likely be a family member or caregiver of the child, who is already in close contact and exposed to secretions. In this case, the lay rescuer should perform compressions and consider mouth-to-mouth ventilation, if able and willing to do so, since most pediatric arrests occur for respiratory/asphyxial causes<sup>2</sup>.

Compression-only CPR is a reasonable alternative if the rescuer is unable to ventilate or has had no prior close contact with the child; rescuers should place a cloth/towel over the victim's mouth and nose or position a mask with continuous low oxygen flow to prevent aerosol suspension during CPR; do not delay defibrillation: the early use of an Automated External Defibrillator (AED) is still recommended as it significantly increases the person's chances of survival and does not increase the risk of infection; positive pressure ventilation with Bag-Valve-Mask (BVM) should be avoided as much as possible and, if necessary, should be performed by two professionals, one of whom is solely responsible for coupling the mask to the patient's face, as appropriately as possible, preventing air leakage. BVM should only be used with a HEPA filter interposed to the mask<sup>2,17</sup>.

One of the technologies that facilitate CPR are mechanical chest compression devices (DMCT). Although superiority for the patient has not yet been proven in comparison with manual external chest compressions, DMCTs are indicated by the AHA, in situations where high-quality manual compressions can be a challenge or dangerous for the professional, for example: limited availability of rescuers, prolonged resuscitation, resuscitation during a hypothermic cardiopulmonary arrest, cardiopulmonary resuscitation in a moving ambulance, and resuscitation in restricted locations<sup>19</sup>.

Currently, there are two widely used devices approved by the Food and Drug Administration - federal agency of the US Department of Health and Human Services: the AutoPulse (Zoll Medical Corporation, Chelmsford, MA, USA) a charge-distributing band device that rhythmically compresses and constrains the chest wall and the LUCAS

(Physio-Control /Jolife AB, Lund, Sweden) a piston device with a shell that is placed in the center of the chest and pushes the sternum down a distance of 5.2 cm and pull it back to neutral position. As they do not demonstrate better outcomes in the treatment of patients with CPA, manual chest compressions are still the recommended standard treatment. However, the use of these devices can be an alternative for less contact between the team and the patient, making it possible to reduce the number of professionals in the scene and bring the professional face to face with the victim<sup>19</sup>.

In children, perform CPR preferably with compressions and ventilations with BVM coupled to the HEPA filter. Airway management, in the pre-hospital setting, should follow the recommendations mentioned above, in order to ensure that the bag-valve-masks and other ventilation equipment are equipped with HEPA filters, and an advanced airway (orotracheal intubation or device supraglottic) is installed early<sup>1,2,7,8</sup>.

Open the transport vehicle's rear doors and activate the HVAC (Heating, Ventilation, and Air Conditioning) system during aerosol generation procedures (perform this procedure away from pedestrian traffic). Do not allow companions to be taken in the ambulance in the same compartment as the patient. Patients suspected or diagnosed with Covid-19 cannot have a companion at risk of contamination, according to the recommendations of the Ministry of Health (MS). It is suggested that caregivers go to the reference health unit by their own means for more information. If the vehicle does not have an insulated driver's compartment, open the external air vents in the driver's area and turn on the rear exhaust fans to the highest setting<sup>2</sup>.

#### **Management and organizational dimension of the multidisciplinary team in the management of patients diagnosed with or suspected of COVID-19 in CPA, who need CPR**

The main updates and recommendations converge strongly to information about the specifics of CPR maneuvers in this scenario; focusing on the preparation of the environment, human and material resources, recognition of cardiac arrest and initial actions; ventilation strategies and invasive airway access; mechanical ventilator adjustments and CPR maneuvers in pronated patients. In addition to recommendations on ethical aspects involving protocols for starting CPR maneuvers and do-not-resuscitate orders in patients without clinical indication<sup>2</sup>.

Emergency health actions are critical in terms of time and, in the initial approach phase, often carried out in confined spaces, the manipulation of the airways and

measures that favor the formation of aerosols are often carried out. Although inpatients are usually tested for an infection such as Covid-19 in the hospital, the status of the infection is often unknown in the initial approach, whether out-of-hospital or in-hospital. A SARS-CoV-2 infection and Covid-19 disease can only be determined in these cases on the basis of clinical or symptomatic judgment. Therefore, the use of adequate personal protective equipment that protects against the transmission of airborne infection in all patients with signs and symptoms suggestive of Covid-19 is mandatory<sup>14</sup>.

SARS-CoV-2 is transmitted primarily through droplets. This type of transmission occurs when infectious droplets come into contact with the conjunctiva or mucosal surfaces of the upper respiratory tract, either directly transmitted by coughing or sneezing or by contacting a surface where the droplets have deposited. The use of personal protective equipment for isolation from respiratory contact (waterproof apron, N95 mask, face shield, caps, goggles and gloves) reduces the risk of transmission as it provides a physical barrier between the droplets and the entry port, and it is recommended in the consensus on to prevent the transmission of SARS-CoV-2<sup>17,18</sup>.

Aerosol transmission is by smaller air-dissipated particles with a diameter of less than 5  $\mu\text{m}$ , which arise from evaporative droplets in the water layer and which have a long range, can float in the air for a long period of time and probably represent an essential transmission mechanism for SARS-CoV-2<sup>14</sup>.

Airborne transmission of SARS-CoV-2 can occur if aerosols are generated during specific procedures such as intubation and non-invasive ventilation. These aerosol-generating procedures are likely to result in an infectious aerosol beyond what would normally be released by coughing, sneezing, or breathing. These aerosols can remain suspended in the air for a period of time and can be inhaled, leading to healthcare provider infection. In this context, there is a consensus that the use of personal protective equipment is recommended for health professionals who perform aerosol generation procedures in patients with confirmed or suspected Covid-19<sup>17</sup>.

In this context, the defined and recommended precaution (STANDARD + AEROSOL precaution) is indicated for all resuscitation team members, in order to ensure adequate individual protection during CPR. The ready availability of Personal Protective Equipment, such as clothing kits in the emergency car, will promote less delay in the beginning of chest compressions and continuity of care. It is a consensus that the following should be included in the personal protective equipment kit: cap, N95 mask, goggles, face shield, waterproof apron,

long-length disposable gloves and pro-feet. Furthermore, although there may be delays in the beginning of chest compressions, the safety of the team is a priority and the use of adequate personal protective equipment is essential for those who care for an individual in cardiac arrest with confirmed or suspected Covid-19<sup>2,16</sup>.

In particular, CPR should not be initiated on a suspected or confirmed Covid-19 patient until the team is fully clothed. It is recommended to restrict the number of professionals at the point of care (if it is a common single room). Hand hygiene plays an important role in reducing Covid-19 transmission. It is recommended that professionals sanitize their hands properly with soap and water, in case of dirt, or alcohol gel. It is important that all guidelines from the Ministry of Health and local governments are properly respected<sup>1</sup>.

In the managerial and organizational dimension of the multidisciplinary team, it is important to anticipate the request for a bed in the ICU and respiratory isolation in case of return of spontaneous circulation. The recommendations converge to the disposal or cleaning of all equipment used during CPR following the manufacturer's recommendations and the institution's local guidelines. In addition, any work surfaces used to position airway/resuscitation equipment will also need to be cleaned in accordance with local guidelines, specifically, equipment used for interventions involving the airway (for example, laryngoscope, face masks, others) . It is recommended to check that such equipment has not been left on the patient's bed, it is suggested to leave them on a tray; ensure that the suction tube is not also on the patient bed, dispose of the contaminated end inside a disposable glove. Remove personal protective equipment safely to avoid self-contamination<sup>1,16,17</sup>.

If resuscitation is unsuccessful, family members may be allowed to see the body in accordance with local hospital policies and infection control measures. However, restrictions in place due to Covid-19 can significantly disrupt the usual grief processes; for example, not being able to touch or kiss the deceased. If necessary, the support of Social Services and Psychology must be provided to family members in a safe place or via telehealth where Covid-19 prevents the visit. Appropriate personal protective equipment must be worn by staff when preparing the body for the morgue<sup>17</sup>.

It is recommended that at the end of each procedure, a debriefing is performed, which is believed to stimulate improvements and growth of the assistant team. Furthermore, it is strongly recommended that simulations for training the correct placement and removal of personal protective equipment and CPA care should be carried out

as early as possible, and whenever possible by all teams involved in the care of patients suspected of or diagnosed with Covid- 19<sup>1</sup>.

Decisions regarding termination of resuscitation must be made in accordance with currently accepted ethical standards. A cardiac arrest in a patient with Covid-19 infection and respiratory failure should prompt rapid assessment and treatment for potentially reversible causes. If no cause is identified, physicians should consider the futility of resuscitation in advance<sup>8,16,17,18</sup>.

The changes described above require significant adaptation for many doctors, nurses, physiotherapists, nurse technicians and paramedics. All healthcare professionals must have regular personal protective equipment and advanced life support training, be able to access in situ simulation sessions, and receive extensive information after actual resuscitations. This will ensure safe, timely and effective management of the cardiac arrest patient with Covid-19<sup>17</sup>.

Finally, it is noteworthy that nursing professionals are a strategic group to ensure the effectiveness and safety of care in cardiac arrest. This team, in most cases, is the first to identify and initiate care in hospital environments, and they are responsible for providing the essential materials that will support the care. Thus, it is extremely important that the entire nursing team is aligned and informed about the algorithms and care protocols for cardiac arrest in patients with suspected or diagnosed Covid-19<sup>8</sup>.

#### IV. CONCLUSION

In the course of the current pandemic, it is recommended to consider each collapsed patient as a potential spreader of infection by Covid-19.

The risk of infection for health professionals on the assistant team who work to fight the disease is real and many have already died.

It is a consensus that CPR maneuvers are actions that generate aerosols, with the potential to infect healthcare professionals. Efforts to maintain the integrity of personal protective equipment are essential during CPR. In patients with multiple comorbidities and no return of spontaneous circulation, a sensible policy of not starting or not continuing CPR should be adopted.

Proper simulation training and exercises for putting on and taking off personal protective equipment in CPR are strongly recommended. All health services must constantly formulate and re-evaluate their guidelines, with the objective of maximizing results, without losing sight of the health professionals' protection strategies during CPR.

When facing a pandemic for a disease with high infectivity, in which many aspects are not fully understood, extremely serious clinical situations, such as CPA, become an additional challenge for the multidisciplinary team.

It was found that the information available in the literature on the subject is based on expert opinions, observational studies, case reports and experiences or single-center studies, in many cases with small samples, therefore not offering high levels of evidence.

A satisfactory knowledge of infection prevention and control, surveillance and protective measures, strict adherence to the placement and removal of personal protective equipment, and preparation for the care of infected patients are of fundamental importance. It was evident the importance that health professionals involved in the care of patients suspected or diagnosed with Covid-19 must follow with scientific rigor all established protocols for the care of CPA, aiming to minimize the risk of contagion by the virus and dissemination of the disease.

Understanding the current epidemiological factors of Covid-19 gives professionals better preparation to protect themselves during procedures that generate aerosols. Based on this understanding, it is recommended to strengthen cooperation between the care team, researchers and managers, for the development of research and continuous records of their practices, so that they can help in a better understanding of the nature of this disease, in particular in the context of cardiorespiratory arrest.

Finally, although the risks of infection presented by Covid-19 influence several aspects of the management of cardiac arrest, the basic principles of CPR remain the same. Prioritizing rapid defibrillation and addressing reversible causes of cardiac arrest continue to be recommended as critical interventions. Modifications include a greater emphasis on the safety of healthcare professionals and the use of appropriate personal protective equipment. Based on these findings, it is recommended that further studies be carried out, with the aim of carrying out updates, which may be the object of other future research and, consequently, updates to the guidelines.

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# A Review on Plastic Moulding Manufacturing Process and Parameters

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**Keywords— Injection moulding, Parameters, Machining, Quality, Maintenance.**

**Abstract—** Injection Mold Design is the process of designing and developing the tools, methods and techniques needed to improve efficiency and productivity. The basic management conditions are learned from conceptual development to product production. The impact of varied factors studied supported processing parameters. Since quality and productivity are two important conflicting goals in any machining process. Quality has got to be somewhat compromised, ensuring high productivity. Similarly, productivity is reduced, but efforts to enhance quality are channelized. To make sure top quality and productivity, it's necessary to optimize the machining parameters. Various reactions of injection molding process quality supported performance parameters and methods are studied. The purpose of this paper is to illustrate the state of the plastic injection molding process. The working conditions are satisfied by the production of a product based on high quality.

## I. INTRODUCTION

Modern-day injection molding tools are often a complex arrangement of mechanical, electrical, pneumatic, and hydraulic components that are expected to fulfill many demanding tasks. Whatever the complexity, mold design must specify a device that will work satisfactorily in production. Injection molding is the most commonly used manufacturing process for making plastic parts. A wide variety of products can be made using injection molding, which can vary greatly in their size, complexity, and application. The injection molding machine, raw plastic material, and mold are required for the injection molding process. The plastic is dissolved in the injection molding machine and then injected into the mold, where it cools and freezes at the end. This is one of the processes that are greatly preferred in manufacturing industry because it can produce complex-shape plastic products and having good dimensional accuracy with short cycle times typical examples are automobile industry, casings and housings of

products such as computer monitor, mobile phone and which has a thin shell feature.

## II. LITERATURE REVIEW

Much research is being done to understand the important factors and design the molding processes. Much of the work over the past decade has been based on: theoretical, computer-based simulation models and practical experimental tests. (Erzurumlu & Ozcelik, 2006) used the Taguchi method to reduce the variance and sink index. In his study he considered mold temperature, melt temperature, packing pressure, rib cross section and rib layout angle and material PC / ABS, POM, PA66. They found in their research that PC / ABS plastic products, rib cross-sectional POM material plastic production and rib layout angle effect PA66 materials significantly affect plastic production. (Ozcelik et al., 2010) attempted to study the mechanical properties of materials using the Taguchi method. They are considered the melting temperature,

packing time, cooling time, injection pressure. (L. Zhao et al., 2010) study the sink marks error with simulation with the help of software mold flow and experiment with the Taguchi method. In their research they study the process parameters on polypropylene content and solubility, mold temperature. Injection Time, Pressure Holding, Cooling Time. (Stanek et al., 2011) A mold design study with the help of cadmol software. They claim that Cadmold software can calculate curing time based on molding time, speed and vulcanization time, and material and technical parameters. (Saman et al., 2009) Study the mold condition of the injection mold to create the proper molding system through CAD / CAE devices. They represent the right gating systems with the help of CATIA and MOLDFLOW software. (Gruber et al., 2011) A study on visual perceptual measurement of sink markings on injection molding components. They study the sink marks of plastic parts that are stable by increasing the holding pressure and other parameters. (X. Wang et al., 2013) studied warpage and sink defects with the help of rapid heat cycle molding technology. They study the effect of melting temperature, injection time, packing pressure, packing time and cooling time on the warpage with the help of Teguchi and ANOVA. (Gruber et al., 2014) Study visual acuity on the sink markings of injection molded parts and develop CCD images. (Rathi, Salunke, 2012) consider the parameters of injection pressure, mold closure speed, mold pressure, rear pressure and short shot defect in the study of the injection molding process. (Raos & Stojic, 2014) studied the effect of injection speed and injection pressure of two processing parameters on the tensile strength of the plastic molded component. He did his analysis on the polyethylene content in plastics. They showed that injection pressure was an important factor influencing tensile content and that injection speed did not affect tensile strength. (Islam et al., 2013) studied the effect of pressure factors on the tensile strength of metal injection molding material. They found that as the pressure increases, the tensile strength of the molded part of the metal increases. (Li et al., 2007) studied the effects of processing parameters on the presence of weldline by the Taguchi experimental design method. Welders are obtained from the right door of the copy machine built with three gates. Images of mold products are taken with digital cameras. They are considered to be the major factors influencing the strength of the material polypropylene, such as the melting temperature, injection pressure, and injection speed. They showed that injection speed is a major factor in the visibility of weld lines. (P. Zhao et al., 2020) This review introduces methods and strategies on the sensing, optimization, and control of intelligent injection molding and summarizes recent

studies in these three areas. (Q. Wang et al., 2019) An experimental work is carried out to study the effect of the micro injection molding parameters on the product weight in this paper. (Park & Dang, 2017) This work introduces a conformal cooling channels applied in a medium-size injection mold that makes an automotive part. We improved an existent mold in order to reduce the cycle time and improve the quality of molded part. (Chen et al., 2018) This article presents a method of efficiently designing a manufacturing process for injection molding by determining the optimal Pareto Set of control factor settings; here these are the values of the melt temperature, packing time, packing pressure, and cooling time of the molding machine. (Elduque et al., 2018) The importance of deeply analyzing the energy efficiency of the manufacturing process has been discussed in this study. (Yu et al., 2020) The numerical calculation is carried out by combining the viscoelastic constitutive equation White-Metzner and the fiber orientation model iARD-RPR and then verified by experiment. (Siregar et al., 2017) This paper presents the design and development of an injection moulding machine for manufacturing lab that have features of low cost, bench top size, and have similar processes as in commercial injection moulding machine. (Wibowo et al., 2019) The results of the study of pure ABS recycling with recycle stated that the parameters of the melting temperature, injection pressure and holding pressure affect the optimal value of a result. (Lou & Xiong, 2020) The MU viscosity model was established based on the ultrasonic energy, the characteristic micro dimension, and the molecular chain length. Ultrasonic microinjection molding experiments were performed using microgrooves with different flow length ratios.

### III. RESULT AND DISCUSSION

Most researchers have studied the injection molding process with different process parameters, different materials and different mathematical techniques. Some of them are listed below:

Table .1 Parameters and responses

S.No.	Paper title	Year	Parameters	Material	Responses
1.	General frameworks for optimization of plastic injection molding process parameters	2014	Melt temperature, mold temperature, injection pressure, injection time, packing pressure, packing time etc	Poylcarbonate	Warpage, clamping force. tensile strength, residual stress ,cooling time
2.	Optimization of Injection Moulding Process using Taguchi and ANOVA	2013	Melt Temperature, Injection pressure, cooling time	-	Tensile Strength
3.	Analysis Of Injection Moulding Process Parameters	2012	Injection pressure, mould closing speed,mouldpressure,b ack pressure	PC AND ABS blend polymer (PC/ABS) made by Chi- Mei Company (Taiwan)	Warpage
4.	Warpage control of thin-walled injection molding using local mold temperatures	2015	Mold temperature behavior offilling With Mold flow software	Reprocessed ABS polymer is used	Warpage
5.	Effect of reprocessing on shrinkage and mechanical properties of ABS and investigating the proper blend of vergin and recycled ABS in injection molding	2014	Young's modulus	Carbon steel AISI 1050 used as a Mold material and ABS used as plastic material used	Warpage
6.	The use of Taguchi method in the design of plastic injection mould for reducing warpage	2007	Melt temperature (240-2900C),Filling Time (.1-.5sec.), Packingpressure,(C 60-90),Packing Time(.6-1)	PP material with 40% calcium carbonate	Warpage
7.	The impact of process parameter on test specimens deviations and their correlation with AE signals captured during the injection moulding cycle	2013	Cooling time(6- 10 sec),Packing time(3-5sec),Packing pressure(300-500 bar),injection pressure (1000-1200 bar), injection speed (40-50 mm/sec), Melt temperature (230-2400C)	Polyacetal POM C9021	Shrinkage and warpage
8.	Comparison of the warpage optimization in the plastic injection molding using	2006	Mold temperature (60-900C),Melt temperature(120-	PMMA-80 is used	Warpage

	ANOVA, neural network model and Geneticalgorithm		2800C),Packing Pressure(60-75 Mpa),Packing Time(10-20sec) Cooling time (9-15 sec)Runner type(Cicular, Hexagon,Trpeze, Gate location		
9.	A study of the effects of process parameters for injection molding on surface quality of optical lenses	2009	Melt temperature (220-2300C), screwspeed (5-15 m/min ), injection speed(50-90mm/sec), injection pressure (1100-1300 bar), Packing time (7-13 sec),Mold temperature(60- 800C), Cooling rate(s)	Phenolic molding compound is shown	Surface waviness, roughness, light transmission
10.	Optimization of plastic injection molding process parameters for manufacturing a brake booster valve body	2014	No of gates, Gate size (18.68 mm to 22.86 mm),mold temperature (147.6 - 180.4), resin temperature(85.5-104.5),switch over by volumefilled (69.57-85.03%),switch over injection pressure (10.8-13.2Mpa), Curing time(108-132 s)	Polybutylen e terephthalate (PBT)	Resin viscosity, curing percentage
11.	Improvement of injection moulding processes by using dual energysignatures	2014	Processingtime, power level	Poly propylene	Energy consumption
12.	Application of Taguchi method in the optimization of injection moulding parameters for manufacturing products from plasticblend	2010	Injection speed(10.74-10.98),Melting temperature (9.79-12.50), Injection pressure (10.70-11.12), holding pressure(10.48-11.47),holding time(10.36-11.15), cooling time(10.54-11.60)	Polypropylene	Shrinkage in cm



13.	A principal component analysis model-based predictive controller for controlling part warpage in plastic injection molding	2015	Cavity pressure,cavity temperature		Warpage by coolant flow rate and cavity pressure temperature
14.	Optimal cooling design	2013	Cooling time, injection time	GE Cyclicoloy C2950 PC/abs	Warpage, shrinkage, thermal residual stress,sink marks etc.
15.	Finding efficient frontier of process parameters for injection molding	2013	Injection time (.5-1.5),injection pressure(100 to 140MPa),packing pressure(80-120 Mpa),Packing time (7.5-12.5)cooling time(14-24sec),coolant temperature(20-30), mold open time(4-6 sec),melt temperature(270-280),mold surface temperature(65-75)	Polyamide PAT considered	Shrinkage and warpage
16.	Simulation and experimental study indeterming Injection molding process parameters for thin-shell plastic parts via design of experiment analysis	2009	Melt temperature(310-330),Mold temperature (115-135),injection Speed (%65-85), Packing pressure (40-45 Mpa)	Polypropylene and polystyrene	Shrinkage and warpage
17.	Parameter study in injection molding process using statistical methods and Invasive WEED algorithm	2011	Melting temperature(240-260),Injection Pressure(50-70),Packing Pressure (50-70MPA),Packing time(5-15 sec)	Ultramid B3S (un-reinforced PA6 material)	Shrinkage and Warpage

18.	Optimisation of injection moulded parts by using ANN-PSO approach	2006	Mold temperature(40-80),Melt temperature (250-270),Flow rate (10-80,103*mm <sup>3</sup> /sec),packing pressure(25-40 Mpa)	-	Warpage
19.	Back propagation neural network modeling for warpage prediction and optimization of plastic products during injection molding	2011	Mold temperature(40-80), Melt temperature(200- 280), packing pressure(80-120),Packing time(8-12),Cooling time(15-25)	Polypropylene	Warpage
20.	Reducing the shrinkage in Plastic injection moulded gear by GREY based Taguchi optimization method	2012	Melt temperature(200-240),Packing pressure(60-80),Packing time(5-15),Cooling time(30-50)	Powder material is used	Shrinkage
21.	The use of Taguchi approach to determine the influence of injection-moulding parameters on the properties of green parts	2006	Injection speed, mould temperature, material temperature, holding pressure, holding pressure time,cCycle time(15-30 sec)	Polypropylene	Shrinkage
22.	A hybrid of back propagation neural network and genetic algorithm for optimization of injection molding process parameter	2011	Mold temperature, melt temperature, packing pressure, packingtime, cooling time	-	Warpage and clamp force analysis
23.	Practical application of Taguchi method for optimization processing parameters for plastic injection moulding- A retrospective review	2013	Mould temperature, melt temperature, Gate dimension, packing pressure,packingtime, injectiontime,fiiling time filling pressure, cooling time		Warpage

24.	Development of a smart plastic injection mold with conformal cooling channels	2017	Mold Temperature , cooling time, Flow nature, Cycle time, Selective laser melting		Cooling time
25.	Effect of Process Parameters on Repeatability Precision of Weight for Microinjection Molding Products	2019	Packing pressure, cavity pressure, mold temperature, injection pressure	Polypropylene(5 090T) (MFI=15g/10min) Formosa petrochemical Corp,Taiwan.	Tensile strength
26.	Intelligent Injection Molding on Sensing, Optimization, and Control	2020	Process sensing, process control, Taguchi method, intelligent method( case based reasoning)		Warpage, shrinkage, mechanical properties, clamping force
27.	Sequential design of an injection molding process using a calibrated predictor	2018	Bayestan analysis, melt temperature, packing time, packing pressure, cooling time		Shrinkage
28.	Numerical Simulation during Short-Shot Water-Assisted Injection Molding Based on the Overflow Cavity for Short-Glass Fiber-Reinforced Polypropylene	2020	Melt short shot size, water injection delay time, melt temperature, water injection pressure	Glass fiber reinforced polyethylene (SGFPP, Grade Hostacom SB224-1, Lyondell Basell Industries, Germany)	Residual wall thickness
29.	Design and development of injection moulding machine for manufacturing maboratory	2017	Flow rate, packing time		Design process
30.	Research of Injection Molding Parameters with Acrylonitrile Butadiene Styrene Composition Recycled Against Mechanical Properties	2019	melting temperature, injection pressure, holding pressure	Recycled ABS combined with pure material on 10%:90%, 20%:80% and 30%:70%	Impact strength and tensile strength

Since raw materials are scarce and expensive, and energy costs are also increasing, mold design strategy should reduce costs and reduce resource consumption. Contraction, Warpage, sink marks, and weld lines are the four most challenging defects in the injection mold. In many cases, their formation is inevitable, especially for complex geometric components

#### IV. CONCLUSION

There is a lot of effort in this area. But some of them have been successful, so this area needs special attention. This is because we know that many errors are caused by processing parameters based on this study. So the production control of processing parameters is necessary for the product. . Based on the above table we find that each researcher focuses mostly on warpage and

contraction. They also pay attention to the sink marks. But some researchers pay attention to weld lines and tensile strength. We have found from above that the study of recycling of plastics is necessary for the benefit of the community. It requires environmental friendly, recyclable material identification.

Therefore processing in this area should be done. So in order to increase the production of quality-based plastic products, studies on other process parameters are needed, which should be free of flaws.

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# Prefabricated Sandwich Panel System in India

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**Keywords-** Prefabricated panel, Economy,  
Technology, Need, Manufacturing

**Abstract**— In a recent period, construction sector is fastest growing sector in India because day by day population increases in rapidly which needs the shelter. The construction sector use vast amount of natural resources and produce significant quantity of construction and demolition waste. These wastages lead lots of environmental effect. This result requires new technology to overcome this problem which is Prefabricated Sandwich Panel System in India.

## I. INTRODUCTION

Prefabrication is nothing but to collect segment for manufacturing the structure which is prepared in factory and transporting and fixing at site. In china, Australia, Africa and Gulf countries already established factory made prefabricated sandwich panel system. Prefabrication method gives designer for assembling their structure in short period of a time. It also allows the designer to use different kind of material, mostly prefer to light weight ones. Generally woods and steel combination is used but these technology needs high level of knowledge and experience. This system replace conventional brick and mortar in load bearing and non load bearing walling for residential and commercial building. In this system cement panel are manufactured at the factory in controlled condition which are dispatched to the site and reduced the erection work at site which one is headache part of construction site. It gives more help to clean and dust free site.

In India, under a global housing technology challenge ministry of housing and urban affairs using this type of technology in INDOR, MADHYAPRADESH to make light house. RISING JAPAN INFRA is technology provider and contract with KPR PROJRCTCON PVT. LTD.

## II. OBJECTIVE

The aim of this type of technology is to the efficiency of construction system that is sustainable, eco-friendly and disaster resilient. This technology is to be cost effective and speedier with quality construction of building to meet the desirable functional needs

## III. METHODOLOGY

In this technology, Factory made pre fabricated sandwich panel system is made out of cement or calcium silicate boards and cement mortar with EPS (Expanded Polystyrene) granules balls and act as wall panel. Prefabricated channel system can be divided according their uses is materials, methods and structural configuration. In structural configuration have also sub part which is frame, panel and cells system. In this paper discussed about how it works. In this technique firstly steel column may be hoisted. Hoisting sequence should be reasonably arranged to prevent structural tilt. After secondary beam and column bracing need to be assembled by floor steel stair case installation firstly column and beam installation. Secondly platform will be placed at last pound rail and stair step installation, laying rebar trust deck. Welding stud bind rebar and other pipe line before pouring concrete. When concrete reaches the

design strength remove the bottom templates of the truss deck.



Fig.1: Steel structure installation

Wall installation:

(i) Interior wall installation:

Cement EPS sandwich panel fixing U-type clips into pre-determined position. Bonding Adjacent seams with polymer mortar. This is shown in fig.2.



Fig.2: Insert the wall -brush mortar in adjacent surface- install two pair U type clip up and down with nailing- insert the wall

Light steel keel partition firstly installing vertical and then horizontal. Fixing calcium silicate board on one side, filling rock wool and other pipe line at last. Fixing the calcium silicate board on the other side. This is shown in fig.3

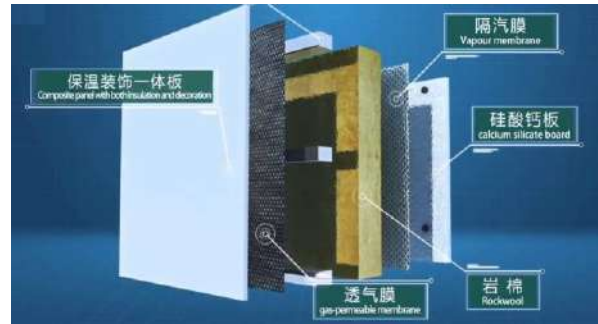


Fig.3: layers of panel system

(ii) Exterior wall installation

Autoclave aerated concrete strip board at first installing fixing the clip then lifting the board to pre determined position and fixing with book bolts adjacent seams with polymer mortar.

Light steel keel exterior wall first installing it gives exterior insulation; decorative board with specific clips them laying waterproof and breathable film inside and filling Rockwool afterwards. Laying other breathable film and sealing interior wall with calcium silicate board which gives water proofing and roof insulation and lighting protection facilities. This is shown in fig 4.



Fig.4: Exterior wall installation

This type of technique has some special core features like;

- Being dry waling system increases the speed of construction and there is no use of water for curing means water conservation.
- The sandwich panels have light weight material as core material, which brings resource efficiency, better thermal insulation, acoustics and energy efficiency. Because of light weight results in lower dead load building and foundation size.
- This system provides less formwork, fast and easy installation that is cost effective and time saving.

- This novel technique gives fast and aesthetic solution and budget friendly for its longevity.
- The lightness of sandwich panel allows to gain advantage of expansion and renovation work without interrupting everyday activities in the building.
- The panel are both economic and practical as they can be dissembled and reused.
- Transportation and handling is easy due to light weight.

#### IV. RESULTS

This technology is familiar but not used in India, Pre fabricated sandwich panel system represent better thermal performance, light absorbing, water proofing and material saving. Therefore investment in the precast construction, taking account high demand to save environment and recycle or reuse of material of building. This type of technology is the best solution of revival of construction sector and economic recovery.

#### V. CONCLUSION

Now a days world facing a global crisis and environmental protection which requires a new or innovative technology, reuse of wastages, cost effective material, and economic structure as a whole. This type of innovative techniques gives sustainability, more eco-friendly and cost effective. To meet the demand civil engineer and architect dealing with this technique gives a better, fast and standard construction.

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# Analysis of Intelligent public Transit Service Models by users: A Literature Review

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**Keywords—** Service quality, Public service, Public transit, Literature review.

**Abstract—** The urban public transit sector for bus passengers has undergone significant strategic changes, motivated by the issue of qualitative management in its service. It has been noticed in the literature that management models, which consider sustainability, eco-efficiency and human capital, are able to value the business, combined with customer satisfaction, quality, and behavior. This article aims to conduct a bibliographical research with the aim of analyzing concepts related to the quality of public road transit service. The methodology was exploratory and explanatory through a literature review on intelligent public transit service models by users. Based on the proposed constructs, the results pointed to the following trinomial: Quality, Satisfaction, and Behavior. It was possible to identify, through the research, models that indicated that service satisfaction is directly related to quality. Nevertheless, the matter is not merely related to quality, but rather social, environmental and economic behavior. Findings were identified in the literature that pointed to the need to build an Intelligent Management Model for public transit, which are qualitative management methods that adapt to user needs, considering urban, environmental, social, behavioral and economic aspects.

## I. INTRODUCTION

Satisfaction and the search for operational performance, translated into competence, has always been propitious to scientific discussion, whether in the academic setting or in the professional scope between companies.

Many studies have shown that service quality affects customer satisfaction, which, in turn, influence behavioral intentions in relation to the service provided, as satisfaction is directly related to service quality, considering aspects such as: speed accessibility, comfort, regularity, punctuality, cleanliness, cost, proximity, and safety (OÑA, ESTÉVEZ, OÑA, 2020).

Conversely, loyalty is directly related to behavioral issues of individuals, whether at the individual or collective level (OÑA, ESTÉVEZ, OÑA 2020).

According to Machado et al. (2018), existing approaches to addressing customer perception data have two key challenges:

(1) Heterogeneity of perceptions obtained by customers; and

(2) Simultaneous questioning of attitudes that explain behavioral issues relating to the customer.

According to Machado et al. (2018), the assessment of service quality based on the behavioral

theory relating the customers of urban public transit must address two key challenges in an advanced way. These are:

- (1) Related to changes in the environment, such as infrastructure improvements and service management; and
- (2) Increased costs relating to car use.

Nevertheless, according to Machado et al. (2018), individual transit policies focus on decision-making by users themselves, aiming to encourage the use of alternative modes of transport on their part, thereby changing the perceptions of these customers about the environment and their judgments regarding different travel options suggested by the companies.

According to Machado et al. (2018), this is generally due to measures that consist essentially of workplace or school travel plans; personalized travel planning and; marketing and travel awareness campaigns to be implemented.

This study aims to discuss which methodologies are researched in the literature on management models, which verify the degree of impact of the quality of urban transport service, with a view to sustainability and eco-efficiency in relation to end users.

The originality of the paper is based on the fact that it seeks management models in the literature that assess qualitative and quantitative, environmental, social, behavioral, economic and financial aspects.

The literature showed gaps on management models that considered variables such as: (v1) speed; (2) regularity; (3) satisfaction; (4) eco-efficiency; (5) behavior etc. Nevertheless, the issue of their impact on the life cycle of the public transit product was not permanent, nor was there a intelligent model that is directly tailored to the needs of its users and allows managers to adapt to new situations, such as issues of mobility, climate, energy scarcity, and change of customer profile, as well as contemplating tax, economic and financial aspects.

Given this, the research problem was proposed, aiming to address the need to identify intelligent public transit service models by users, which could celebrate and pacify a term for peaceful and effective adjustment.

The structure of this article is as follows: (1) Introduction; (2) Foundation; (3) Methodology; (4) Results; and (5) Conclusion.

## II. PUBLIC TRANSIT

Da Silva (2018) states that urban public transit is a service that works as an essential process for people's mobility, particularly in large and medium-sized cities in

Brazil. From the 1950s to the 1960s, buses became a means of public transit for the population through the privatization of the vast majority of companies providing public transit services, supported by the concessions law.

According to Gois (2019), the Public Transit System is essential for society as a whole, as it allows people to move around, facilitates access to desired locations, and helps in consumption activities, moving the country's economy. Through public transit, people achieve accessibility to work opportunities and quality of life.

Angnes (2019) portrays that public services are essential for the construction of social, economic and urban mobility. Without access to them, people are severely limited in developing their capabilities and exercising their rights or equal opportunities. Urban public transit in Brazil, as provided in the Federal Constitution, Article 30, item V, is considered an essential public service, as it is defined by society, represented by the constituents.

Bordalo (2016) reminds us that transport is a service that has accompanied mankind since its inception, having grown as an economic activity alongside communication and financial services since the Industrial Revolution. As a result of the Industrial Revolution, public transit appeared almost simultaneously in several cities. The production that used to be carried out in workers' homes is now conducted in factories equipped with special machines and tools, generating the need for workers to be displaced on a daily basis to the factories.

According to Lapa (2019), the need for displacement, encouraged by a culture of individual consumption, allowed the formation of a new road structure marked by the intense flow of private vehicles, resulting in a series of difficulties both in the accessibility of urban services and equipment and in the mobility of city dwellers.

The hypothesis encompasses highways, waterways, airports, and ports – in some cases. Railroads, in turn, may (or may not) be bundled with the provision of the service. If the state (or the private sector) makes use only of the railways available, it falls into the latter case. Conversely, if it is combined with the provision of a freight or passenger rail transit service, it is placed in the first hypothesis (COSTA, 2016).

London was the first city in the world to build underground lines and currently has the world's second longest subway system. Opened in 1863 (LONDON'S TRANSPORT MUSEUM, 2015), the London Underground is over 400 kilometers long, for a population of eight million people, and was a determining factor in its economic and social development. With the London

Underground, there was a connection between the suburbs and the center, allowing the population to live further away from their workplaces, at lower costs. The London Underground system allowed the integration between the city center and the districts, promoting the city's territorial expansion (MARRARA, 2012).

One of the ways to measure results in relation to public transit consists of analyzing the schedule of lines and avoiding problems in public transit through the monitoring system. This system makes it possible to evaluate the system's performance applied in transit and address improvements (MUNIZ et al., 2020; MISHRA).

Muniz et al. (2020) claim that accessibility, as a means to reach the desired destinations for a given person, is the most direct indicator of the effects of a transit system.

The urban public transit system is a public service, under the responsibility of the municipalities, as defined by the Brazilian Constitution (2011), seeking "to organize and provide, directly or under a concession or permit agreement, public services of local interest, including collective transit, which has an essential character," is a key priority service for the population (MARRARA, 2012).

The term urban mobility has been widely debated by several researchers in congresses and events on transit and transport, as well as urban planning, in Brazil and worldwide, as many countries are undergoing major social, economic and even demographic transformations, changing the characteristics of urban space and influencing the circulation of people and vehicles (MISHRA, WELCH and JHA, 2012; ROSE, 2008).

It can be considered that urban mobility is directly linked to people, who play a number of roles – including those of pedestrians, cyclists, drivers, and passengers – to ensure their displacements, considering the dimension of the urban space,

Mobility, for Muniz et al., (2020) can be affected by factors related to age, gender, personal income and factors related to the urban space, such as its organization and the way transport is scaled. The handling of mobility can be understood as a function of the public agencies. In Brazil, however, there is still no effective policy for the treatment of urban mobility, which aims to ensure quality accessibility and movement for all.

Urban mobility goes beyond the conditions of displacement and use of existing transport – it also serves for people's relationships with space, reflecting the cultural characteristics of a society (WELCH and MISHRA, 2013; ROSE, 2008).

To know the mobility index of a region is to understand the amount of urban trips carried out and the distribution of trips between the various modes of transport, and these depend on a country's development level, climate, public policies, and quality of transport. This mobility index is higher if the level of socioeconomic development of the country and the city is also higher. This indicator also depends on state policies and the demands of the population. Conversely, with the evolution of the means of communication, there has been a reduction in the number of displacements (MUNIZ et al., 2020).

Cities must be treated for the benefit of man. Urban transit systems must provide conditions for people to have opportunities to live together in society and with nature. Thus, it is necessary to encourage and raise awareness among the population of the importance of prioritizing the modes of locomotion through buses, pedestrian means and bicycles, while also showing the importance of using one's own vehicle rationally, as it also requires other elements of society.

When discussing public transit, it is worth highlighting two positive aspects of great importance (COSTA, 2016). First, the social issue: public transit is the only motorized mode accessible to the low-income population that offers full security and great comfort. Second, due to its democratic nature, public transit is often the only form of transit for those who do not have cars or who cannot or do not wish to drive, thereby highlighting the great importance of a good service to meet social needs (MUNIZ et al., 2020).

Since the 1990s, commuting patterns have undergone changes, mainly due to labor relations, such as flexible working hours, activities carried out from home, de-concentration of industrial centers, and even the logistical strategies of some companies.

Social efficiency is linked to the evaluation of public transit, which is based on factors such as ease of movement for people, and quality of service, thus being a service that meets basic needs and improves the population's quality of life.

The dependence relation of the poorest people regarding urban public transit can even be classified as inhumane, as they have lower family incomes, but still depend on this resource, increasing the percentage of their salary spent on public transit (COSTA., 2016).

The middle classes had their travel needs met more quickly and efficiently, while sectors that rely on public transit remained subject to poor average circulation conditions. The most direct way of meeting the needs of the middle classes was through the adaptation of the urban space to the life of these social groups. Thus, cities

acquired the contours of middle-class spaces, in which they could exercise their lifestyle comfortably and efficiently (COSTA, 2016).

The automobile then became a means of reproduction for social groups, mainly middle-income groups that, in order to assert themselves, require a set of social, cultural and economic activities, including the acquisition of a motor vehicle, which evidently provides greater mobility. Thus, the public policies implemented prioritized the demands of middle-income social groups to the detriment of the majority of the population that relies on public transit (KIM and ULFARSSON, 2012).

Since the transport policy, particularly in Brazil, is not efficient with regard to public transit, the use of the motorized modal, especially the automobile, is becoming more and more frequent.

It is known that one of the causes of congestion is the flow of trucks that enter the big cities for supply purposes, as well as to follow their routes to ports or other distribution centers. This phenomenon only occurs due to the absence of railways that cut across the entire national territory, as well as the lack of sufficient and adequate waterway transport. Transport is a network, which is why it is impossible to separate urban transit from other transport infrastructure (MISHRA, WELCH and JHA, 2012; COSTA, QUIRINO, & GRANEMANN, 2017).

The functioning of a transport mode, even at the urban level, interferes with all other modes, and the latter interfere with the mobility of cities. The use of an individual vehicle generates traffic. Nevertheless, in order to reduce the use of private vehicles, it is necessary to implement efficient public policies in the field of public transit. The first solution is to invest in subways, so that individual transport can be discouraged – which has not been done in recent decades. It is necessary that urgent investments be made in the construction and expansion of the subway network in large cities (HAQUE, CHIN and DEBNATH, 2013).

According to Machado-León et al. (2017), the profitability of public transit systems requires that the public agent implement a complete diagnosis of the services provided based on the perceptions and expectations of users and invest public resources according to users' needs, perceptions, and satisfaction, as they will be the ones driving government gains. Such gains are not only quantitative, but above all qualitative (MACHADO-LEÓN ET AL. 2017).

According to Oña and Garrido (2017), when a public transit manager conducts a customer satisfaction survey, the goal is to determine the general satisfaction of

these passengers regarding the service provided, as well as their satisfaction with specific aspects such as frequency, speed, comfort, etc.

Thus, it is essential to assess the importance given by customers to each attribute pointed out. Another important perception is to ask directly about this importance and which ones bring advantages and disadvantages to them (OÑA E GARRIDO 2017).

According to Oña and Garrido (2017), the demographic profile and travel behavior are characterized by the following aspects and factors: (1) Gender; (2) Age; (3) Availability of private vehicles and reason for the trip; (4) Frequency; (5) Complementary modes from the starting point to the bus stop; (6) Complementary modes from the bus stop to the destination; and (7) Type of ticket.

Regarding the average values for declared importance and perception rates, according to Oña and Garrido (2017), they represent the following: (1) Information; (2) Punctuality; (3) Transit security; (4) Courtesy driver; (5) Bus interior cleanliness; (6) Bus space; (7) Bus Temperature; (8) Accessibility to/from the bus; (9) Fares; (10) Speed; (11) Frequency of service; (12) Proximity to the starting point/destination; and (13) Overall satisfaction.

### III. METHODOLOGY

As for the research method used to prepare the research strategy, an explanatory documentary research was proposed. Based on a bibliometric study, the foundation of this article was validated.

With the knowledge of the concepts offered, the objective of the bibliometric study is validated based on the introduction and development of the problem proposed in this article.

It was mandatory to carry out a survey of articles inherent in the central topic of the research, namely: (1) Service quality; (2) Public service; (3) Public transit; and (4) Literature review, which are in harmony with the proposal of the general objective of the research.

Based on the research design, the bibliographic study was chosen as the research method to validate the research instrument used, as it is intended to apply a bibliometric study aiming to verify the adherence to the criteria and requirements proposed in this dissertation, so that the researcher can build the foundation for the choices of the research strategy.

A new tree of key terms and keywords was created, adjusted according to the previous analysis. Figure 1 presents this last keyword tree.





Research Objective	Thematic Areas	Thematic Sub-Area
What methodologies researched in the literature on management models verify the degree of the impact of urban transit service quality, with a view to sustainability and eco-efficiency.	Service quality	Overall satisfaction
	Public service	Passenger satisfaction
	Public transit	Smart city
		Eco-efficiency

Fig.1: Last Keyword Tree Formation

Source: Adapted from Vieira Neto (2012)

Analyzes were carried out using search engines with the following guiding keywords: (1) Service quality; (2) Public service; (3) Public transportation; (4) Literature revision. Through the analysis, the following Boolean was generated: ( TITLE-ABS-KEY ( serviçoAND qualidade ) AND TITLE-ABS-KEY ( públicoAND serviço) AND TITLE-ABS-KEY ( público AND transporte) ) AND PUBYEAR > 2015 AND ( DELETE ( SUBJAREA,“COMP” ) OR DELETE ( SUBJAREA,“MEDI” ) OR DELETE ( SUBJAREA,“MATH” ) OR DELETE ( SUBJAREA,“ENER” ) OR DELETE ( SUBJAREA,“EART “ ) OR DELETE ( SUBJAREA,“PHYS” ) OR DELETE ( SUBJAREA,“AGRI” ) OR DELETE ( SUBJAREA,“BIOC” ) OR DELETE ( SUBJAREA,“CHEM” ) OR DELETE ( SUBJAREA,“CURAR” ) OR DELETE ( SUBJAREA,“ENFERMEIRAS” ) OR DELETE ( SUBJAREA,“CENG” ) OR DELETE (

SUBJAREA,“PSYC” ) OR DELETE ( SUBJAREA,“PHAR” ) OR DELETE ( SUBJAREA,“IMMU” ) OR DELETE ( SUBJAREA,“NEUR” ) OR DELETE ( SUBJAREA,“VETE” ) ). This originated a group of 1,243 documents, which served as the basis for the preparation of the bibliometrics of this research, carried out from January 2016 to June2021.

Of these, after implementing the filters for refinement, they were selected as the object of study and analysis, considering the following order: most cited, with a greater degree of relevance with adherence to the central subject of the research from the titles and abstracts considering a period of five (5) years of publication; and greatest impact factor.

It should be noted that this table was created based on the Boolean generated, after refinements and filters implemented, within the search engine obtained from the Scopus Base. Due to the refinements caused, the



total number of documents extracted totaled eight thousand, seven hundred and sixty-six (8,766).

It should be noted that the totals presented in the Boolean do not express the final amount of documents used, as filters were implemented that provided a quantity of documents at 1,243, with 619 documents being selected from this sample universe, according to the following strategic selection criteria: (1) Most relevant; (2) Most current; (3) Oldest and; (4) Most cited.

This framework and the general objective of the research primarily sought to find what methodologies researched in the literature on management models verified the degree of the impact of the quality of the collective urban transit service, with a view to sustainability and eco-efficiency, pointing to a satisfaction system for both customers, the company, society, and above all, the validation process of the Smart City concept.

After the preparation of the words concerning the thematic areas of the study, the Boolean logic of the connectives “AND” and “OR” vertically was used as a base factor, establishing the validation of the search of journals in the CAPES database, represented as one of the main means and channels of existing bibliographic data, for the search for scientific knowledge as a basis for academic research.

#### IV. RESULTS

Specifically on the main issues addressed in the literature, through the analysis of the findings, the development of a hybrid management model based on the studied literature was proposed.

According to Antunes (2017), exploratory research is necessary for the improvement of the subject, and the literature review supports the project. The field research, based on interviews with customers of the company providing the public service, will be integrated so that quantitative and qualitative assessments can be carried out, as well as a reflection on resources and financial investments in improving public transit by bus.

The survey results demonstrate a diagnosis of the quality of the service offered in the municipality of Santos, in the state of São Paulo, Brazil (considered, in general, satisfactory, despite its various infrastructural, logistical and behavioral aspects to be improved), in order to constitute an instrument in the proposition of a mechanisms for mitigating or solving serious urban mobility problems – these mechanisms aim to improve user service and can be used by the public authorities, the granting agent, and the licensees.

Costa, Quirino, & Granemann 2017. This article uses a Multicriteria Constructivist Decision Aid Model (MCDA-C) built in conjunction with specialists from the Graduate Program in Transport at the University of Brasília (UnB). The results show that users are not satisfied with the quality of services provided by the operating companies, in addition to indicating the points that must be prioritized in order to improve the quality of the semi-urban service in the Federal District, Brazil.

Cavalcanti, 2017. In order to understand the perceived quality of SEI users, the Barro Integrated Terminal (TI Barro) was chosen as a case study, as it is one of the terminals with the highest demand for passengers, allowing for intermodal integration between buses and subways, in addition to being one of the first terminals opened by RMR, being well known by the population. Through the application of a questionnaire with the users of TI Barro, their dissatisfaction regarding their experiences with the terminal was observed, which can be justified in the analysis the service level of the terminal according to the criteria of the Transit Capacity and Quality of Service Manual, as well as the literature in general. Problems are encountered, mainly, with areas intended for waiting and circulation, frequency of service, total travel time, and comfort. It can then be inferred that the economic benefits of fare integration at the transshipment stations are overlapping, in the planning of systems, with the quality of the operation of the transport system and the terminals.

Tavares (2019). The research was developed by the World Resources Institute Brazil and then applied and made available for this study by Empresa Pública de Transporte e Circulação. The modeling used enabled an analysis of the interrelationships between the quality attributes evaluated in the research (observed variables) and the interrelationships between unobserved variables (latent variables), which represent concepts that cannot be directly measured. The three latent variables evaluated in this study comprised operational characteristics of comfort and health & safety. The results showed that operational characteristics have a direct influence on overall satisfaction, while comfort and health & safety have an indirect influence on satisfaction. We also sought to assess the impact of money spent on public transit, but the observed variable used to represent this concept did not present a significant influence on the general satisfaction of users. In the latent variable of the operational characteristics, the observed variable that had the greatest impact was the one related to the arrival at the final destination without delay. In relation to comfort, the variable observed that had the greatest impact was related to the comfort of the terminals. Finally, in the latent

variable of health & safety, the most relevant aspect is associated with public safety against robbery, theft and aggression on the way and inside buses.

Braz & Nascimento (2020). A qualitative and quantitative research methodology was used, with the application of a questionnaire to one hundred and five (105) volunteers. Bibliographical research was also carried out to ensure a better understanding of the subjects addressed in the study. The results showed that users are under stress and dissatisfied with the public transit service provided in the municipality Anápolis, Goiás. According to them, transport is slow, affecting their quality of life.

The authors (LAU, 2015; MISHRA, COSTA, QUIRINO, & GRANEMANN, 2017) have listed the main characterizing factors that influence the quality of public transit by bus, as presented below, not necessarily in descending order of importance:

- Accessibility – it is associated with the ease of getting to the starting point in public transit and of leaving at the place of arrival, as well as reaching the destination;
- Service frequency – related to the time interval for the passage of public transit vehicles;
- Travel time – time spent inside the vehicles until reaching the destination;
- Capacity – number of passengers inside the vehicles;
- Reliability – the users' degree of certainty that the public transit vehicle will pass by the starting point and arrive at the destination on time;
- Safety – accidents involving vehicles and acts of violence;
- Vehicle characteristics – technology and state of conservation;
- Characteristics of the stopping places – adequate signage, existence of benches for seating, and cover;
- Information system – availability of tables, maps, leaflets with timetables, routes, and indication of stations;
- Connectivity – ease of movement of public transit users between any two places in the city, integration;
- Operator behavior – the attitude of drivers and other employees during the performance of their activities; and
- Road condition – the quality of the running surface.

Public transit has been undergoing a crisis in its pricing and infrastructure model for some time now. During the last decades, cities that have a transport system model had suffered from these situations, reflecting the migration of passengers to other alternative transport schemes, thereby causing an increase in fares. Transport remuneration is exclusively through fares (COSTA, QUIRINO, & GRANEMANN, 2017).

Due to the remuneration model for services, the constant increase in costs and inputs, low productivity of transport and concession of gratuities are the reasons for the increase in the fares, the main effect of which is the withdrawal of lower-income classes from public transit (BRAZ; NASCIMENTO, 2020).

Public transit passengers, even with lower financial conditions, also seek attributes such as reliability, timeliness, accessibility, comfort, convenience, safety and cost (fares) when referring to locomotion – characteristics that are also demanded by those who use other transport options. Public transit users seek use aspects of mobility and favorable service, as they also aim to minimize factors such as excessive travel time or lack of accommodation and comfort (LAU, 2015; MISHRA, WELCH).

In the case of public transit, this further harms environmental conditions, as it involves high levels of concentration of carbon monoxide (CO) in the atmosphere. Another situation is the high rate of noise pollution. Urban growth requires an integration between public transit and development, in order to reduce inequalities in transit, offer transport efficiently and with quality, and contribute to economic development (HAQUE, CHIN and DEBNATH, 2013; KIM and ULFARSSON, 2012).

In terms of environmental sustainability, it is necessary to have a balanced use of urban space, improve people's quality of life, and improve air quality and energy sustainability. Sustainable development, in turn, comprises the search not only to preserve or compensate for the damage caused, but also to cause the least possible impact on the environment as a result of the provision of public transit services (ANTUNES; ROMEIRO; SIGRIST, 2017).

Conversely, ecological development consists of the awareness of respecting environmental capacity, conservation and recycling of resources, reduction of effluents, and the employment of appropriate technologies for the reuse of natural resources. Thus, associating the public transit service with environmental sustainability would be an alternative to mitigate environmental impacts (LAU, 2015; ZHOU, 2012; SANTOS and SOBRAL, 2014; CAVALCANTI, 2017).

The awareness that natural resources are finite and must be preserved for the maintenance of life and humanity is of fundamental importance for public transit companies, as opposed to the people who are also actively contributing to environmental degradation (SANTOS and SOBRAL, 2014).

The operation of public transit involves driving vehicles along scheduled lines (itineraries), with stops for passengers to embark and disembark. The purpose of controlling the operation is to ensure that trips are carried out according to schedule, prevent fraud or revenue evasion, ensure adequate behavior of transport operators with regard to the treatment of users, fair rates charged for services to users, and finally the gathering of information for the adequate planning of operations. In order to carry out an efficient operational control, it is necessary to have the support of qualified professionals in the field of inspection and an adequate technological system (ANTUNES; ROMEIRO; SIGRIST, 2017).

Many of the technologies used to control the operation of public transit are referred to as Intelligent Transport Systems (ITS). As explained by Ferraz and Torres (2004), the ITS aims to provide safety, improve operational control and transport productivity, and reduce delays, congestion and emission of pollutants in vehicle traffic (HAQUE, CHIN and DEBNATH, 2013).

According to Oña (2021), in order to attract more users to public transit services in an urban and metropolitan context, it is necessary to evaluate and take as a starting point a sustainable mobility approach in cities.

The author further notes that it is crucial and essential to improve our knowledge and perceptions of the quality of services provided, as well as the satisfaction and behavior of traffic intentions from the standpoint of users of private transit (OÑA, 2021).

According to Oña J., (2021) the relationship between service quality, satisfaction and behavioral intentions or loyalty in the domain of public transit become preponderant.

He pointed out, in a hypothesis-based test, that satisfaction with service quality leads to loyalty behavior intentions on the part of users (OÑA, 2021), forming the three hypotheses to be tested as follows:

(1) Service quality has a direct positive effect on satisfaction;

(2) Satisfaction has a direct positive effect on behavioral intentions or loyalty; and

(3) Service quality has an indirect positive effect on behavioral intentions or loyalty.

Nevertheless, according to Oña J., (2021), despite the growing interest in the subject, there is a lack of consensus regarding various aspects studied, citing as examples (1) the difference between service quality and satisfaction; (2) the relationship between behavioral intentions and loyalty; and (3) the mediating effect of satisfaction between service quality and behavioral intentions.

Thus, for the formation of indicators related to quality should be considered attributes of the service provided. For satisfaction, aspects related to user loyalty must be considered (OÑA, 2021). Below, the author describes the factors related to satisfaction and loyalty pointed out in his research as a model proposal:

Table 1: Absolute frequency of keywords

Factors	Description
1	Frequency
2	Proximity
3	Frequency
4	Punctuality
5	Speed
6	Cost
7	Accessibility
8	Intermodality
9	Personal space
10	Temperature
11	Cleanliness
12	Internet
13	Safety
14	Information

Source: Author's own work (2021)

Through the analysis, a hybrid model of intelligent qualitative and quantitative management was developed:

Table 2: Absolute frequency of keywords

Modelo Híbrido de Gerenciamento Inteligente de transporte coletivo urbano					
Direcionadores	Fatores	Variáveis Manutenção	Itens	Autores	Fases do ciclo de Vida
(1d) - Comportamento (2d) - Qualidade (3d) - Satisfação	(1f) - Ambiental (2f) - Econômico (3f) - Social	(1vm) - Corretivas (2vm) - Predictivas (3vm) - Preventivas	(1i) - Acessibilidade	de Oña J., 2021; de Oña J., 2021; de Oña J., 2021; de Oña J., 2021; de Oña R., Estévez E., de Oña R., 2020; Machado J.L., de Oña R., Diez-Mesa F., de Oña J., 2018; Dell'Olio L., Ibeas A., De Oña J., De Oña R., 2017; Machado-León J.L., de Oña R., Baouni T., de Oña J., 2017; de Oña J., de Oña R., Garrido C., 2017; Diez-Mesa F., De Oña R., De Oña J., 2016; de Oña J., de Oña R., López G., 2016; Machado-León J.L., de Oña R., de Oña J., 2016; Hernandez S., Monzon A., de Oña R., 2016; de Oña J., de Oña R., Eboli L., Mazzulla G., 2016.	(1fcv) - Planejamento (2fcv) - Construção (3fcv) - Uso e Manutenção (4fcv) - Descarte e Retrofit
			(2i) - Análises de dados Histórica		
			(3i) - Atendimento		
			(4i) - Cortesia		
			(5i) - Custo		
			(6i) - Espaço individual		
			(7i) - Fidelidade		
			(8i) - Frequência e Horário Inteligente		
			(9i) - Informação		
			(10i) - Intermodalidade		
			(11i) - Internet e mídias sociais		
			(12i) - Lealdade		
			(13i) - Limpeza		
			(14i) - Mobilidade		
			(15i) - Perfil do Cliente por faixa etária		
			(16i) - Pontualidade		
			(17i) - Proximidade		
			(18i) - Segurança		
			(19i) - Simplicidade e Adaptação		
			(20i) - Tarifa ou Preço Inteligente		
			(21i) - Temperatura		
			(22i) - Trajeto ou Rota Inteligente		
			(23i) - Velocidade		

Hybrid Intelligent Public Transit Model

Drivers	Factors	Maintenance Variables	Items	Authors	Lifecycle Stages
(1d) – Behavior	(1f) - Environmental  (2f) – Economic  (3f) – Social	(1vm) – Corrective  (2vm) – Predictive  (3vm) – Preventive	(1i) – Accessibility	de Oña J.,2021; de Oña J., 2021; de Oña J., 2021; de Oña R., Estévez E., de Oña R., 2020; Machado J.L., de Oña R., Diez-Mesa F., de Oña ., 2018; DeII'Olio L., Ibeas A, De Oña J., De Oña ., 2017; Machado-León J.L., de Oña R., Baouni T., de Oña J., 2017; de Oña J., de Oña R., Garrido C., 2017; Diez-Mesa F., De Oña R., De Oña J., 2016; de Oña J., de Oña R., López G., 2016; Machado-León J.L., de Oña R., de Oña J., 2016; Hernandez S., Monzon A., de Oña R., 2016; de Oña J., de Oña R., Eboli L., Mazzulla G., 2016.	(1fcv) – Planning  (2fcv) – Construction  (3fcv) – Use and Maintenance  (4fcv) – Disposal and Retrofitting
(2d) – Quality			(2i) – Historical Data Analysis		
(3d) – Satisfaction			(3i) – Service		
			(4i) – Courtesy		
			(5i) – Cost		
			(6i) – Personal Space		
			(7i) – Loyalty		
			(8i) – Frequency and Intelligent Schedule		
			(9i) – Information		
			(10i) – Intermodality		
			(11i) – Internet and social media		
			(12i) – Loyalty		
			(13i) – Cleanliness		
			(14i) – Mobility		
			(15i) – Customer profile by age range		
			(16i) – Punctuality		
			(17i) – Proximity		
			(18i) – Safety		
			(19i) – Simplicity and Adaptation		
			(20i) – Fare or Intelligent Pricing		

			(21i) – Temperature	R., López G., 2016;	
			(22i) – Trip or Intelligent Route	Machado-León J.L., de Oña R., de Oña J., 2016;	
			(23i) – Speed	Hernández S., Monzon A., de Oña R., 2016; de Oña J., de Oña R., Eboli L. Mazzulla G., 2016.	

Source: Author’s own work (2021)

**V. CONCLUSIONS**

Initially, a gap was identified in the research on the identified models of urban public transit management, in which a proposal for a Hybrid Intelligent Management Model was prepared based on the literature.

In the literature, no model was identified that could qualitatively and quantitatively measure the degree of impact of the guidelines on the lifecycle stages of the urban transport product.

Another absence was a discussion of models that could deepen the subject, considering environmental, social, behavioral, economic and financial needs, both for managers and for the business owners and users.

A serious criticism should be made regarding management that exclusively focuses on profits, satisfying the users’ desires, or even meeting the efficiency of the process. We noticed relevant issues in the literature, but they did not envision this subject in general.

In this sense, we observed the need to build a model that could adapt not only to customers, but also to the management method, and to business owners. For this purpose, the following trinomial was developed: (1) Business Owner; (2) Manager; and (3) Client. It has the following structure: (1) Satisfaction by base; (2) Quality by order; and (3) Result by purpose (with a qualitative and quantitative breakdown).

The idea arose in putting the name “intelligent model” to be truly manageable at the qualitative and quantitative level, i.e., adaptable and built through trial and error. This has remained a constant in the literature, as a competitive advantage is characterized by being competent – such competence does not involve only managing, but also providing an excellent service that caters to the desires of the collective.

Thus, the errors would represent the preventive and corrective factors, as well as predictive hits, establishing values, principles, and external and internal factors in business decisions.

Regarding the selection of items, the existing models were analyzed, with the issue of satisfaction, quality and behavior persisting in all of them. Regarding satisfaction, this driver favors the choice between public transit at the individual level, this satisfaction always being accompanied by quality and behavior.

As for the general objective of this research, which focused on the search for intelligent models related to the public transit service – pointing out the degree of impact of the variables of satisfaction, quality, and behavioral aspects of customers – it fully satisfied, with no finding identified that pointed to such a premise.

Regarding quality, the vast majority of items contribute to increasing customer and user satisfaction of urban public transit. To increase the satisfaction indicator, it is important to understand which of these items increases and decreases as a function of customer behavior towards the service provided, as well as environmental, social and economic issues.

In this sense, the research identified gaps that indicated that customers choose public transit while considering environmental, social and economic aspects, with environmental aspects relating to the need for renewable energy and the use of recyclable materials.

As for the social aspect, it was noticed that customers now define the choice while considering not only comfort and quality, but also other preponderant factors, such as intelligent paths and the design of transit systems that meet their collective choices, preferences, and trends. Companies must be aware of changes in each generation, and there is a need to create models that



consider this aspect. One example is the third generation, providing greater mobility to persons with disabilities, effectively meeting their needs, etc.

Customers in a worldwide contexts are not concerned only with the price, but also consider social and environmental, alongside comfort and quality. Here in Brazil, pricing is still the leading factor due to the economic crisis that marred the country for decades.

Another perception was that, based on the findings, the concept of eco-efficiency and smart cities was identified. This translates into a new trend in the form of management. Looking at the service from the standpoint of resources, integrating quality and satisfaction, can direct the customer's behavior. Companies now want to know not only why customers choose their services, but also take time to understand which parameters and factors lead to this decision.

Regarding the objective of the research, it was fully satisfied, as the authors carried out a bibliographical analysis on the main concepts studied, based on the established constructs, which pointed to these three guidelines: (1) Satisfaction; (2) Quality; and (3) Behavior.

Regarding satisfaction, customers need to feel safe, happy, and satisfied, not only having a request fulfilled, but also feeling pleasure in the form, conduct and purpose of the service provided while considering professional, traditional, innovative and artisanal aspects, without neglecting items deemed relevant for this purpose. That involves meeting what is expected through one's latent desire.

As for quality, the goal is to identify that all items have maximum safety, good taste, flexibility, and comfort, as a basis for satisfaction. Quality represents the essence of the service itself, offering excellence in its execution. Competence is strongly linked to quality, which is the accumulation of skill over time. This points to the need to understand the lifecycle of the service provided, based on the resources used in this process, whether they are material (structural capital) or immaterial (intellectual capital), as well as the human, environmental and social resources inherent in this macro process.

Competence is now directly related to competitive advantage, as the company becomes increasingly competitive based on its competences.

Finally, regarding behavior, customers have a strong inclination to be listened to, served and considered as participants in this process. Thus, it is important to have customers as allies and partners, providing them with daily platforms for redesigning satisfaction and quality, not only of what they hope to have as a service, but also pointing to

a social vision of this process. This is translated in the smart city concept.

Adaptable routes that include environmental, social and economic aspects, routes that are evaluated in compliance with not only a reduction in consumption, but also the quality of this reduction, with a reading of new renewable energies, compromise models that consider resources that are recyclable and less aggressive to the environment.

The scientific contribution of this study lies in proposing a hybrid management model that uses current guidelines, in its 23 items, with a view of the life cycle of the public transit service.

Therefore, the practical contribution can be identified over time in the appreciation of satisfaction, quality, and the understanding of the customer's behavior towards the service provided, with the cost and its reduction demonstrating efficiency in conducting the business.

Another perception pointed by the survey was the need to create new business trends to explore this market, opening up the current model of companies to explore a limited sector or territory and creating alternative routes that facilitate, improve and adapt to the real needs of users.

As for the limitations of this research, they involve the lack of presentation of a literature that determines the degree of impact of the satisfaction, quality and behavior guidelines in relation to the Intelligent public transit service, based on the lifecycle of the products.

Proposals are made for new research that indicate the degree of impact of each item of the guidelines based on the product's lifecycle, as contained in the Intelligent public transit model proposed in this research, identifying the reason for each one of them. Such research should also point out the main advantages and disadvantages at the qualitative and quantitative level.

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## Use of VR/AR techniques in Remote Laboratories: a systematic review

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**Keywords**— *Virtual reality, augmented reality, remote laboratories.*

**Abstract**— *Educational technology is now a necessity for teaching and learning and this necessity became even bigger with the pandemic of COVID-19, where many students can't access the facilities of their educational centers. Virtual Reality (VR), Augmented Reality (AR) and Remote Laboratories are great trends for the future of education. While remote laboratories bring the opportunity of access to experimentation that many students don't have, VR/AR provides an immersion that completely changes the user's experience. These tools bring several opportunities for the classroom, mainly when working with STEAM subjects. Therefore, this paper seeks to verify the current situations of integration of VR/AR techniques in remote laboratories presented in research papers. Through systematic research, the authors researched open access papers published in the last five years (period 2017-2021). The databases chosen were IEEE Xplore, Science Direct, and Scopus. After finding the papers, it was possible to identify successful situations of integration of VR/AR techniques in remote laboratories and also to verify expectations and trends for VR/AR integrated to remote laboratories that the authors of these papers presented. After the publishing of this paper, the authors will seek to research further on VR/AR and remote laboratories to develop research projects and educational software.*

### I. INTRODUCTION

Virtual Reality (RV) and Augmented Reality (RA) are emerging trends for the future of many fields of knowledge such as medicine, industry, entertainment, and education. They bring many opportunities for the education of STEAM (Science, Technology, Engineering, Arts and Mathematics) subjects [1].

Everyday technology becomes more participative in the classroom, and the advent of the COVID-19 pandemic brought even more evidence for this fact. Therefore, the use of techniques such as RV/AR brings many opportunities for the educational field.

In the past, AR used to be an expensive technology mainly used by the industry [2].

Today, it is possible to find several software which makes use of AR for educational means. Meanwhile, VR is becoming more popular each day in entertainment, for example, in games [3]. Although, it also has great potential for the development of educational software.

Remote laboratories and VR/AR have much-discussed tools in the educational context. They offer a practical and motivating way for teaching students and are therefore an interesting subject for scientific research [4]. Remote laboratories are laboratory experiments that can be

controlled and monitored remotely from a distant location [5], so it offers many advantages in education scenarios in comparison to a classic laboratory. It is even more important to think about a scenario where students can't access the school or university facilities.

The integration between RV/AR techniques and remote laboratories is a very interesting concept to work on because there is a high demand for excellent laboratory equipment in many fields of education, such as medicine and engineering. Thus, the research and development on this integration have great potential for educational and economic means.

This research paper aims to verify situations of integration of RV/AR techniques and remote laboratories developed and published in the last 5 years and it will be done through systematic research.

**II. MATERIALS AND METHODS**

The research method chosen for this paper is a systematic review. A systematic review of the scientific literature in a specific area is important for identifying research questions, as well as for justifying future research in said area [6]. Additionally, they identify and minimize bias via transparent, explicit, and systematic methodology. [7]

According to Khan et al [8], there are five main steps for conducting a systematic review:

Table 1: Five steps in a systematic review

Step	Description
1	Framing questions for a review
2	Identifying relevant work
3	Assessing the quality of studies
4	Summarizing the evidence
5	Interpreting the findings

Source: Adapted from Khan et al [8]

During the first step, the researcher needs to define the problems to be addressed by the review. Once the review questions have been set, modifications to the protocol should be allowed only if alternative ways of defining the populations, interventions, outcomes, or study designs become apparent [8].

The second step is the moment to research relevant work in databases. The study selection criteria should flow directly from the review questions and reasons for inclusion and exclusion should be recorded.

Assessing the quality of studies is related to selecting studies for a more refined quality assessment based on defined criteria.

Related to the fourth step, data synthesis consists of tabulation of study characteristics, quality and effects as well as the use of statistical methods for exploring differences between studies and combining their effects (meta-analysis) [8].

Finally, in interpreting the findings; the issues highlighted in each of the first four steps should be met. The risk of publication bias and related biases should be explored [8].

For this paper, the research question is to verify situations of implementation of VR/AR techniques in remote laboratories.

The databases chosen for this research were IEEE Xplore, Scopus, and Science Direct. The keywords chosen were "augmented reality", "virtual reality" and "remote laboratories" and the filters were only open access papers that were published in the last 5 years (2017 to 2021) - the first idea was to research publications newer than 2019, but only one paper was selected after applying all the filters for the systematic review.

As the following table presents, 34 results were found.

Table 2: Results from Databases

Especificações		Results from Databases			Total
		IEEE Xplore	Science Direct	Scopus	
Keywords	1. Augmented Reality 2. Virtual reality 3. Remote laboratories				

Type of publication	1. Open access only papers	21	180	44	245
Publication date	1. Last 3 years				

Source: Authors

The following topic, Results, presents further information related to the results found after applying these filters.

5	Complete reading	4	2	2	8
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Source: Authors

### III. RESULTS AND DISCUSSION

This topic aims to present the results found in the systematic review. It has three subtopics: "Results of the systematic review", "Situations of integration of VR/AR techniques and remote laboratories" and "Expectations and trends for the future".

#### RESULTS OF THE SYSTEMATIC REVIEW

This subtopic presents the results of the systematic review and the description of all steps taken to develop this research.

After finding the last results found in the table presented in the Materials and Methods topic, five more filters were applied. They were: analysis of the relevance, reading of title and abstract, exclusion of double papers, reading of introduction and conclusion, and complete reading. The following table presents the remaining papers after applying the filters:

Table 3: Filters applied to the results found in the databases

Specifications		Results in databases			Total
Filters		IEEE Xplore	Science Direct	Scopus	
1	Analysis of relevance	21	180	44	245
2	Reading of title and abstract	6	10	20	36
3	Exclusion of double papers	6	10	20	36
4	Reading of introduction and conclusion	6	10	3	19

The first filter, analysis of the relevance, was related to verifying the keywords and if the paper was available for download. All the papers found were suitable to keep the research.

After that was the moment to read the titles and abstract. Many papers were dismissed because they were not about remote laboratories, but only about augmented reality or virtual reality. Also, many of them were about the application of VR/AR techniques in the fields of industry and health. From Science Direct just a few papers remained, but they needed to be dismissed because they did not approach remote experimentation.

The filter for exclusion of double papers did not exclude papers because none of them were doubles.

After reading the introduction and conclusion, from the 20 papers from Scopus, only 3 were selected because most of them were not about the integration of remote laboratories and VR/AR techniques - they were about the creation of simulations.

In conclusion, only 8 papers were selected for complete reading: 4 from IEEE Xplore, 2 from Science Direct, and 2 from Scopus.

It is possible to conclude that just a few research works related to VR/AR techniques integrated into remote laboratories were developed in the period 2017-2021. Although, some papers affirm that it is a trend to explore for the future.

#### SITUATIONS OF INTEGRATION OF VR/AR TECHNIQUES AND REMOTE LABORATORIES

From the papers found in the systematic review, x presented situations of integration of VR/AR techniques and remote laboratories. This subtopic presents these situations.

The following table shows the papers presented on this topic and their authors.

Table 4: Situations of integration of VR/AR techniques and remote laboratories

Paper	Authors
Virtual reality for remote-controlled robotics in Engineering Education	A. Rukangu, A. Tuttle and K. Johnsen
Adding augmented reality to laboratory experimentation	J. Rodrigues, T. Andrade, P. Abreu and M. T. Restivo
Using marker-based augmented reality and natural user interface for interactive remote experiments	A. Maiti, A. D. Maxwell and A. A. Kist
Programming and testing a PLC to control a scalable industrial plant in a remote way	M. Márquez, A. Mejías, R. Herrera and J. M. Andújar
Augmented reality for remote laboratory improving educational learning: using elevated particle swarm optimization in object tracking scheme	S. M. Zandavi and V. Chung
Remote and virtual labs for engineering education 4.0	J. Grodotzki, T. R. Ortelt and A. E. Tekkaya
Remote lab meets virtual reality - Enabling immersive access to high tech laboratories from afar	P. Trentsios, M. Wolf and S. Frerich
Factors affecting Chinese university students' intention to continue using virtual and remote labs	M. Zhang, C. Su, Y. Li, and Y. Y. Li

Source: Authors

In the paper "Virtual reality for remote-controlled robotics in engineering education," they use virtual and augmented reality to build and test a remote UR-10 robotics lab that allows students to work together on a hands-on robotics-based lab [1]. In conclusion, the authors find out that the use of a virtual reality interface coupled with a digital twin of a UR10 robot allows them to investigate the suitability of different user interfaces.

The paper "Adding augmented reality to laboratory experimentation" proposes the use of augmented reality in laboratory experiments as a way to enrich the user experience in conducting the required procedures as well as reinforcing students' skills [2]. According to the authors, as the experiment involves

controlling the level of a water tank, the user controls the water pump through a virtual command provided by AR. Finally, the three AR applications developed by the authors are available for download.

The paper "Using marker-based augmented reality and natural user interface for interactive remote experiments" introduces a method to use augmented reality and a natural user interface to create interactive laboratory experiments [9]. The new system allows hands-on experience with virtual objects as a part of the remote laboratory's activity.

The authors of "Programming and testing a PLC to control a scalable industrial plant remotely" present a scalable industrial plant that puts plug and label to bottles. Although it is not a study related to education, it is still a combination of real and virtual elements [10]. The element which puts the plug is virtual, implemented using augmented reality techniques and the labeler is a real element.

The algorithm proposed by the authors of "Augmented reality for remote laboratory improving educational learning: using elevated particle swarm optimization in object tracking scheme" regarding target tracking in AR remote labs represented better performance in comparison with classic and other improved PSO [11].

"Remote and virtual labs for engineering education 4.0" presents the main achievements of the ELLI (Excellent Teaching and Learning in Engineering Science) project at the TU Dortmund University - which is the center of the development of remote and virtual labs for mechanical engineering education with a focus on manufacturing technology [4]. The second phase of the project will integrate other technologies to remote experimentation, such as augmented and virtual reality.

Since virtual reality is one of the strongest trends in the consumer and gaming industry, while remote labs are becoming more popular in engineering education, "Remote lab meets virtual reality - enabling immersive access to high tech laboratories from afar" combined these two domains. As the whole nature of this approach is experimental, the authors aimed at a variable degree of immersion and established two different approaches for the creation of a virtual environment [3].

"Factors affecting Chinese university students' intention to continue using virtual and remote labs" presents results related to the satisfaction of Chinese students while studying with the help of remote labs integrated with VR/AR [12].

## EXPECTATIONS AND TRENDS FOR THE FUTURE

Most of the papers found in this research presented expectations and trends related to VR/AR and remote laboratories.

VR/AR are great trends for the future of education - mainly in the fields of engineering and health, where the students must have the opportunity to practice concepts they learn during theoretic classes. Most of the papers found in the systematic review were related to the integration of remote experimentation of VR/AR for educational means. Most of them affirm that both remote laboratories and VR/AR are growing trends.

A few years ago, AR was an expensive technology mainly used by the military and aerospace industry [9]. At present, there are many different types of devices that allow distinct AR implementations in multiple areas such as medicine, entertainment, industry, and education. So some authors [2, 3, and 4] believe it is considered mandatory to introduce it in every engineering curriculum.

On the other hand, virtual reality is currently one of the strongest trends in the consumer and gaming industry, while the typical remote lab in engineering education is also a very popular tool [1]. There is a high demand for high-end lab equipment in engineering education, especially for courses that require practical hands-on lab exercises [1]; therefore, a system that allows students enrolled in remote courses to experience hardware-intensive classes just as they would in an in-person course - especially in light of the COVID-19 pandemic - is a real necessity.

Thus, it is possible to notice that the integration of AR/VR techniques and remote laboratories is a great trend to create a more immersive experience for students from many areas of knowledge.

## IV. CONCLUSION

The systematic review allowed the authors to verify the situations of implementation of VR/AR techniques in remote laboratories published in the last 5 years. As these concepts are great trends for the future of education, just a few results were found, but they proved to be excellent research works that show examples of implementation of these situations.

It is a great field to explore and there is much space to develop new and innovative projects to perpetuate the use of these tools. It can also be said that the COVID-19 pandemic brought another motive to encourage the use of practices such as VR/AR and remote laboratories because

so many students do not have the opportunity to access hands-on laboratories.

Therefore, after the publishing of this paper, the authors will seek further information on the integration of VR/AR techniques and remote laboratories to develop projects and software to integrate these technologies in STEAM education.

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# Swarm Intelligence based Fire Fighting Robot

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**Keywords**— *SIFFR, Swarm Robotics,  
Temperature Sensor*

**Abstract**— *The swarm robotics inspired from nature is a combination of swarm intelligence and robotics, which shows a great potential in several aspects. Swarm robotics is a relatively new and rapidly developing field which draws inspiration from swarm intelligence. It is an interesting alternative to classical approaches to robotics because of some properties of problem solving present in social insects, which is flexible, robust, decentralized and self-organized. Fire detection and extinguishment are the hazardous job that invariably put the life of a fire fighter in danger. By putting a robot to perform this task in a fire-prone area, it can aid to avoid annoying incidents or the loss of lives. This paper describes the development of Swarm Intelligence Fire Fighting Robot using (SIFFR) that is equipped with the basic fighting equipment that can round through the hazardous site via a guiding track with the aim of early detection for fire. When the fire source is being identified, the temperature will be promptly extinguished using the fire extinguishing system that is mounted on receiving robots platform. To detect for fire source, the input from temperature sensors were finely-tuned in relation to the surrounding area, external interference and the mobility of the SIFFR prior the deployment of the platform.*

## I. INTRODUCTION

Fire-Fighting is an extremely dangerous task but still often being carried out by human operators, thus putting human life, invaluable as it is, in a very wobbly situation [1]. Swarm robotics is a relatively new technology that is being explored for its potential use in a variety of different applications and environments. In particular, swarms of robots potentially employ different types of communication channels; have special concepts of identity; and exhibit adaptive emergent behavior which could be modified by an intruder [4]. Addressing these issues now will prevent undesirable consequences for many applications of this type of technology.

This robot will detect any obstacle comes in his way. IR sensors are mounted on this robot which will operate on 5v input and emits infrared signals continuously. Sensor will sense and manipulate the signal reflected by the obstacle.

Sensor output will have main role for the movement of robot. Slowly when the robot will reach to the obstacle, the intensity of reflected light will increase and at a particular value the robot will stop and will change its path automatically. The IR output will give to the microcontroller, which will set the relay ON or OFF position. DC motor driver L298 is used for driving the motor. Here the first robot start working then it senses light or fire with the help of temperature or light sensor. Which building floor is suffered with fire is detect with sensors and send data to second robot. Then the second robot receives that data with the help of RF transceiver and start working on same path. After reached destination point the robot will start sprinkling water on that floor.

This paper presents the design, implementation and experimental demonstrations of the SIFFR. The contents are organized as follows. Section 2 introduces the concept

of swarm robotics. Section 3 shows the system specification and block schematic of SIFFR module. Hardware design is described in Section 4. The software design and algorithm is explained in Section 5. Test setup and testing procedure is interpreted in Section 6. Meanwhile results and analysis are shown in Section 7. Finally, Section 8 summarizes the research conclusions and sheds some light on the future work.

## II. SWARM ROBOTICS

Swarm intelligence embodied by many species such as ants and bees has inspired scholars in swarm robotic researches. Nature always gives humankind knowledge and inspirations. Through distributed collaboration or assembling themselves into different collective structures, insects like ants and bees get able to transport objects that are too large for any single one of them or to bridge gaps that will stop them separately as individuals. Swarm intelligence personified by these social insects when they cooperate with one another in a large scale has been brought into robotic research by scholars and become an attractive topic in the robotic community [2].

Non-communicative swarming has to be achieved without central or on-line control. In non-communicative mode the swarm consists of homogeneous but anonymous robots, the latter means that the robots are able to recognize another robot as a robot but they cannot identify other robots as a particular individual with a unique name. The advantages of this approach are that the swarming behavior is relatively independent of the number of robots that are active, making the swarm robust to failures of individuals and its size may vary considerably. A drawback is that as the swarm behavior depends on many parameters and is inherently complex, it is hard to fully predict the behavior. Swarm research therefore usually aims at behavior types of a general nature. The basic behaviors that can be generated in the non-communicative mode are [3], [5]:

1. Obstacle and Robot avoidance.
2. Wall/Track/. Gradient following
3. Aggregation/Dispersal/Gathering/Clustering
4. Area Coverage
5. Basic Search/Exploration Behavior
6. Acquisition/Maintenance of Geometric Formations
7. Autonomous Navigation

## III. SYSTEM SPECIFICATION AND BLOCK SCHEMATIC

### A. Specifications

- MLX 90614 Infra Red Sensor: - It is low noise amplifier, 17-bit ADC and powerful DSP unit, a high accuracy and resolution of the thermometer is achieved.
- Microcontrollers (AVR-ATMEGA 16), display units (LCD) are used to perform the coordination between various blocks.
- Motor driver LM298 is used to drive DC motors in both the master and slave robot.
- CC2500 low-cost, low-power 2.4 GHz, SPI interface RF Transceiver is used communication between transmitter and receiver robot.

### B. Block Diagram

Transmitter side block diagram

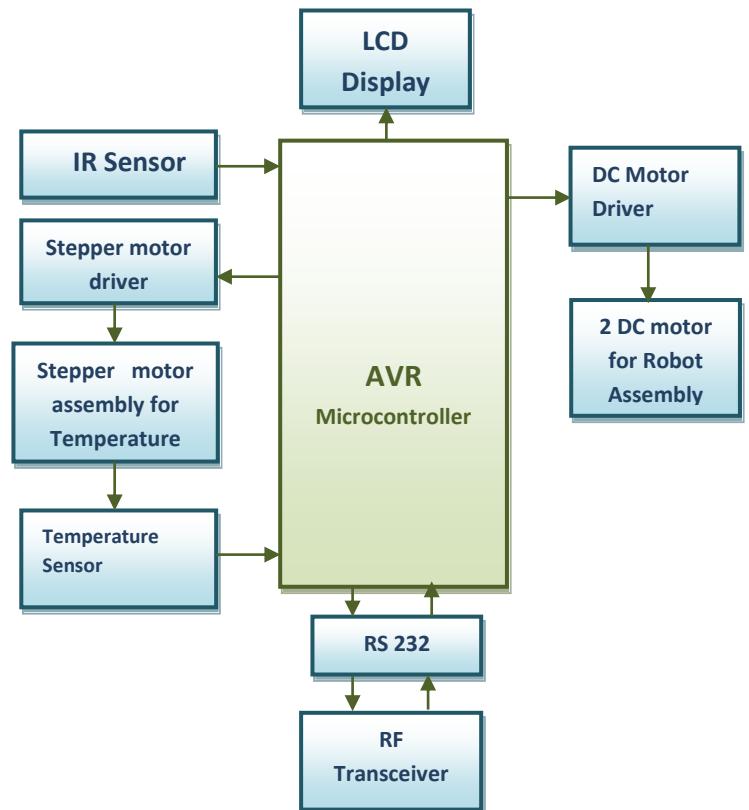


Fig.1: Schematic diagram for Transmitter block.

Working: - MLX 90614 Infra Red Sensor will sense the change in temperature and give signal to the AVR-ATMEGA 16 microcontroller. Microcontroller will check temperature at different degrees with the help of stepper motor. If it will find any change in temperature it will send command to the receiver via CC2500 RF Transceiver.

Receiver side block diagram:-

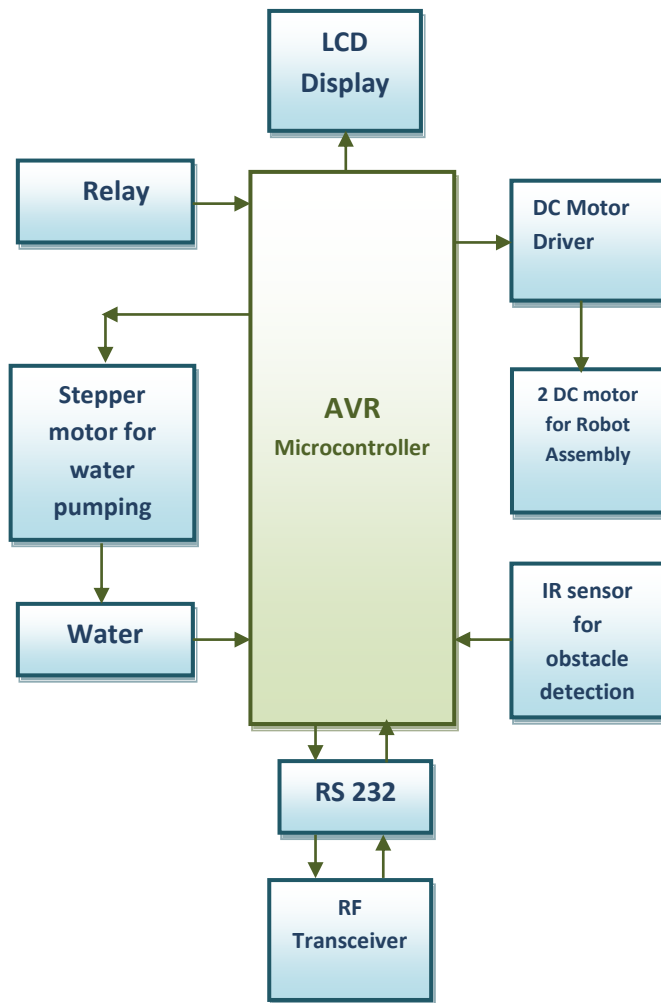


Fig.2: Schematic diagram for Receiver block.

Working: -The receiver side block is also having an IR sensor for obstacle detection in its path. After getting signal from the transmitter through RF transceiver it will follow its path to reach upto the desired location with the help of DC motors provided to it. After reaching to the required location it will start sprinkling water at the fire place with the help of water pump which it fitted on the stepper motor so that it will sprinkle water in all directions.

#### IV. HARDWARE DESIGN

Hardware design begins with selection of proper equipment required to do the various jobs. Selection is mainly on the basis of current and voltage ratings, IC packages, clock rate and cost. Power supply is designed for the various components according to their ratings.

##### A. Microcontroller

Two microcontrollers are required one for transmitter and other for receiver robot. AVR is preferred over PIC and 8051, as it takes only one machine cycle to execute one instruction as against 12 for 8051 and 4 for PIC [11].

Specifications:

Advanced RISC Architecture

- 131 Powerful Instructions – Most Single-clock Cycle Execution
- $32 \times 8$  General Purpose Working Registers – Fully Static Operation
- Up to 16 MIPS Throughput at 16 MHz
- On-chip 2-cycle Multiplier

High Endurance Non-volatile Memory segments

- 16 Kbytes of In-System Self-programmable Flash program memory
- 512 Bytes EEPROM, 1 Kbyte Internal SRAM
- 10,000 Flash/100,000 EEPROM
- Data retention: 20 years at 85°C/100 years at 25°C
- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by On-chip Boot Program
- True Read-While-W

##### B. Sensors

Using MLX 90614 Infra Red Sensor for temperature detection and it is fitted on stepper motor so that it will sense temperature at different step angles. IR sensors on both transmitter and receiver for obstacle detection.

- Melexis' MLX90614ESF-BAA is an infrared thermometer designed for non-contact temperature sensing. An internal 17-bit ADC and a powerful DSP contribute to the MLX90614's high accuracy and resolution. It has a huge number of applications including body temperature measurement and movement detection.
- The MLX90614 provides two methods of output: PWM and SMBus . The 10-bit PWM output provides a resolution of  $0.14^{\circ}\text{C}$ , while the TWI interface has a resolution of  $0.02^{\circ}\text{C}$ . The MLX90614 is factory calibrated in wide temperature ranges:  $-40$  to  $85^{\circ}\text{C}$  for the ambient temperature and  $-70$  to  $382.2^{\circ}\text{C}$  for the object temperature. The measured value is the average temperature of all objects in the Field Of View of the sensor. The MLX90614 offers a standard accuracy of  $0.5^{\circ}\text{C}$  around room temperatures [10].

### C. Motor driver LM298

LM L298 is an integrated monolithic circuit in a 15- lead Multiwatt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver de-signed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the in-put signals. The emitters of the lower transistors of each bridge are connected together and the corresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage.

### D. CC2500 low-cost, low-power 2.4 GHz, SPI interface RF Transceiver

The CC2500 is a low cost 2.4 GHz transceiver designed for very low power wireless applications. The circuit is intended for the 2400-2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. The RF transceiver is integrated with a highly configurable baseband modem. The modem supports various modulation formats and has a configurable data rate up to 500 kBaud.

### E. ULN2003 driver is used to drive relay and stepper motor.

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers. The ULN2003 has a 2.7k $\Omega$  series base resistor for each Darlington pair for operation directly with TTL or 5V CMOS Devices. The main features are 500mA rated collector current(Single output), High-voltage outputs: 50V, Inputs compatible with various types of logic, Relay driver application

### F. Power supply design

An ideal regulated power supply is an electronic circuit designed to provide a predetermined voltage  $V_o$ , which is independent of load current, temperature and also of any variations in line voltage. The power supply consists of Step-down transformer, Bridge Rectifier, Filter, IC Regulator. Power supply is a vital part of all electronic systems. This circuit is required to drive the various components on the board. It is normal voltage regulator built with ubiquitous Transformer-Bridge Rectifier-Filter-

Regulator assembly. We required a 5v supply for digital IC's.

## V. SOFTWARE DESIGN

Codes were written in AVR Studio. Part by part circuit simulation was carried out on Proteus Design Suit. Complete interfacing diagram was prepared on EAGLE.

Algorithm:

1. The transmitting robot which consists of Infrared sensor enters a lane with multi storey and single storey residential Houses and buildings.
2. As the transmitting robot moves from one house to other it checks the temperature of that floor or house using IR sensor.
3. If the temperature is less than threshold voltage the robot moves on to the other house.
4. If the temperature is more than threshold voltage the robot sends a signal using RF trans receiver to receiving robot.
5. The receiving robot follows up the signal and goes to the house of which the transmitting robot had send in the signal and sprays water using water jet [5].
6. The Receiving robot also gives audio and visual signal to nearby people.
7. The Transmitting robot keeps checking the Temperature of affected region as the Temperature comes below the threshold voltage the Receiving robot stops spraying water.
8. The Transmitting robot moves on to the other house.

## VI. TEST SETUP AND TESTING PROCEDURE

Once the PCB along with the peripheral devices, it is necessary to verify that, the design is correct & the prototype is built to the design drawing. This verification of the design is done by writing several small programs, beginning with the most basic program & building on the demonstrated success of each. It is important to test and troubleshoot the hardware in the following steps:

- Physically check all the connections.
- Check whether power supply wires are firmly connected to all boards.
- Check for any dry solders.
- Check if IC's are physically in place.
- Check whether all components are correctly mounted.
- Check whether VCC and ground are shorted.
- The PCB has a single main VCC and ground track on it. It is necessary to ensure that neither of these tracks is shorted or open at times a short circuit may occur



and IC's would be in danger of being shorted. This can be checked by a multi-meter at various points of tracks carrying necessary VCC. Ground has '0'V across it.

- Check IC's VCC and ground:
- Once the above step is performed check individual IC's to see that correct pins are connected to VCC and Ground. This can be achieved by checking the voltage levels on multi-meter at each VCC and Ground pins of all IC's.

In the figure 3 the transmitter robot is checking each house on its path for any rise in temperature and the receiver robot is following the path of the transmitter. In this setup authors showed the transmitter in the check mode and the receiver in the receiving mode.

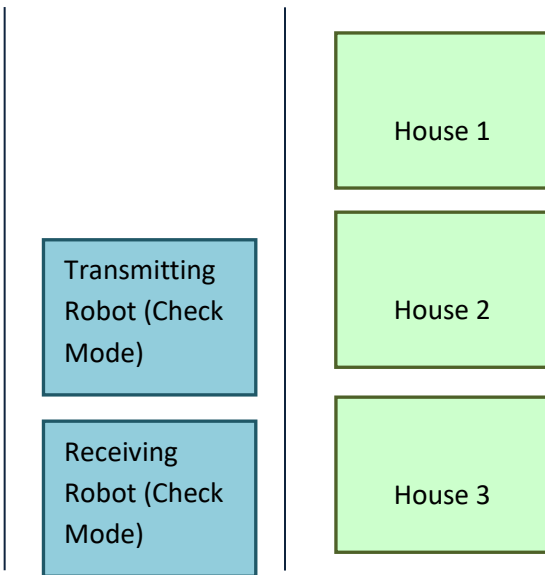


Fig.3: Setup of check mode at transmitting side

In figure 4 setup, the transmitter has detected the origin of fire at house 1 and called the receiver to the required location. The transmitter itself has gone in wait mode while the receiver in the spraying mode is spraying the water at the fire place.

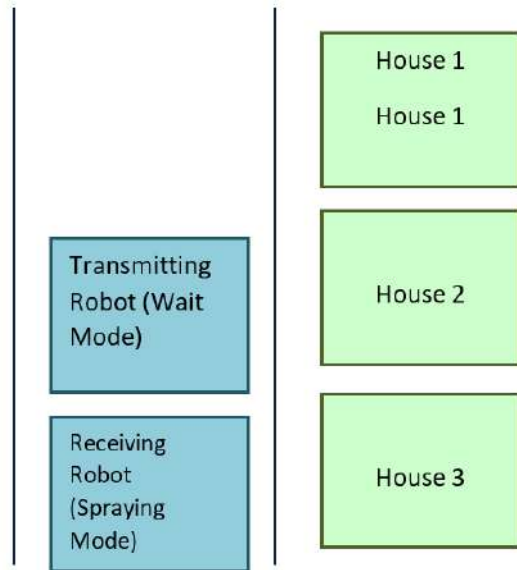


Fig.4 Setup of check mode at receiving side

### VII. RESULT AND ANALYSIS

This paper served two purposes. First it helps to find the origin of fire in multi-storied buildings. Since it is very difficult to control fire in multi-storied buildings because the newly constructed buildings have fire safety system installed in it but what about the old tall buildings, they don't have such kind of system installed in it. For such buildings this project will play important role to detect the origin of fire and its control. Second, it continuously checks any rise in temperature in all directions in densely infra structured areas and as soon as it finds any rise in temperature(chances of fire occurrence) it will send signal to slave robot. Slave robot will come to the fire place and sprinkle water to extinguish fire.

Results-Output:



Fig.5: Transmitter robot moving forward

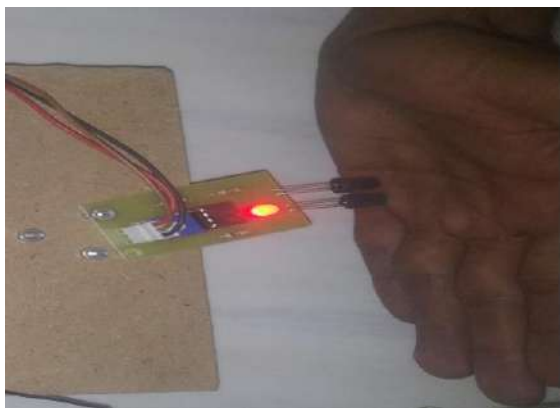


Fig.6: Transmitting Robot detecting Obstacle.

In Figure 5, the transmitter robot is moving forward while checking the surrounding temperature and the same will be displayed on 16X2 LCD.

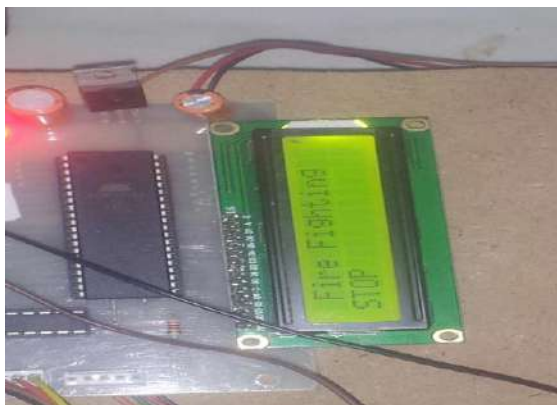


Fig.7: Transmitting Robot stops.

In Fig 7,when the transmitter comes across any obstacle in its path it will stop the moment it senses the obstacle and the same is displayed on LCD.

## VIII. CONCLUSION

From this paper, it is evident that the Swarm intelligence can be used for the Fire-fighting purpose. The transmitter (master) robot will sense the rise in temperature in multi-storied as well as densely infrastructure areas with the help of Infrared temperature sensor fitted on it. It will send signal the moment it will come in contact with the rise in temperature using RF Transceiver to the receiver robot. Receiver(Slave) robot will follow its path and reach up to the fire place and start sprinkling the water until the fire extinguishers using water pump and relay fitted on it. Design of multiple fling robots is proposed in future studies.

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# The Digital Game ‘Artesaga’ as a Methodological Strategy for Teaching Art History

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**Keywords**— Educational digital games; Art  
History; methodological strategy.

**Abstract**— Digital games have been presented as mediation tools in the Learning Process area in educational contexts. As such, this article aims to present the educational digital game ‘ArteSaga’ which allows the learning of Art History in high school. For that to happen, a survey was conducted in IFRN – Campus Parnamirim, in four second grade classes of high school, allowing for the development of software, whose conductive approach is the Design Methodology. This investigation started with a bibliographic research, followed by a questionnaire applied to the students, with the purpose to determine the digital game shaping, and it is developed in C# language and its graphic design created with Raster graphics. The game ‘ArteSaga’ was created and validated presenting the content related to the Prehistoric and Ancient Art periods, and the final prototype was exhibited at scientific research expositions and scientific and technological events in the area.

## I. INTRODUCTION

The ever-moving, transformative society of which we participate constantly fosters the evolution of the most diverse digital technologies, which in exchange tend to interact, disrupt and significantly change how we live and connect as human beings. Among society segments that have been changing due to the prevalence of new technologies, there is Education. In this segment, digital technologies have boosted significant changes, linked to learning and teaching process, making it possible for the emergence of new theories that extend our comprehension of the processes involved in knowledge acquisition.

Accordingly, in the last years the Virtual Learning Environment (VLE) has been causing a revolution in education and extending the spaces of human interaction, since they interfere in and mediate informational and communicative processes. This way, important tools of knowledge diffusion and democratization of information

have been produced, allowing students access to a variety of new technological resources (SUZUKI, 2007).

With the dissemination of these technologies, a new demand arises: the use of technological tools in education to stimulate learning. Damasceno (2008, p. 1), discussing the use of technologies such as digital games, says that “The use of virtual games, as education strategy, is extremely effective to the increase of students’ motivation and a powerful educator tool to the teaching and learning process”. It is, therefore, noticeable that digital resources and their many interaction tools allow students to be active subjects on building their own knowledge, stimulating a better educational development.

Building from that, we noticed the importance and need of developing a digital game via a virtual learning environment to contribute to students’ education in the Visual Arts subject. In a VLE, the interactive interface between students and their learning object is deemed essential for the effectiveness of knowledge absorption.

The digital game 'ArteSaga' is presented as a studying instrument, making possible the teaching and learning processes and putting into practice skills and competences, in a ludic and affectionate way, combined with specific target topics in the Art subject, considering that some of these topics can be as ancient as humanity. As Mattar (2010) explains that "Art is one of the ways encountered by (men) to transcend themselves. It brings men's testimony about their own existence with its complexity and depth."; and in that way, this is a game that has the purpose to instigate the study and interest in Art History topics.

The goal of this research is to develop the educational digital game 'ArteSaga', which proposes a connection between the Visual Arts subject and Art History content, allowing a better learning for the students, focusing on their motivation and comprehension of the worked content.

The game is developed in an interactive way, with the purpose of being used as a methodological strategy for education, enabling content comprehension of second graders of high school at IFRN – Campus Parnamirim that is localized in Parnamirim city, in the state of Rio Grande do Norte, Brazil.

#### 1. The context of Research on Virtual Learning Environment

Communication, technology and education form the fundamental pillars to the formation of humans in the 21st century (FERREIRA; SOARES; LIMA, 2012). For that, the use of VLE has been an interactive technological resource among these pillars, promoting the formation of students and encouraging the transmission of knowledge via appropriate instruments.

As Frosi and Schlemmer (2010) said, the use of Information Technology and Communication has been revolutionizing the ways of teaching and learning, and a way of using them in education happens by means of Virtual Learning Environments. This way, with the advances in programming languages and methodologies over the past century, there has been a significant progress on building VLEs.

There is evidence that the increasing access to VLE on Brazilian schools has been providing a great contribution to the education of high school students, given that almost half of the educators have declared using computers so students may participate in activities in virtual environments (BARBOSA, 2014). That data illustrate the fact that educators understand the importance of the use of technology in schools to the development of the teaching and learning process.

Simultaneously, the young students are the most frequent users of technology in their everyday lives, which results in a big familiarity with this new learning method. Not only that, but the digital games very often provide a way to escape from stress caused by the school activities due to the exhausting learning methods imposed by schools.

This way, in order to contribute with the engagement of students and with the learning of the Art subject, we noticed the importance of developing a digital game through a virtual learning environment with its interactive processes between students and the learning object. Such interaction is essential to the appropriation of the learning process, since the game may be used as an alternative of education to assist on curricular contents and a methodological strategy that helps on the necessary education across the curriculum.

Based on the above considerations, the digital game 'ArteSaga' may act as a learning tool, given that its use may also occur at any given moment, allowing the teaching and learning process and putting in practice skills and competences, in order to be added to the previously acquired knowledge.

#### 2. An educational digital game as a methodological strategy

In Art education, there are some examples of instruments to develop a virtual learning and reading environment. An example for that is the digital game GAMEDUCA (NÓBREGA, 2011), which proposes the development of a multiplayer digital game as didactic instrument to the teaching and learning of Art History, allowing that its users, registered through profiles, act as curators mounting expositions and exercising the practice of critical analysis.

According to Pereira (2016, p. 8), "the use of VLE, allied to other available resources on cyberspace, contributes significantly to the search for improvement of the teaching and learning processes in the Visual Arts subject". This way, such environment has the role to mediate knowledge through elaborated softwares, aiming to ease the learning process, according to Jordão, Martini and Salomão (2007). The authors observed that "the game mobilizes mental schemes, stimulates thinking, time and space ordination; integrate many dimensions of affective, social, motor and cognitive personality" (JORDÃO; MARTINI AND SALOMÃO, 2007, p. 9). This way, it is a space designated for knowledge transmission, besides developing technical and psychological skills among the students and educators involved.

In that context, teenage students are the most frequent users of technology in their everyday lives, which means that they have a big familiarity with this new learning method. As McGonigal (2012) says, "humanity spends



around three billion hours weekly playing. Considering the dedicated time to that activity, it is undeniable that games have a clear appeal in current society.” This way, we’ve come to realize that digital games can be part of school life, keeping in mind the potential to integrate technology with conceptual, procedural and attitudinal contents. According to Paula and Valente (2016),

Digital games have been finding, more and more, space in Education. We believe that one of the reasons for this option for games is the ability of motivation that these artifacts have. It is considerable that this power of engagement from video games is supported by the pervasiveness of digital games nowadays (PAULA; VALENTE, 2016, p. 11).

In Education, digital games can also be seen as a way to motivate students that are uninterested in school contents and in imposed methodologies. However, they do not have to be accepted with that bias, but as a booster of education contributing with students’ engagement on school subjects. For Presky (2001), when considering the importance of learning based in digital games, he expresses that it functions for three reasons:

1. The increased engagement comes from the learning process being placed in a game context. This can be considerable, mostly for people that hate learning.
2. The interactive process of applied learning. That can, and should, assume many different forms depending on learning objectives.
3. The manner in which both are united in total package. There are many ways to do it and the best solution is highly contextual (PRENSKY, 2012, P. 209).

However, in this context, it is observable that the use of digital games has grown in high school subjects (DAMASCENO, 2008). So that, in ‘Arts II’ subject, in 2<sup>nd</sup> year of high school at IFRN – Campus Parnamirim, students have grouped to propose the development of a digital game for History of Visual Arts content in order to provide an active learning process. Such question is emphasized on the following affirmation,

[...] the games seem to offer activities that are highly consistent in relation to the modern theories of effective learning proposed by psychologists and educators. The learning from games provide activities that benefit an active learning process, based on experiences, situated, based in problems, that provide immediate feedback, consistent with cognitive theories and involve communities that offer collaborative support to the players while they learn. (BOYLE;

CONNOLLY; HAINEY, 2011, p.72 qtd. in PAULA; VALENTE, 2016, p.13).

Finally, educational digital games can be deliberated as interactive and active forms, leading students to develop attention by experiencing challenges that occur at increasing levels, enabling the learner to be offered playful moments and at the same time integrated into the learning processes, since gamification contemplates the use of skills, mechanics, aesthetics and thoughts to adhere people, motivating them to action, promoting learning and solving problems (KAPP, 2012). Students can find through their playful action the meaning of conceptual elements, the visualization of real situations and possible learning outcomes.

## II. METHODOLOGY

The research on the development of the ‘ArteSaga’ digital game has taken place since 2019 and is carried out using the Design Methodology as a leading approach, which presents itself as a process in the development of projects by which a certain result is instigated, being structured in different stages based on methods and tools, with the objective of helping the team in the conception and development of the digital game to be developed. For this, the following phases of the methodological procedure were followed:

1. Bibliographic survey on the state of the art that was carried out from bibliographical research in articles, books, dissertations and theses. Its objective was to compose the investigation of bibliographical references about: educational digital games, the teaching of Art and Art History through new technologies. To facilitate the search, the Google Academic platform was used, a research tool that allows locating academic papers in specific areas in order to develop the theoretical framework established for the study. With the content accessed, the use of digital educational games is currently perceived as a generator of good results with regard to learning the subject content.

2. Application of data collection instruments: elaboration of a questionnaire on Google Forms in order to search the student profile, more specifically, of the four classes of the second year of the integrated high school of the IFRN - Campus Parnamirim, and their appreciations about the game digital ‘ArteSaga’ as a methodological strategy for teaching Visual Arts.

3. Study and planning of the research project to define analysis and development categories, such as: goals and objectives to be achieved, deadlines, target audience, scope and necessary resources. These steps were structured in line with the educational objective that was established



from the student's motivation to know the Art through the playful game, in order to make him understand the transformations that have taken place in Art from the main periods in the history of visual arts, in order to perceive the founding characteristics present in each moment, in the midst of contact with different artistic expressions through their aesthetic experience, enabling greater student interaction with artistic languages through technology.

4. Anatomy of 'ArteSaga' game modules: definition of mechanics, narrative, aesthetics and technology that are components that make up a game (TEIXEIRA; CRUZ; GONÇALVES, 2016).

5. Game prototype development: physical representation of the intended product. For this stage, the following tools and methodologies were considered: C# (C Sharp) programming language for game construction and development. The historical periods, its setting and the characteristics of the time, as well as the changes that took place in the technological and artistic advancement of the period. The idea is to provide the student player with an experience similar to the appreciation of the work of art in its original context, the observation of artistic images and interpretation. At the same time, the player experiences an eminently playful experience, building a pleasant memory of such practices (RIBEIRO, 2006). In the graphic design stage, the image editing tool was used. For such procedures, the work performed by a team is of fundamental importance for the development of the game: a team responsible for building the game's programming; the second team responsible for building the design and visual identity; and the third team responsible for the script of the story and the texts that comprise the Art History content existing throughout all stages of the game.

6. Script for the game's digital narrative: execution of a script as a tool for organizing, planning and structuring the narrative. The context of the 'ArteSaga' game takes place in a museum where Pablo, the main character, is in a field class with his class and the Art teacher. The events take place as the cutscene progresses and takes the character to experience the main events of Visual Arts throughout history, at first inside the museum and at a second moment already immersed in the period studied. For all historical periods, the player is exposed to the setting and characteristics of the time, as well as the changes that occurred in the technological and artistic advancement of that period. The idea is to provide the student player with an experience similar to the appreciation of the artwork in its original context, the observation of artistic images and their interpretation.

7. Implementation of the digital book that presents itself as an icon on the game screen. When selected, the book

opens and the player can have access to content about the history of visual arts that have been played previously. At the end of each phase of the game, the book is opened and complemented, giving access to information about the challenges experienced throughout the playful experience.

8. Presentation of the game in the classroom for pre-test and application of a questionnaire for feedbacks; analysis of the questionnaires. At this stage, the optimization of the game is verified to facilitate its gameplay and its use as a methodological strategy.

9. Development of monthly research report writing and final report writing. Publication of research results and availability of the 'ArteSaga' game on Android, iOS and PC.

The educational digital game 'ArteSaga' has advanced in its creation during the second year of research work (Module I, II, III and IV), but we intend that it advance concretely in relation to the historical periods along the development of Art by humanity.

In view of the entire methodological procedure of the technological investigative project, the innovation proposal is to make the player learn the history and artistic aspects present in artistic periods in a playful way, through minigames and challenges that encourage user learning. In addition, the achievements unlocked by completing the challenges lead the student to the digital book that addresses the module's specific art history content, presenting images, texts and references to complement the exposed subject. Finally, we observe that the game presents itself as a curricular learning tool that provides the improvement of education for Art, enabling greater student interaction with artistic languages and technology.

### III. EXPECTED RESULTS

The 'ArteSaga' digital game presents itself as a process in the development of the research project through which data and results are investigated in different stages. Such results achieved in the game, as a methodological strategy, may occur enabling the learning process and putting into practice the student's skills and competences, in order to combine with the knowledge already acquired (MARTINS ET AL, 2020).

The results obtained so far are presented through the following topics: creation, development and validation of the game for the discipline of Art - Visual Arts Project related to the content of Rock Art, Art in Egypt and Art in Greece, which the player has the opportunity to experience adventures exploring the secrets, playful strategies and artistic aspects of each artistic period.

Furthermore, throughout the creation of the game during the research, the development of the ‘ArteSaga’ digital game created to be used in Art classes through the History of Art content is observed, as shown in the images below:



Fig.1: Pablo at the ‘ArteSaga’ Museum

Source: ‘ArteSaga’ Game – Initial Cutscene.



Fig.2: Pablo in prehistory (Age of metals)

Source: ‘ArteSaga’ Game – Rock Art Module.

Figures 1 and 2, above, show the development of the physical representation of Modules I (Introduction and Rock Art). Figures 3 and 4 below present the result of Module II (Art in Egypt and Art in Greece) of the ‘ArteSaga’ game. For all modules, historical contexts with the characteristics of the time were considered. Scripts were produced with all the scenes and phases of the games to better develop the program and the design that is built, in order to provide a narrative used as a guideline to guide the course of the construction of digital game development.



Fig.3: Pablo in the Temple of Nefertari (Egypt)

Source: ‘ArteSaga’ Game – Art module in Egypt.



Fig.4: Pablo at the Gateway to Ancient Greece

Source: ‘ArteSaga’ Game – Art module in Greece.

The digital game ‘ArteSaga’ advanced in its creation during the first year of work, addressing Prehistoric Art (Module I). In the current project, the content of Art in the Ancient Age (Module II) was added to the game, but we intend to establish it concretely in relation to the historical periods along the development of Art by humanity. We observe that the game is a curricular learning tool that provides the improvement of education for Art, enabling greater student interaction with artistic languages and technology.

As for the dissemination of results, we will establish dissemination goals, through the IFRN-Campus Parnamirim website, media and social networks, as well as submission of articles in magazines/periodicals and participation in local, regional and national scientific events, in order to disseminate and to qualify the work and the institution in the production of knowledge in the field of Art.

#### IV. CONCLUSION

The accomplished article initially fulfilled its objective which was to present the digital game 'ArteSaga' which allows a better learning, focusing on students' motivation. In this context, it was observed that the digital game 'ArteSaga' will be capable to act as a study tool, once its use also will occur at any moment, facilitating teaching and learning processes and putting in practice skills and competences, in order to be added to the previously acquired knowledge.

Additionally, 'ArteSaga' was evaluated during events and congresses it participated, winning prizes (annexed image) and positive reception by evaluators. It was possible to perceive that by the great approval from students and educators that experienced the game on expositions in science fairs. The game still continues to be developed to cover remaining subjects related to Art History.

This way, however the game has only two finished modules related to Art periods, the game is able to be used as a learning instrument to Art subject in high school. In addition, the developed game has presented great reverence from the target public, according to research done in classrooms and presentations in events.

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## Modeling and Decision Making Applied to Agriculture

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**Keywords—** *Decision Making. Modeling. Agricultural. Quali-quantitative analysis.*

**Abstract—** *The study analyzed the variables that interfere in the choice of the soil cultivation system, using conventional and/or biodynamic agricultural practices for Vitis vinifera grapes production. The method was an exploratory and descriptive study of quali-quantitative analysis. The intentional sample, for convenience and not probabilistic, had 26 vineyards of Vitis vinifera Chardonnay being 19 vineyards of the conventional cultivation system and 07 in transition to the cultivation system using biodynamic agriculture practices. It was concluded that economic variables are the driving force in decision making more than the environmental or social issues in the management of the cropping system, as well as it was noticed the tendency that some properties are looking for new cultivation practices. In the case of biodynamic agriculture, however, it is still tenuous signal that, in this case, the environmental issues could gain a greater value in equalization of alternatives for decision making in vineyard management and especially in soil care.*

### I. INTRODUCTION

The present study consists of analyzing the variables that interfere in the choice of the soil cultivation system using conventional and/or biodynamic agricultural practices for the production of wineries. For this, the data under analysis consisted of two bases, namely: a) the reports in the interviews, relating them to cognitive biases

and errors arising from the limitation of rationality; and b) technical information during participation in field activities in the vineyards participating in the study. The theoretical framework was supported by the Theory of Limited Rationality [1]; [2]; [3]; [4] and by the Theory of Contingency [5]; [6].



The identification of the variables that influence the tradeoff in the management of the agricultural production unit is of paramount importance, which is justified by the need for the manager to be able to find mechanisms that enable a more satisfactory decision-making or in accordance with the proposed business objectives. Scenarios are often adverse to the proposed business objectives, making the manager need to make

choices that best meet the cost-benefit ratio for his property. These are alternatives known as the classic model of rational decision making. Cognitive influences and biases can, however, privilege decisions based on intuition that, at that moment, are sufficient to achieve the expected results. In this case, the situation may be associated with the model based on contingency theory [1]; [3].

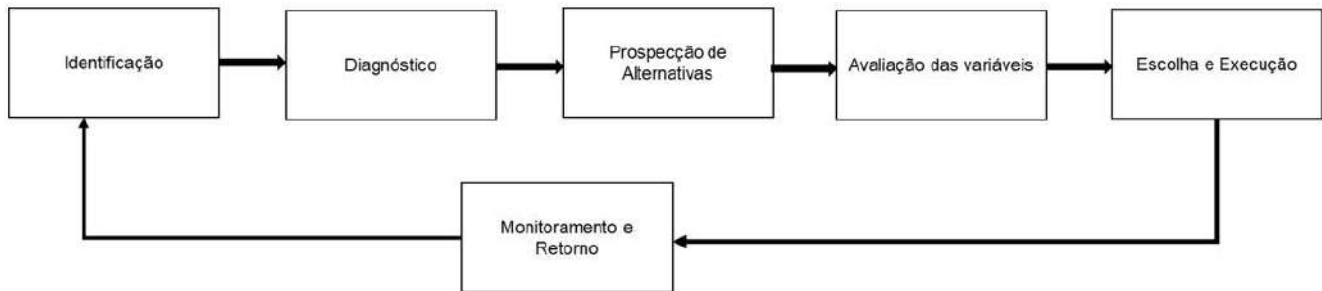


Fig.1: Decision making process

Source: Adapted from Sobral and Peci[7].

The process, whatever the reference model, is a sequence of at least six phases or steps, becoming systemic at the time the decision result is evaluated. The phases or steps can be sequential or present systems internal to the process when, for example, a step presents a limitation or inconsistency due to a previous step, and when the alternatives prospected in the next step do not satisfy the decision maker, this would be the case to redo the diagnosis more often and with more depth. It is important to raise this alternative of internal subsystems to the complete, six-stage system, as it approaches the way in which the organizational decision-making process takes place, especially in the process involving agricultural activity, where the number of intervening variables is, theoretically, infinite.

In this scenario, the decision maker needs to choose those variables that he/she considers relevant at that time and for that situation, dispensing with the others so that he can respect the time he has to make such a decision. The difference between the processes is in the way the information is used. The balance between the information collected and the choices made by managers is what can guarantee an optimal or sub-optimal result in the decision-making process. At the same time, the manager's perceptual, reactive and adaptive capacities can contribute to the decision-making process when making choices in the management of the agricultural unit, including those related to the conduct of agricultural land use in vineyards.

The managerial decision process is influenced by variables that can be classified as internal and external influences to production units. The important thing is to

equalize the opportunity cost in view of the trade off of internal variables, which are the following questions: a) what to produce?; b) how to produce?; and the external variables represented by the questions: a) how much to produce?; and b) when to produce? It is observed that the use of a sub-optimal choice can be seen as the result of a rational cost/benefit approach in relation to strategy selection [8].

Tversky and Kahneman[9] draw attention to human limitations in the decision-making process, as both emotions in the face of facts and lack of knowledge can influence the understanding of facts. In this case, the search is for a satisfactory solution rather than an optimal one.

The decision must be seen as a set of aspects that can be controlled and others that cannot. These aspects are identified as internal and external variables that serve as indicators to consider the alternatives to make choices in conducting the soil cultivation unit. These aspects compete with each other, and some of them end up weighing heavily in the decision-making phase. In parallel, the decision process never fails to prospect the possible and probable outcomes related to the choices. This is the step that can be called the "result". The process and the prospected result, in turn, influence each other, forming, at this level, a system that is also flexible and dynamic. These two systems reinforce the personal aspects of the internal decision of subsystem "I", as well as their convictions regarding the internal sustainability of subsystem "II". For Andrade et al[10], in certain situations, decision makers may be acting based on restricted information.



Furthermore, they may be conditioned by the ability of the human mind to process, formulate and solve complex problems. A rational and structured decision, in this case, would lead to the use of specific, systematic and directional biases to make their choices. Therefore, a satisfactory solution ends up being adopted with a high frequency.

Because of this, the problem-question that supports the present study is: how can the evaluation of the variables that interfere in the decision-making process help in choosing the cultivation system in the agricultural unit? For this, the internal and external variables that are part of the opportunity cost and are present in the equalization of alternatives in the decision-making process of any organization will be evaluated, and, theoretically, they are independent of the economic segment or its dimension. Further on, its application to *Vitis vinifera* production units was verified.

### 1.1. DECISION MAKING BASED ON THE CONTINGENCE THEORY

The Contingency Theory allows the understanding of organizations in a dynamic environment, requiring an interpretation of external and internal variables to the system, as they are mutually influencing the behavior of organizations in the macro environment.

For Donaldson[11], internal and external variables interact dynamically, which makes it difficult to accurately predict the results of choices, making it necessary to measure risk and the ability to be predisposed to uncertainty. To understand the functional relationship between environmental conditions, Contingency Theory seeks to be effective in identifying environmental conditions and administrative practices so that they are always in harmony [11]. The dynamics of the internal and external environments show that nothing there can be considered absolute, as everything is relative and everything depends.

Thus, the techniques and the environment that cause the influences do not have a cause-and-effect relationship, but rather as a system, because regardless of the cause or effect, the choices are justified by "everything depends" without a methodological sequence, because in the contingency theory, everything will depend, including the adaptive or reactive capacity that cognitive biases can have a preponderant influence on the manager's choices, resulting in new effects and causes that influence the environment that will present adverse or favorable reactions to the objectives and expected results in decision making.

According to Donaldson [11], Structural Contingency Theory developed as a puzzle, in which the insights of various theorists contributed to its empirical support. Burns and Stalker [12] analyzed the mechanical and organic external environment, Woodward [13] approached technology as a contingency factor, Lawrence and Lorsch [14] studied the relationship between structure and environment, Hage [15] and Perrow [16] wrote about technology and structure, and Chandler[17]; [5] analyzed the strategy-structure relationship, providing the background of this theory and offering support from real organizations.

The organizational structure was continuously adapted to its marketing strategy. In Chandler's[17]; [5] perception, the time of decision-making processes in a company's internal environment, such as choices of raw materials and production processes, remains relatively invariable, business decisions have a smaller impact on the business structure due to greater control of variables indoor environmental "what to do"? "And how to do it" When, however, do technology, markets and sources of supply change that external "when to do" variables are considerable? And "how much to do"? The dysfunctions of the structure become more evident and the strategies end up focusing on the architecture of the organizational structure [17]; [5].

The Contingency Theory can help farmers in the relationship with care in the agricultural unit, improving their ability to choose in the face of uncertainties in the external environment and the risks exposed by the internal environment. Beach and Mitchell[18] identify the steps that allow a driver for the decision maker and are related to the following questions: a) what to do? and b) how to do it? These questions allow you to look at the property's internal environment and, with this, not only assess its strengths and weaknesses, but also direct its efforts to achieve the established objectives and purposes.

Other questions that allow a look at the perception and quantification and qualification of the variables that are present in the environment outside the organization are: a) how much to do? and b) when to do it? These inquiries allow analyzing the potential and threats of the external environment, and show alternatives in relation to the market's behavior in a given period of time. For Beach and Mitchell[18], the categories of opportunity cost variables start from a strategy to make choices in the care of the unit's soil with the purpose of reaching its maximum utility in agricultural cropping systems. Collecting information, as well as costs and benefits, provides an attractive framework as it considers task efforts and contingent processing behavior [19].

In this way, the process that allows for the permanent interaction of internal and external aspects lies in the four questions of opportunity cost, which are: What to do? How to make? When to do it? How much to make? Which, somehow, support the interaction of purposes and direct prospects for possible results.

Contingency Theory is very similar to Limited Rationality; the first uses the “everything depends” on “n” variables that, in this case, could result in an “optimal” or sub-optimal decision”. The decision role can be seen as the result of a rational cost/benefit approach related to strategy selection [20]. In particular, it assumes the existence of Simon's Limited Rationality[1] on the part of the decision maker. A decision process conditioned to Limited Rationality requires choices with a certain degree of certainty, a certain degree of limitation of information, time, cost and also cognitive capacity, which can often lead to disruptions in the alignment of objectives and purposes, as the individual believes that limitations are part of the contingency and, at the same time, that, based on his decision, everything will depend on new actions that are not yet possible to perceive.

The decision maker, in this situation, is limited to the time and information available in a state of trade off in which he allows himself to rationalize the usefulness of the choice for the desired results. Therefore, Limited Rationality is constituted by: a) situational limitations, which are a function of the complexity of the situation itself and the set of restrictions; and b) individual limitations, which are a function of the decision maker's ability to perceive and process information. Thus, decision makers try to be rational, however, they hardly manage and act using full rationality, which happens due to factors such as incomplete data and even the inefficiency of technical advice. The decision maker, when opting for an alternative in solving the questions, foregoes others that could be better, if the knowledge of the variables were greater.

For Schneider[21], decision-making in agriculture results from strategies that occur subject to social, cultural, economic and spatial factors. These factors exert constant and variable pressure on the agricultural production unit. Therefore, the decision-making process has a framework that, in exercise, is materialized through the social, cultural and economic relations established between people. Thus, the author considers that, although these are conscious and theoretically rational strategies, this awareness is mediated by a rationality informed by reality that is both the expression of present material relations and those inherited and culturally transmitted.

Therefore, strategies are not causal or teleological, but rather the result of human action in the face of objective contingencies [21]. The author also emphasizes that, among the factors that seek social, economic and cultural reproduction resulting from the relationship between individuals and their families, there are: a) improvements in housing; b) well-being; c) progress in the production unit; and d) the material possibilities of achieving certain goals. With this, it is evident that social reproduction in family farming is the result of a set of factors that can be reinforcing or antagonistic, which vary over time and have flexible relative weights.

## 1.2. DECISION-MAKING PROCESS, LIMITED RATIONALITY OR INTUITION?

The trade-off, an equalizing issue between present and future results in a decision-making process, can be used to quantify and qualify the alternatives in the choices made in the management of the cultivation system.

Decisions in farm unit management can be formulated as multi-stage decision making. The process is characterized by a sequence of decisions taken to meet business objectives. Choices are linked to periods of time that divide the decision-making process, which can be called stages, representing the moments in which decisions are made.

Decision making is a dynamic process sustained over time [22]; [23] and [24]. Each stage requires a choice of alternatives, so the technical coefficients need to be updated and re-evaluated for the next choices. Faced with this, there is a behavior of adaptation and reaction of farmers.

The trade-off variables in agricultural land use decisions, for Slovic et al[25], affect the heuristic, "risk as feelings". According to this theory, intuitions about risky decisions are linked to previous experience by feelings or affective states (for example, the feeling that if I do not carry out the treatment against pests, it can influence the amount of grapes produced). In the use of decision-maker cognition, Kahneman and Tversky [26] emphasize the heuristics and biases in the decision-making process. They are: a) an intuitive and/or emotional one, with quick response, with little effort, (System 1); and b) another one of “labor mental activities”, “complex calculations”, “choice and concentration”, (System 2) considered rational.

The Theory of Limited Rationality, on the other hand, has the advantage of “providing satisfactory descriptions of actual human behavior” [4].

With it, one must consider the factors that influence decision making, such as: a) past experiences; b) a variety of cognitive biases; c) an escalation of commitment and irrecoverable results; and d) individual differences, including age, income, local beliefs and customs. All these factors influence, to different degrees, the decision-making process and the decisions taken.

Therefore, both intuition and bounded rationality participate or can participate in the trade-off, forming systems that simultaneously self-reinforce. For Simon[2], the selection of information for decision making can be influenced by a series of influences, both from the internal and external environment of the organization. Often the decision maker is limited by his cognitive capacity, and the decision-making process is also limited by this capacity [2].

For Juliusson, Karlsson and Garling[27], past decisions influence the decisions people make in the future. It is expected that when something positive results from a decision, people are more likely to decide in a similar way, given a similar situation. On the other hand, people tend to avoid repeating past mistakes [28]. This is significant as future decisions, made based on past experience, are not necessarily the best decisions.

For Marques et al[29], the influence of information on the decision also depends on the management characteristics of farmers and, more specifically, on their theoretical models, formal or not.

The authors believe that:

“... the decision maker, when making a decision, expects a certain result, or better: a set of results associated with a set of probabilities and objectives. Therefore, the consequences of a decision, whether to 'do' or 'not to do', can be considered as being 'foreseen'[29].

The decision-making process is complex and requires multiple assessments, with the formulation of variables and biases to parameterize decision-making. This process takes place through decision-making models. Models exert considerable influence on decisions, as individuals decide based on specific mental models, however, they should not be seen as a recipe to be followed, but rather as a tool for understanding complex elements [30].

When multiple complicated decisions come together and interact, variables are difficult to quantify or

weigh against each other. Decisions become complex, such as: deciding which type of agricultural practice to adopt for a wine growing system. For this, it is necessary to consider some variables such as: a) type of climate; b) soil; c) vine; d) driving system; e) equipment; f) technology; g) available labor; h) market demand; and others. This involves risks and uncertainties that may be present both in the conventional agricultural system with synthetic and chemical treatments and, in the case of biodynamic agriculture, with its herbal and unconventional treatments using a calendar based on astrology that seeks a balance of the forces of nature. Variables are many and extremely difficult to equalize in a simple way.

A choice on the type of cultivation system that, at the very least, leads to a desired result needs to consider the choices made in conducting the cultivation of vines and, at the same time, the expectations of the production of wines with an identity. It is also desirable to have and consider information on the natural, human and financial resources available and suitable for the type of wine system chosen, which would facilitate the management of the production unit, regardless of the type of production system to be used to assess the capacity for the proper use of the natural resources.

. What the business requires are decisions that, at a minimum, meet the moral requirements with the sustainability of the environment, and that the economic and social results meet the purposes of the actors involved in the production chain. The questions of choice can also be an expression of reaction or just a condition of adaptation of the farmer in face of issues of the macro system of the production chain.

Decision-making, therefore, takes place with action in the choice of alternatives that best suit the characteristics of the business and the profile of the manager who brings, in his/her perceptions, cultural and social factors, economic concerns and concerns with natural resources. With this, it is possible to perceive the need to align perceptual, reactive and adaptive capacities in a harmonious and dynamic way in the management of cultivation of *Vitis viniferas*.

Gasson[31]shows that the producer's personal characteristics influence his decision-making process. Brandt [32],in his studies on the offer of agricultural products, points out economic, technological, ecological, institutional factors and uncertainties (arising from externalities beyond the farm gate). These factors and the information between them refer to the decision-making circumstances of producers, which are often sources of uncertainty (eg, climate, biological aspects, pests, diseases, etc.) and market conditions.

The uncertainties, subject to causing mismatches in the prediction of results in the agricultural sector, in the decision-making process, such as the accentuated complexity in agrarian systems, have their origin in the chemistry and physiology of the soil as well as in the technologies used, which also reinforces the differentiation of productivity and the role of farmers in the market [33].

Some strategies may be suitable to minimize uncertainties when using an adaptive and reactive profile in the face of complexity and uncertainties, such as, for example, seeking people to exchange experiences and guidance. This person can often be the cooperative's technician, the consultant, a neighbor, experiential courses or technical trips. Seeking help rather than someone to transfer responsibilities and penalties for choices can be desirable behavior for the decision maker.

### 1.3. DECISION MAKING MANAGEMENT IN THE CULTIVATION UNIT

Decision-making in the management of the cultivation unit requires experience, knowledge, as well as clarity of objectives. For Choo[34], goals have an impact on priorities, choices and the amount of information about the methods and processes by which tasks must be fulfilled, as well as the goals that need to be achieved. In other words: decision making is hardly the result of a structured, sequential and oriented process to solve a given need. In this case, Nutt[35] considers the opinions of people who can intervene in the decision-making process, since their experiences and choices lead to an acceptable decision process.

In the perception of March [36], decision making is an act oriented towards objectives and driven by problems in which the behavior of choice is guided by norms and routines, leading organizations and individuals to act in a procedural and intentionally rational way.. According to Simon [4], there are six basic elements to be considered in the decision-making process: a) decision maker: it is the individual who makes a choice among several action alternatives; b) objectives: what the decision maker wants to achieve with his/her actions; c) preferences: the criteria used to make the choice; d) strategy: the focus of action that is chosen to achieve the objectives according to available resources; e) situation: all aspects of the environment in which the decision maker is inserted and that directly interfere in his/her choice; and f) result: is the immediate effect of a decision strategy. Therefore, there is a systematic or random order, technical or intuitive, that will drive a final choice.

For Carrieri [37], rural producers, as agents of a production system, need to be aware of their agricultural

reality and understand their real situation in alignment with the business objectives. Objectives can be rationally defined as centered on profitability, but regardless of the choice of agricultural cropping system. Many of the farmers consider agriculture to be a people-based industry with a family history. These characteristics are present in properties that grow vines in the Serra do Nordeste region in southern Brazil. The history of the vineyards is intertwined with that of the families who live there, being more than a simple business with a profit purpose.

The practice adopted in the execution of agricultural activities in the vineyard very much portrays the relationships of friendship, social interaction between neighbors, family members, and the values and customs of ancestors. Therefore, the trajectory of the people who live there connects with the history of each grape harvest. Thus, decision profiles are based on the global vision of their environment, which means being in agreement with the objectives they intend to achieve. Then, it starts to act and manage its production system, giving it a logic that is aligned with a rationality that is its own and conditioned by a physical, environmental, social, political and economic environment.

Decision-making, in this way, can be based on the influence received from social groups, neighbors, family members. It can be said that it is based on beliefs and/or "facts", or faith and is acquired from various sources, including formal information such as education, experience, peers and cultural environment (eg religion, education). This decision-making profile is close to the behavior of winegrowers who make use of biodynamic agriculture, since they form a system of interpersonal and collaborative relationships for the preparation of compounds and nutrients to take care of the cultivation and soil in their properties.

To do this, it is necessary to understand the component elements of every decision. For Simon [4], "... every decision is composed of two types of elements, called elements of fact and elements of value, respectively". In Jones'[38]view, decisions made by farmers are partly influenced by an expectation of financial profits and partly by family and cognitive factors. In this case, Ocaña, Vecino and Avilés[39]emphasize that the farmer, as a decision maker, is the result of a profile that is defined by the combination of socioeconomic factors (age, income, education, information, associations, management time, the succession process and others) and psychosocial (values, customs, religiosity, beliefs). The decision-making context is one in which the farmer tries to equalize the variables to seek a more relevant and satisfactory solution at a given time and that represents a great opportunity for



the expected results of his vine growing system, such as: relationship with "the that" to plant. Often this choice is limited to crops that have proven to have good yields in the region or that guarantee their subsistence in climatic conditions depending on the soil. Alternatives can also be defined in "how to do it", and refer to the property's infrastructure. According to Mandelli[40], the cultivation of the vine goes through several stages ranging from sprouting, pruning, phytosanitary treatments, flowering and maturation of the grapes, which enables the organization of field work.

The decision maker also considers situations of externalities that depend on the market's behavior at a given time, which are "when to plant", which indicates the most appropriate period for planting or increasing the cultivation of a given vine, which is classified as a plant perennial, but that requires attention to the climatic conditions in the production regions, and also the question of "how much", which becomes a driver of the amount of area to be allocated for the cultivation of vines. If the ideal is the quantity of kilos of grapes or the degree of sugar or babo of the wine, which Will be responsible for the added value, which will indicate the expected financial result at the time of the decision driver in the management of the vineyard' land use.

. The farmer, in many cases, manages to develop the adaptive capacity to face the high levels of uncertainty and risk offered by the environment, elements that, in most cases, are not controllable by the farmers. These and other factors can be internal and/or external to the property, which is an open system [41]. Farmers need to know that a bad decision is as harmful to a vineyard as a contaminated vine graft and/or a type of vine that is not adaptable to the type of soil.

In the case of using intuition for decision making, the individual adopts conceptual representations and the use of logic that make sense to a context, but with processes similar to those of perception, which provides speed, little effort and even the ability to individual engages in multiple tasks while using this system. When this individual uses rationality, the process is slower and demands more effort [1]. This is where, for example, criticism happens, since its ability to identify logics in different contexts makes it capable of doubt, which is nothing more than the ability to think of two or more alternatives of divergent choices, which does not happen in moments when the individual uses intuition [42].

## II. MATERIAL AND METHODS

As for the typology, it can be considered that the research was an exploratory and descriptive study of quali-

quanti analysis. For Gil [43], exploratory research aims to develop, clarify and modify concepts and ideas. The sample was intentional for convenience and not probabilistic. This type of data collection from a sample is used in exploratory and descriptive studies [44].

The steps of this study were: a) survey of bibliographic data; and b) data collection to analyze the choices in light of the criteria of weighting opportunity costs in researches for the choice of conventional or biodynamic cultivation system regarding the care and treatment of the soil and with the vine in the vineyard. The criterion for choosing the sample was the willingness of *Vitis vinifera* Chardonnay producers to participate. Obeying this delimitation, 19 vineyards of the conventional cultivation system and 07 in transition to the cultivation system with the use of biodynamic agriculture practices were found, totaling 26 vineyards.

The interviews were conducted individually, with visits to winemakers on their properties from June 6 to 28, 2018. With this, it was possible to carry out a direct and extensive observation. The questionnaire used was structured, made up of questions that help to equalize the trade off, such as questions about opportunity cost. This collection tool was adapted from the validated study in **Dalcin** [45].

Data processing was performed using the Statistical Package for Social Sciences 18 (SPSS) statistical program, with correlation tests to analyze the data obtained in the collection of interviews carried out in the viticulture properties of conventional and biodynamic systems.

## III. ANALYSIS AND DISCUSSION

According to the rational choice model of decision making, individuals decide in a mechanistic way, delimited by a guiding objective which, in commercial and productive organizations, is profit. This objective also serves as a thermometer to signal the vitality of the business. However, in all types of enterprises, especially in the agricultural sector, decisions based only on this factor do not guarantee the longevity of natural resources, which are necessary inputs to actually promote profit.

Therefore, most managers started to consider other variables in the decision-making process, such as the ability to intuit and also know that their choices "depend" on contingent situations that lead to the expected results. According to Schneider[21], rural producers are conditioned to social, cultural, economic and spatial factors that exert pressure on their production units.



Inherited expressions are present, such as fears and care in their choices in conducting the crop, for example.

With the results of the research carried out in the field, it was possible to perceive the mechanistic way in the behavior of winegrowers, both those who still use the conventional system for treating their vines and those who opted for an unconventional system of soil care. The results collected in the interviews and direct observations carried out show that the use of biodynamic agriculture practices is still in its infancy. It can be said that those who are migrating to this system of cultivation practices are in a process of adjustment in every way. These adjustments can be seen from the conduct of soil care, as well as in the

transformation of the behavior of winegrowers in the approach to the philosophy that underlies biodynamic agriculture, which is anthroposophy.

It can be seen that, so far, in the vineyards that have migrated to the practice of biodynamic agriculture in the production of *Vitis vinifera* Chardonnay, there has been “an adjustment of agricultural cultivation techniques”. This means a concern with the balance of the ecosystem, with fertility and good soil quality. It was possible to notice the concern of the managers of the production units in using less aggressive techniques and treatments to the environment, especially in soil treatments.

Table 1: Correlation of the Economic variable.

		Correlations					
		QtoP Ambiental- Recursos_ Naturais	QtoP Econômico_ Recursos_ Financeiros	QtoP_Social _Recursos_ Humanos	QdoP Ambiental- Recursos_ Naturais	QdoP Econômico_ Recursos_ Financeiros	QdoP_Social _Recursos_ Humanos
OQP_Ambiental- Recursos_ Naturais	Pearson Correlation	-,106	-,170	,039	-,067	-,446*	-,077
	Sig. (2-tailed)	,606	,407	,851	,746	,022	,710
	N	26	26	26	26	26	26
OQP_Econômico_ Recursos_ Financeiros	Pearson Correlation	,223	,352	-,332	,117	,000	,308
	Sig. (2-tailed)	,275	,078	,098	,571	1,000	,125
	N	26	26	26	26	26	26
OQP_Social_ Recursos_ Humanos	Pearson Correlation	-,234	,084	-,229	-,220	-,506**	,113
	Sig. (2-tailed)	,250	,683	,261	,279	,008	,583
	N	26	26	26	26	26	26
CP_Ambiental- Recursos_ Naturais	Pearson Correlation	,437*	,155	-,184	,048	-,147	,295
	Sig. (2-tailed)	,026	,450	,369	,816	,473	,143
	N	26	26	26	26	26	26
CP_Econômico_ Recursos_ Financeiros	Pearson Correlation	,050	-,028	-,086	,047	,502**	,054
	Sig. (2-tailed)	,809	,890	,675	,820	,009	,793
	N	26	26	26	26	26	26
CP_Social_ Recursos_ Humanos	Pearson Correlation	,090	-,328	,303	,028	,302	,032
	Sig. (2-tailed)	,663	,102	,132	,891	,134	,875
	N	26	26	26	26	26	26

\*. Correlation is significant at the 0.05 level (2-tailed).

\*\*. Correlation is significant at the 0.01 level (2-tailed).

Source: Survey Data (2020).

As shown in the data in Table 1 for the correlation of the Economic variable in the item of financial resources in relation to “how to produce” and “when to produce”, the result was a moderate correlation of  $R^2 = 0.502$ , perfect positive. This means that the decision maker concentrates on evaluating the economic variables at 50.2%, and that he reserves 49.8% for the other variables. The other variables are related to Environmental and Social issues. Therefore, the decision maker's concerns are balanced when assessing the opportunities to make the choice of the agricultural cropping system for a given time and type of crop.

for the manager's equalization in “how to produce”,  $R^2 = 0.437$  was found, perfect positive. The variables that constitute the Environmental-natural resources issues are in 43.7% correlated with the variable “how much to produce”, having also the relevance for the Environmental issue, being one of the important factors to consider in the decision of how to achieve the amount of kilograms of *vinifera*. The opportunity cost variable of “what to produce”, Environmental and Social factor, in relation to the variable “when to produce”, Economic

issues, showed a negative correlation with  $R^2 = -446$  and  $R^2 = -506$ , variables that imply social issues.

Biodynamic vineyards are characterized by young vines because the soil needs to go through a detoxification process with biodynamic treatments to receive cultivation in accordance with the guidelines of biodynamic agriculture. What was also noticed is that some winegrowers from conventional systems migrated to the use of biodynamic treatment [46].

In this cultivation system, in some cases, there may be a reduction in the planted area, as this system requires greater monitoring of care and greater involvement of the human being, which implies more labor, as well as an area with fewer vines per hectare. As a result, there was a reduction in the production volume in kilograms of grapes from the conventional to the biodynamic. On the other hand, the latter can, in theory, achieve a higher added value in the market, as well as a better quality of fruit characteristics.

According to the winegrowers of the biodynamic cultivation system, "it is a matter of changing their minds and seeking better quality of the fruit" (testimonial of the SCBD 004 vineyard manager), and for the SCBD 005 vineyard manager, "... to produce grapes with biodynamic practices and to preserve the soil pattern, biodiversity, and human health is not a unanimous reality, yet, but with the intention of improving."

Decision-making, regardless of the cultivation system adopted in the agricultural unit, presents risks and can also generate uncertainties due to some flaws in the decision-making process, such as the lack of reliable information and adequate tools that enable a correct assessment resources as well as adequate technical guidance; Add to that the limitations of cognitive ability inherent in human beings, and what you get is a sub-optimal choice for the moment (Limited Rationality). In parallel, the intuitive ability can also lead to choices that converge to a pessimistic or very optimistic scenario, which happens due to past experiences or beliefs or cultural imperatives. In this scenario, the choice is also just satisfactory.

The profile of decisions that the study shows is related to the characteristics of the vineyard model. Thus, for example, regarding the extension of the cultivation areas, it appears that the planting area has, on average, one hectare, many of which are family-oriented properties, and they present a strong valuation of the beliefs and guidance received from their predecessors and the sharing of experiences with neighbors, technicians and suppliers, all of which started to be considered of significant value when establishing the criteria for decision-making.

Deciding, in the face of complex situations in the management of the vineyard unit, requires the winegrower to innovate, even in his way of acting. There needs to be a detachment from beliefs and habits that do not contribute to the desired results, a focus on process innovation, as well as a commitment to issues in which it is necessary to follow procedures that require planning for long-term results and that denote many uncertainties and learning in the face of the new. In this sense, there is a need for adequate technical tools, information, monitoring and learning to enable the improvement of the management process.

Decision making is at the root of any organizational process. It is important to develop effective skills and strategies that allow problem solving, cost-benefit assessment and an examination of possible choices [47]. The decision-making process can be complicated and "overwhelming". As a result, the model that was perceived in the decisions of the sampled winemakers, both daily and long-term, has two sets of variables: internal and external.

The internal variables answer the questions: "what to produce" and "how to produce; the external variables answer: "when to produce" and "how much to produce". These issues are often inter-influenced and are not clearly defined for decision-making, as they are strongly influenced by different external agents or by the local culture or family values. A third process perceived in the interviews was the systematic relationship between what is being called here as internal and external variables. Decision making can be represented by alternatives of producing or not producing and rethinking the investment (adaptation or reaction).

The decision-making process can be facilitated by three decision support routines in order to reach a satisfactory alternative: a) control routine; b) communication; and c) policies [43]. Corroborating, Daft[48] includes the subjective variables of the intuitive field such as experience and common sense, as intuition is not despotic or irrational; it is based on years of practice and direct experience, accelerating the decision-making process. March and Simon[49] make it clear that most decisions, whether individual or organizational, involve the discovery and selection of satisfactory alternatives. Choo[43] explains that, for the most part, these alternatives are motivated by the occurrence of a problem, oriented towards the symptoms or towards an old solution and conjecture: the training, experience and objectives of the decision participants.

Decision makers in the agricultural unit individually seek to be rational through their behavior; however, as it is a complex process, they are subject to

limitations, often in terms of information and training. In this dimension, the farmer needs knowledge and agility in the search for competitiveness and even survival. In agricultural production, the complexity of the processes is accentuated due to the particularities of the activity, such as the influence of climatic variations, soil type, management and care with cultivation. It was possible to notice, in the interviews, that all these elements are present in the decision questions, although with different weights and a little disjointed.

Finally, the analysis of the results shows that the decision-making required the management of a flow of information that allows for a result that is not only satisfactory for a certain time, but rather a choice that leads to the sustainability of the business. It needs to be a choice that generates reliability and allows the farmer to react to adapt or react to an internal or external context. Their choices, in parallel, need to be in line with the longevity of the use of natural resources. Your decisions need to be consistent with maintaining the good quality and fertility of the soil in your vineyards.

The choice of a conventional and/or biodynamic agricultural cropping system goes beyond the capacity of a rational or intuitive choice. It is a choice that “everything depends” (according to Contingency Theory). In this specific case, knowing the physicochemical characteristics of the soil allows the use of a technical tool that will help in decisions on vine planting.

The analysis report allows knowing the soil profile and its nutrients, therefore the type of crop that is best suited to it, such as what, how, how much and when it should be cultivated in a given territory and time, which can greatly help decision on the choice of treatment management and vineyard management system and also indicate the regions with soil profile, climate and natural conditions that are best adapted to certain agricultural cultivation systems.

With the results found, it was noticeable that the winegrowers do not have knowledge or do not take into account the compatibility of soil characteristics and the type of crop that will be introduced in the place, but rather the economic result that has weight equivalent to the sum of all other variables that are part of the complex decision process, and, often, today's decisions can lead to unsatisfactory long-term results and even environmental and human health consequences, due to the choice of care for the soil and systems of cultivation with high intensification of fertilizer treatments.

#### IV. FINAL CONSIDERATIONS

Information is the limiting factor in decision making. Transparency and speed of data flow contribute to improve the efficiency of all components involved in the process, resulting in better management and, consequently, an efficient use of productive resources. Faced with the challenges of the trade-off, the decision maker needs to access and appropriate the tools and techniques that guarantee him to achieve or approach the desired results for that moment, given the conditions that present themselves in the context.

The relevance of choice valuation must also be intrinsically linked to the decision maker's cognitive capacity. With this, the influences absorbed in a trajectory of activities and coexistence in the environment are present, which may be to equalize decision-making with greater or lesser emotional or intuitive content due to experiences in previous events.

The time factor and environmental conditions for decision making are part of a dynamic and complex context that are not always considered to assess the ability to choose an optimal or sub-optimal decision. The item global knowledge of the problem and the individual's capacity must be related to the business objectives and aligned with its purposes. It means that your capacity for rationality acquires a range of perception in a larger radius, which facilitates access to alternatives that guarantee you, at the very least, choices that maintain the alignment of objectives with the expected results.

Farmers who work with the cultivation of Chardonnay vines, for the most part, decide with restricted information and often do not meet the needs of the company or family. It was found that the choice for an alternative cultivation system, with management and use of alternative techniques, in most of the properties participating in the research, was firstly due to the economic factor, followed by environmental concerns, represented by the care of the soil. This is due to the consequences that the soil of the region shows in technical reports of analysis of soil quality content and soil profile, such as the high accumulated indices of: a) copper due to treatments with “bordeaux syrup”; and b) other chemical additives influencing the vegetative process of the vines [29].

Soil properties influence mineral elements, organic acids, phenolic compounds and aromas, which are factors closely linked to the characteristics of the grapes cultivated in each soil of a region, causing changes in the sensory and chemical properties of the wine, interfering with the result of a good “terroir”.

The difficulties encountered and the concerns in adapting to a less conventional cultivation system, according to the manager of the SBD002 vineyard, "is due to the climatic conditions and the profile of the soil characteristics of the wine-growing regions in the Serra Gaúcha region, which have many variations that do not always favor the cultivation of *Vitis vinifera*".

Even so, the reduction in the use of chemical treatments in the vineyards has been gradually taking place on the properties participating in the study, until all the care and treatments of cultivation are carried out with the techniques of biodynamic agriculture. On the other hand, conventionally cultivated vineyards are still heavily dependent on the use of chemical products for pest control and cleaning between vine rows.

The relevant question was to analyze the variables that interfere in the choice of the soil cultivation system, with the use of conventional and/or biodynamic agricultural practices for the production of vineyards. The results showed that decisions are influenced by economic variables in the case here demand and value paid by the market, that is, financial profitability. That said, the valuation of economic issues is the driver in decision making, more than environmental or social issues in the management of the cultivation system in vineyards regardless of the system, that is, conventional or biodynamic.

The tendency of some properties is the search for new cultivation practices, in the case of biodynamic agriculture; however, it still faintly signals that environmental issues may gain greater weight in the equalization of alternatives for decision-making and, above all, the concern with climatic conditions and the proper use of the soil.

It should be noted that the study has its limitation in the analysis of only some of the variables that imply the tradeoff of opportunity costs, making it impossible to carry out an analysis with a greater number of variables that may be interfering in decision-making in vineyard management. Another limiting factor is the lack of a database with technical information about the properties and treatments and care for the soil that occurs with the two vine growing systems, also including winegrowers linked to the local Cooperative.

Finally, biodynamic agriculture is still a topic that needs to be studied, treatment tested, although its use began in the 20th century (in 1924), by Steiner (1861-1925), still today requiring new studies and scientific deepening, due to the its application is based on facts, reports and foundations in beliefs, customs and philosophy rather than scientific evidence and techniques recognized

and validated, requiring care, as well as signaling possibilities for studies and research.

For future work, it is suggested to carry out a comparison of decision-making in the cultivation system and soil care in vineyards in the south of the country with other Brazilian wine-producing states, in order to validate the variables that interfere in the choices of the manager.

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# Towards innovation on computer science courses

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**Keywords**— Curriculum, Computer Science,  
Classroom, Framework, Innovation.

**Abstract**— Technologies change very rapidly, and universities need to be increasingly connected to the needs of the industry. With the advent of industry 4.0, the transformations in curricula must be continuous. The current scholar must be a professional future who finds new solutions, who knows how to make a decision based on the data, and who can communicate with different areas. The insertion of entrepreneurship practices towards the development of innovative products in computer courses can academically boost the scholars' characteristics necessary to the today's world, such as teamwork, problem-solving, systemic vision, communication, protagonism, and creativity. A new approach that makes it possible to address the needs of the locality to the surroundings of the educational institution, to highlight the strengths of the scholars in terms of solving such demands, and to propose innovative works strongly linked to the local productive arrangement. The design of the approach follows an innovation framework proposed by Steinbeis University-SIBE, which expands and potentiates the phases of Design Thinking in a larger number of more detailed steps that guide well-defined activities. The results presented by the use of the approach shows that most of the work developed has the potential to become an innovation, which will help in local and regional development.

## I. INTRODUCTION

The way we construct knowledge, in a way, defines us. In other terms, if knowledge is presented in the academy in a fragmented approach, if the curricular elements do not integrate and do not answer to a learning project aimed at the full development of the scholars, it will not be possible to form a whole, integral subject. The fragmentation of scientific knowledge to be taught reveals itself in the disconnection of disciplines at the academy and has been detrimental to education. Even in the context of a given subject, knowledge is separated into some relatively watertight contents, which are presented in a detached and disconnected manner. The effect of the fragmentation of learning to be taught is the loss of meaning, which manifests itself in scholars as a refusal of specific disciplines, showing that they can not understand the connections and associations among the different areas of knowledge.

As critical as the conception of a human being that one wishes to form is to present comprehension of relational knowledge in which the areas of expertise - and their contents, methods, and worldviews - can be perceived with excellent integration. In the area of Education, interdisciplinary [1], multidisciplinary [2], and transdisciplinary [3] proposals are investigated to overcome the fragmentation of the curriculum [4], which, by making the disciplines very technoscientific, ends up creating academy dynamics in which the scholar is responsible for bridges between knowledge, and not the curricula. However how to integrate the curriculum without giving up the several forms of knowledge construction that the areas carry? What do to make learning more meaningful by correlating knowledge with daily life?

For curricular integration to become a reality in the academy, it is necessary that the Political Pedagogical

Project (PPP) states new ways of handling management and collaborative effort among lecturers [5]. One way to do this is to institute practices common to all areas, concerning active teaching and learning methodologies (such as cooperative learning, project learning or research and problem-solving), as involving formative and procedural assessment strategies [6].

Fieldwork, projects, complex problem solving and end-of-course work are cases of integration activities that give purpose to learning, connecting them together and involving scholars and lecturers through proposals that succeed in essential knowledge of fundamental skills that fill the whole curriculum. Group work is an outstanding challenge for all, at any age, and in today's society, it is a relevant and fundamental capacity, which aims to encourage cooperation and foster learning in the coordination of different roles, self-control, articulation, and management of tasks, research, planning, and construction.

This work proposes the inclusion of an innovation framework to support the curricular integration, and contributes to the vocational affirmation of the scholar within the chosen area of action, although providing the development of applications that can reinforce local and regional rise.

This paper is organized as follows: In section II we present a discussion about the difficulties of integrating the curriculum and some literature proposals that try to address such difficulties; In Section III, we present Steinbeis-SIBE innovation framework and its applicability as a viable solution to such limitations; In section IV we present a real practice combining several disciplines towards innovation projects; In section V we present and discuss the products resulting from such practice; In section VI we end with our conclusions and future work.

## II. PROBLEM DESCRIPTION AND RELATED WORK

Nowadays, there is no more place for solely technical education, which only prevailed for the development of specialties - based on the scientific development of knowledge. This path crystallized the academy history marked by the disciplinary fragmentation [7] [8], in a departmental arrangement that crosses the constitutive cycles of the course. Though, this paradigm shift is needed but challenging to accomplish in practice.

Interdisciplinarity rose at the end of the last century from the demand to overcome the fragmentation caused by a positivist epistemology. The sciences were divided into several disciplines, and interdisciplinarity renewed at least

dialogue among them. Considered by the science of education as an organic relation of the subject discipline and applied discipline, interdisciplinarity has become an admitted term in the academy because it is seen as a way of thinking.

In this way, interdisciplinarity would be a way of obtaining transdisciplinarity, a stage that would not be in the interaction and interchange between the sciences, but would reach a stage where there would be no more barriers among the disciplines. Currently, interdisciplinarity has been welcomed by most educators, since such a position globally ensures the construction of knowledge, breaking with the boundaries of disciplines because only the integration of content would not be enough.

The logic behind is simple: if reality is a complex and broad one, fragmented education does not consider for understanding it in its entirety, making it as needed as it is essential to exchange and dialogue among disciplines during the process of the meaningfulness of both content of the world in which we live. Additionally, interdisciplinarity reveals precious skills in scholars, such as curiosity, interest in learning, and the ability to work in groups. It leads, at the same time, to significant results in scholars' performance and their development as social beings.

Faced with the progressive globalization of the economy [9], the conditions for the formation of a new professional are emphasized, with flexibility stressed at the expense of specialization. From this, and for safeguarding the flexibility of curricular organization, interdisciplinarity takes strength given the delineation of a new formative pathway. According to this new methodology, several proposals try to address the limitations imposed by the non-integration of the disciplines.

Perhaps it is the most popular among all proposals for integration between disciplines is in the form of project development [10]. In such a model, several disciplines run during the academy year focusing on the development of a process or product that should be ready at the end of the term. Each subject contributes to some of the skill necessary for the development of the processes or products, which can be developed individually by the scholars, or uniquely throughout the class.

However, this type of integration is not something officially regulated, unless it is curricular. Integration of curricular disciplines [11] does not offer the opportunity of not occurring combination, either through projects or any other chosen methodology. This model has given rise to some higher technology courses that do not offer a single formation, but a more general primary formation, and from

a certain point, the scholar can choose the formative path to follow, thus selecting a more specific area.

Teaching along with research is also an option that has always worked well in *stricto sensu* programs and has also been used in secondary and higher education courses [12]. This model lets the scholar to be updated and in line with a specific study object, and to improve their knowledge by taking advantage of the supervision of a specialist lecturer in the chosen area.

A proposal that in addition to being interdisciplinary -- the transdisciplinary -- consists of projects integrated by teams of scholars from different areas and courses [13] [14]. This model expands the possibilities of projects with new ideas because there are many problems of a specific area that researchers in the area alone can not solve. In general, computation has done well this role, being support for the resolution or speed up in solving problems of physics, biology, chemistry, among others.

From the integration of exact sciences emerges the STEM, a movement of integration between Science, Technology, Engineering, and Mathematics. STEM proposals range from projects applied in early childhood education [15] to higher education [16]. The approach involves scholars in hands-on activities that combine different knowledge and lead to creative learning.

### III. INNOVATION FRAMEWORK

Based Faced with the challenges of a corporate world, marked by high technology and competitiveness, the development of software products and services needed to keep pace. To this end, so-called agile methods have emerged. Agile Software Development involves a set of methodologies that serve to accelerate the pace of software development processes [17].

With its origin dating back to the mid-1990s, the Agile concept was soon spread among the experts, which resulted in the creation of different models that support project management. The reason agile methods suggest is to address traditional development models, which are slow and bureaucratic, to reduce the development cycle in weeks or months - in conservative models this cycle can last for years.

Therefore, assuming that the projects have a defined beginning and end, and that they are planned and developed in stages, some of the main characteristics - besides agility - of the agile methods are incremental process (almost an antithesis of the traditional cascade model), customer collaboration, adaptability (each project is subject to various modifications), simplicity, constant feedback, small teams (but with a high technical level).

Several frameworks that support the agile methodology have been created, and we can mention the main methods: Feature Driven Development (FDD) [18], Extreme Programming (XP) [19], Microsoft Solutions Framework (MSF) [20], Dynamic System Development Model (DSDM) [21], and Scrum [22].

FDD's [18] basic premise is the focus on functionality, which allows the project team to perform incremental planning. This type of action helps to give agility to the development of solutions in environments of extreme uncertainty, where changes are inevitable. FDD programming starts with the business overview since this method considers the sum of everything more important than each of the parts separately. We then proceed to the detailing of the product with the subdivision by areas to be modeled, culminating in the description of each function.

XP [19] is an agile method focused on software development based on three pillars: agility in the development of the solution, resource saving and quality of the final product. In order to achieve excellence in the services provided, an XP team must be values-based, that is, a contract of attitudes and behaviors that lead to success. These behaviors and attitudes guide the actions of the XP team in each activity to be performed, ensuring the integration and synergy necessary for good performance. In addition to the values, the agile XP method also takes into account better working practices, which aim to ensure the effectiveness of the XP team's work, as well as customer satisfaction throughout the development process.

MSF [20] is one of the agile methods most used for the development of technological solutions by small teams, focusing on reducing risks to the business and increasing the quality of the final product. The purpose is to identify the most common flaws in technology projects, mitigating them and improving the success rates of each initiative.

DSDM [21] is one of the oldest agile methods used not only in project development but also in technology. A little different from the other agile methods, it is aimed at the development of projects with a fixed budget and short deadlines, taking into consideration that the client has no way of knowing how much the final solution will cost. Among its best practices are incremental and iterative development, a collaboration between client and team, and integration of functionalities, which we also see in other agile methods. It is worth noting that DSDM differs from other agile methods in its structure, which is composed of interconnected processes of modeling, design, construction, and implementation, as well as time management, which is not flexible until the functionalities change, but since that the deadlines for implementation remain the same.

Scrum [22] is the most widely used agile method today, especially since it can be easily integrated with other agile methods, applying not only to software development but also to any work environment. With a focus on project management, Scrum is based on iterative and incremental planning, which occurs, as explained, by the meetings known as Sprints - this time we will approach the concept in detail. It reiterates, from the beginning of the project, the list of functionalities to be developed - practice also called, in this case, product backlog. In the process progress, each feature becomes a Sprint, whose details to be created and developed go from the product backlog to the sprint backlog. From the sprint backlog, the activities are distributed among the members of the Scrum Team, who must develop them within a deadline that usually takes no more than four weeks. At the end of each sprint, the sprint review meeting, an alignment meeting on what was delivered, is held. From there, you begin to plan the next sprint. These steps happen in succession until the final product is ready for delivery.

In addition to these already established methodologies, an approach has been taking place. Design Thinking [23] is a way of the approach taken from the field of design and tailored to companies and corporations. Design Thinking is seen as a set of practices and processes, a method that proposes a new approach to problems. This is related to obtaining information, its analysis and the resulting solutions offered from the generated knowledge. The focus becomes the experience of the consumer or the target audience, in the search for answers to the problems found through Design Thinking as a methodological approach. The significant difference of this method is that it starts from the solution, from the project, and not necessarily from all the parameters of the problem, as is common in the scientific method. The steps assigned to design thinking are immersion, ideation, prototyping, and development. The process, from immersion to development, seeks innovation in a non-linear way, the attribution and discovery of new values and meanings for projects, services and products, as well as the constitution of integrative thinking as a tool to reach solutions, not exactly definitive, but holistic and based on the experience of the consumer.

The framework proposed by the Steinbeis School of International Business and Entrepreneurship (SIBE - <https://sibe-edu.com>) consists of joining the best practices of most frameworks based on agile methods. The Figure 1 shows the life cycle of such a framework.

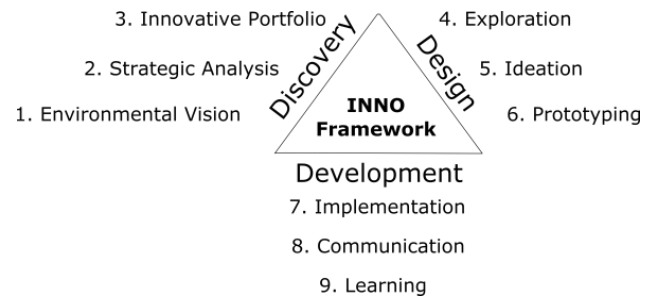


Fig.1: Steinbeis-SIBE Innovation Framework.

It consists of an expansion of design thinking to define the focus of the products to be developed, as well as to define all phases of the project. Also, it uses Scrum sprints for each new phase, active collaboration between client and development team like DSDM, performs risk analysis like MSF, and performs small deliveries like PDD and XP. This framework is divided into three dimensions: discovery, design, and development. The discovery dimension includes the phases of environmental vision, strategic analysis, and innovation portfolio. The design dimension consists of the exploration, ideation, and prototyping phases. And the development dimension consists of implementation, communication, and learning phases. For each phase, a specific tool was used.

#### IV. INTEGRATED PROFESSIONAL PRACTICE

The Integrated Professional Practice (IPP) consists of a teaching methodology that proposes to ensure space and time at the curriculum, allowing the connection between the knowledge built in the different disciplines of the course and the real world. In this way, it is possible to customize the curriculum and expand the dialogue between different areas of activity.

Currently, it is a practice widely disseminated and implemented in institutions of vocational education, being an important piece for the development of practical activities correlated to the course [24]. In one course of the computing area, the objective of IPP is to search for theoretical and practical knowledge to base the choice of the discipline that will be developed, and providing the scholars to combine the concepts studied daily with the practice, predicting their professional use.

Therefore, it is evident that the IPP has as its focus the overcoming of curriculum fragmentation [25] and the search for a curriculum that makes sense and meaning to the scholar. It is possible to highlight in this practice the intention to operationalize the vertical integration of the curriculum, providing unity throughout the course, comprising a logical sequence and an increasing deepening of the knowledge in contact with the actual work practice,

constituting as a permanent space of reflection-action involving the entire faculty of the course in its planning.

IPP is strongly influenced by the STEM learning [26] [27], where the original idea is to unite knowledge of these four areas around the construction of something that solves the proposed challenge. STEM works in the form of creative workshops so that scholars in groups can solve some challenge practically. The main thing is that it is a practical challenge that requires knowledge from different areas.

In this work, we present an IPP that takes into account an entire innovation framework to define the fields of action of future projects to be implemented. We believe that inventions that solve local problems have a more significant potential to become an innovation, allowing an improvement in the quality of life of such a community. The IPP was proposed through the integration of three disciplines: (i) technological innovation, (ii) prototyping of hardware and software, and (iii) development of mobile applications.

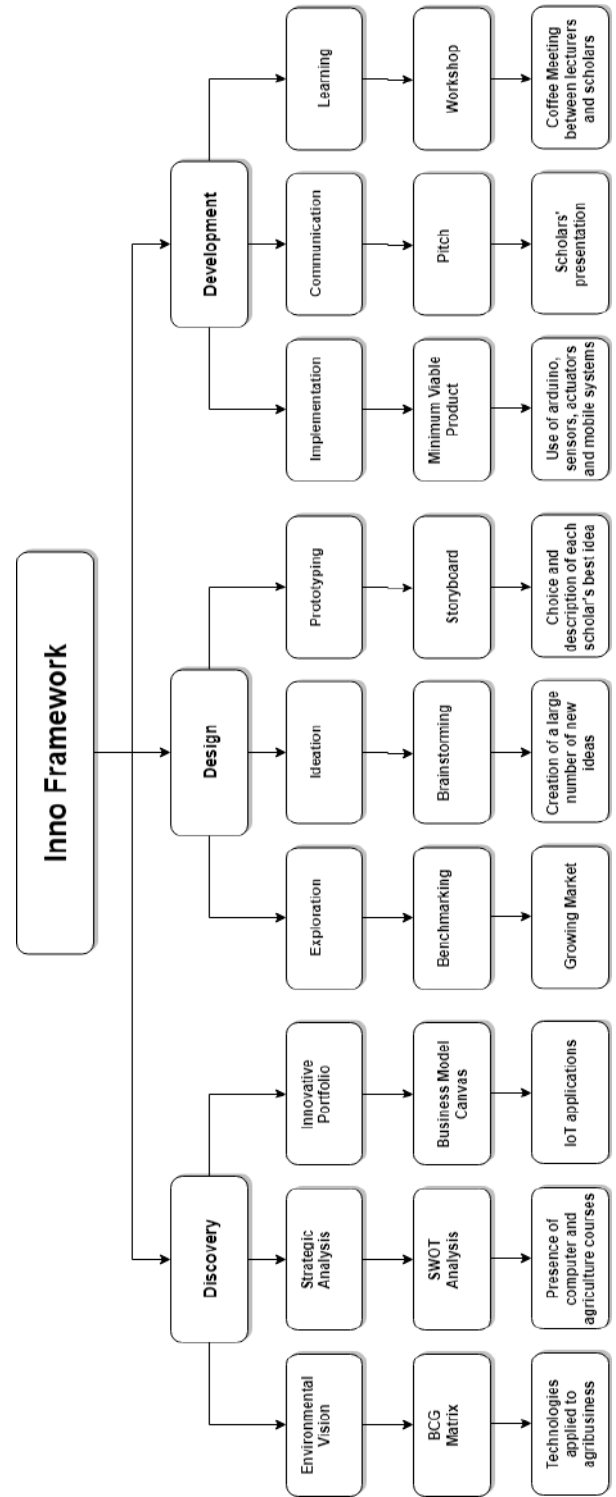


Fig. 2: Steinbeis-SIBE Innovation Framework.

The discipline of technological innovation consists of working concepts and practices focused on innovation through technical products applied to local and regional development. Figure 2 presents all the dimensions, their phases, tooling, and the result. The framework is divided into three dimensions. Each dimension is divided into



three phases. Each phase presents main objectives and some findings.

The results showed in Figure 2 demonstrated that our campus is located in a region that has a robust agricultural vocation and that our university offers courses and counts on specialists in the farming and computing areas. This set of factors guided the work of IPP to the Internet of Things (IoT) applications [28], as it is a paradigm that can bring together all the areas addressed towards local and regional development.

The discipline of prototyping of hardware and software consists of developing hardware and software solutions that can be prototyped in a small electronics lab through inexpensive, easy-to-implement opensource platforms. Proposed projects used Arduino (or some of its variants) [29], which consists of a board with a microcontroller and some complementary components that aims to facilitate the development of projects for reading electronic sensors and actuators, besides some expansion modules.

The discipline of development of mobile applications [30] consists of learning technical knowledge about the Android Software Development Kit (SDK) architecture, library features, besides good practices for mobile programming apps. The majority of the lectures are focused on the practical aspect, developing and deploying smartphones applications. Also, we developed a final software product for Android mobile devices that communicate with the Arduino through data communication modules (such as WiFi), and allow the reading of values coming from the sensors and manipulation of the actuators. Internally, Arduino uses a variant of the C language, but for development on Android mobile devices, we used Java programming language.

Therefore, the integration among the three disciplines occurred as follows: in the innovation class, the scholars defined their potential in developing new products aligned with the needs of the local productive arrangement (LPA). They participated in a creative process that resulted in one idea per scholar, which solves one of the limitations investigated in the LPA. Each of the solutions was prototyped and implemented in conjunction with the two technical disciplines. The products generated were presented to an interdisciplinary committee and had their potential evaluated. It was a moment of learning and socialization of knowledge, ensuring a space destined for the focus of professional training, constituting a moment of reflection, which encouraged research and promoted interdisciplinarity.

## V. RESULTS AND DISCUSSION

Agriculture, livestock, and aquaculture are a source of subsistence for a large part of the rural population who maintain small and medium-sized farms and produce agricultural products for their consumption and sale to the urban population. The outcomes of these segments consist of an essential source of income and employment for the field, usually performed by teams formed from a family unit. The data show that this economic activity is present in 85% of rural properties in Brazil, and 70% of the food consumed in the country is produced through this segment, the southern region of Brazil is the second largest producer (<http://www.fao.org>). This is the scenario that our research is established, and it was pointed out by the mechanisms of the innovation framework.

After defining each scholar's research theme, the prototypes to be developed were established, and are listed below:

- Automatic feeder for fish: the region is a major producer of fish in confined tanks. In most, the feeding is carried out manually. The proposal implemented an electro-mechanical device, which at predefined hours of the day, pour in the water of the tank an amount of fish feed.
- Automated greenhouse: several small producers keep greenhouses for the production of vegetables. Factors such as humidity and temperature should be controlled. The proposal implemented moisture and temperature sensors that drive greenhouse cooling devices when minimum and maximum limits are reached.
- A system of automation of irrigation of the soil: the region maintains a strong vocation concerning the production of grains. Grain crops, especially rice, need a layer of water to develop. The control of this layer of water is usually done manually. The proposal implemented through depth sensors dispersed in the plantation, a monitor in the opening of the siphons that allow managing the amount of water to be scattered in the plantation.
- System for detecting carbon monoxide and flammable gases: industries must control the amount of carbon monoxide in order to maintain the health of their employees. This proposal implemented through gas sensors, an alert for high levels of carbon monoxide.
- System for the control of entrance or exit of people: several institutions must control the presence of its employees. The proposal implemented radio

frequency identification cards to manage entry and exit of employees on an electronic point card.

- Lighting control system for studios: home automation is an area that automates the management of electrical and mechanical devices in homes. The proposal implemented a centralized control of lights and appliances so that the owner of the residence can trigger any device through only one interface.
- Checking for spinal problems: Spinal problems such as lordosis, kyphosis, and scoliosis are quite common these days. The proposal implemented through a range of positioning sensors, a device that can generate a 3D image of a person's column, and show the type of curvature of the column and its degree.

The driver devices were developed in the discipline of prototyping of hardware and software, and the user interface was developed in the discipline of development for mobile devices. Therefore, all prototypes can be controlled or display reports to users through mobile applications developed by scholars. It makes all proposed solutions more dynamic and up-to-date, and attractively presented to future investors.

Such prototypes were presented to a group of researchers and evaluated regarding innovation potential. From now on, these jobs will pass through investor, and the chosen ones will become startups who can develop their products for the productive market. Therefore, what started as an IPP may have fostered the entrepreneurial spirit in scholars, to the point that when they graduate in the graduation course, they already have their companies selling their products.

## VI. CONCLUSION

The organization of scholarly knowledge by disciplines a few years ago has been the point of criticism ranging from the argument that disciplines represent more of an outcome to education than to social, cultural and political issues, underpinning the educational policies that guide the organization of academy curricula. However, the main criticism of the curricular disciplinary approach is the fragmentation of knowledge. Among the alternative proposals to the organization of academy knowledge by disciplines, those that focus on interdisciplinarity and curricular integration stand out.

This traditionally fragmented model does not lead to the rise of innovation. An environment conducive to innovation is one in which there is a clash of ideas. People of various experiences and specialties must be present in the process of creation, and these moments of creation must be structured to produce results. Another point of

stimulus to diversity is the possibility that exchanges occur in any direction, be it between peers and between people from very different areas. An innovative environment was proposed and supported by IPP.

Interdisciplinarity via IPP can materialize in teaching methodologies, curriculum, and teaching practice. From the historical perspective that reveals that the process of fragmentation of knowledge is accentuated with the process of fragmentation of work, one must be aware that forms of work organization, which do not focus on completeness, can emphasize the fragmentation of school knowledge.

IPP allowed several issues to be addressed. Approaching the campus with LPA, one of the missions of higher education institutions, which consists of developing the region in which the campus is located. Scholars experienced a real-world innovation environment, ranging from a vision of open product development opportunities, designing solutions to prototyping. Also, they have experienced the most current development methodologies, such as design thinking, agile methods, and project management. Finally, each scholar has a finished product with potential patent registration, and the possibility of opening a startup aimed at marketing such a product.

Besides, IPP understands different situations of experience, learning, and work, guided by research as a pedagogical principle, whose purpose is to articulate knowledge through the integration of the disciplines in the course and to bring the training of scholars closer to the world of work.

As future work, the products will be presented in rounds of investors, to capture resources and boost the creation of startups. Regarding teaching, the practice of IPP will be adopted as a complementary activity to the scholar's education, in a continuous and absorbed by the current curriculum of the technology courses.

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# Public Management Role for the Encouragement of the Entrepreneurial Ecosystem in Imperatriz (Ma) – Brazil

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**Keywords—** *Public Management, Regional Development, Entrepreneurial Ecosystem, Entrepreneurship.*

**Abstract—** *This study aims to analyze the participation of municipal and state public management in fostering the entrepreneurial ecosystem in the municipality of Imperatriz (MA) and is based on the six pillars proposed: public policies, financial capital, culture, institutions support, human resources, and markets. The descriptive research method was used; the semi-structured interview for data collection; descriptive document analysis and the application of sensemaking techniques, such as visual map and narrative strategy. The research is also qualitative, by accessibility criteria, and in the field for comparison with the data obtained in the mapping. About documentary research, a temporal scaling of the last ten years was carried out. It is observed, in view of the mapping, that there is engagement and efforts of the municipal and state public administration directed towards entrepreneurial actions, above all, these actions need to be more widespread among higher education institutions. The data obtained in the field analysis were relevant to this investigation, showing the inclusion and participation of public management in the development of actions that optimize and develop the entrepreneurial ecosystem in the municipality. The data obtained in the two types of analysis were compared by triangulation to promote a clear understanding of the role of Empress' public management within the investigated scenario. Therefore, it is concluded that the objective of this study at the end of the assessment was achieved.*

## I. INTRODUCTION

The world scenario has been going through several demographic, social and especially economic transformations in short periods of time, especially from the 20th century onwards, as it was mainly during this period that new ideas that improved the lifestyle of individuals were intensified.

These ideas usually come from innovation, from doing something original, or positioning themselves to have a vision under a new paradigm through actions, services or

products that already exist, promoting significant ruptures or substantial improvements (Moraes, Lobosco & Lima, 2013). For these ideas to happen, they rely on entrepreneurs, who have peculiar characteristics, think eccentrically, face challenges and risk inventing the unprecedented, exploring new paths to undertake.

These particularities of entrepreneurs need to be contemplated and understood, since with the advent of globalization, competition has become increasingly fierce and the consumer more demanding.



For many decades, economic policy has directed its efforts in support of large organizations or large economic groups already established, to establish balance and economic sustainability. This model, in the view of Carvalho, Viana and Montovani (2016), had flaws and weaknesses given the economic crises with significant regional impacts.

Therefore, it can be said that the economic atmosphere suitable for entrepreneurship is still conditioned to young and innovative organizations, which appear with greater capacity to adapt to volatile markets, and with greater ability and speed to react to changes (Moraes & Lima, 2019).

Entrepreneurship cannot be considered a single solution to the challenges of economic policy. For this reason, there was an opening for economic growth and for the improvement of regional social well-being.

In this scenario, the importance of the entrepreneurial ecosystem became notorious, considered a regional space that comprises many institutional and individual actors, promoting the entrepreneurial spectrum of entrepreneurship and innovation.

Another important point is that entrepreneurship has been the core of public policies in most countries. The increase in entrepreneurship in the global context increased in the 1990s and expanded in dimension in the 2000s, which will be noticed during the reading of the subsequent sections related to the theme (Howkins, 2005).

Today, several fields of knowledge are concerned with investigating the phenomenon of entrepreneurship, such as economics, business management, sociology, psychology, anthropology, management history, marketing, finance and even geography, representing various views of entrepreneurship.

Consequently, the entrepreneurial ecosystem emerged in this scenario, which in the view of Mason and Brown (2014) corroborates this discussion as it corresponds to a set of interconnected, existing and potential business actors; in addition to organizations such as corporations, venture capital, business angels and banks; from institutions such as universities, public sector bodies and financial bodies; and processes, such as the rate of business emergence, number of highly successful entrepreneurs, levels of business ambition and society's progressive mentality.

This meaning highlights the importance of formal and informal links as intermediaries of execution within the regional business environment. In this respect, the focus on entrepreneurial ecosystems provides a new point of view

and different characteristics, analyzing the geographic concentration of local economic activity.

It is noteworthy, however, that the term entrepreneurship, according to Mason and Brown (2014), came from the private administration, but is increasingly inserted within the public initiative as a tactic to engage, modernize and stimulate the public situation in each region.

In this way, entrepreneurship makes it possible for the action stimulated by the public power, whether local, regional, or national, to promote the optimization and development of dynamic and active entrepreneurial ecosystems, causing, consequently, sustainable economic development.

Understanding the factors that contribute to fostering the entrepreneurial ecosystem, the multiple fields of innovation that are part of entrepreneurship, is not a simple task, however, when working with strategic planning and with the entrepreneurial action plan, it is acquired an efficient and effective that has proportions in the long term. Therefore, it is possible to achieve satisfactory results in this regard.

For that, it is necessary the effective participation of the public spheres, to foment the local entrepreneurial ecosystem and to ascend the economy of a certain region. Public management for local actions leverages business activities, making the success of policies to support SMEs supported by a regional innovation system.

The articulation between private organizations, employer, commercial and class co-optations, financial institutions, teaching and research centers and policy bodies that distinguish a system of innovations change according to each region, which in a way imposes limits on policies based on successful experiences from developed regions.

The entrepreneurial ecosystem, innovation and entrepreneurship are noted as dynamic actions, marked by peculiar aspects, in which information/knowledge is agglomerated by learning and mutual influence among stakeholders. In this context, knowledge of the panorama of the municipality of Imperatriz (MA) – Brazil - is essential, precisely because it highlights the components of the entrepreneurial ecosystem and its promoters.

From this perspective, it is worth noting that this study is based on a momentary representation of the current situation of the entrepreneurial ecosystem, through information from the last ten years investigated.

It was found that there is a gap in this research because the studies that are dedicated to understanding the role of public management in promoting the entrepreneurial



ecosystem in the municipality of Imperatriz are insufficient or even non-existent.

Therefore, the question that guides this research is: how is the participation of public administration in fostering the entrepreneurial ecosystem in the municipality of Imperatriz (MA) - Brazil?

## II. PUBLIC POLICIES FOR THE PROMOTION OF ENTREPRENEURSHIP

Public management in Brazil often goes through many challenges, especially about the direction of public policies and the competence of administrators to follow its guidelines as stated in the Brazilian Federal Constitution of 1988, in article 37: legality, morality, publicity and efficiency (Brasil, 2007).

Countless times, these discussions go beyond the limits of the institutions and directly affect the city's inhabitants, who position themselves as particularities of making public (Lucas & Moraes, 2019).

When discussing the inefficiency of the use and applicability of public resources Capez (2017) reports that the irregularity in the application of public money prevents the resources from providing quality public education, at a level compatible with that of the private network; turns public hospitals into warehouses for the sick and wounded awaiting death; what sometimes happens in the service queue itself; makes public employees poorly paid and discouraged workers, which feeds the lack of commitment to the function, among other aspects.

It is noteworthy that public management, from the point of view of understanding, differs in several factors from conventional organizational administration. This discrepancy focuses on the objectives, as a traditional organization aims to leverage quantitative results, while the public one aims at the population's quality of life (Carneiro, 2010).

Also, according to the conception of Carneiro (2010), public institutions are also considered organizational institutions, however, in contrast to private organizations, they do not aim at profit, but rather seek to correspond to the expectations and interests of society. It can also be said that public companies also use administrative resources and expedients similarly to private organizations: they are run by public administrators (managers), hired or career employees.

According to this theory, the dichotomy between business management and public management is extremely exact, but it does not match its execution. This is because most public administrators in Brazil, in the view of

Silveira (2006), operate the bodies for which they are responsible as if they were private organizations.

According to Carvalho, Viana and Montovani (2016), one of the most important components of an entrepreneurial ecosystem are the public policies promoted by the Government, whether it is about policies aimed at SMEs, but also about a range of policies related to taxation, financial services, telecommunications, transport, labor markets, immigration, industry support, education and training, infrastructure, and health. In terms of public policies aimed at entrepreneurship, several studies can be identified that report the importance that governments give to SMEs and their role in job creation (Carvalho, Viana & Montovani, 2016, p. 89).

Entrepreneurship public policies aim to create circumstances that promote the emergence of innovative actions, reaching the socioeconomic scenario, maximizing the insertion of new jobs with qualified professionals prepared for the labor market, in addition to innovations with highly competitive value.

Given this situation, public policies to promote entrepreneurship have been perceived and implemented in the light of the concept of economic growth stage practices mentioned by the authors Porter, Sachs, Cornelius, Macarthur W., Macarthur J., and Vasquez (2002) in studies carried out for the World Economic Forum in 2002.

The State has its main role as a promoter of the entrepreneurial ecosystem, however, it is also incumbent upon other spheres of government, such as municipal domains and entities, to assume and play this role in the vision of increasing economic and social indices in the region, adopting public partnerships. for an effective construction of local entrepreneurship.

When reflecting on public policies, the main aspect to be considered for the expansion of its effectiveness is related to solving the issue of the diversity of realities observed in this scenario of the entrepreneurial ecosystem of SMEs.

In analogy to public policy, Mason and Brown (2014) named a typology to foster entrepreneurial ecosystems. Table 1 presents different approaches and elucidates them.

*Table.1: Types of Public Policies for the development of the entrepreneurial ecosystem*

FOCUS	EXAMPLES
Entrepreneurial Actors	Business accelerators, business incubators and talent attraction.
Entrepreneurial	Business Angels, venture

Organizations	capital, banks, service providers and universities.
Entrepreneurial Connections	Public-private partnerships, partnerships and alliances, learning, local and global connections.
Entrepreneurial Guidance	Entrepreneurial education, and networks.

Source: Mason and Brown (2014)

It is noteworthy that, in addition to these typologies, there is the role of universities, which fits perfectly into the process of entrepreneurial orientation, as they perform essential functions to improve and leverage intellectual skills in the region (Moraes *et al.*, 2016).

It is also important the participation of service providers such as lawyers, accountants, recruitment agencies and business consultants, who understand the obligations and needs of entrepreneurial organizations, helping newly emerging organizations to minimize difficulties and the practice of non-crucial outsourced exercises (Mason & Brown, 2014).

### III. METHODOLOGICAL PROCEDURE

The research used in this investigation, which corresponds to the phenomenon studied, is qualitative and descriptive in nature, which according to Bauer and Gaskell (2017) seeks to explore various thoughts and concepts, tending to a broader and deeper investigation, researching attitudes, trends, and the complexity of the human behavior. It is a method that has a relevant role in the field of organizational studies.

Still on this topic, Garcia and Quek (1997) argue that qualitative research is concerned with processes and meanings that are not measured in terms of quantity, accuracy, or constancy. Godoy (1995) corroborates by saying that researchers who choose this type of research are intrigued and motivated to investigate how the process takes place and not just the results that will be obtained within the investigation.

This paper adopted, in terms of nature, the public management of the municipality of Imperatriz, including the mayor of the municipality, a senator from the state of Maranhão, the superintendent of political articulation of the State and some councilors of the municipality.

Regarding the research design, it is a documental, qualitative analysis since the intention is to bring documentary representations of a relevant nature within

the studied context. It also brings an interview involving public managers. In this aspect, documents are seen as a source of data that allowed the investigator to embark on a qualitative research, which is why they need exclusive or particular care.

Documents are non-reactive sources since the subsidies or information contained in them are preserved for long years, which in the past could be considered organic sources of information of historical, economic, and social origin, as they constitute important elements of this same situation (Godoy, 1995).

Documentary research, still according to Godoy (1995), is suited to the study of time frame, aiming to investigate one or more convergence, behaviors, and intentions. It so happens that the absence of a standard model and the entanglement of data coding are endorsed by many researchers as elements that bring methodological difficulties, precisely because of their degree of complexity.

Also, with regard to document design, and by way of temporal scheduling, legal provisions were taken into account, such as the investigation of draft laws, master plans, official documents, public circular and bodies such as the Commercial Association of Empress (ACII), the local press newspaper, the City Council and the Municipal Bidding Law (MPEs).

This is because these are elements that contain pertinent information that evidence or not the participation of municipal public administration in fostering entrepreneurship in Imperatriz.

In the construction of this paper, descriptive research was also used, which, along the lines of Vergara (2000), shows attributes or particularities of a certain population or phenomenon as it forms relationships between the variables, defining their nature.

It is added that this method proposes to map the particularities, the characteristics of a set of elements and build relationships between the evaluated variables.

In this research, for the data analysis procedure, sensemaking techniques were used, such as: visual mapping (visual map) and narrative strategy. Sensemaking refers to the construction of meaning, becoming important in face of complex situations in which it is necessary to make or promote a sense of the experience (Weick, 1995). Mapping is a visual technique, a map, and it is a relevant instrument to present information visually and describe actions in a succinct and expressive way. Mental or visual maps, according to Frey (2009), are considered relevant to absorb and organize information, knowledge, and other fundamental elements.

As for the narrative strategy, it can be said that most research processes seek to involve a resource of this type in some issue, as it is considered a fundamental product of the investigation. It is added that, when properly conducted, this strategy provokes a feeling of *dejavu* among experienced readers (Weick, 1995). About data analysis, the processes and meanings involved in this research were not measured in terms of quantity, intensity, or frequency.

#### IV. RESULTS

This study relied on information extracted from semi-structured interviews and field research, which corroborated the confrontation and association of the information collected.

To preserve the identities of the actors involved and promote greater reliability to this investigation, the participants were designated here as G1 and G2 in the case of managers of the state of Maranhão and the municipality of Imperatriz; V1 and V2 the councilors; and S1 and S2 the State and Municipal Secretary and Superintendent respectively.

The interviews took place in the absence of other people who could, in any way, interrupt or disturb them. The fact that the interview was preceded by semi-structured questions also facilitated the dialogue. Highlights were given to each high point of the interviews, as well as the situations experienced and perceptions about public management in the region. All reports were different in some cases and similar in others, however, with a wealth of information.

In this investigation, we sought to expose the crucial elements as well as the highlights presented, since, to reach a good ethical direction, it is necessary for the researcher to be aware of what he is looking for, his objectives or the element he seeks to know (Salomon, 2001).

Each of the interviews was carried out on alternate days, according to the schedule and availability of the participants involved in the study. A priori, it was questioned which actions the public management of Imperatriz develops to support companies to grow and hire qualified labor. So V1 replied:

*A bill was sent to the city council that benefits micro entrepreneurs, that is, those who are starting their activity in the market, providing for partnerships with bodies such as SEBRAE so that they can foster this informal economy or that of the micro entrepreneur. We know that it is still in its infancy, as the project was voted on by the chamber*

*a short time ago, it is only 5 months old. This was forwarded with the participation of civil society, trade association bodies, businessmen and micro-entrepreneurs and in addition to the city council, which is the executive body that implemented this project (V1).*

The interview excerpt refers to the indicator "entrepreneurial actions", represented in this research as one of the diagnosed variables that relate to each other and that are associated with fostering the entrepreneurial ecosystem. In this case, in V1's speech there is a desire to implement the project, however, according to his own words: "it is still in the initial phase". There are only expectations.

It should be remembered that there are partners, such as SEBRAE, that develop entrepreneurial actions that effectively support the promotion of the entrepreneurship ecosystem in the municipality. Therefore, the actions promoted were not explained by the interviewee in question. In this questioning, S1 mentioned that:

*Yes, it happens. Although it could happen more effectively. We have a city that has a purpose since its structuring that grows much more in theory than in the field of practice. Therefore, developing mechanisms that optimize entrepreneurship in Imperatriz so that it can become a true center of potential is still a challenge, but it is undoubtedly something that can be achieved. And I believe we will achieve (S1).*

In the interviewee's perception, there is entrepreneurial action, even if still timidly on the part of the municipal public administration. If there were greater engagement of actors and entrepreneurial stimuli, this would no longer be so challenging. Also, in relation to indicator A, V2 explained:

*Today, in Imperatriz, we have almost 300 thousand inhabitants and we have approximately 18 thousand academics regularly enrolled [...] On the other hand, we have two public universities here, UFMA – Federal University of Maranhão and UEMASUL – State University of Maranhão do Sul. we have several private universities, we have the IFMA – Federal Institute of Maranhão; a hundred courses in almost all areas, precisely to meet this new reality, which refers to market demands for increasingly qualified professionals. Companies generate this opportunity; however, it is necessary to have a team prepared for this, and in this case, I see higher education organizations with great strength and Empress is well served by this (V2).*

It was noticed in the interviewee's speech that universities, as well as institutes, are included in the process of construction and entrepreneurial mobilization. Obviously, the workforce that comes from these academic environments concentrates an important part of knowledge and ends up standing out from the mass workforce, which can favor them to ascend professionally. In this same prism, respondent G2 exposed:

*The city hall was our first partner in the implementation and application of legislation, which was the Complementary Law 123/2006, which institutes the statute of micro and small companies. This statute was created at the national level and then each State and Municipality approved its own. From the moment the city hall approves this legislation, it gives different treatment to micro and small businesses to grow within its municipality, and this differentiated treatment ranges from the issue of support to formalization - especially of individual micro entrepreneurs, who are a type of company that you can have a simplicity in the formalization process and even in the process of dealing with this entrepreneur, in addition to facilitating that some public policies meet the micro and small companies (G2).*

Interviewee G2 continues, saying that there are examples that attest to this partnership, such as:

*[...] public purchases, mainly in food purchases, the PAA and the PNAE, which are programs aimed at education, so the city hall already directs them to micro and small businesses in the municipality, as well as the process bidding. Because, the tenders already give a preference to micro and small companies, so there are a number of devices within the city's legislation that favors it. For example: if there is a tie between a small and a large company, the small company has the advantage of presenting R\$ 1.00 more in its proposal and coming out as the winner of the contest. At the level of competition, public notices of up to R\$ 80,000.00 are directed to micro and small companies, so the large company no longer participates (G2).*

That said, one must also consider that public-private partnerships still bring benefits to contracted companies, which ends up boosting the local economy. This reinforces the thinking of Etzkowitz (2005), when he says that there is a growing awareness that collaboration with the private sector, in PPPs, has the ability to provide numerous benefits for improvement and efficiency in the public sector, from the acceleration of a advance of infrastructure

as well as improvement in public management. Analogous to this argument, respondent V1 replied that:

*In relation to the workforce itself, when it comes to public authorities, it is already much more qualified in terms of partnerships, we have many more partners working in this issue of own qualification, with employees more involved in the small business cause. SEBRAE also does this with the public authorities [...] In terms of the market, the qualification of the workforce still leaves a little to be desired, as we have entrepreneurs who still do not have a good qualification, they leave the desire in the supply of products and services, or in the manner of management. And that is why we develop partnerships to work towards improvements, whether in the technical and operational part, here are partners such as SENAI, SENAC, SEST, or in the management part, which we have the educational institutions, the city hall itself and so on (V1).*

It can be seen here that SEBRAE is a strong ally of the city hall for the development of the entrepreneurial ecosystem, so the statements by Etzkowitz (2005) again fit in this context. The author says that a region can only be fostered for the purposes of economic advancement as each actor in the entrepreneurial ecosystem starts to adopt the role of the other, establishing alliances with a common purpose, which confirms the statements made by V1 and G2.

V1 was asked about the partners to foster the entrepreneurial ecosystem in Empress's companies: *"In addition to SEBRAE, there are some technical schools (private), Banco do Nordeste, the micro friend, which has partnered with entrepreneurs who use this microcredit and training as well, but SEBRAE is still the most active (V1).*

Accordingly, the statements of interviewees V1 and S1 present similar opinions in affirming SEBRAE's effective performance as a partner of the entrepreneurial ecosystem, also meeting the vision of V2 when it says:

*The Municipality of Imperatriz has in its structure the Secretariat for Economic Development – SEDEC and it, in turn, has the attribution of seeking training partners for the personal development of individuals who will enter the labor market. There is a concern in this regard, despite high school education being a prerogative of the State, but the city government maintains a job of directing these young people to the job market. [...] Here we have the Commercial and Industrial Association of Imperatriz – ACII and we have FIEMA – Federation of Industry of the State of*



*Maranhão, which is the biggest owner of the GDP of the State of Maranhão, and together we have some actions, as a bank of talents, the management of jobs, which are programs managed by SEDEC in partnership with ACII, FIEMA, CDL – Chamber of Store Directors that work in harmony, seeking to place and replace people in the market (V2).*

Based on this information, the process of searching for partnerships is essential for building an efficient entrepreneurial atmosphere. The answers refer to the indicator 'public-private partnerships', which refers to public-private partnerships that are driving forces for the development of the local economy. Still on the prism of this same indicator G1 replied:

*It is important that there is a partnership between the federal, municipal, and state government, each one of these entities has its taxes, and each one of them participates with its share to encourage these projects, because if it only depends on the private sector, the risk is greater. That is why there are PPPs – Public-Private Partnerships to enable exactly that. Municipalities can help in this regard with land, for example, where the Industrial District enters, they can also help with fiscal and economic incentives. This favors the growth of this entrepreneurship ecosystem (G1).*

Through this same questioning, V1 alludes that:

*We at SEBRAE have the city hall as the main partner, along with its secretariats and subfolders. We have as a great ally the educational institutions, especially those of higher education, but we also have those of basic and technical education that also help us in this matter, we have class entities, such as: Regional Councils, Commercial Associations, city council, Chamber of Store Managers, CONJOVE, Startup Associations that are carrying the issue of innovation very well here in the municipality. So, we have several partners, several agents involved that work together with SEBRAE (G2).*

It was found that the partnership between public entities and the private sector is essential, since both, interacting towards common interests, contribute to the growth and development of the community and region.

Another point raised refers to the large industries in the region. In V1's opinion: *"The large industry that exists today in the city is Suzano Papel e Celulose, but society, including mine, is very questioned about hiring people for high positions in our region" (V1).*

The respondent adds: *"A lot is taken from our (environmental) ecosystem, they benefit from it, generate wealth for them, however, for the municipality itself, there is not much benefit, especially in hiring local labor in higher positions to mass labor at operational levels" (V1).*

Here, there is already a certain dissatisfaction with the local industry. S1 was also asked about this same spectrum in relation to industries and he replied:

*There is Suzano, a Pulp and Paper industry, in our region. But I want to emphasize by saying that the model that Empress has and has grown was a kind of "predatory" model, as there is an idea of a movement of exploitation of commodities and this ranges from distributive sectors such as the energy issue and I quote here the gigantic hub of the Estreito hydroelectric plant and the pulp and paper plant, which is the case of Suzano in Imperatriz. These companies have very "predatory" characteristics because they in fact exploit the natural wealth and once, they are completely established, they create a difficulty in accessing local labor, so this is a problem in my opinion (S1).*

The respondent added:

*I see Imperatriz-MA in relation to the industries that they are being promoted by the Government of the State of Maranhão, and I cite the case of the recent Piracanjuba that is coming to our city to constitute a large center for the processing of milk (dairy and dairy products). I also mention the leather hub that is established between Imperatriz and the city of Governador Edson Lobão, which are structures that can quietly let Imperatriz be just a commodity export hub, so that we can process these products and aggregate value achieving income for the region (S1).*

Based on the interview reports, indicator 'public-private partnerships' is a crucial point in fostering a strategic partnership, since industries have the role of leveraging and developing the economy of a given region.

Regarding this issue, G2 said that: *"[...] the industry is closely linked to the issue of transformation, and when it comes to transformation, it is the addition of value to the product. So, from the moment you have this added value, we believe that there is collaboration for the development of the city" (G2).*

V1 adds saying:

*In the sense of developing entrepreneurship, I share this same vision, if we were to list the industries that we have here, you will find the Suzano company, in which practically all of its fleet of*

*transportation of inputs, which is wood, are made up of small and micro entrepreneurs. that invested in this logistics. Apart from the other courses she has brought since her implementation of mechanics, planting, which motivate people to take this course and then invest in their own business. In addition to that, we have Piracanjuba, which is coming, which will invest in the production of milk and its derivatives, which is also an entrepreneur, which they end up buying from other investors as well (V1).*

It is important to note that the existing industry in this scenario is important because it signals a positive trend in the local economy and trade and service sector, as mentioned by Porter (1998).

Concatenated to this context, it was questioned whether there had been planning for the implantation of these industries, and the public administration recognized that it expected an economic boom after the arrival of the industries to the municipality. V1 was expressed:

*I believe there was no organization. Some people here called themselves the "father of the project" of implementation, but when the car wash operation started and Suzano was mentioned, many people ended up abstaining, and then the city did not plan in my view, it did not qualify, the real estate boom where speculation is carried out did not sustain itself, and today we see a city with many houses for rent, many houses for sale, many condominiums that were made to serve this workforce are vacant, because the skilled workforce withdrew from the municipality (V1).*

In this aspect S1 also replied:

*In fact, there is always a plan, but when you look deeper you realize that there isn't or wasn't there. In the specific case of Suzano, it is a typical example, we have to carry out a process of accumulation of land, of exploitation of this land for vegetable production, and when the wood is removed, it takes up to a decade for this land to actually generate again fruits and vegetables. The same thing happens with other industries (S1).*

The respondent adds: *"I am convinced that the accumulation of strength between the partnership of these bodies to create a master plan organized with the Industrial District so that we could do all kinds of industrialization based on this planning process" (S1).*

It is concluded that V1 and S1 have similar opinions, as they both believe that there was no effective planning for

the implementation of the industry and that the expected economic development has not yet occurred.

On the other hand, there is the perception of interviewee V2, which contradicts these lines. The interview excerpt provides a brief explanation of strategic planning in the implementation of the local industry:

*Suzano's coming here has a very peculiar history. It was initially going to be installed in the municipality of Porto Franco, a few kilometers from here, also on the riverbank. There, yes, there was a political intervention, both by the State at the time, with the governor and our mayor here at the time, together with the city council, including the Commercial Association and organized civil society - which really got organized and mobilized. Everyone went to Suzano in São Paulo, which is the headquarters, to explain that the same river that passes there, passes here, that Porto Franco, would not have the same hotel structure, medical structure, sufficient fuel and other series of attributes, once that they would have to travel to get treatment at Empress. So, nothing better than staying in a city that already offers all the necessary support. [...] And when Suzano's plant was disclosed, the city automatically understood how much would enter the municipal coffers through the collection of the IPI, ICMS and countless taxes that are collected with an organization of that size. So, all of this was previously thought out and strategically planned, as it would heat up and give more oxygen for the municipality to work more on actions towards development (V2).*

It can be seen in this testimony that there was a strategic planning process. The indicator 'strategic planning' highlights this element, associated with the sociocultural aspect and which directly influences the promotion of entrepreneurship. It was verified, in the interviewee's speech, that the objectives outlined by the public administration are in harmony with those of civil society, that is, the community, which in this case participated in the actions planned and directed towards the development of the region.

In this way, an addendum is made that civil society has shown increasingly organized, participatory, and enthusiastic in the aspect of public issues and in this case, explained by the respondent, it did not deviate from the rule. According to Safarti (2013), public actions are born from common goals, individual or collective, in public benefit, so this involvement is necessary.

Another important aspect questioned was whether public, state, and municipal management has entrepreneurial action plans. In this regard, interviewee V2 said:

*[...] The State Government has an Economic Development Secretariat – SEDEC, which is concerned with this issue of attracting new ventures. We have a privileged position in Maranhão, which is the Port of Itaqui, which has one of the most important drafts in the world and is second only to Amsterdam in the Netherlands, and it is closer to Africa, this geographical position makes the issue of international trade much easier and in a way it undertakes. We have two railways that pass here, the North South and Carajás, even if the ore is extracted from Carajás it passes through here, the municipalities where the rails cut, they have a cooperative and receive some incentives, royalties from this exploration. The State maintains this policy of attraction and the industrial districts themselves are there for everyone to see. There is EMAP, located in São Luís, which is the agency that controls the Port of Itaqui. In the municipality of Imperatriz there is a series of actions. Because all this is part of the will of the main municipal manager (mayor) to have the understanding that it is necessary to undertake and seek new actions. In my opinion, we are on a good path (V2).*

It was noted in this speech the presence of the element represented by the identifier 'entrepreneurial action', which was repeated twice in this analysis: firstly, when the respondent reported the entrepreneurial actions. It is perceived that the mobilization for the speed of these actions is a determining factor for a region to grow and develop at economic levels.

Parallel to this, it was described that with the creation of Law 1680, of 2017, the Municipality of Imperatriz-MA should present the Municipal Plan for Entrepreneurship and Innovation to the local community.

In this juncture, the Municipal Secretariat for Economic Development (SEDEC) recently promoted training with all departments in the municipality to integrate public policy actions, meeting with representatives of Urban Planning, Civil Defense, Public Policy Secretariat for Women, and other representatives, to verify and be aware of the progress of the plans of each administrative sector (Imirante, 2017).

Another aspect that confirms this was mentioned by S2, who said:

*Law 1680 established the Municipal System of Entrepreneurship and Innovation with more than*

*30 complementary institutions. The objective is to strategically articulate activities and mobilizing actions to increase economic development in the region. The mutual influence between the secretariats and other institutions will develop channels and qualified tools to support entrepreneurship and innovation for the Municipality (S2).*

In line with this statement, G2 reports:

*In relation to the State, I'm sure so. Because there is a state-level committee that works on entrepreneurship and that SEBRAE participates, and it is headed by the Governor, where he calls several actors, SEBRAE collaborators, municipal secretariats, all of this to work on the entrepreneurship agenda in the State of Maranhão. And from there, it unfolds into several actions, such as, for example, we also have the State Board of Trade, which is implementing in all municipalities a system called REDE SIM, aimed at facilitating those who want to open their business and interconnecting all the organs: fire department, taxes, health surveillance. This system reduces the deadline for opening the company. And this involvement, as the General Law 123/2006, is an indication that the State and municipality are tuned in to this issue of stimulating micro and small businesses within their environment (G2).*

In this aspect, it can be said that entrepreneurial actions are those that promote administrative changes or even allow the implementation of new methodologies and that can be initiated by a single subject or by several individuals (Carneiro, 2010). Thus, it includes the strategic planning of the public sector, allied with the private sector, as an instrument of participatory management through entrepreneurial actions.

From this point of view, V1 complements:

*There are also government programs such as 'More Production'. For the rural producer, there was a program that ended which was more focused on industries, so from time to time they have government actions. There was the business mission that already made an edition to China and are already going to make the second one. So we do see engagement. In relation to the municipality, I see it in the same way, there is the Entrepreneurship and Innovation Committee, which deals with various institutions that meet to debate what actions can be taken in the municipality for development (V1).*

This ratifies the importance of promoting actions that stimulate entrepreneurial capacity and help to foster and heat up the local economy. Therefore, within this same questioning of entrepreneurial actions, respondent S1 replied:

*As a State, we are carrying out a conclusive project for the Industrial District, which will create not only from a tax point of view, greater appreciation for industries that come from abroad or even those that already have potential for local growth but will create more participation. decisive role of the State, in the sense of generating more jobs and income for the region (S1).*

There is a concern of the State in optimizing mechanisms that promote the economy and that have a positive impact on the generation of employment and income for the municipality. S1's speech refers to the 'job and income generation' indicator, which characterizes exactly this crucial point of employment and income, and which needs to gain more and more notoriety within governmental and municipal agendas.

What is the role of public authorities in relation to universities was questioned. Interviewee V2 said:

*One of the university's roles is extension, which goes beyond the institution's walls, and the city hall is an important partner. I'll give you a very practical example, in the area of health, for example, we have medicine here at UFMA (Federal), medicine at CEUMA which is a (private) university, there will be biomedicine at PITÁGORAS, nursing at various institutions in public and private. The Municipal and State public authorities have a series of units installed in the city, there is the HMI – Municipal Hospital of Imperatriz, which has an agreement with higher education institutions (public and private) for the internship issue, which is already a partnership very important (V2).*

In this sense and in the same prism of the conception of V2, the respondent V1 added: *“The role is to create opportunities for this mass that is formed in the research and extension universities, so that these people together with the universities can be occupying the discussions and the positions offered by these companies” (V1).*

It is clearly noted here the importance of universities for the growth and development of entrepreneurship in the region and how the engagement of public authorities with the academic environment is essential to generate opportunity for the community inserted in this universe, ensuring qualified professionals in the occupation of positions. Still within this scenario V1 mentions that:

*[...] the role of public authorities in relation to universities is linked to the qualification of labor with a clear objective to investigate market trends. I believe that every market trend arises there within the academy, with studies, with research, because, from the moment we have this study and research, mainly applied to individual micro entrepreneurs, we will have new trends in the market and that they will consequently open new markets. For example, here last year (2020), we partnered with a research program at UFMA, which is INOVAR, they carry out a market diagnosis with the companies and they will identify whether that company is aware of the market opportunity and what it does with the market opportunity (because companies are often attentive but do nothing). Then we gathered at SEBRAE about 60 small companies, each company received a lecture, which had a market diagnosis carried out in partnership with UFMA. They received feedback on what point to take advantage of the market and what stocks they were failing. Public authorities need to be interacting because knowledge is built from that (V1).*

Parallel to this, it is worth noting that extension research as a link between academia and society is an opportunity for public management to build assertive public-private partnerships, because, according to Bresser (1989), this interrelation promotes competitive advantages and provides benefits for society.

The role of public authorities in companies was also asked, and V2 stated:

*There is an incentive for companies to grow in Empress. Both for those who are arriving and for those who already exist. There is frequent dialogue via the Commercial and Industrial Association of Imperatriz – ACII, Chamber of Store Directors – CDL (very active in the region), in addition to the Unions. Everyone is always very tuned in, discussing important issues for the region. For example, at Christmas time, there is a campaign to decorate the city, there are the Municipal and State public authorities, the private sector, unions, and representative entities, of course I gave a very simple example here. But I realize that there is a permanent dialogue between the initiatives [...] (V2).*

Given this statement, V2's speech is configured as the indicator 'dialogues between initiatives', which is characterized by the promotion of dialogue between public and private initiatives to ensure greater incentives for local organizations, so that grow and obtain economic results



that contribute to the region's development. Therefore, the same V2 when asked about the role of public authorities in relation to SEBRAE replied:

*In the case of Imperatriz, there is a partnership, in relation to the attraction of labor, training of personnel, among others. I say this because invitations arrive at City Hall frequently. For example, in relation to bakery there is an effort to learn the whole dynamics of the bakery chain. The Secretariat for Social Development - SEDES and the Secretariat for Economic Development - SEDEC have a series of pertinent actions. Another example, the "pop center", which is a center, where people are passing through, without prospects, 'housed', let's say, and are placed, precisely in these courses, in order to somehow awaken to acting, a professional aptitude. Thus, these people will have a perspective of the future, will have a job, income and possibly a family. [...] So there are numerous actions of the public power that march together with SEBRAE (V2).*

In line with the interviewee's speech, a connection is made to the indicator 'capturing opportunities', referred to here as an element of capturing opportunities and which is related to the sociocultural aspect. Considering what was exposed by the interviewee, SEBRAE and the public administration corroborate efforts to promote programs and actions capable of attracting new investments. The formation of a team or of new talents can incur in the identification of a good opportunity, which in turn can generate the formation of the team and fundraising. Also, about this question, G2 reports that:

*Our main partner of SEBRAE is the government. And when we have this ease of dialogue with the government, our actions really develop in a much easier way to have a better city. Of course, the public power is not the only partner, we have municipalities that sometimes do not have the figure of the public power there, and we always look for a business organization entity or a trade association or even a group of entrepreneurs organized to for us to develop our actions. But, when we have a public power as the main partner, SEBRAE's actions are without a shadow of a doubt much more efficient (G2).*

Here, once again, the 'entrepreneurial action' indicator appears to reinforce the action of public-private partnership in the context of the municipality of Imperatriz. It was questioned which municipal secretariats work for the development of local entrepreneurship. To do so, S1 said:

*I will talk here about SINFRA – Infrastructure Secretariat, which was supposed to be very active in our city, but I suspect that it is not. It even poses obstacles to this growth and development of local entrepreneurship in my view. Lack of planning is perhaps the biggest problem. The lack of technical capacity of managers, I also see as a problem. And this ends up having a very strong impact on the city's management. So, I am particularly independent of proselytism, I have the understanding that in this aspect the municipal administration is lacking (S1).*

In this same aspect V1 mentions:

*Here in Imperatriz there was a Secretariat for Economic Development – SEDEC, but unfortunately, for about nine years now, the only role it had was to send this project of the local micro entrepreneur, and from the moment it reached the City Council, we demand more actions, therefore, in my view, in a generic way, the Secretariats are not showing so much service in this regard (V1).*

In this context, there is a weakness in relation to the performance of some Secretariats since the effective performance of these public bodies are decisive increments in the encouragement and growth of entrepreneurship. Regarding this G2 alludes to:

*There is the Secretariat for Economic Development – SEDEC, which is very active, and in previous terms we did not have this involvement as we have now, and this is a very positive point. In previous terms, it was more the Agriculture Department, which is usually a partner, the Municipal Revenue Department, which is also a partner because it deals with permits, invoices, among others. But this year, we have a partnership with the Department of Education - SEDES, which we have a strategy of entrepreneurship and innovation in schools, and we also have the Municipal Department of Taxes (G2).*

It is noted that the involvement of municipal secretariats is linked to the attributions of formulating and executing plans, programs and projects that are linked with government agencies and entities and private and public bodies, providing a scenario that supports the attraction of new investments with costing and modernization existing economic activities.

The Secretariats' actions are also part of operating as a facilitator between the government and entrepreneurs, with the intention of attracting and optimizing investments (Carneiro, 2010). As for the projects designed to develop the entrepreneurial ecosystem, S1 replied:

*[...] today we have important production chains that are linked to the logic of trade, for example, in the trade relationship. Today, the State government has an important program called Juro Zero, where the State Government encourages small children's entrepreneurs to access via bank credit up to R\$20,000.00 and pay in various installments, with the interest earned on this amount being paid by the State. Therefore, it is an incentive for the small entrepreneur. We also have in some sectors that involve the issue of microcredit, those who wish, for example, to establish themselves as a State to sell school supplies, those who are veterinarians who want to sell products to AGED - State Agency for Agricultural Defense of Maranhão and to Maranhão State Agency for Research and Rural Extension - AGERP, those who want to make leather, for example, a production chain. Also, those who want to partner with the State and establish relationships with their dairy products so that the State can also promote this milk chain. And of course, our flagship, the Industrial District, which is without a doubt a more effective action by the State, in the sense of reducing taxes, breaking some barriers, including bureaucratic ones, so that industry and commerce can develop better (S1).*

Partnerships are important for the development of efficient projects. In this sense, it is noted that there is a favorable insertion of designs towards the implementation of actions that support the entrepreneurial amplitude in the municipality. Regarding this, G2 complements saying that there is also:

*[...] the project that SEDEC is carrying out, which is the capillarization of service to MEI through the CRAS, through higher education institutions. And there is also, for example, the innovation incentive program, where a part of the resources, of the taxes will be destined to the promotion of innovation, which is an initiative of the Entrepreneurship and Innovation Committee, that is, it will have a resource (fund ) coming from the government for innovation projects in our municipality. Apart from other actions being carried out in partnership with SEBRAE (A1).*

Based on this report, it is added that the relationship between public and private, about educational policy, is a constitutive element of social and economic transformations. It is not a point of determination, but of inclusion and process (Carvalho, Viana & Mantovani, 2016). Therefore, universities are relevant in the composition of the entrepreneurial ecosystem, therefore, the strengthening of these alliances is necessary.

The public administration partners were asked to promote the entrepreneurial ecosystem in the region, and V1 replied: *"Our partners are the Industrial Association of Imperatriz - ACII, SEBRAE, City Council and the community itself"* (V1). In this same aspect, respondent V2 added:

*The partners are formed by the Secretariat of Economic Development - SEDEC, Secretariat of Social Development - SEDES, Industrial Trade Association of Imperatriz - ACII, Federation of Industries of the State of Maranhão - FIEMA, National Learning Service - SEBRAE, Chamber of Store Directors - CDL and Universities - public and private (V2).*

The increase in partnerships or strategic alliances is considered an effective mechanism within organizations, whether public or private. Within this aspect, indicator B appears again in the analysis, represented by the public-private partnership.

Nevertheless, the interviewees make clear the existence of a strategic grouping for a common objective. It is known that partnerships need to start by understanding the challenges and activities that are involved within the established alliances, hence the importance of the assertive choice of allies that aim to ignite an organization. In this case, organizations in the macro sense of the word since we are talking here about the entire entrepreneurial ecosystem of the municipality.

Another relevant issue raised, which is linked to the previous one, questions the existence of strategic planning in the search for public-private partnerships in institutions and companies in the municipality. In this sense, respondent S1 reported:

*[...] Due to the fact that Maranhão has had a deficiency in investments for decades, the private initiative ended up working as a strong vehicle for all of this. But I suspect that a lot is changing. The construction of full-time schools, the IEMA schools, which are full-time vocational schools that will end up generating a huge number of qualified labors, the partnership that the State is making with many companies. For example, with Suzano, with the production of leather, milk, the trade sector, and also investments in infrastructure through some hubs such as the riverside. All of this ends up directing and making us believe that a future that lies ahead can be better (S1).*

G2 reports that: *"On our part (SEBRAE) yes. We map the areas that we want to serve in a certain period and year, and through those areas that we intend to serve, we*

are looking for who our partners are so that we can carry out these actions, whether public or private" (G2).

There is evidence, in relation to the interviewees' statements, that strategically planning partnerships is important to establish economic growth. In this regard, the speeches of participants S1 and G2 refer to indicator C, an element represented here by economic development. Public-private partnerships provide a greater likelihood for a region to develop economically.

What can be seen from the interviews, in the case of the municipality of Imperatriz, is that although some weaknesses have occurred, there is a demonstration of actions by the local government for partnerships with other public and private emissaries, directing their efforts to leverage the ecosystem entrepreneur in the region.

## V. CONCLUSION

According to the data collected for the mapping of the entrepreneurial ecosystem, the municipal management of Imperatriz provides entrepreneurial stimuli.

Although there are efforts aimed at the entrepreneurial promotion of local public management, the participation of municipal public agents and higher education institutions (IES), which play an important role in the entrepreneurship scenario, is still not widespread.

It is also noted that in various regional and local events, discussion spaces are opened regarding entrepreneurial issues with the aim of developing the municipality's economy. These events are mostly attended by SEBRAE, which is a foundation within the ecosystem, and local educational institutions, colleges, and universities.

For this reason, in the proportion of clashes or in approximate equivalence, the public authorities would need to provide more enticement from the HEIs in this juncture addressed.

The efforts and the necessary designs need to be more widespread to give concreteness to the projects outlined more quickly, with the intention of promoting the development, in a more efficient and growing way, in the entrepreneurial ecosystem of the municipality.

It can be said that the entrepreneurial ecosystem is composed of the elements of public policy, culture, financial capital, support institution, human resources and markets, and the performance of public authorities can propagate concomitantly within these variables.

About financial capital, it was diagnosed with the documental analysis that there is also a need for progress, since the direct participation found was that of the

BNDES, in the participation in a project that took approximately 20 years to assume format and be effective.

As for the aspect of culture, the municipality had some inclinations and achievements directed towards entrepreneurship, although there has been no change since 2004, when the municipality's master plan was created, until the present moment.

This year is not part of the time frame of this research; however, it was mentioned because it refers to the only master plan that currently exists. There is a new master plan in progress at the City Council, however, it has not yet been put into effect.

On the other hand, support institutions, such as SEBRAE, stand out in this scenario, as they have been playing important roles in partnership with the local government, promoting courses and effectively stimulating entrepreneurship in the city.

In relation to human resources, Instituto PROE collaborates with companies in the search for professionals with technical qualification, with skills and competence to occupy business positions and administrative functions, which characterizes a relevant issue from the point of view of generating incentives for the entrepreneurial ecosystem.

Finally, it can be said that the fact that the Imperatriz market is considered dynamic and competitive and the city's economy is the second largest in the state, the municipality attracts considerably many entrepreneurs to this ecosystem.

It is noteworthy that this research aimed to analyze the participation of public management in fostering the entrepreneurial ecosystem of Imperatriz. Therefore, it moved towards data with greater foundation and concreteness, which were obtained through interviews, since mapping alone would not be enough to vehemently affirm the role of public management in fostering this ecosystem.

As for the limitations of the research and recommendations for future studies, it is noteworthy that even if the objective has been achieved, it is important to emphasize that all research, especially of a qualitative nature, has constraints, that is, some limitations.

A limiting aspect was the difficulty of scheduling interviews in relation to some actors, since the commitments of the public administration delayed the collection of information, which focused on rescheduling visits, which were often recurrent.

Another guiding point is related to the fear of having the identities revealed, even knowing that the research has an ethical apparatus and the free document clarified to ensure the identification of those involved. It is noteworthy

that not everyone had the same fear, only some participants.

Regarding future work, it is recommended to deepen this study to understand entrepreneurship and its direct relationship with innovation and research the governance of the entrepreneurial ecosystem and the conflicts of public and private interests.

Finally, it is plausible to ensure that the research regarding the role of public management in fostering the entrepreneurial ecosystem in the municipality of Imperatriz was relevant, as it is a material that will serve as support to assist other researchers working in this same line of research.

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# What motivated students at the Diana Colaça Education Center to choose the Administration Course and what are their Expectations when Completing the Course? – A Case Study

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**Keywords—** Administration course,  
motivated the choice, expectation and  
conclusion.

**Abstract—** This article is the result of a case study on what motivated students at the Diana Colaça Education Center (CEDC) to choose the administration course and what their expectations were when they finished the course. The main objective is to analyze the aspects that influenced the students of the administration course to choose the referred course, describing whether there was any influence, social, family, professional or of another level on the choice, analyzing the degree of satisfaction of students in relation to the which is being studied in the course, as well as understanding what the expectations of these students are after completing the higher level. It started from a theoretical and introspective analysis from bibliographical sources, extending to the field of case study with collection, analysis and interpretation of data, facts and phenomena that influence students to choose higher education in the administration course. With the great diversity in higher education offer, realizing that the demand for the administration course is very present, arouses the curiosity of the educational and social class to try to understand what drives these students to choose this course, and throughout the research realizing that they did not try to know the course and its areas of expertise, its pros and cons, before joining it, makes us believe that when they graduate, such professionals will not have "passion" for their professions, thus becoming frustrated professionals and in some sometimes disabled.

**Resumo—** Este artigo resulta de um estudo de caso sobre o que motivou os alunos do Centro de Educação Diana Colaça (CEDC) a escolha pelo curso de administração e quais suas expectativas ao concluírem o curso. O objetivo principal é analisar os aspectos que influenciaram os alunos do curso de administração a escolherem o referido curso, descrevendo se existiu alguma influência, social, familiar, profissional ou de outro nível sobre a escolha, analisando o grau de satisfação dos discentes em relação ao que está sendo estudado no curso, bem como entendendo quais são as expectativas desses alunos após a conclusão do nível superior. Partiu de uma análise teórica e introspectiva a partir de fontes bibliográfica, se estendendo ao campo de estudo de caso com coleta, análise e interpretação de dados, fatos e fenômenos que influenciam os discentes a escolha do nível superior no curso de administração. Com a grande diversidade em ofertas de curso superior, perceber que a procura pelo curso de administração se faz muito presente, desperta a curiosidade da classe educacional e

*social para tentar compreender o que leva tais alunos a escolha por este curso. Ao longo da pesquisa perceber que os mesmos não tentaram conhecer o curso e suas áreas de atuação, seus prós e contras, antes de ingressarem nele, nos faz acreditar que quando formados tais profissionais não terão “paixão” pelas suas profissões tornando-se assim profissionais frustrados e em algumas vezes descapacitados.*

**Palavras-chave— Curso de Administração; Motivou a escolha; Expectativa e conclusão.**

## I. INTRODUCTION

Given the vast offer of higher education courses, the ease of access and admission that has been taking place, as well as the fierce competition in the labor market and social and technological advances, it is observed that more and more people are seeking higher qualifications and within a regional context, there is a greater search for the administration course.

It is noted that, upon completing high school, students are full of curiosity, anxiety and uncertainty about their future, some prefer to seek immediate entry into the labor market, while others decide to invest in academic life, motivated by several factors: pressure family, vocation, social influences, opportunity for professional growth, among others.

For SOARES (1987), considering that the entrance exam takes place just when students are completing high school, and if the student still does not feel prepared to do so, he will lose the opportunity to enter higher education as soon as possible. , as early as the following semester. This provokes in the student a feeling of anxiety and anguish, because, if he has not yet made up his mind professionally, there is the possibility of being frowned upon by society.

With this came the curiosity to know what motivated the students to choose the Administration course, was it the social pressure or was it in fact a conscious choice about the professional career they wanted to follow, as well as knowing their degree of satisfaction in relation to their academic life and the expectations they have at the end of the course?

This study, when completed, can help high school students to reflect and research a little when choosing a higher-level course, not being influenced by external reasons, actually choosing the course that most identifies with their students. longings and their characteristics.

On the other hand, society will understand that it is not possible to impose the choice of a profession, for reasons of status, financial vision or any other reason, as people must choose their higher education course according to their own dreams. The work may also motivate secondary schools during this period to carry out campaigns, workshops or through any other methods you wish in order to make the student know a little about

higher level courses and the professions that he/she will be able to perform. when finished.

The present work has as general objective to analyze the aspects that influenced the students of the administration course of the Diana Colaça Education Center to choose the referred course. And as specific objectives: Describe the social influences on students when choosing higher education; analyze student satisfaction in relation to the chosen course; understand the impact of that choice and expectations.

## II. THEORETICAL DEVELOPMENT

### 2.1. Social influences on students when choosing a higher education course.

With the advance of modernization and increased competitiveness, society is evolving every day in all sectors and it is no different in the academic sector. The range of higher education courses is increasingly diversified, and with that, students are increasingly indecisive.

Tozzi (2004) reports that at 17 or 18 years of age, on average, teenagers who are going to apply for the entrance exam, go through the most difficult decision of their lives, as it is a choice that students still do not have control over issues. basic, in relation to the profession they are going to choose. Most of these people who are at this age are coming out of adolescence and need emotional security and professional experiences.

Crites (1974, apud ARAUJO et al 2010). It states that when a person chooses a career related to higher education, this choice is linked to different theories, which may have suffered psychological, non-psychological influences, ie economic and social, and general influences that are interdisciplinary.

Psychological theories are more associated with culture, family and resources, they are characteristics of the individual, related to their personal history of constructions and deconstructions of culture and values. Non-psychological theories are linked to the external conditions of each person, such as social class, religion, access to opportunities, access to the labor market, among others. On the other hand, general theories are defended as the proposition of sustainable compositions, being the

balance point between individual characteristics and socio-environmental concerns.

Society and the environment in which people live influence high school students, by an immediate choice for a higher education course, not allowing time for students to complete high school and rest from school fees, research courses and professions with which they most identify with, they already have to have an immediate answer about which entrance exam they are going to take, which courses they are going to choose and in which area they will work.

For Bock et al. (2005), in the past, people's professional occupations were determined by blood ties and after the installation of the capitalist model, people choose their occupations influenced by their skills, aptitudes and interests, based on the social conditions in which they live.

It is a common pressure in adolescents and when they are asked about the course, society expects this answer instantly, otherwise they will be seen as indecisive people, who do not know what they want from the future, or who do not want anything from the future.

On the other hand, if they answer that they want to attend, some course that does not pay well for professionals when they graduated, or that are not well regarded by society, they already receive several criticisms.

For Guhur et al. (2010), parents should talk to their children to facilitate their choice, opening up to dialogue, to know their preferences and understand what motivates them to make such choices, providing their children with self-knowledge and facilitating their choice. .

The professional choice is one of the most important choices in people's lives, because despite being a professional choice, it directly impacts personal and family experiences. Even though people have the opportunity to change their profession over time, it is important to analyze very carefully which profession they will choose.

## **2.2 Student satisfaction in relation to the chosen course**

After choosing the course of their choice, students create expectations in relation to the chosen course, as this is their first contact and their first impressions about the profession that they will follow after completing higher education.

Regarding the administration course, Dias (2002) argues that with the growth and expansion of higher education courses in this area, companies are increasingly looking for more qualified people, so the administration course, in addition to preparing efficient professionals, also has the function of making people more flexible,

creative, easier to adapt to change and understand that learning is a continuous and lifelong process.

This demand to make professionals more flexible and adaptable will not only serve for professional life, but for the entire existence of the being, because the more adaptable, the more flexible and more empathetic it is, the easier it will be for the person to get around the difficult situations of the day daily, this being a strategy that should be used by all higher education institutions in all courses: Not only train professionals, but train more humane and more capable professionals.

For Camargos et al. (2006), Higher Education Institutions, in order to awaken the interest of students and thereby gain in learning, it is necessary to identify students' preferences in order to plan and establish didactic-pedagogical strategies and guidelines, with the objective to improve the perception of students about the course and higher education as a whole.

Therefore, it is necessary that HEIs become increasingly dynamic and more adaptable to the changes that society in general has been going through. They need to be up-to-date and within the reality of the field of action, so that when the student finally completes their course, they will in fact be able to work in their area of training, and not be just another graduate with a higher-level certificate in hands.

For Walter (2006), The main concern of higher education institutions must be the student's well-being and the satisfaction of society's needs, involving two aspects, namely: society's perception of that professional who has just joined the labor market coming from an HEI and the discovery of the student, during the course or in the future, about the services they receive from the HEI, and which they must put into practice in the labor market. The performance of students in the labor market is a reflection of the quality of education they obtained in the Higher Education Institutions they attended.

For Neves and Ramos (2001), Given the current scenario, HEIs cannot limit themselves to just providing knowledge, as today's students, due to economic conditioning, are visibly concerned with their inclusion in the labor market. IES must adapt to these new requirements.

Pereira (2019), states that school dropouts are present in three factors: family, student and school. In the family, it can be related to family breakdown, unemployment, and affective problems. Regarding the student, there is a lack of interest, lack of participation in activities and little prospect for the future. In relation to the school: lack of quality in teaching, lack of motivation on

the part of teachers, way of teaching classes, lack of interaction between school and family.

For this reason, it is necessary that higher education institutions seek as much as possible, in the first semester, to develop the student's interest in the chosen course, because if the student really identifies with the course, he will certainly have more pleasure in attending the classes, in dedicating himself to the course, and even if there are difficulties that lead him to think about giving up, he will continue, because he will already feel pleasure in what he set out to do.

### **2.3. Understand the impact of that choice and expectations.**

Even when they are in high school, the students are already full of expectations regarding the future, the course they want to join and the profession they will follow, however these expectations are not always met and people often end up having to draw new routes to your dreams.

According to Soares et al (2014, apud, MORENO 2014), students encounter several changes when entering higher education and these changes can lead to several difficulties, thus frustrating the students' expectations. For him, these changes are related to disciplines, non-sequenced classes (unlike high school), more flexible schedules, routines that high school students were not adapted to.

Faced with these difficulties, often associated with the lack of identification with the chosen course, a process of university evasion begins, bringing a negative impact both on the HEIs and on the students. For Heublein, (2014 apud AMBIEL et al. 2018) university dropouts happen in different ways and fluctuations and means the non-completion of the course for any reason.

Castro and Teixeira (2014 apud AMBIEL et al. 2018) states that university evasion is related to financial or health issues, non-identification with the choice of course, dissatisfaction with the future profession.

The choice of which course to choose when taking the entrance exam and, consequently, the profession they will pursue in the future directly impacts people's lives, as it is the work that keeps people going. For this reason, people have to know very well what profession they want to pursue so that this profession can have a positive impact on their lives.

After the impact with the reality of academic life, students still go through other disorders, because when they are completing higher education they are full of expectations to put into practice everything they have learned in their academic life and often they face a reality distinct from the desired one.

Young people often need to reorganize their life projects, adopting other trajectories, investing in another higher education course, or in a graduate program, in view of the frustration of their expectations when they complete higher education and seek stability in their professional career quickly. , states (MELO 2007).

When students complete higher education and enter the labor market, they experience difficulty in entering the labor market or difficulty in putting into practice everything they saw in college. For this reason, higher education institutions must also work this reality with their students, so that the clash between expectation and reality does not make them give up on their dreams, or become bad professionals.

## **III. RESEARCH RESULT AND ANALYSIS**

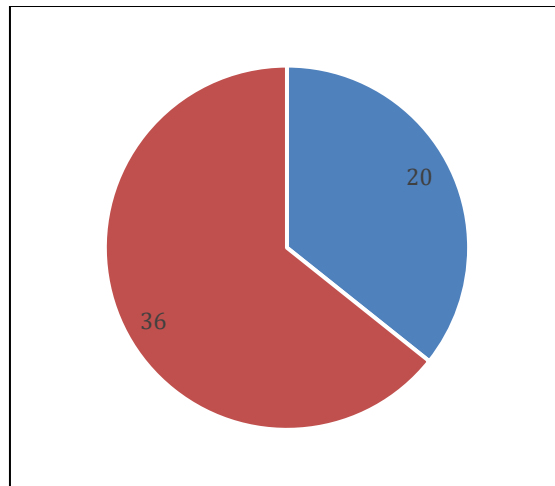
The survey was conducted with students from the Administration course at the Diana Colaça Education Center, which was founded in the city of VárzeaAlegre/CE in 2019, offering several courses, technicians, superiors and specializations in partnership with accredited educational institutions by the MEC. CEDC offers both on-site and distance learning courses, making students choose the option that best fits their profile.

According to data provided by the institution, 82 students entered the administration course between January 2019 and April 2021, however over time there were some dropouts and enrollment closings, totaling 26 students (32% of enrolled students), which shows us a high number of university dropouts in this course. According to the institution, most enrollments were closed during the on-site course, with these students migrating to the distance learning network at the same institution, while others reported enrollments being blocked, motivated by financial reasons.

A survey was made available on the online platform Google Forms, the survey was carried out under online conditions, for health safety reasons, in view of the current moment experienced in the world with the Covid-19 pandemic.

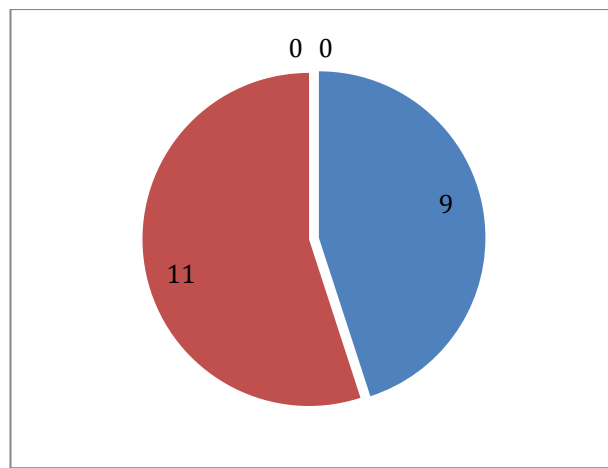


Graph 01 – Researched.

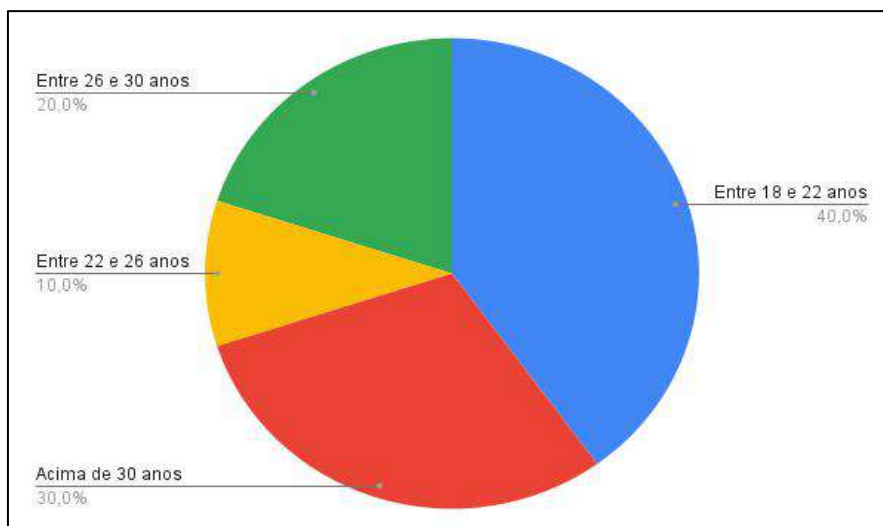


Even with 56 students enrolled in the administration course and having direct contact with each one of them, being asked to respond to the survey for greater precision in the results, only 20 students showed interest and participated in the survey.

Graph 02 –Gender

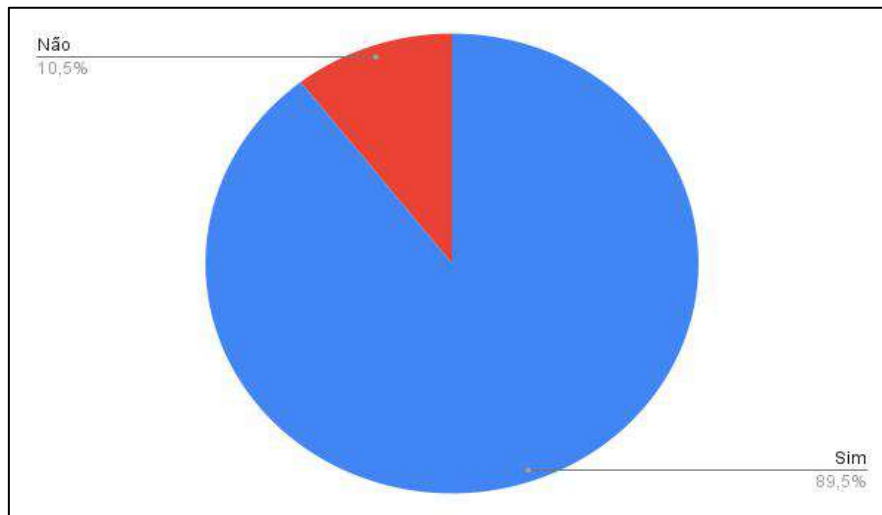


Graph 03 - Age Group



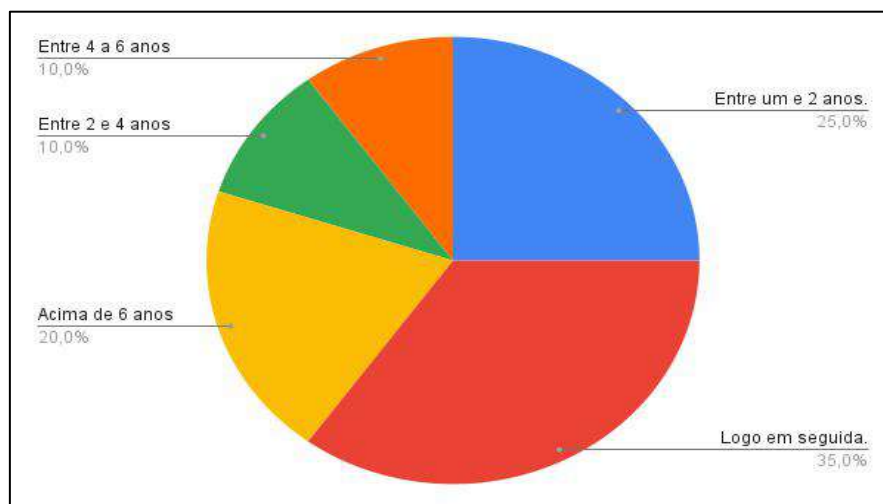
Students are mostly female, representing 55%, 11 women and 9 men. And they are in different age groups being all over 18 years old, however the vast majority of students are between the age group of 18 to 22 years old, representing 40, soon after come people who are over 30 years old representing a percentage of 30% of the total, which leads us to believe that they had already completed high school some time ago.

Graph 04 – Is this your first higher-level course?



For most of the 89.5% class, the administration course is the first higher-level course, this being their first experience with the pace of teaching, with 18 people in their first degree and only 2 (10.5%) already have experience with the university routine.

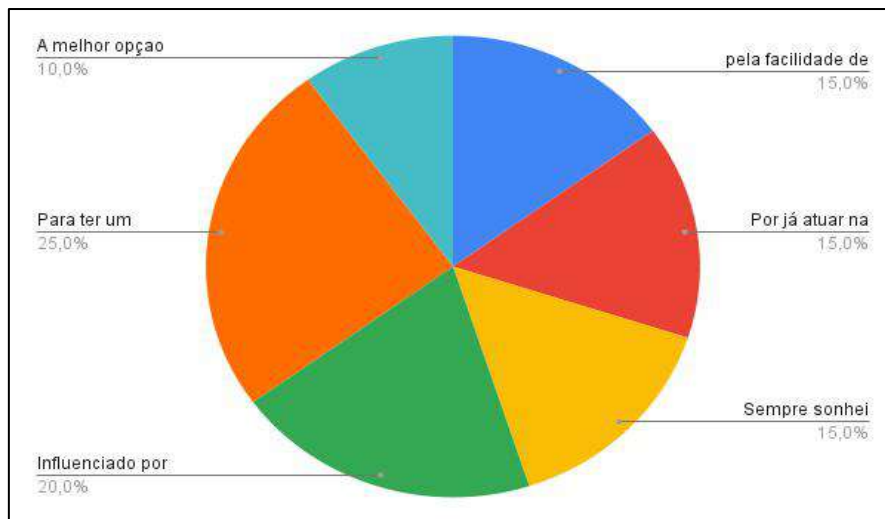
Graph 05 – How long did you start the course after completing high school?



When asked how long after they finished high school they started higher education, 35% said it was soon after. 25% reported that it took place between 01 and 02 years after completion. 10% found that it was between 02 and 04 years after completing high school. 10% reported that it was between 04 and 06 years after completing it.

While 20% declared that they started their academic life after 06 years of completion of higher education, leading us to believe that even after a long time out of the classroom, older people are returning to their studies.

Graph 06 – Why did you choose the administration course?

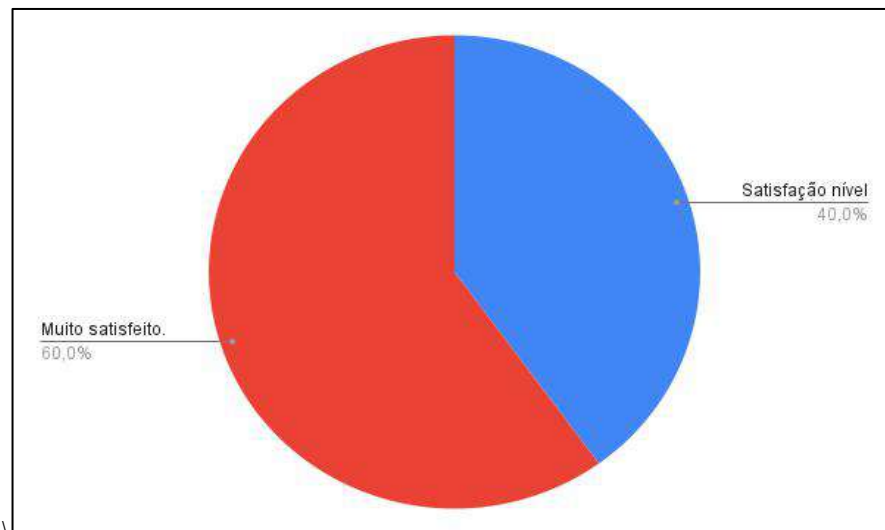


When asked why they chose the administration course 25% (05 responses) the majority stated that they only wanted a higher education certificate, this being their main motivation. 15% (3 people) say they always dreamed of a business course.

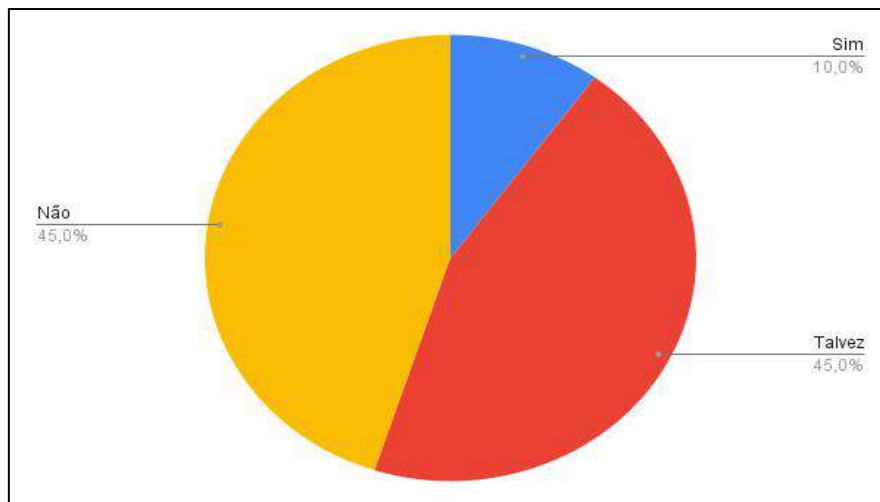
As such, 10% (2 people) reported that it was the best course option available in the city at the time of

choice. 15% (3 people) reported already working in the area and therefore the choice of the course, the same percentage said they chose it motivated by the ease of access. For 20% (4 people) their motivation was inspired by professionals already working in the administration area.

Graph 07 – What is your degree of satisfaction with the course so far?



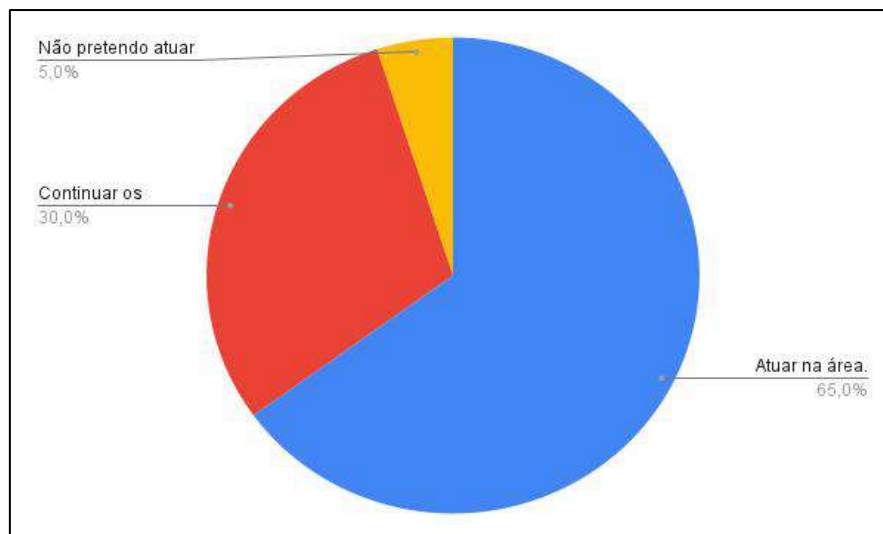
Graph 08 – If you could go back in time, would you choose another course option?



Asked about the degree of satisfaction with the administration course, 60% (12 answers) said they are very satisfied, while the remaining 40% (8 people) reported that their satisfaction is at medium level, however when asking if they had the opportunity to change the course choice, only 45% reported not being interested, less than half (9

people), while 45% (9 people) said yes and 10% (2 people) were undecided. These data lead us to think about the indecision, if 60% are very satisfied with the course, why only 45% show interest in staying on the course, if there was the possibility of changing their choice.

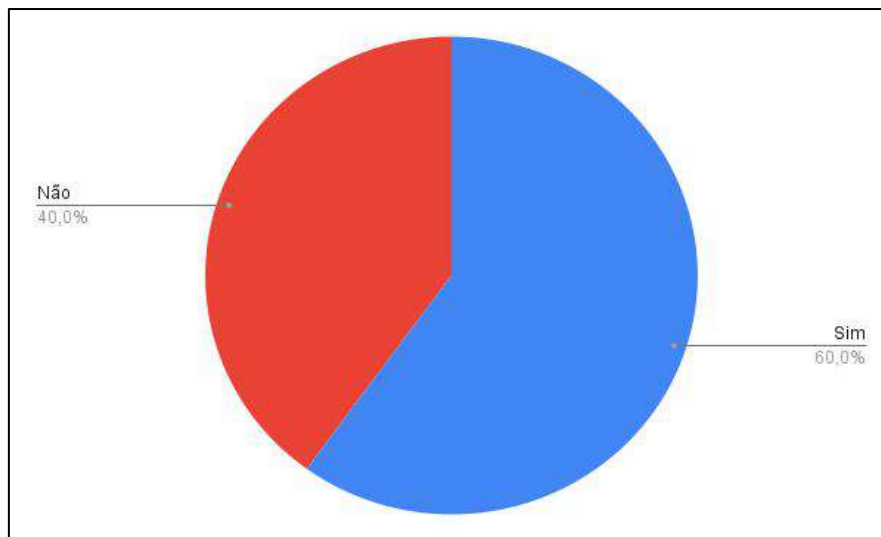
Graph 09 – What do you intend to do after completing the course?



Asked what students intend to do after completing the administration course, 65% (13 people) confirmed that they intend to work in the area, while 30% (6 people) intend to continue their studies, whereas 5% (1 person) do not want to work in the area .



Graph 10 – Did you try to know the course and your area of expertise before choosing?



Asked whether they sought to know the course and areas of expertise before opting for it, 60% (12 people) said yes, while the remaining 40% (8 people) said no.

#### IV. FINAL CONSIDERATIONS

This study intended to show a little bit about what motivated the administration students of the Diana Colaço Education Center to choose the administration course, considering that it is an area of activity with a lot of growth in the professional market.

The accuracy of the final result of the research was compromised by the fact that the students did not show interest in participating in the aforementioned, even though contact was made with them, through the institution, through teachers who were teaching in the class during the period, and individually by part of the research applicator.

The lack of interest in participating in a survey that takes no more than two minutes to complete, leads us to think that it may be a reflection of the commitment and/or commitment of students in the classroom, or even the degree of satisfaction that he has in relation to his own academic life.

With the study, it is clear that higher education institutions have more and more challenges to be overcome, including the most difficult and increasingly important and the maintenance of satisfied and committed students. For this reason, HEIs must be an environment dynamic, updated and bringing the student to live experiences that they may face when they complete the course. Because only with student satisfaction on the rise is it possible to avoid the number of dropouts.

On the other hand, high school institutions themselves must work on raising students' awareness, so that they have the desire and curiosity to research and choose the course that best fits their profile, so that they can feel more fulfilled. when they become professionals and start working in the area of their chosen graduations.

As a suggestion for future research, it would be interesting to contact dropouts to understand what motivated these students to drop out. And do a new survey in a few years with the 20 people who answered this survey, to find out if they are working in the area and positive cases feel fulfilled and when the university collaborated for such accomplishment.

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## Extension Activities of Administration during Pandemic: University of the State of Bahia (2020)

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course, Universidade do Estado da Bahia-  
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Brazil)*

**Abstract**— *This article seeks to show the experience of the extension course offered during the pandemic in the year of 2020 called "Processes, Technologies, Management Systems and the Economic Context" of the Bahia State University (UNEB), from the perspective of the course participants, with the objective to carry out an evaluation about it, from the following question: What is the evaluation of the course participants in relation to it?. The methodology was a case study with 2 phases. The first through 3 objective questions using the lieutenant. The second through form on the UNEB Moodle platform. As a result, we have that students were favorable to the type of instruments used by professors with the use of the Inverted Classroom to contemplate their improvement and professional qualification in the area of Management.*

### I. INTRODUÇÃO

A partir de 30 de janeiro de 2020 a Organização Mundial da Saúde (OMS) declarou que havia uma pandemia mundial de cunho viral provocada pelo Covid-19 (WORLD HEALTH ORGANIZATION, 2020; BARRETO et al, 2020). Este fato promoveu modificações na vida das pessoas e da academia, devido a questões de isolamento social o que gerou o fechamento das Unidades de Ensino, inclusive das Universidades, que foram obrigadas a dar uma resposta rápida a sociedade através, por exemplo, do desenvolvimento de atividades extensionistas. Assim, o curso ora objeto deste artigo foi concebido e adaptado ao modelo remoto emergencial, com o uso de ferramentas computacionais, para a condução de um processo de ensino-aprendizagem mediada por tecnologias digitais (TANGO et al, 2020).

Todo e qualquer curso de Extensão Universitária busca atuar de forma interdisciplinar, científica, educativa,

cultural e política, a fim de promover a interação transformadora entre a sociedade e a universidade (FORPROEX, 2010). As atividades extensionistas estão previstas em 2 Leis Brasileiras: (a) a primeira é a Constituição Federal de 1988 que prevê a indissociabilidade entre pesquisa, ensino e extensão nas universidades (BRASIL, 1988); e (b) a segunda é a Lei de Diretrizes e Bases da Educação Nacional, que em seu artigo 46, inciso VII, define, dentre as finalidades do ensino superior “promover a extensão, aberta à participação da população, visando à difusão das conquistas e dos benefícios resultantes da criação cultural e da pesquisa científica e tecnológica geradas na instituição” (BRASIL, 1996).

A partir destas observações, a extensão universitária foi reinventada, de forma a manter o vínculo e a interação entre a Universidade e a sociedade, ainda que exclusivamente de forma não presencial, mas garantindo a

atenção às demandas sociais emergentes, em um contexto de pandêmico (FERRARI et al, 2020; SARTI et al, 2020; NASCIMENTO et al, 2020). Diante deste cenário surgiu o curso de extensão denominado “Processos, Tecnologias, Sistemas de Gestão e o Contexto Econômico”, que foi ministrado por 3 professores do Departamento de Ciências Humanas (DCH) da Universidade do Estado da Bahia (UNEB), no Curso de Administração do campus de Salvador no ano de 2020.

O curso foi proposto para aperfeiçoar e qualificar principalmente os estudantes e profissionais relacionados diretamente com as áreas de Administração, de Ciências Contábeis, de Sistema de Informações e Engenharia, compreendendo-se que a pandemia promoveu o fechamento de vários empreendimentos comerciais, e conseqüentemente o aumento do desemprego principalmente na Região Nordeste que chegou a 17,3%, seguida pelo Norte (15,1%) e o Sudeste (14,2%). Somente Centro-Oeste (12,1%) e Sul (9,4%) registraram taxa inferior à média nacional, lembrando que a Bahia e o Maranhão são os Estados com maior índice de desemprego, o que corresponde respectivamente 19,9% e 19,5% (IBGE,2020)

Alguns autores, como por exemplo, Amor Divino et al (2013) relatam que as ações extensionistas atuam mais localmente ou com a população próxima da Universidade que promoveu o curso, mas é bom sinalizar que com a pandemia o ensino passou a ser remoto, o que pode proporcionar atividades extensionista fora deste contexto local.

Assim, este artigo busca mostra a experiência do curso denominado “Processos, Tecnologias, Sistemas de Gestão e o Contexto Econômico” da UNEB, a partir da visão dos cursistas, com o objetivo verificar as lições apreendidas ao longo da atividade extensionista considerando o seguinte questionamento: Qual a avaliação dos cursistas no que tange ao planejamento e desenvolvimento didático-pedagógico e tecnológico do curso desenhado em uma base metodologia apoiada na Sala de Aula Invertida?

Durante o processo de ensino aprendido os 3 docentes trabalharam com o modelo de Sala de Aula Invertida (SAI), ou seja, buscaram colocar os cursistas em um papel ativo para encontrar seu próprio conhecimento, onde eles têm a liberdade de construir seus próprios saberes. Assim, os professores atuam como orientadores que desenvolveram aulas síncronas menos expositivas e mais interativas e participativas, de modo a engajar e otimizar os tempos dos cursistas dentro das atividades proposta no curso, utilizando por exemplo estudos de caso e problematizações na área de gestão, que são dialogados por todos os atores do processo de ensino e aprendizagem

(VALENTE, 2018; AQUINO et al., 2019; BERGMANN; SAMS, 2018). Afinal, “o conhecimento não se estende do que se julga sabedor até aqueles que se julga não saberem; o conhecimento se constitui nas relações homem-mundo, relações de transformação, e se aperfeiçoa na problematização crítica destas relações” (FREIRE, 2006, p. 36).

Para a concretização deste artigo, o mesmo foi dividido em 4 partes. A Introdução, onde retrata o tema, o problema e o objetivo, fazendo uma breve contextualização da importância dos cursos extensionistas e sua relação com a SAI. Depois apresenta-se a metodologia, que explica os métodos e instrumentos utilizados para obter a opinião dos cursistas, seguido dos resultados e por fim a conclusão.

## II. METODOLOGIA

Trata-se de um estudo de caso qualitativo dedutivo ocorrido com os cursistas que participaram do curso extensionista “Processos, Tecnologias, Sistemas de Gestão e o Contexto Econômico” da UNEB, entre os dias 16/09/2020 até 15/11/2020.

Os cursistas avaliaram o curso em 2 fases. A primeira fase foi após a finalização das 3 aulas síncronas através de 3 perguntas objetivas utilizando o mentimeter ®. A segunda etapa foi no final do curso através de um formulário on-line postado na plataforma do Moodle da UNEB onde havia 14 perguntas fechadas.

Após estes dois estágios, os dados foram transformados em gráficos, para análise e interpretações dos resultados e depois realizar as conclusões.

## III. RESULTADOS

O período da inscrição do curso ocorreu entre os dias 17/08/2020 até 10/09/2020, foram oferecidas 200 vagas para a sociedade. A inscrição foi feita de forma on-line através do link <http://sge.uneb.br/inicio/index> pelo site do Sistema Gerenciador de Evento (SGE) da Universidade do Estado da Bahia (UNEB), com o uso de folder e vídeo ([https://youtu.be/y\\_K\\_30dNAz4](https://youtu.be/y_K_30dNAz4)) elaborado pelos 3 professores do curso, com o apoio de 2 tutoras voluntárias. As tutoras por sua vez, atuavam auxiliando nas perguntas presentes nas aulas síncronas e nas demandas dos cursistas nas atividades assíncronas presente no Moodle. A carga horária total do curso de extensão foi de 180h, organizado em 3 módulos que ofertavam aulas síncronas e assíncronas.

As aulas síncronas tiveram uma carga horária total de 9 horas, distribuídas em 3 encontros distintos ocorridos nos dias 16/09/2020 (<https://youtu.be/-qsdT4OUmR0>),



08/10/2020 (<https://youtu.be/cFBbEPj2UnA>) e 29/10/2020 (<https://youtu.be/rWOkfPs4f9A>). Cada aula síncrona teve uma carga horária de 3 horas que ocorriam sempre das 19 horas até às 22 horas. Toda os encontros síncronos foram desenvolvidos e gravados na plataforma do Microsoft Teams®, para posteriormente serem disponibilizadas no Youtube®. A plataforma Moodle foi disponibilizada como ambiente de atividades assíncronas, servindo como repositório de objetos de aprendizagem a exemplo de módulos, vídeos autorias gravados pelos docentes, os vídeos dos encontros síncronos e links para vídeos de terceiros, esta plataforma também foi utilizada como suporte para registro de frequência, realização das avaliações objetivas e avaliações discursivas.

Nos encontros síncronos buscou-se não apenas ter uma palestra dos 3 professores, mas a interação dos cursistas a partir da concepção metodológica do SAI, através de recursos didáticos como um mural on-line concebido com o apoio do padlet® (<https://pt-br.padlet.com/>) e a nuvem de palavras com o uso da ferramenta mentimeter® ([mentimeter.com](https://www.mentimeter.com)) cujo objetivo de ambos os instrumentos era o de gerar discussão e interatividade entre os docentes e os cursistas durante o desenvolvimento da aula, de forma que ao final da mesma as ideias principais fossem apresentadas e enfatizadas com base no ponto de vistas de todos os presentes. A Fig. 1 mostra um exemplo que aconteceu no dia 08/10/2020 em que as palavras com maior destaque foram: Tecnologia, Pix e E-commerce e que as outras palavras da nuvem estão relacionadas de forma direta ou indireta com as 3 principais. A Fig. 1 foi elaborada automaticamente durante a aula síncrona a partir dos conhecimentos e saberes dos cursistas sobre a aula.



Fig.1- Nuvem de palavras das principais palavras debatidas em aula - Curso de Extensão de Processos, Tecnologias, Sistemas de Gestão e o Contexto Econômico – 08 out.2020

Fonte: Elaboração própria, 2020. Adaptado do [mentimeter.com](https://www.mentimeter.com).

Já as aulas assíncronas foram disponibilizadas na plataforma do Moodle da Instituição de Ensino Superior (<http://www.avate.uneb.br/course/view.php?id=1170>), onde foram disponibilizados vídeos e materiais didáticos elaborados pelos 3 docentes.

O primeiro módulo foi denominado de Contexto Econômico tendo carga horária 60 horas e foi relacionado com a disciplina Macroeconomia. O segundo módulo com o nome de Processos Organizacionais previu uma carga horária de 60 horas trabalhou conteúdo da área de Organização Sistema e Métodos. O terceiro módulo foi intitulado de Tecnologias e Sistemas de Gestão, também com 60 horas e trabalhou conteúdo da área de Administração de Sistemas de Informação. Para a avaliação de aprendizagem do curso foram aplicados 3 tipos instrumentos, cada um com um valor total de 10 pontos.

O primeiro foi o registro das presenças nas aulas síncronas com interação nas atividades realizadas on-line, para isso era gerada uma lista com o nome dos cursistas participantes, a partir da plataforma Microsoft Teams. A lista era disponibilizada no formato de formulário na plataforma Moodle e os cursistas deveriam realizar o preenchimento manual do registro de presença em dois momentos específicos das aulas.

O segundo instrumento de avaliação foi uma atividade em equipe com até 5 integrantes, onde cada grupo deveria postar até o dia 23/10/2020 um vídeo de forma a resolver um único estudo de caso de problematização, onde foram dadas 3 missões empresariais em 3 períodos distintos durante o decorrer do curso; os objetivos desta atividade foram: (a) Resolver o estudo de caso empresarial com soluções viáveis e reais; (b) Observar o contexto econômico e (c) Considerar as dimensões tecnológicas e organizacionais da empresa, conforme proposta dos 3 módulos.

No terceiro instrumento avaliativo o cursista deveria responder a 3 formulários, cada um com conteúdo dos 3 módulos. Cada formulário continha 10 questões objetivas, cada pergunta com cinco alternativas e apenas uma resposta correta.

Assim, os cursistas no decorrer do curso fizeram 5 atividades no valor de 10 pontos cada, e a média final correspondeu a média aritmética das 5 notas. O curso teve 200 inscritos, sendo que no primeiro encontro síncrono participaram 188 cursistas, na segundo 150 registraram presença e no terceiro encontro 100 discentes se fizeram presentes. Do total de matriculados, 113 finalizaram o curso realizando todas as atividades e destes 83 foram aprovados com média igual e superior a 7,0, ou seja 41% do total. Já 30 cursistas não conseguiram alcançar a média mínima de 7,0, o que corresponde a 15% do total de

matriculados e 87 desistiram do curso, ou seja, 41% abandonaram o curso de extensão (Conforme Fig. 2).

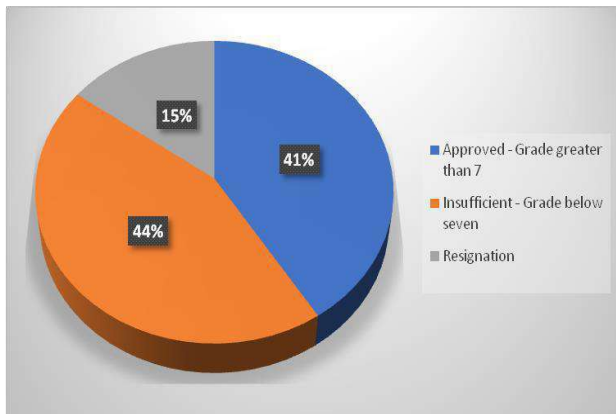


Fig.2 - Frequência absoluta e relativa dos números de concluintes e desistentes - Curso de Extensão de Processos, Tecnologias, Sistemas de Gestão e o Contexto Econômico -2020

Fonte: Elaboração própria, 2020.

Em relação a avaliação do curso, por parte dos cursistas, aconteceu em 2 momentos: (1) durante a 3 aulas síncronas e (2) ao fim do curso.

A primeira avaliação, acerca da efetividade do curso, sempre foi realizada ao término das aulas síncronas, com o objetivo de ouvir os cursistas e assim aprimorar o desenvolvimento do curso ao longo de sua execução, conforme a demandas dos discente. A segunda avaliação ocorreu após a finalização do curso em um questionário objetivo com 14 perguntas.

O Fig.3 a seguir, mostra a média das notas dadas pelos cursistas em relação às 3 aulas síncronas, onde os cursistas aplicaram notas de 0 a 10. Percebe-se que os cursistas relataram que se apropriaram dos conteúdos dos 3 módulos ministrados e aplicaram a nota 9,4. Em relação às tecnologias utilizadas para desenvolver os encontros síncrono, foi aplicada a nota 9,0, demonstrando uma elevada satisfação com os recursos empregado. No que tange à interação e a colaboração nas aulas síncronas, os cursistas apontaram que poderia ter maior quantidade, tal item alcançou nota 8,9. Destaca-se que para o desenvolvimento da interação, recursos como mural digital, quiz e nuvens de palavras foram disponibilizados com vistas a apoiar o debate com todos os 200 participantes, os quais também poderiam contatar os professores e tutores via Moodle e/ ou chat durante as aulas síncronas no MS-Teams. Considerando o elevado número de participantes, os professores do curso consideraram metodologicamente inviável disponibilizar o

microfone para todos se manifestarem em tempo integral. Desta forma, os professores periodicamente dirigiam perguntas ao grupo, para que os mesmos respondessem, via áudio ou chat, e também, em momentos específicos, eram abertos espaços para que estes “levantassem a mão” na plataforma MS-Teams, a fim de formularem perguntas oralmente.



Fig.3- Avaliações das aulas síncronas pelos cursistas através do mentimeter com notas de 0 a 10 - Curso de Extensão de Processos, Tecnologias, Sistemas de Gestão e o Contexto Econômico - 2020

Fonte: Elaboração própria, 2020.

Alguns cursistas informaram também que, por participarem das atividades através de um smartfone, era tecnicamente complexo sair da aula síncrona desenvolvida no Microsoft Teams, responder ao mural on-line com o uso do padlet, participar da nuvem de palavras no mentimeter e ainda preencher o formulário de frequência disponibilizado no Moodle e novamente retornar a aula síncrona. Entretanto, os professores consideraram relevante a disponibilização de recursos didáticos e tecnológicos diversos que estimulassem a interatividade e a participação dos discentes ao longo do encontro, bem como gerassem registros de sua efetiva presença.

A Fig.4 mostra a avaliação realizada pelos cursistas, acerca da concepção e desenvolvimento das atividades didático-pedagógica e emprego dos recursos tecnológicos do curso. Conforme o Fig.4, 113 cursistas concluíram o curso (83 aprovados e 30 reprovados) e destes 73 fizeram a avaliação sobre a andamento do mesmo, ou seja aproximadamente 65%. Neste sentido para o desenvolvimento da avaliação, foi solicitado que os cursistas aplicassem notas de 1 até 5 em relação a 14 itens do curso, onde foi considerando 1 péssimo, 2 ruim, 3 regular, 4 bom e 5 excelente. A maior nota foi 4,8 em relação aos conteúdos ministrados e a menor nota 4,0 em relação a navegabilidade no ambiente do Moodle da UNEB.

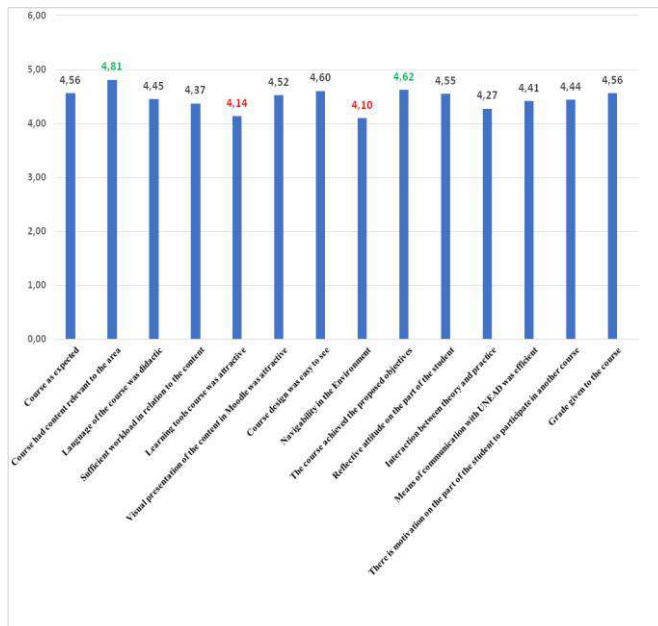


Fig.4- 14 itens avaliados com notas de notas de 1 até 5 após finalização -Curso de extensão Processos, Tecnologias, Sistemas de Gestão e o Contexto Econômico -2020

Fonte: Elaboração própria, 2020.

Outro aspecto das respostas ao questionário que chama a atenção, foi a pergunta sobre a atratividade das ferramentas de aprendizagem, utilizadas ao longo do curso, com a segunda pior avaliação 4,14 o que evidencia a necessidade de buscar plataformas, recursos tecnológicos de suporte didático e ao mesmo tempo, implementar estratégias que combinem todas estas dimensões do ensino-aprendizagem.

Diante destes números, pode-se concluir que o curso foi considerado de bom para ótimo pelos 73 cursistas que avaliaram. Ao analisar os comentários dos discentes, estes classificaram os conteúdos e atividades dos momentos síncronos como atuais e práticos e consideraram que os 3 módulos se inter-relacionaram, entretanto, acharam que as atividades síncronas deveriam ter uma maior carga horária.

#### IV. CONCLUSÃO

A partir dos resultados evidenciados das Fig. 2, 3 e 4, percebe-se que os cursistas apropriaram-se dos temas e conteúdos trabalhados, bem como demonstraram um elevado grau de satisfação com a metodologia da Sala de Aula Invertida, neste sentido o curso atendeu às expectativas estabelecidas, contemplando o aperfeiçoamento e qualificação profissional dos participantes, gerando um nível de interatividade e colaboração entre os atores, promovendo a autonomia da

aprendizagem dos sujeitos participantes. Entretanto, há muitos desafios pela frente entre eles a necessidade de aprimorar as estratégias didático-pedagógicas que ampliem a interatividade entre os discentes e destes com os docentes, sobretudo em curso com um número elevado de vagas e uma diversidade de público, conjugando o emprego de tecnologias que favoreçam a dinâmica de uma construção coletiva e a autonomia do sujeito aprendente.

Continua sendo necessária a proposição e implantação de Políticas Públicas que possibilitem a melhoria do acesso à internet para os docentes e a população em geral, além de melhores equipamentos móveis, bem como a ampliação da capilaridade da Universidade através de uma infraestrutura mais flexível e adaptável às demandas da sociedade. Percebe-se que 98% dos cursistas acessaram o curso através de aparelhos de smartfone e que algumas vezes a internet não realizava conexão satisfatória para docentes e discentes.

O curso de extensão atendeu em sua maioria o público local, é necessário ver novas estratégias, para contemplar outros públicos.

Há muito ainda o que inovar e aperfeiçoar, e a pandemia criou condições que têm acelerado este processo de aprendizado apoiado na mediação tecnológica.

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# Pharmaceutical Conduct Applied to Pharmacies During the Sars Cov2 Pandemic (Covid-19)

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**Keywords— COVID-19, Pharmacy, Pharmaceutical Conduct, Clinical Pharmacy.**

**Abstract—** *The new Coronavirus (COVID-19), has already infected more than 5 million people in more than 181 countries, has been causing numerous socioeconomic problems and increasing morbidity and mortality related to the infection. The virus still lacks adequate, effective and safe pharmacotherapy and even vaccinated people are still at risk of acquiring the disease. Therefore, the focus has been on prevention and health promotion, thus contributing to the reduction of transmission. In this context, the doctor, nurse, pharmacist, physiotherapist has been playing a fundamental and vital role in controlling the transmission of the disease and meeting the health needs of the community during the crisis, dissipating information based on evidence, epidemiological control and strengthening of rational use of medicines. This paper aims to address the pharmaceutical conduct in pharmacy during the COVID-19 pandemic.*

## I. INTRODUCTION

The virus causing the pandemic was named SARS-CoV-2. This New Coronavirus generates a disease classified as COVID-19, being the agent of a series of pneumonia cases in the city of Wuhan (China)(CRODA; GARCIA, 2020). Without concrete information on the mechanism of action, nor unquestionable effectiveness measures for the clinical management of cases of human infection by SARS-CoV-2, there are still many details to be clarified. However, it is known that the virus causes an acute respiratory syndrome which ranges from mild cases – around 80% – to very severe cases with respiratory failure – between 5% and 10% of cases. Its lethality varies mainly according to the age group and associated clinical conditions(KENNETH MCINTOSH, MD; MARTIN S HIRSCH, MD; ALLYSON BLOOM, 2019).

SARS-Cov-2 proved to be a virus with high transmissibility, thus it was decreed a state of alert for

pandemic and the World Health Organization decreed quarantine in Brazil.

The easy access to community pharmacies makes them a strategic point for managing the care of Covid-19 suspects and for forwarding interprofessional work in the health care network (CADOGAN; HUGHES, 2020; ZHENG et al., 2020).

Pharmacists are the ideal professionals for preventing inadequate self-medication, reporting suspected mild cases and providing advice on medical care when necessary, as patients with health-related concerns choose to seek pharmacies as the first form of care (PERROT et al., 2019).

The International Pharmaceutical Federation (FIP) defined a list of attributes for pharmacists during the Covid-19 pandemic: evaluation of suspected and confirmed cases, as well as their risk stratification; determination of cases for referral; disease prevention, infection control, health

information and education for the public, among others(SOUSA PINTO et al., 2021).

Considering the above, it is possible to understand the relevance of performing pharmaceutical conduct with excellence, the importance of pharmaceutical care, thus reducing the workload generated to the health system during the Covid-19 pandemic.

## II. THEORETICAL FOUNDATION

In the city of Wuhan, China, at the end of 2019, a series of cases of pneumonia of unknown etiology emerged, which generated a severe watery respiratory syndrome(DI GENNARO et al., 2020; LAKE, 2020). In January 2020, a few weeks later with a sample from the lower respiratory tract, the new Coronavirus (SARS-CoV-2) was identified as the causative agent of the pathogenesis(HUANG et al., 2020).

From the Coronaviridae family, the new Coronavirus has characteristics common to other members of this family. The virus has single-stranded RNA as its genetic material(KANNAN et al., 2020).

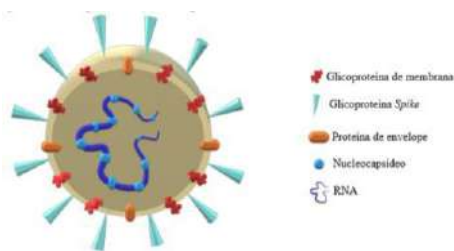


Fig.1: Morphologically, Coronavirus is enveloped, predominantly spherical, with approximately 150 to 160 nm in diameter. Its name originates from the presence of spicules that project from the viral envelope, giving the appearance of a crown (from the Latin corona) (Figure 1). The Coronavirus genome codes for four or five structural proteins, namely: Spike glycoprotein (S), membrane glycoprotein (M), envelope protein (E), nucleocapsid (N) and hemagglutinin-esterase (HE).(KANNAN et al., 2020). Image:(TÚLIO DI ORLANDO CAGNAZZO\*, 2020)

The incubation period for COVID-19 is approximately 5 days, ranging from 3 to 14 days (LI; DE CLERCQ, 2020). The time from onset of symptoms to the fatal outcome, when it occurs, is approximately 6-41 days, with an average of 14 days(ROTHAN; BYRAREDDY, 2020).

Second Bulut and Kato (2020) Covid-19 can be classified according to its seriousness in 5 groups: I - Asymptomatic Infection: when there is no symptom with a positive diagnosis for SARSCoV-2; II - Mild symptoms:

symptoms of upper respiratory infection, including fever, fatigue, myalgia, cough, sore throat, runny nose and sneezing, no pneumonia; III - Moderate: with pneumonia, frequent fever and cough; there may be wheezing but not hypoxemia like shortness of breath; IV - Severe: rapid progression within a week, dyspnea with central cyanosis, oxygen saturation less than 92% and other manifestations of hypoxemia; Critical: patients with Acute Respiratory Distress Syndrome (ARDS) or respiratory failure, shock, organ failure.

However, clinical protocols and therapeutic guidelines to guide clinical practice have been developed by countries and health organizations(MINISTRY OF HEALTH, 2020). As a result, even without strong scientific evidence, many drugs have been used empirically in an attempt to minimize the lethality of COVID19. This situation has been seen at different levels of health care and alerts to the risk of iatrogenic in health care(PAU et al., 2021).

Pharmaceutical services aimed at promoting the Rational Use of Medicines (URM), comprises a prescription that is adequate to the health condition, timely access and the use, with defined intervals and time, of cost-effective, safe, effective and quality medicines(MINISTRY OF HEALTH, 2001).

A study by ZHENG et al. (2020)indicate a model of pharmaceutical service during the COVID-19 pandemic. These authors report that the pharmacy, through pharmacists, can promote approach to patients in the direct interaction between professional and patient. Figure 2 shows six pharmaceutical services to be provided by the professional.

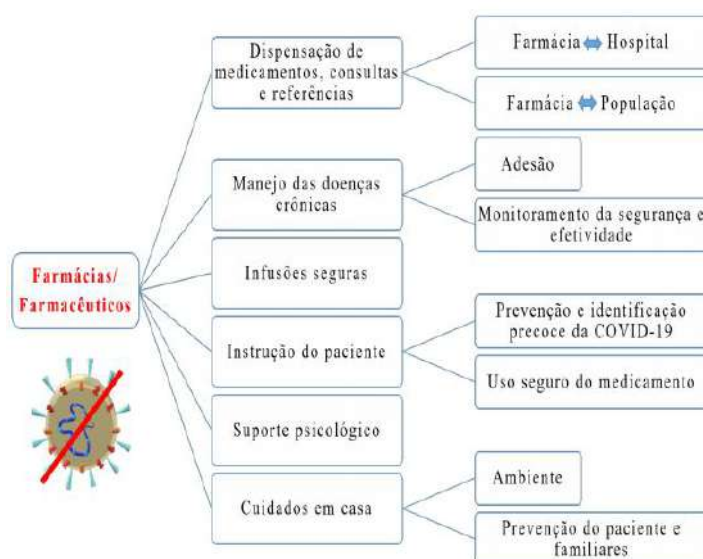


Fig.2: Pharmaceutical service model during the COVID-19 pandemic. Source: Modified from (ZHENG et al., 2020)

### III. METHODS

This study consists of a literature review, classified as exploratory and descriptive. The work carried out is of a quali-quantitative nature. Qualitative data analysis is performed intuitively and inductively during the survey of the theoretical framework. It is also quantitative through the use of the multicriteria method. The bibliographical research was carried out in the following databases: *US National Library of Medicine* (Pub Med), Scientific Electronic Library online (SCIELO), Caribbean Latin American Health Science Information System (LILACS), Science Direct (Elsevier) and Embase.

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 searching the databases were: Coronavirus, COVID-19, SARS-CoV-2, Pharmaceutical care. As a tool to support the decision in the selection and prioritization of articles, a set of criteria were considered essential to represent the state of the art of the subject of research. 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.

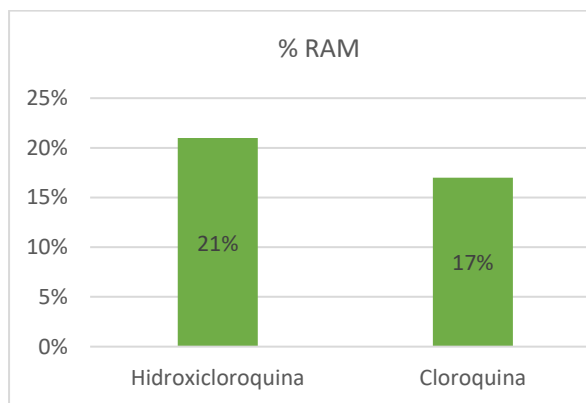
### IV. RESULTS AND DISCUSSION

The Federal Council of Pharmacy establishes the internationally recommended steps:



<b>PREPARE</b>	<ul style="list-style-type: none"> <li>• Acquire, store and distribute medicines and other health products to meet demand;</li> <li>• Manage the pharmacy so that the flow of suspected cases and cases minimizes the spread of the virus;</li> <li>• Define an isolated area for the care of confirmed cases, probable cases of covid-19, based on technical parameters;</li> <li>• Develop emergency plans and local work flow;</li> </ul>
<b>IDENTIFY</b>	<ul style="list-style-type: none"> <li>• Carry out clinical screening and rapid tests in suspected cases, close contact and home contact that access the pharmacy;</li> <li>• Notify confirmed cases and suspected cases;</li> </ul>
<b>ISOLATE</b>	<ul style="list-style-type: none"> <li>• Direct confirmed or suspected cases, according to severity and risk of complications, to primary health care, or home isolation;</li> <li>• Monitor the evolution of confirmed cases, probable cases and mild symptomatic suspected cases;</li> <li>• Monitor the health status of the team and recommend isolation if any member meets the definition of a confirmed or suspected case;</li> </ul>
<b>TO CONTAIN</b>	<ul style="list-style-type: none"> <li>• Promote infection containment and symptomatic relief of confirmed mild cases and suspected cases;</li> <li>• Renew prescriptions for continuous-use medications for asymptomatic patients with non-chronic diseases Promote infection containment and symptomatic relief of confirmed mild cases and suspected cases;</li> <li>• Renew prescriptions for continuous-use medications for asymptomatic patients with chronic non-communicable diseases;</li> <li>• Educate the team and establish work processes that provide environmental and occupational protection in order to minimize the risks of contamination;</li> <li>• Inform and educate the community, the work team and the service manager with official information based on scientific evidence.transferables;</li> <li>• Educate the team and establish work processes that provide environmental and occupational protection in order to minimize the risks of contamination;</li> <li>• Inform and educate the community, the work team and the service manager with official information based on scientific evidence.</li> </ul>

Following Technical Note, Technical Note 03/2020, Chloroquine/hydroxychloroquine is being used as a contingency plan for COVID-19 in hospitals and Emergency Care Units (UPAs), with special attention to QT interval prolongation, elevated cardiac enzymes and disorders important hydroelectrolytics. In view of the narrow therapeutic range of chloroquine and hydroxychloroquine and their possible adverse effects (prolongation of the QT interval, elevated cardiac enzymes and important electrolyte disturbances), SESA published Technical Note No. 04, of April 12, in which it guides professionals the need to report the use of and suspected adverse reactions to the drugs hydroxychloroquine and chloroquine.



*Fig.3: Adverse reactions associated with the use of chloroquine and hydroxychloroquine from 1968 to November 2020 accounted for 21% of ADR reports to chloroquine and 17% of ADRs attributed to the use of hydroxychloroquine. Considering the entire historical series, the year 2020 was the one with the highest number of ADRs for chloroquine and the third highest incidence of ADRs for patients using hydroxychloroquine. (Source:LINDQUIST, 2008).*

In a study carried out in Ceara from April to May 2020, 996 uses of hydroxychloroquine (or chloroquine) and azithromycin were reported in the treatment of hospitalized patients with COVID-19. The notifications contained some drugs that were introduced due to the worsening of the patient's clinical condition. 98.8% of cases were reported by pharmacists and the most reported AMI were renal failure(CABRAL, et. al., 2020).

SecondRismanbaf and Zarei (2020), liver and kidneys can be damaged in patients with COVID-19, which can make it difficult to reach the therapeutic dose of the drugs and increase the risk of adverse reactions.

The creation of a form for monitoring the use and recording of adverse drug events, prepared in the urgency of the actions raised by the COVID-19 pandemic, was

designed as an aid tool to monitor the use of drugs, helping to avoid their use irrational use of medications.

## V. FINAL CONSIDERATIONS

The experience of using unknown drugs for the purpose of treating COVID-19 provides an opportunity to exercise the rational use of drugs, as more adequate doses and regimens for patients can be defined. In addition, monitoring the use and monitoring of adverse drug reactions can result in the reduction of personal injuries and avoid possible financial waste.

Considering the above, it is possible to understand the relevance of performing pharmaceutical conduct with excellence, the importance of pharmaceutical care helping to prevent the transmission of COVID-19 and guiding the rational use of medicines, thus reducing the workload generated by the system during the Covid-19 pandemic.

There was a need for the pharmacist to make it clear that there is still no effective vaccine or specific therapy for COVID-19. In the case of suspicious symptoms such as fever, cough and fatigue, individuals should be advised to seek medical help and follow the professional's guidelines, explaining all precautions from good hygiene to social isolation, especially in suspected cases.

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# Child Obesity in Brazil and its Prevalence in the (Pre) Pandemic Times of Covid-19

## A Obesidade Infantil no Brasil E Sua Prevalência nos Tempos (Pré) Pandêmicos da Covid-19

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**Keywords—** Childhood Obesity. Disease. Covid-19.

**Abstract—** The present paper aimed to carry out a theoretical-analytical study of childhood obesity in Brazil, not only as an approach and its diagnostic and prevention aspects, but above all to verify its prevalence in the Covid-19 pandemic periods. In this investigative scenario, the search for scientific articles was carried out through the MEDLINE, Ovid and Scielo databases. Terms were used in our search for review articles, clinical trials, and observational studies. In view of our bibliographical study, it was possible to verify that there was a prevalence of obesity in children who remained sedentary at home and absent from any sport, considering that the dysregulation of their diet was associated with lack of locomotion and leisure. Perceived by example, we also sought directly indicated references. Our results pointed to the fact that the prevalence of childhood obesity tripled during the COVID-19 pandemic, and this should be prevented with medical and nutritional monitoring, but especially with the help of indoor measures, by parents or relatives. next.

**Resumo—** O presente trabalho se propôs a realizar um estudo teórico-analítico da obesidade infantil no Brasil, não apenas enquanto abordagem terapêutica e os aspectos de seu diagnóstico e prevenção, mas sobretudo verificar sua prevalência nos tempos pandêmicos da Covid-19. Nesse panorama investigativo, foi realizada busca de artigos científicos através das bases de dados MEDLINE, Ovid e Scielo. Foram termos utilizados em nossa busca artigos de revisão, ensaios clínicos e estudos observacionais. Diante de nosso estudo bibliográfico foi possível verificar que houve prevalência da obesidade em crianças que permaneceram sedentárias em casa e ausentes de algum esporte, tendo em vista que a desregulação de sua alimentação esteve associada à falta de locomoção e ócio. Percebida a relevância, também se buscou diretamente referências indicadas. Nossos resultados apontaram para o fato de que a prevalência da obesidade infantil triplicou durante a pandemia

da COVID-19, e esta deve ser prevenida com acompanhamentos médico e nutricional, mas sobretudo com o auxílio de com medidas tomadas dentro de casa, por pais ou parentes mais próximos.

**Palavras-chave— Obesidade Infantil. Doença. Covid-19.**

## I. NOTAS INTRODUTÓRIAS

Desde a virada para o século XXI há um consenso entre os estudiosos (em sua maioria médicos, nutricionistas e enfermeiros) sobre o fato de que a obesidade infantil vem aumentando de forma significativa (SAWAMURA et al., 2019) na medida em que determina várias complicações na infância e na idade adulta (MELLO; LUFT; MEYER, 2004). De acordo com pesquisas realizadas por estes estudiosos, “Na infância, o manejo pode ser ainda mais difícil do que na fase adulta, pois está relacionado a mudanças de hábitos e disponibilidade dos pais, além de uma falta de entendimento da criança quanto aos danos da obesidade” (MELLO; LUFT; MEYER, 2004, p. 173).

É preciso considerar que a obesidade na faixa etária pediátrica, em decorrência de suas variações e adaptações dos sujeitos a novas formas de se alimentar, tornou-se uma epidemia mundial nos últimos vinte anos (BROWN et al., 2015). No Brasil, a prevalência de sobrepeso/obesidade quadruplicou na faixa etária de 5 a 9 anos, nos últimos 30 anos (BRASIL, 2020). Além disso, entre os adolescentes, a prevalência de excesso de peso tem aumentado gradativamente seis vezes no sexo masculino e três no sexo feminino, de acordo com levantamentos do IBGE (2020).

A partir desse levantamento inicial, o presente trabalho se propôs a realizar um estudo teórico-analítico da obesidade infantil no Brasil, não apenas enquanto abordagem terapêutica e os aspectos de seu diagnóstico e prevenção, mas sobretudo verificar sua prevalência nos tempos pandêmicos da Covid-19. Foram termos utilizados em nossa busca *artigos de revisão, ensaios clínicos e estudos observacionais*. Do que pudemos verificar, há uma miríade de pesquisas e alertas (OMS, 2020; BRASIL, 2020; 2021; IBGE, 2020) que reacentuam constantemente o aumento gradual da obesidade entre as crianças.

Quando paramos para pensar nessa situação nos tempos pandêmicos em que fomos acometidos em decorrência do coronavírus ou COVID-19, de acordo com uma pesquisa de Orçamento Familiar (POF), realizada pelo Instituto Brasileiro de Geografia e Estatística (IBGE), uma em cada três crianças do Brasil, com idade entre cinco e nove anos, está em situação de sobrepeso, considerando as recomendações da Organização Mundial de Saúde (OMS, 2020).

A estrutura deste trabalho subdivide-se em seções: A) *Discussões panorâmicas sobre a obesidade infantil no Brasil e seu aumento durante a pandemia da Covid-19*, em que realizamos um debate em torno de

pesquisas bibliográficas que protagonizam fatores e índices da obesidade no Brasil, antes e durante a pandemia provocada pelo coronavírus e b) *Traçado metodológico da pesquisa*, em que detalhamos cuidadosamente o processo de construção do trabalho, bem como nossas delimitações e escolhas. Essa seção precede as considerações finais.

## II. DISCUSSÕES PANORÂMICAS SOBRE A OBESIDADE INFANTIL NO BRASIL E SEU AUMENTO DURANTE A PANDEMIA DA COVID-19

Uma das principais causas para o aumento significativo da obesidade infantil no Brasil em decorrência do cenário devastador da COVID-19 foi o sedentarismo<sup>1</sup>, o qual se constitui como fator de grande preocupação e um dos principais determinantes para o surgimento de doenças, influenciado pelo uso excessivo (e abusivo) de tecnologias, bem como pelo desenvolvimento de hábitos alimentares sem qualidade, com alto consumo lipídico, advindo daí sobrepeso e obesidade (GUEDES; GUEDES, 2012).

É fato incontestável que a Pandemia provocada pela disseminação do coronavírus (SARS-CoV-2)<sup>2</sup> acarretou medidas protetivas e de contenção da saúde pública, o que acabou exigindo de crianças e adolescentes que deixassem de frequentar colégios e permanecessem cumprindo, junto a seus pais e parentes, o distanciamento social (necessário) (OMS, 2021; BRASIL, 2021). É nessas condições de alarme, desequilíbrio emocional e vulnerabilidade social, conforme outrora apontado por Santana; Oliveira et al., (2021), que se torna imprescindível a atuação da Estratégia de Saúde da Família (ESF) que, além de atuar na prevenção, promoção e manutenção da Saúde, conforme descreve a Política Nacional da Atenção Básica (BRASIL, 2012), age como

<sup>1</sup>O comportamento sedentário, conforme Antunes, Rossi e Lira (2019) argumentam, é um fenômeno relacionado à vida humana e diz respeito a atividades corporais que apresentam um gasto energético inferior a 1,5 MET. O comportamento sedentário e a inatividade física, atestam os autores, não são sinônimos, pois ambos apresentam respostas fisiológicas diferentes em relação à saúde. Portanto, não podem ser mensurados e interpretados de maneira igual. Trata-se de um termo direcionado para as atividades que são realizadas na posição deitada, inclinada ou sentada e que não aumentam o dispêndio energético acima dos níveis de repouso.

<sup>2</sup>A pandemia de Covid-19 tornou-se uma problemática complexa e de alta gravidade, que afetou diretamente a vida de pessoas no mundo inteiro com graves problemas respiratórios (O GLOBO, 2021) e tendo ocasionado mais de 500.000 (quinhentas mil) mortes no Brasil (MINISTÉRIO DA SAÚDE, 2021).

“porta preferencial de entrada para os usuários que necessitam ter acesso as Redes de Atenção à Saúde (RAS)” (Oliveira et al., 2021, p. 45364).

Estudos científicos de Dalcastagne et al.(2008) e Campos, Gomes e Oliveira (2008) indicam que a obesidade é causada por diversos fatores internos e/ ou externos, bem como por fatores genéticos, a exemplo de pais obesos que podem transferir este gene a seus filhos, e estes podem apresentar sobrepeso desde muito cedo. Observemos um excerto de reportagem divulgado por Oliveto pouco antes da disseminação do Coronavírus:

#### **Obesidade infantil pode surgir do mau exemplo dos pais para os filhos**

Estudo feito em seis países mostra que os hábitos e a genética da família podem influenciar em até 60% do índice de massa corporal de uma criança. Segundo especialistas, as atitudes do dia a dia são as principais responsáveis pelo ganho de peso. Em um mundo cada vez mais pesado, as crianças estão herdando dos pais um triste legado: a obesidade. Estudos recentes evidenciam o papel crucial da família nesse fenômeno crescente, estimado pela Organização Mundial da Saúde (OMS) em 42 milhões de casos — e isso considerando apenas a faixa etária até os 5 anos. Uma nova pesquisa da Universidade de Sussex, na Inglaterra, mostrou que, no geral, 20% da composição do índice de massa corporal (IMC) de meninas e meninos vem do pai e da mãe. Entre os pequenos que estão muito acima do peso, contudo, essa proporção aumenta para 55% a 60%. Isso significa que mais da metade do risco de ser obeso é determinado pela combinação de genética e ambiente familiar. [...] Embora quando se fale em herança e transmissão de características seja irresistível associá-las à genética, o problema é muito menos dos genes e bem mais dos hábitos ruins. “A obesidade é multifatorial. Mães obesas tendem a gerar filhos que serão obesos, há doenças genéticas que podem alterar o apetite”, reconhece a endocrinologista pediatra Fabiana de Luccas, membro da Sociedade Brasileira de Pediatria. “Mas isso é exceção. Os hábitos têm um peso muito grande. A sociedade moderna trouxe muitas vantagens, mas também trouxe comida de caixinha, falta de tempo para

cozinhar em casa, sedentarismo...”, enumera. A culpa não é só do hambúrguer com batata frita ingerido eventualmente, depois do cinema. O problema, de acordo com um estudo da Universidade da Carolina do Norte em Chapel Hill, está nos hábitos familiares, repetidos no dia a dia [...] (OLIVETO, 2017, s.p., grifos nossos).

No discurso do excerto, percebe-se que há uma culpabilização dos pais pelo gradativo aumento no quadro de obesidade de seus filhos. A autoridade do discurso está na materialidade que circunscreve pesquisas científicas feitas em vários países na interrelação entre obesidade e hábitos alimentares, bem como o descuido para com o crescimento nutricional de crianças (SAWAMURA et al., 2019).

Lançando olhares para informações fisiológicas que não podem ser desconsiderados, “A definição de obesidade é muito simples quando não se prende a formalidades científicas ou metodológicas. O visual do corpo é o grande elemento a ser utilizado” (HAMMER, 2018, p. 441). Acrescenta a pesquisadora que “O ganho de peso na criança é acompanhado por aumento de estatura e aceleração da idade óssea. No entanto, depois, o ganho de peso continua, e a estatura e a idade óssea se mantêm constantes”. (HAMMER, 2018, p. 441).

Nesse sentido, é sabido que o excesso de peso na infância está relacionado, também, com progressivo declínio da função renal ao longo da vida (MONTEIRO; CONDE, 2000). Fisherg et al. (2016), por sua vez, apontam que mundialmente, a obesidade infantil na última década, teve aumento de 2,5% passando de 4,2% para 6,7% levando em conta maiores acréscimos em países desenvolvidos do que nos em desenvolvimento. Assim, diante da realidade de que “o Brasil é o quinto país do mundo em relação ao número de pessoas cujo peso destoa dos padrões recomendados pelas organizações de saúde pública e, em muitos casos, encontra-se num quadro elevado de obesidade” (DA SILVA, 2018, p. p. 237), foi nosso propósito escavar o gradativo aumento da obesidade em crianças e adolescentes durante a pandemia da COVID-19.

Levando em consideração tais informações, durante o período em que houve massiva proliferação da COVID-19, foi sintomático que a obesidade infantil esteve gestada como um corolário da obesidade recorrente, haja vista a gama alimentar direcionada para os *fast foods*. Sabe-se que, segundo informações divulgadas pelo Panorama da Segurança Alimentar e Nutricional da OMS, a população infantil da América Latina está com sobrepeso ou obesidade, com variação de 18,9% a 36,9% em



crianças de 5 a 9 anos de idade (OMS, 2020). Para Da Silva,

O efeito de verdade desses dados estatísticos, combinados com a abjeção que historicamente se construiu em torno da gordura, acentuam a constatação de que ao sujeito obeso recai o estigma da doença. De acordo com Costa (2015), a condição de doença atribuída à obesidade a transforma num problema de saúde pública, a despeito de a da gordura e os modos de perdê-la ou de adquiri-la serem considerados uma questão de cunho individual (DA SILVA, 2018, p. 238).

Nessas instâncias argumentativas, ainda em concordância com o pesquisador brasileiro, entende-se que escrutínio da obesidade nas crianças através do saber médico, além de proporcionar imensa preocupação no sentido de sua variabilidade e gradativo crescimento, alia-se a diversas outras doenças na dinâmica do corpo, com vistas a assegurar a saúde da população. Então, especificamente nesses tempos pandêmicos em que a população passou a cumprir regras governamentais de isolamento para contenção do coronavírus e efetividade do distanciamento social (Aquino et al., 2020) constituiu-se um momento em que o Brasil esteve gestado pela seccionalidade em diversas esferas de poder (SANTANA; OLIVEIRA, et al., 2021).

Apesar de todas as prescrições advindas dos campos da saúde, por meio de seus sistemas, em meio à eficácia de ações como “a quarentena, o distanciamento social e as medidas de contenção comunitárias” (WILDER-SMITH; FREEDMAN, 2020, p. 27), houve falta de comprometimento dos responsáveis familiares para com o caráter nutricional da alimentação infantil, o que agravou diversos problemas de saúde, cuja consequência foi a) o aumento no índice de crianças com de gordura elevado (OMS, 2021) e b) expansão do número de crianças com hipertensão, diabetes e outras patologias concatenadas ao acúmulo de gordura (BRASIL, 2020; PAHO, 2021).

A situação alarmante fez com que diversas entidades se posicionassem, a exemplo do UNICEF, OMS e Banco Mundial. A representante da Organização Pan-Americana da Saúde (OPAS) e da Organização Mundial da Saúde (OMS) no Brasil, Socorro Gross, realizou no dia 04 de março de 2021, um chamado à união da sociedade para acabar com o estigma relacionado à obesidade e controlar e prevenir a condição na Região das Américas (PAHO, 2021). Preocupa saber que, em decorrência do aumento e prevalência em crianças e adolescentes, “Na faixa etária de 5 a 19 anos, 33,6% das crianças e

adolescentes estão com sobrepeso ou obesidade e 7,3% das crianças menores de cinco anos, segundo as últimas estimativas do UNICEF, OMS e Banco Mundial” (PAHO, 2021).

A cientista, Gross enfatizou que pessoas com excesso de peso estão mais vulneráveis a complicações graves da COVID-19, e elencou algumas ações que podem ser eficazes no sentido de prevenção e controle da obesidade:

- Aprimorar o cuidado das pessoas com obesidade na atenção primária à saúde;
- Fortalecer o código internacional de comercialização de substitutos do leite materno;
- Implementar impostos sobre bebidas açucaradas;
- Ampliar as compras públicas de alimentos saudáveis;
- Implementar a rotulagem nutricional frontal; e
- Fortalecer o programa de alimentação escolar e a restrição da venda de alimentos e bebidas ultraprocessados em escolas (PAHO, 2021).

Observamos que a Organização Pan-americana de saúde (OPAS), juntamente à Organização Mundial da Saúde (OMS) se posicionaram publicamente em marco de 2021 preocupadas com a redução dos índices de obesidade na população, sobretudo “para prevenir outras doenças crônicas, já que essa condição é um importante fator de risco para várias doenças, junto ao tabagismo e o sedentarismo” (PAHO, 2021).

Diante de nosso estudo bibliográfico foi possível verificar que houve prevalência da obesidade em crianças que permaneceram sedentárias em casa e ausentes de algum esporte, tendo em vista que a desregulação de sua alimentação esteve associada à falta de locomoção e ócio. A seguir adentremos no traçado metodológico de nosso trabalho.

### III. TRAÇADO METODOLÓGICO

Esta seção agrega o traçado metodológico da pesquisa, em que delimitamos o percurso de sua classificação. No que diz respeito à abordagem, a pesquisa se constitui como qualitativa, haja vista ser caracterizada pela qualificação dos dados coletados, e a cada momento incorremos sobre sua interpretação. Na ótica de Goldenberg, “os pesquisadores qualitativos recusam o modelo positivista aplicado ao estudo da vida social, uma vez que o pesquisador não pode fazer julgamentos nem permitir que seus preconceitos e crenças contaminem a pesquisa” (GOLDENBERG, 1997, p. 34). Ainda de acordo

com o estudioso “A pesquisa qualitativa não se preocupa com representatividade numérica, mas, sim, com o aprofundamento da compreensão de um grupo social, de uma organização etc.” (GOLDENBERG, 1997, p. 34).

No percurso de nossa pesquisa, incidimos sobre uma população de dez (dez) estudos científicos, tendo em

vista o cronotopo dos últimos 5 (cinco) anos. No entanto, apenas 4 (quatro) artigos estiveram na circunferência que sustenta nossa pesquisa, sendo essa a nossa amostra, exposta no quadro 1:

*Quadro 1: A obesidade infantil no Brasil nos tempos (pré) pandêmicos da Covid-19*

ARTIGO CIENTÍFICO	OBJETIVO GERAL
OLIVEIRA R. L.; Santana, W. K. et al. “Sobre aplicação de condutas na consulta de puericultura: relato de experiência profissional numa clínica da família no município do rio de janeiro”, <b>International Journal of Development Research</b> , 11, (03), 45364-45367, 2021.	Discutir sobre aplicação de condutas na consulta de puericultura, a partir de um relato de experiência profissional numa clínica da família no município do rio de janeiro.
DA SILVA, Francisco Vieira. Muito além do peso: modulações biopolíticas em discursos sobre a obesidade infantil. <b>Calidoscópio</b> . Vol. 16, n. 2, p. 237-248, 2018.	Analisar dizeres que discursivizam a obesidade infantil, com o intento de investigar o funcionamento de estratégias biopolíticas, as quais concebem a obesidade infantil como um mal a ser combatido.
OLIVETO, P. <b>Obesidade infantil pode surgir do mau exemplo dos pais para os filhos</b> . Disponível em: <a href="https://www.uai.com.br/">https://www.uai.com.br/</a> 2017.	Perceber a Obesidade infantil a partir do ponto de vista de que há uma culpabilização dos pais pelo gradativo aumento no quadro de obesidade de seus filhos.
MIRANDA, R.A.; NAVARRO, A.C. A obesidade infantil e o exercício agudo da natação e a resposta da sudorese para um desenvolvimento saudável. <b>Revista Brasileira de Obesidade, Nutrição e Emagrecimento</b> , 10(56):93-104, 2016.	Compreender que o aumento no número de crianças com obesidade está ligado aos casos de hipertensão, diabetes e outras patologias concatenadas ao acúmulo de gordura.

Fonte: dados coletados pelos autores no Portal Regional da BVS

Os critérios de seleção para o presente estudo orbitaram em torno de discussões sobre obesidade, sobrepeso, sedentarismo e taxas de gordura. Não é um processo fácil adentrar nas escolhas que norteiam tal discussão, pois há variantes que podem levar a interpretações sobre gordofobia ou ainda não aceitação do corpo gordo, e tais olhares se distanciam de estudos advindos de lugares institucionais, do médico, do enfermeiro, do nutricionista.

Uma vez que o movimento teórico-analítico do estudo é de natureza teórica, trata-se de um trabalho bibliográfico. Sobre isso, apontam Marconi e Lakatos (1992) que “A pesquisa bibliográfica é o levantamento de toda a bibliografia já publicada, em forma de livros, revistas, publicações avulsas e imprensa escrita” (Marconi; Lakatos, 1992, p. 75). Por entendermos que “A sua finalidade é fazer com que o pesquisador entre em contato direto com todo o material escrito sobre um determinado assunto, auxiliando o cientista na análise de suas pesquisas ou na manipulação de suas informações” (Marconi; Lakatos, 1992, p. 75), nossas delimitações estiveram no hall de postulações das pesquisadoras.

Diante de tais decoros argumentativos esta pesquisa realiza uma discussão teórica sobre a obesidade

infantil no Brasil, não apenas enquanto abordagem terapêutica e os aspectos de seu diagnóstico e prevenção, mas sobretudo verificar sua prevalência nos tempos pandêmicos da Covid-19.

#### IV. CONSIDERAÇÕES FINAIS

A partir da constatação de que houve prevalência da obesidade em crianças que permaneceram sedentárias em casa e ausentes de algum esporte, nossos resultados apontaram para o fato de que a prevalência da obesidade infantil triplicou durante a pandemia da COVID-19, e esta deve ser prevenida com acompanhamentos médico e nutricional, mas sobretudo com o auxílio de com medidas tomadas dentro de casa, por pais ou parentes mais próximos.

Diante do exposto, reiteramos que esses dados funcionam como índices representativos da produção científica acerca de um fenômeno: a obesidade. É preciso entendermos que toda essa superfície discursiva nos faz compreendermos como simples atitudes humanas podem agir não apenas na modificação estética de nosso corpo, mas no nosso metabolismo, o que evidencia a importância do orgânico e do biológico na gerência da saúde humana. No caso específico de crianças e adolescentes,

interpenetram--se vozes clínica e hospitalar, entre o discurso médico e nutricional, que se agregam para mantimento e gestão dos corpos.

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# The influence of the agricultural management systems in the maintenance of the biodiversity in benefit of the Phyto sanity control

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**Keywords**— *agrobiodiversity, Agroecology, environmental sustainability.*

**Abstract**— *The management system adopted in the agricultural production influences directly on the biodiversity of the growing areas, whether inhibiting or favoring the proliferation of the natural biota. This article aims to highlight the influence of agronomic practices in certain cropping systems that interfere in the control of the Phyto sanity by the participation of the biodiversity. The greater part of the agricultural Production in the world comes from the conventional growing system, which gained strength from the 'Green Revolution' in mid-twentieth century, but due to its production techniques that contribute negatively for the environmental devastation, mainly by the monoculture, use of non-renewable inputs, agrochemicals, and others, not respecting the environment, alternative forms of Productions based on organic or agroecological management emerged with the adoption of practices which use renewable inputs, polyculture, green fertilization, organic fertilization, nutrient cycling, banning of agrochemicals, and mainly respecting social requirements, cultural and environmental. Thus, the alternative management tends to provide the development of the agrobiodiversity, essential for the adoption of practices related to the biological control, with no use of pesticides, enabling a food production with quality, with no chemical residue and ecologically correct, meeting the world requirements of the world market. Therefore, researches are needed, having a greater interaction between the researches, extension works, growers and society, All in the search of the environmental sustainability in the agricultural production.*

## I. INTRODUCTION

The adoption of the type of the agricultural systems of paramount importance when it comes to biological pest control and diseases in agricultural cultivations. In the conventional cultivations implemented from the 2<sup>o</sup> world

war with the advent of the “Green Revolution”, who preached to feed the world population through the modernization of the agriculture with the adoption of practices based on the monoculture, overlapping cultural cycles, intensive mechanization, technified irrigations,



massive use of pesticides, contributed to the environmental degradation and the increase of production costs. Besides favoring the development of phytopathogens to the crop, once these practices, by not contemplating the biodiversity in these areas contribute negatively for the establishment and maintenance of the natural enemies of pests and diseases (VENZON et al., 2019).

The conventional agricultural production, due to the considerable environmental damages began to lose support from part of the world population worldwide, that requires alternative production models based in organic systems and / or agroecologicals to reduce or chemical residues in the final product to be consumed.

The agricultural growers, due to the requirements of the consumer market, became more concerned with problems related to the poor preservation of the environment caused by the conventional production practices and started the adoption sustainable alternative technologies, practiced since the ancient times with organic practices which promote the agrobiodiversity, such as the polycultures, crop consortium, crop rotation, agroforestry systems, organic fertilization and other processes that favor the natural and biological interaction, mainly those related to biological control.

As one of the greatest demands of chemical products in the agricultural production is related to the management of the phytosanitary, the natural biological control stands out, this, being favored by the interaction of plants in the growing areas, and being possible to cause repellent effects and not food preference, being it visual or olfactory to the phytopathogens (Togni et al., 2010), Besides of attracting and favoring the maintenance of species of natural enemies which act on the pests (VENZON et al., 2015; TOGNI et al., 2018).

In addition to the regulation of the phytosanitary, the biodiversity in the agricultural cultivations also provides several other ecosystems services important in the productive process, like the pollination, the nutrient cycling, the microclimatic regulation and the increase of the soil fertility (SUJII et al., 2010). These biological processes and their persistence depend on the maintenance of the biodiversity in the crops, aiming the functionality and the permanence of the associated ecosystems services (VENZON et al., 2019).

Thereby, the present work aims to contribute with relative information's regarding to the agronomic management practices essentials to the agricultural production and which interfere on the development and maintenance of the natural biodiversity, and which may favor the biological control of pests and diseases, reducing

then the pesticides used in the conventional systems of production.

## II. METHOD

The present work is about an exploratory and qualitative bibliographic research with consultations of scientific publications of access to bases like: IEEE, Science Direct, Scielo, and others, such as books, dissertations, these and journals, aiming to summarize and highlight the importance of alternative practices based on strategies management of the agrobiodiversity in agricultural systems for the biological control of pests and diseases.

For Gil (2017), the exploratory researches seek to list hypotheses about the theme or a studied phenomenon for other researches test and validate them, being more flexible in their planning process, because they intend to observe and understand the most varied aspects related to the studied phenomenon, being one of the principles of the bibliographic survey, to have a better comprehension of the problematic in study.

This way, this article shows the importance of the biological poise in the cultivations, provided by agronomic practices which favor the biodiversity, Essentials to the environmental sustainability in the diverse agrosystems, minimizing the noxious effects of the phytosanitary in the agricultural production.

## III. DISCUSSION AND RESULTS

### 3.1 Management of the biodiversity in the control of the phytosanitary in agrosystems.

The exploitation of the land for the agricultural production is essential for the human survival, but, being it Direct or indirectly the actions of the productive management interfere in a significant way in the biodiversity of the cultivated areas, and depending on the type adopted may cause serious damages to the environment and the health of the workers and consumers of agricultural foods, Besides to anticipate de degradation of the environment, turning the areas unable for the agricultural production (ALTIERI, 2012).

In the seek of minimizing the environmental effects in the productive agrosystems, many studies are being implemented to introduce and agricultural management turned to the fortification of the agrobiodiversity and the environmental sustainability, putting itself in debate the type of management system, being it the conventional or the alternatives, most adequated to be kept the high

productivity of food with minimal negative impacts to the environment.

### 3.1.1 Organic practices which favor the biodiversity

The structural complexity of the agricultural landscapes influences the local biodiversity, as well as the services of the associated agrosystems (HAENKE et al., 2009). The diversity of the vegetation favors the increase of natural enemies of pest insects, having in view of it provides alternative food resources, such as the pollen and the nectar, for adults of parasitoids or predators, increasing their longevity and reproductive becoming more effective in diversified systems than when in agricultural monocultures (BEGUM et al., 2006).

The alternative systems of agricultural production tend to adopt diverse practices associated to the productive management which favor the agrobiodiversity, defined as the plot of the biodiversity constituted by a set of organisms and ecosystems that present Strong relations to the human beings (Jackson et al., 2007), being possible to be domesticated, semi domesticated, cultivated or managed by the man, which represents a practically inexhaustible range of combinations between their four levels of complexity: diversity within the species, between the species, between ecosystems and ethnocultural diversity, essentials for the development of a sustainable environment (STELLA et al., 2006).

Depending on the sort of the agriculture, the area to be explored, the technical knowledge and available resources, various organic technologies may contribute in a significant way in benefit of the biodiversity when applied in its proper way.

Because, it is not only to apply organic practices in the agricultural cultivations, but to combine a determined alternative management that can be better adequated to the expected purpose, within technical knowledge that favor the biological interactions together with the exploited cultivation.

Among the various alternative technologies we can highlight the following:

- **Agroforestry systems (AS's)**

The policultures which combine agricultural crops and tree species are named AS's. In the AS's, the incidence and the damages caused by the pests are reduced, mainly by increasing the population of natural enemies and increasing the difficulty of finding the crops by the pests, through the moderation of the microclimate and through

the increase of water and nutrients in the soil (PUMARIÑO et al., 2015).

Generally, the trees that compose one AS are selected by criteria based on the compatibility between the crops, in the biomass production, in the easiness of management and in the diversification of the production with species of the native flora of the region (SOUZA, 2010). In addition to the introduction of plants which favor the biological control of pests (VENZON et al., 2019).

The AS's can be interspersed with vegetable planting plots in a way that these planting plots stay divided by lines of AS's. In the off-season ages of the vegetables the natural enemies tend to migrate from the planting area as to the agroforestry's, where keep their population reduced. By the occasion of a new planting, the natural enemies tend to recolonize the new cultivated areas and increase their populations (HARTERREITEN-SOUZA et al., 2014).

The AS's, when applied properly are considered those that present the higher rates of sustainability in the agricultural cultivations.

- **Polyculture**

The simultaneous crops of different taxonomic groups create a heterogeneous environment, often forming mosaics of vegetation which difficult the localization of the host plant by the herbivore, and interfere negatively in the establishment of the pest populations (ROOT, 1973).

The areas, in general, are smaller, when compared to the monoculture, and present major number of species and biological interactions favoring the natural biological control. Among the strategies used in the crops in polycultures is highlighted the use trap crops. For that, it is necessary to determinate at first which is the main culture and the key pests associated and after that, it is planted next to the other culture with major preference for the insect and minor interest for the grower in a given moment (SUJII et al., 2010).

As already commented, the technical agronomic planning is Paramount for the success of the alternative strategy applied.

- **Consortium of cultures**

The association of cultures in which two or more species with different cycles and vegetative architectures grow simultaneously, exploited concomitantly in the same area and in the same period of time, not necessarily been sown at the same time present various positive aspects, mainly when talking about maintenance of the biodiversity

in cultivated areas. It can be done in the form of strip crops, mixed crops, mosaic plots, cultivars in alternated lines and ground cover crops. The arrangement in the time can be established as simultaneous cultivation, in sequence, with synchronous or asynchronous combinations, and continuous or discontinuous (SUJII et al., 2010).

The mechanisms involved in the pest control through the diversification by the consortium of cultures are due to the Direct or indirect actions on the pests. In the Direct action, one of the associated cultures imposes physical barriers and / or chemicals which difficult the localization, the reproduction and / or the colonization of the host culture by the pests. Whether by the chemical repellency, masking and / or inhibiting the feeding, due to volatiles from non-host plants, movement prevention, pests immigration or sync optimization between the pest cycles and their respective natural enemies (NICHOLLS et al., 1999).

In the indirect action, one of the associated cultures allows the increasement of the abundance and / or diversity of natural enemies of the pests by providing vital resources for the survival and reproduction of the pests. Nonetheless, the consortiation of cultures must be studied before its implementation, because effects completely contraries to the expected may occur, Besides to repelling the pest insects, can attract them as well, compromising the cultivation base (PICANÇO et al., 1996).

- **Management of Covered Crops**

The green fertilizes, so used in agroecological cultivations for the improvement of the chemical characteristics, physical and biological of the soil, can also contribute to the reduction of the incidence of pests (VENZON et al., 2006).

It is considered as a special type of consortium. Between its advantages are the protection of the soil against the impact of rains (and consequent erosion), increasement of the infiltration capacity and water retention, in addition to the maintenance of the porosity na the aeration, attenuating the temperature and humidity oscillations, intensifying the biological activity in the growing area (HARTWIG; AMMON, 2002).

The living coverage also can provide the increasement of the organic matter content, the availability of macro, and micronutrients, pH stability and reduce the toxic effects of the aluminium and the manganese. Living coverage of the soil also help bringing to the surface from the deeper layers, improving their natural properties. Besides that, can present allelopathic effects, liberating

substances from the roots that inhibit the germination of weeds, which contributed to diminute the necessity of weedings, and yet, to contribute for the biological control of pests. Some plants make the microclimatic conditions more adequated for the development of predators and parasitoids, favoring the increasement of the population of natural enemies, particularly predator insects with earthly habits, it may also dilute the effects of the infestation (SUJII et al., 2010).

- **Genetic Variability**

The use of varieties and / or genetically resistant pest cultivars available in the market, as well as the use of species and plant varieties adapted to the local environment conditions and to the management adopted, mainly the organic, ar the best preventive measures of pest control to be used. In California, for example, Letourneau and Goldstein (2001) observed that in organic tomato cultivars occurred a major density of natural enemies and minor density and damages from phytophagous insects in relations to the conventional cultivate. Resistant or tolerant varieties arranged between the susceptible may contain the dissemination of the insects, protecting the susceptibles (SUJII et al., 2010).

- **Crop Rotations**

The alternance of cultivated species in a same area is a traditional practice and widely recommended due to the nutritional question of the plants and phytossanity. Nonetheless, its application is more efficient for pests specialized fews of host species, being more used for the control of diseases caused by soil fungi, involving the deceleration mechanism of the pathogen by the stimulation of the antagonists. The use of plants from unrelated families is important because it allows the breaking of the biological cycle of the pests and pathogens, preventing them from spreading from the oldest to the newsts crops (SUJII et al., 2010).

- **Management of invasive plants**

Practices as weeding or selective thinning of invasive plants and even the cultural management of the area are important practices for the management of pests, in the average of these plants serve as refuges and factor of attraction of natural enemies.

These plants may offer feeding resources, as alternative prey, besides the nectar and the pollen that serve as exclusive diet for adults and parasitoids or complementary diet for predators. In addition to this, these plants serve as

local refuge for mating and oviposition for many species of natural enemies of pests, increasing the chances of establishment of these populations in cultivated areas. Other factor to be considered is that some determined species can also increase the structural complexity of the agroecosystem and difficult the meeting of the host plant by the phytophagous insect (MEDEIROS et al., 2009).

- **Other Organic Practices**

In addition to the organic practices associated to the cultures cultivated with the intention of improving the biodiversity and to reduce the entrance of external inputs, other management activities can be adopted which present similar biological results, such as:

- ✓ **Marginal Vegetation Strips**

The range established between the limit of the cultivated field and the planted area with the agricultural crops, Generally form transition areas (ecotones) with huge diversity of species and are used rather by predator insects, and possible composed by native species of natural occurring or implanted. The strip of the marginal vegetation can be composed by trees, shrubs, flowering herbaceous plants, including the ornamentals, grass, and others (RIES; FAGAN, 2003). Anyway, it is a practice that helps in good ways in the maintenance of the biodiversity of the cultivated area.

- ✓ **Vegetation Corridors (or biological corridor)**

Are strips of vegetation that surround the property, allowing isolation of the conventional growing areas from the other neighbor areas. They can also be used for the Division of the cultivation plots and present multiplex purposes and work as phytosanitary barriers, difficulting the free circulation of pests and diseases the neighbor properties and between the cultivation plots, and still favoring the creation of microclimates more adequated to the cultivate, mainly to the vegetables, and the formation of areas of refuge.

These strips work like some “avenues” that facilitate the movement of benefic arthropods, Among which parasitoids and pest predators. Besides that, provide the increasement the interface between the area with the native vegetation (such as forestries, forest fragments and riparian forests), that serve as a reservatory of natural enemies (VENZON et al., 2019).

- ✓ **Crop Borders**

Border strips with cultivated species, Generally are with the type “corridor” (linears) or “island”, that border the outermost rows of the area (s) with the agricultural crop (s) and also serve as barrers and wind break. Generally, the natural biological controls more intense in the neighbor planting lines to the native vegetation or living fences, occurring the opposite in the central lines. This type of adjacent vegetation in the borders of the growing area is commonly used as living fences and windbreaks, constituted with a single of a few species (SUJII et al., 2010).

- ✓ **Planting Season**

The determination of the planting season is important, because of the ideal is to plant when its phase of greatest susceptibility scapes from the attack of pests.

The anticipation of the planting processor the use of earlier varieties are practices that collaborate for a minor attact from the pests, due to na asynchrony in the relation plant-pets. Planting in non favorable times to the plant development increases the predisposition to pest attack, although artifices can be used to conter this situation, like the use of the irrigation or the cultivate in a vegetation house. It is worth to say that favorable conditions to the plant development can also favor the pest development. In these cases, only the use of control measures, like biological control agents, can minimize the caused damages (VENZON et al., 2015).

- ✓ **Organic Fertilization**

Refers to the use of various types of residue (waste), like tanned manure, worm compost, fermented compounds, enriched biofertilizers with micronutrients and mulch, between others. All these materials are rich in useful organisms, macro and micronutrients, natural antibiotics and growing substances. The organic fertilizer, by improving the physical properties, chemistries and biologies of the soil, allows a good development of the culture and giving them resistance to pests (MEDEIROS et al., 2009).

- ✓ **Water management in the cultures**

The irrigation is one of the cultural practices with major impact in the occurrence of determined insects. Has special importance to the cultivate of vegetables, that normally request high volumes of water during the cycle of production. The frequency between the waterings, water depth applied and form of irrigation (sprinkling, dripping



or infiltration for example) interfere substantially in the removal of young forms (eggs, nymph or larvae) and, eventually, affect adult insects present in the surface of the plant (TOGNI et al., 2010).

#### IV. FINAL CONSIDERATIONS

The many alternative methodologies employed in the agriculture seeking to produce food without chemical residue and that at the same time assuage the effects of the agricultural activities to the environment present a growing demand in all the world, required mainly by the consumer market, favoring the increase of organic crops and / or agroecologicals.

Within the premises of the environmental preservation is the ecological control of pests and diseases. The control of pests and diseases in the conventional production system requires a high demand of agrochemicals, but the alternative management of pesticides are replaced by practices that favor the biodiversity, highlighting the biological control due to the perfect interaction between the biota in the production areas, and tend to reduce or banish the economic damages caused by the phytopathogens.

Even so despite the advances of biodiverse practices in the controls of pests and disease, but the difficulties of production are still recurrent, needing researches that aim to improve the biological management of the phytosanitary to meet the prerogatives of the sustainable development in the agricultural production.

Therefore, for there to be an increment and a better use of these ecologic strategies there must be a major interaction between the researches, extension workers, growers and the society, so that in sync increases the understanding about the importance of the biodiversity in the agricultural systems and make part of the construction of one sustainable agriculture in long term.

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# Shipment Delivery and Covid-19: An Indian Context

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**Keywords**—COVID-19, E-commerce, India,  
parcel, shipment.

**Abstract**—The novel coronavirus disease also known as COVID-19 has disrupted almost every sector of human development. From mental health to physical wellbeing, from sports to tourism, from schools to offices, from travelling to leisure, from entertainment to social life, from exports to local sales everything has been disordered. While everyone around the globe was under lockdowns and strict stay at home orders were given by the respective governments, the businesses, factories and enterprises were locked and sinking to new lows.

## I. INTRODUCTION

The COVID-19 pandemic disrupted almost every aspect of life including shipment delivery industry (Alam et al., 2020). Government imposed lockdowns and curfews forced everyone to stay at home, which lead to closure of many businesses. Thousands of hundreds of people from the urban areas started heading towards their native places because they had no work and no source of income(COVID-19 Lockdowns, n.d.). When the lockdown was imposed in India for the first time, the orders for the government was total blackout of the streets. No one was allowed to come outside of the houses. Tourism halted and was brought to a stand-still(Alam & Parveen, 2021). This total lockdown led to utter panic among the people as they started to worry about the food and grocery items and other daily use products.

Since no movement was allowed, transportation of goods and items was halted all of a sudden. People started realizing and understanding that the disease was not a fluke and they had to protect themselves and their families. Online stores stopped taking orders and the current open orders were either cancelled of the assured delivery dates were changed to “as soon as possible”. India has a vast network of shipment delivery touching almost every city and village in the country(Press Trust of India, n.d.). With

the manyfold increase of e-commerce in India, the shipment delivery system also picked up the pace, but the lockdowns and curfew had tremendously affected the services.

Shipment delivery, in India, includes shipment of goods, grocery, apparel purchased online, cooked food ordered on various platforms, money orders, gifts, important documents and papers etc. These services can be used by an individual just to send a birthday wishes postcard, or people running a small business as well as giants like Amazon and Flipkart(*Best Courier Service in India For Online Business*, n.d.).

In this paper, we have discussed the effects of COVID-19 on the shipment delivery industry. We present a comparison between the pre, during and post (the new normal) COVID-19 status of the shipment industry in an Indian perspective.

## II. LITERATURE REVIEW

To obtain the studies of interest we passed word queries to the search column present in the databases. We have used generic terms so that we get a broader result set. The primary search term used is placed between the logic AND and OR operators ang can we written as

“Query”: {“COVID-19” (in all metadata) AND “Shipment” (in all metadata) AND “India” (in all metadata)} “filter”: {Publication Date: (01/03/2020 TO 01/07/2021)} OR

{“Coronavirus” (in all metadata) AND “Shipment” (in all metadata) AND “India” (in all metadata)} “filter”: {Publication Date: (01/03/2020 TO 01/07/2021)}

The major databases which were explored includes:

- ACM Digital Library
- IEEE Xplore Digital Library
- MDPI
- ScienceDirect
- SpringerLink
- Wiley Online

The main reason for exploring these major databases is their rich library of conference proceedings and journals and articles.

No results were found in either of the databases for the searched query. But a few related papers popped up in the search results. Mahajan et. al. found that online product availability fell by 10% on average, but there was little impact on online prices. This fall in product availability in online retail was equally matched by a fall in product arrivals in the wholesale markets, pointing toward a general supply chain disruption (Mahajan & Tomar, 2021). Research conducted by Sharma et. al. gave insights on the challenges, solutions and recommendations, which when followed can strengthen the logistics supply chain management in developing countries like India (Sharma et al., 2020).

Singh et. al. proposed an action plan to tackle pandemic based disruptions for fulfilling the need of food grains, ingredients, medicine, PPE, and other essential items (Singh et al., 2021). Sinha et. al. developed a novel modelling approach to identify few nodes, which require additional inventory allocations (strategic inventory reserves) to ensure minimum service level (67%) under the possibility of lead time disruptions (Sinha et al., 2021).

### III. DELIVERY SYSTEM BEFORE COVID-19

India has been experiencing a 19% growth in parcel volume since the year 2013 and stands at the third position only after China and Norway. 2.8 billion parcels have been shipped reaching a CAGR of 22% in 2013. Before the onset of the novel coronavirus, the delivery industry and logistics was being used abundantly throughout the country. The promise and commitment they assured the users and their clients like accuracy, timely and quick delivery were increasing the faith of the users on them. The exponential increase in the number of relocations, movement of goods, manufacturing sectors, retails and online e-commerce have helped delivery industry in growing rapidly between the years 2010 to 2019 before the onset of COVID-19 pandemic. Shipment delivery was experiencing its steady growth since the introduction of online e-commerce giant, Amazon and the biggest local player, Flipkart. The giants could foresee the benefits and interests in the shipment delivery system way before the e-commerce was a thing of every household. Therefore, they introduced their own, self-controlled and supervised shipment delivery entities. Amazon named its shipment delivery unit as Amazon Transportation Services whereas, Flipkart named it to be Ekart Logistics.

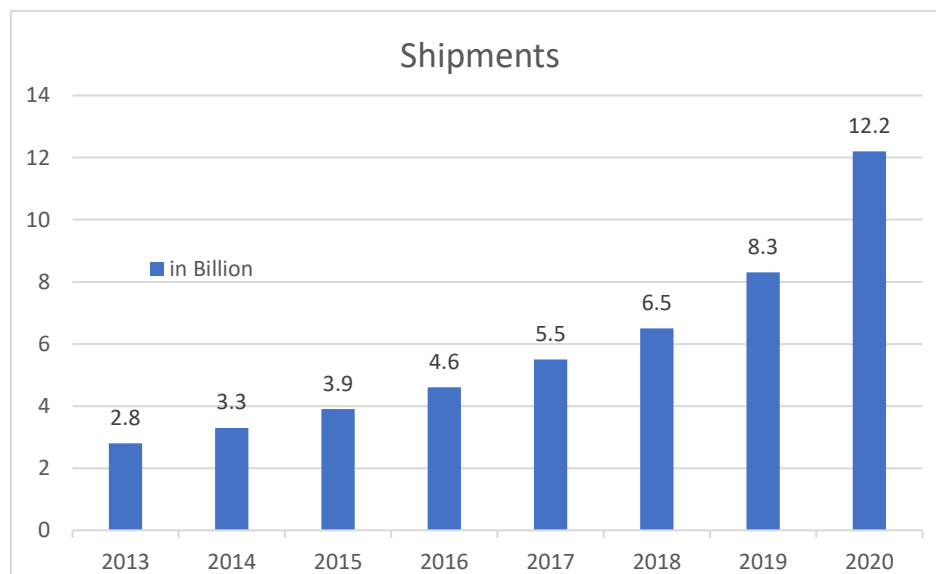


Fig.1: Shipments growth per year (2013-2020).

+



Indian shipment volume was growing significantly and reached 8.3 billion parcels in 2019 before the onset on the pandemic. Amazon Transportation Services reported a parcel volume growth of 54.5% in 2019 when compared to 2018. Logistic and shipments accounted for 11% of the GDP of the country. India’s e-commerce sector was worth 320 billion dollar (2374864 Crores India Rupees) in 2019. Figure 1 depicts the increase in the number of shipments

from 2013 to 2020 in India. It is evident from the graph that from 2013 to 2018 the number of shipments is increasing at a steady pace of 15-16% each year. But the year 2019 witnesses a bump in the number of shipments to year-on-year (YoY) increase of 21%. The next year, 2020, further increased the number of shipments YoY increase of 31% making the total to 12.2 billion shipments.

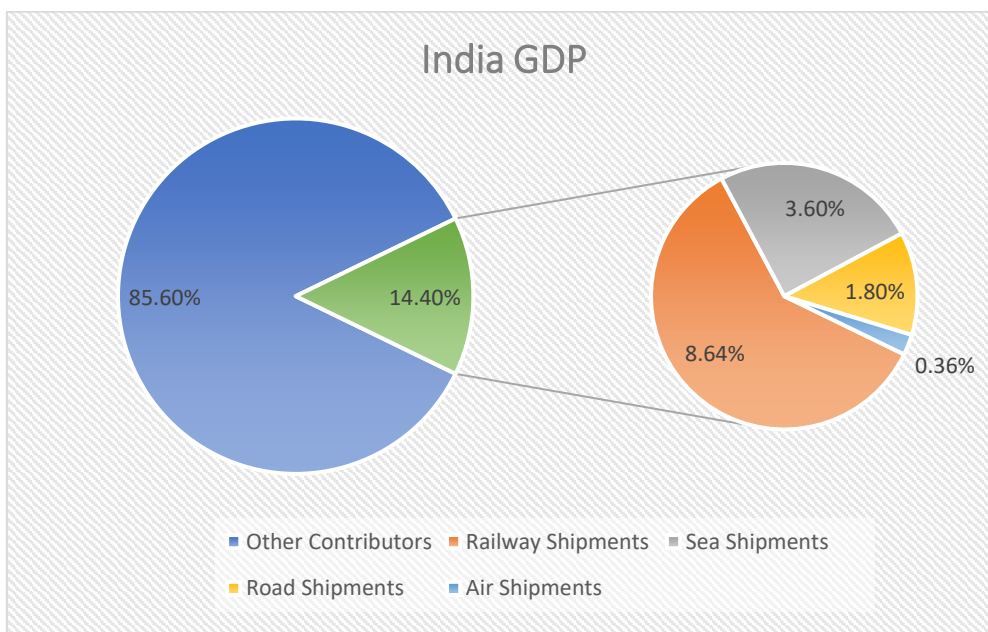


Fig.2: GDP share of Logistic and shipment industry in India (14.40%)

The shipments and logistics have a share of around 14.4% in the Indian Economy. The Indian economy is a 3.05 trillion USD economy standing at number 6 in the largest economies of the world, only after USA, China, Japan, Germany and UK. The shipment and logistics enjoy a healthy share of 439.2 billion in the GDP of

India. Railways has the maximum contribution in the total share of shipments and logistics at 60%, followed by Sea transport at 25%. Roadways contribute at 12% and the air travel contributes at 3%. The data is summarized in table 1.

Table 1: Share of shipment components in GDP of India.

SHIPMENT COMPONENT	SHARE IN %	SHARE IN USD (BILLION)
Railway	60%	263.52
Sea	25%	109.80
Road	12%	52.70
Air	3%	13.18

Smartphones and the internet are slowly and gradually increasing its depth in the India with the rural population increasing its number exponentially. In 2013 the total number of smartphone users was around 76 billion which has been steadily increasing to 479.34 million in 2018. The number of users was increasing at nominal pace in 2019

with 563.58 million users as depicted in figure 3. The beginning of the year 2020 saw a similar rise in the number of smartphone users until the announcement of the lockdowns and travel restrictions were announced. The details about during lockdown growth will be discussed in the next section.

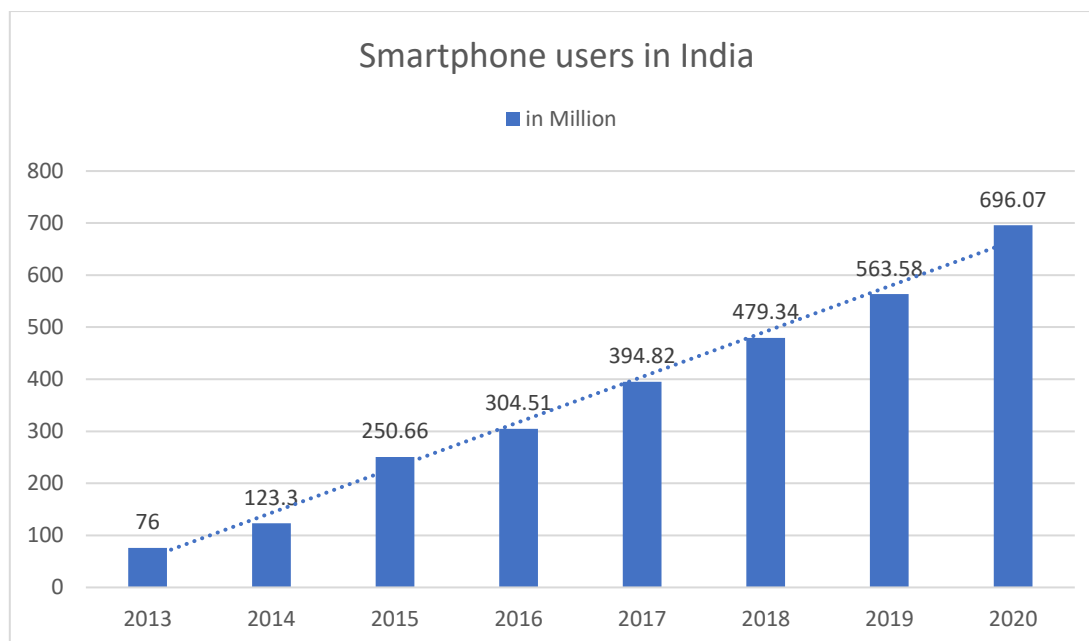


Fig.3: Number of smartphone users in India.

The penetration of the smartphone and the internet into the rural regions allowed the users to purchase items online or send gifts to their family and friends. This new trend helped greatly in increasing the shipments being travelled from one place to another. From figure 1 and figure 3, we can infer that with the increase in smartphones sales the number of shipments also increased. And as the number of users of smartphones and internet increase, the number of users willing to purchase things online also increases which in turn increases the number of shipments.

#### IV. DELIVERY SYSTEM BURING COVID-19

In the beginning of 2020 corona virus was just a name in India. People of the country didn't know about the seriousness of the disease or the spreading capability of the virus. It was on 30<sup>th</sup> January when India recorded or tested a patient positive for the virus. By 1<sup>st</sup> March 2020, India recorded just 2 positive cases for the virus. But no travel restrictions were imposed till then, people were free to come to India from abroad as well as countries which reported a lot of new cases as well as deaths. This led to a spike in the positive cases, on 6<sup>th</sup> March the total was 31, which increased to 44 on 9<sup>th</sup> march 2020. There were no restrictions in the country and all the regularities were still taking place as normal. It was on 25<sup>th</sup> March 2020, when India realized the severeness of the disease and imposed a total lockdown and movement restrictions throughout the country.

The total lockdown led to removal of people and vehicles from the road. The migrant people in the cities like Delhi,

Mumbai, Bangalore etc. went jobless and were forced to leave the big city keeping in eyes the expenses needed to stay there without a job and the striction of movement and removal of vehicles and stoppage of trains forced the poor migrants to travel to their hometowns on either foot, or manual carriages. During the early stages of the lockdown and the onset of the pandemic, the business to business and the business to consumer shipments collapsed to a standstill. The impacts were profound as businesses and offices were closed and locked out. The Indian e-commerce and parcel delivery sectors were severely hit. For the first few weeks, people were not allowed to go anywhere except to buy the daily essential and food items. During this time, the shipment delivery system was at stand still. In the next few weeks, government realized that movement of goods is a necessity for the people, so the shipment industry was given a little respite from the strictness. The movement of goods like food items, medicines and daily essentials started but a very low level. Only 5% of the total goods carrying vehicles were on the road at that time. E-commerce was allowed to sell items on their platform but only those items which fell under the category of "essentials". But, the migration of the working class to their native places led to decrease of man power present to do the job. This further resulted in pulling back the shipment delivery industry.

In mid of May, the Indian government allowed the e-commerce firms to resume full operations, which led to a surge in volume. In April 2020, the Center of Disease Control and Prevention (CDC) published some important guidelines for the delivery agents to ensure their safety and

reducing the spread of the COVID-29. Aside from the obvious and most important measures like staying at home when ill or not well, disinfecting surfaces and hands with prescribed sanitizers, wearing a face mask of the required standard, wash hands regularly with hand wash and avoiding touching your face, the CDC emphasized the benefits of practicing contactless deliveries whenever possible.

Some of the main points from the CDC’s recommendations for proper contactless delivery services during the COVID-19 pandemic are listed below:

- Maintaining a minimum distance of 6 feet from other people.
- Limiting contact with frequently touched surfaces and items such as door bells, door knob and handles, lift buttons etc.
- Avoiding the customers touching the pens, scanner and other such items belonging to the delivery agents.
- Wearing gloves when ever required and washing and changing them at regular intervals.

Like the CDC, the Occupational Safety and Health Administration (OSHA) also recommended business and organizations to practice and implement contactless deliveries whenever and where ever possible. In a letter published for shipment delivery workforce, the following strict and mandatory guidelines were introduced.

- Set up flexible working hours environment and suggest the workers to stay at home when not well or feeling sick.
- Reduce the interaction between customers as well as coworkers whenever possible.
- Leave the deliveries at doorstep with the consent of the buyer and step back whenever possible.

- Promote personal hygiene of the staff and provide sanitizer, handwash.
- Avoid workers from sharing and exchanging tools, equipment’s, scanners etc.
- Use EPA-approved cleaning chemicals that are labeled for use against COVID-19.
- Encourage staff to report and disclose any COVID-19 related health or safety concerns they might have.

With all these efforts and restrictions, India was among the top countries with maximum COVID-19 cases.

The COVID-19 pandemic and the lockdowns and restrictions forced the communities to stay indoors at home which led to the increase in the business-to-consumer market which exploded as people under lockdown and stay at home orders turned to the internet to make their purchases, sales of smartphones among them also skyrocketed in various online platforms. Offline sales did not rise since the shops and showrooms were all closed due to the pandemic. The online sales further hyped the shipment and transportation industry. In 2020, the number of smartphone users increased significantly to 696.07 million. Figure 4 depicts the trend in detail. In the beginning of the year when COVID-19 was not a scare in India, the increase in the smartphone users was according to the previous trends. Early March was also witnessing the same number of smartphone sales as earlier, but the implementation of lockdown and stay at home orders, drastically reduced the sale and shipments of smartphone as well as every other item. April, saw the minimum number of smartphones sold in a month ending a decade long trend. From the month of May onwards, with some lenience from the government, the sale and shipment grew to the normal and exploded to new heights towards the end of the year with holidays and festivities.

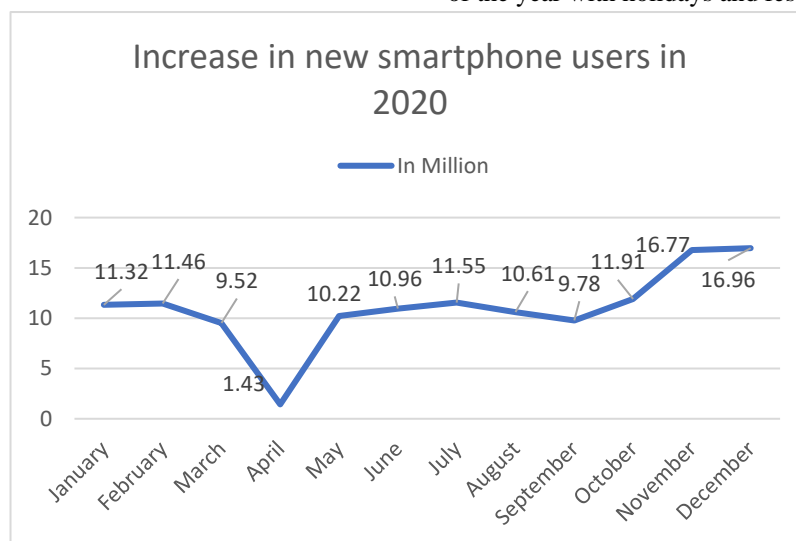


Fig.4: New smartphone users per month in 2020

Since offline market was not fully operational and functional, people moved towards purchasing smartphone via the online mode. This switch from offline (local shops, showrooms, malls etc.) mode to the online (Amazon, Flipkart etc.) mode helped in increasing the number of shipments to a large extent.

In table 2, we summarize the number of new smartphone sales in 2020 on a monthly note.

Table 2: Smartphone sales in 2020

Month	New smartphone sales	Month	New smartphone sales
January	11.32	July	11.55
February	11.46	August	10.61
March	9.52	September	9.78
April	1.43	October	11.91
May	10.22	November	16.77
June	10.96	December	16.96
<b>Total</b>		<b>132.49 million</b>	

Another major bearer of the increase in the sale of smartphones was the shifting of the classes, meetings, seminars, lectures, conferences etc. to the online mode. Everyone was supposed to be at home and at the same time attend their classes, meetings as well as do their job in a work from home (WFH) manner. This WFH wave also triggered an increase in the number of shipments because college students, office workers, teachers and professors had to switch to technology in order to fulfil their duty and day to day tasks. The sale of personal

computers, tablets, iPads and laptops saw an increase during the period and most of them being purchased online hence increasing the number of shipments. In figure 5 we have tried to depict the number of shipments each month in the year 2020. As the lockdown was announced in mid-march, the shipments became scarce. With relaxation and lifting of stay-at-home orders, the number of shipments rose at an unprecedented rate with 2 billion shipments in the month of December only.

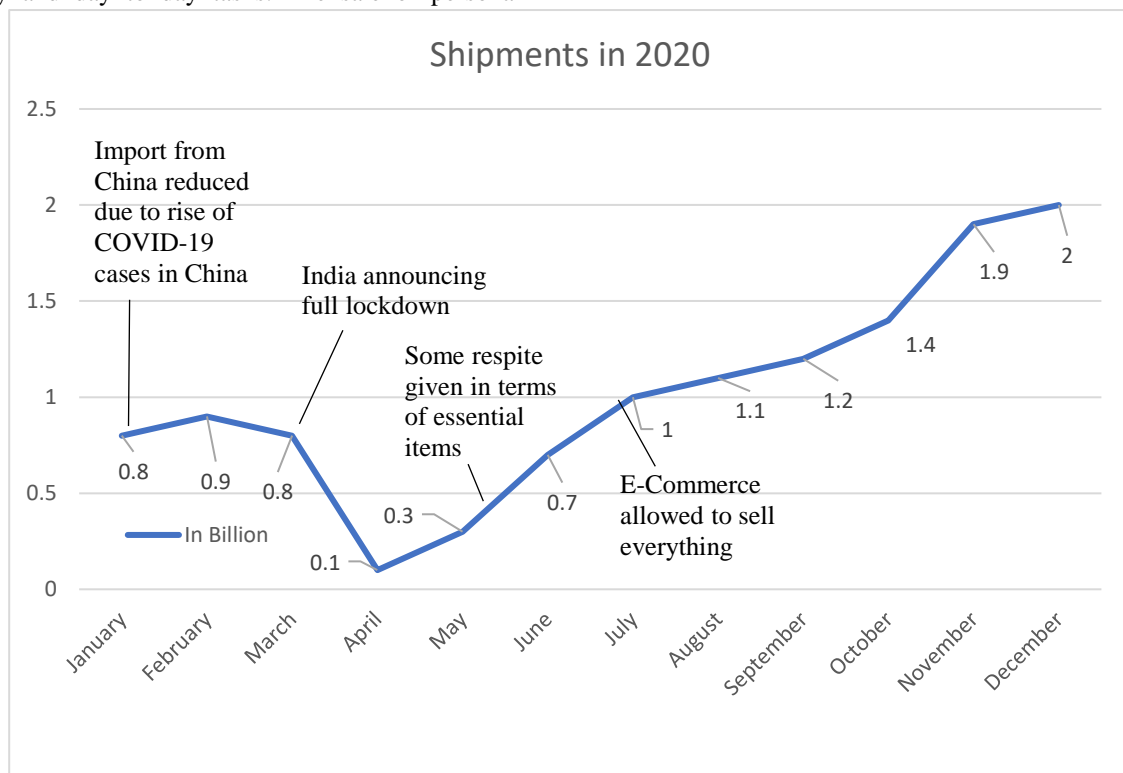


Fig.5: Shipments in India in 2020

In table 3, we summarize the number of shipments in 2020 on a monthly note.

Table 3: Monthly shipments in 2020

Month	No of shipments	Month	No of shipments
January	0.8	July	1
February	0.9	August	1.1
March	0.8	September	1.2
April	0.1	October	1.4
May	0.3	November	1.9
June	0.7	December	2
<b>Total</b>		<b>12.2 billion</b>	

The WFH paradigm also saw an increase in purchase and shipments of information technology. Personal computers, laptop and accessories sales saw a hike. The hike was predominantly visible in the third quarter (Q3). Figure 6 depicts the comparison of sales of IT components for the year 2019 and 2020. Q1 2020 saw a similar sale as in Q1

of 2019. Q2, due to lockdown and stay at home orders saw a significant decline in the sales. But once the restrictions were lifted and online sales commenced, the figure rose to a new high in the Q3 2020. Q4 2020 again saw a huge YoY difference. The data is summarized in table 4.

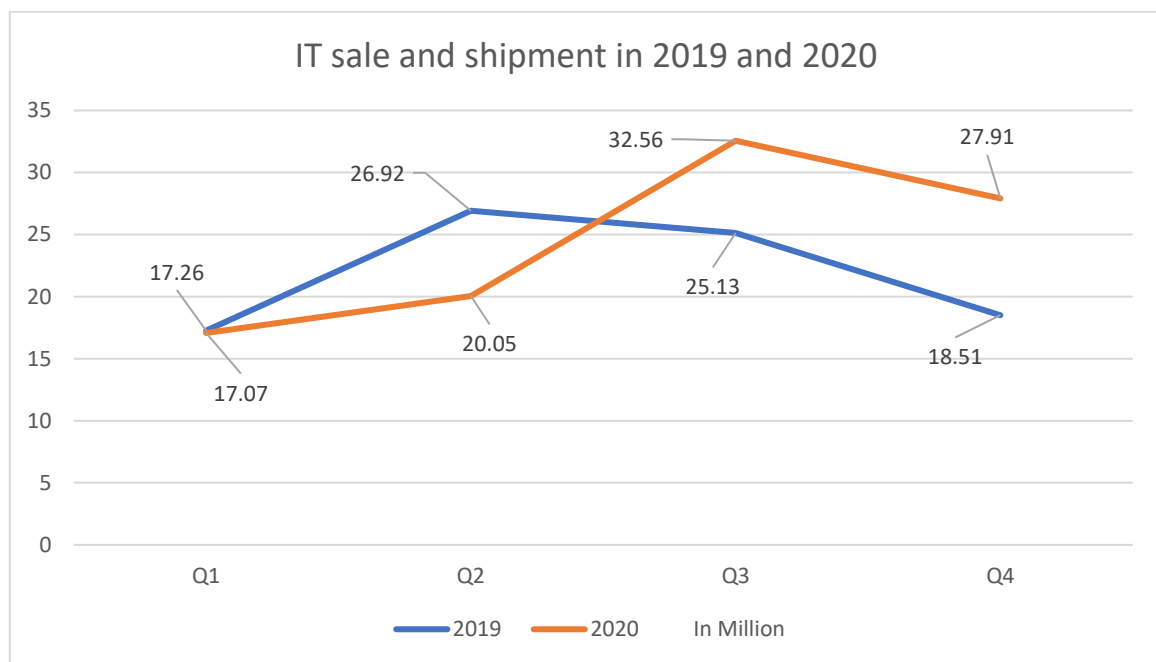


Fig.6: IT sale and shipment: 2019-2020

Table 4: Quarterly shipments of IT items: 2019-2020

Quarter	2019 (million)	2020 (million)	Difference 2020-2019
Q1	17.26	17.07	-0.19
Q2	26.92	20.05	-6.87
Q3	25.13	32.56	7.43
Q4	18.51	27.91	9.4
<b>Total</b>	<b>87.82</b>	<b>97.59</b>	<b>9.77</b>



### V. DELIVERY SYSTEM AFTER OR WITH COVID-19 (THE NEW NORMAL)

Due to the COVID-19 pandemic, the shipment volumes which were projected for the year 2026 are likely to be reached by 2023. The huge demands to home deliver almost everything has acted as a catalyst to increase these numbers. Shipment and logistic industry need to step up to the challenge of making deliveries safer and convenient for both costumers and the employees.

Inevitable shifts that need to be kept in mind for better, efficient and sustainable future

- Shift to Regionalization from Globalization
- Hold Intermediate Inventory and Safety Stock
- Uncover and address hidden supply chain vulnerabilities
- Build resilience through Digital Transformation

The shipment companies need to keep the above points in mind in order to be ready for future disruptions and “black swan” events such as another pandemic, trade wars, regulatory changes, or even acts of war or terrorism.

A few methods have been listed below which can be used in order to keep shipments sustainable, efficient and safe for both, the employees and the customers.

- Contactless last-mile delivery solution can prove to be crucial in the new normal.
- The use of drones can be one more method in delivering the last mile solution (Alam et al., n.d.).
- Use of smart locker solution is the next method
- Leading shipment companies are using connected technologies to collect and share data in real time to help drivers reduce fuel consumption and drive safely.
- Logistics providers will need to optimize and automate as much as possible and collaborate with others to operate safely, efficiently and preemptively. And as the world adjusts to a new normal, the safe and efficient movement of goods is at the very heart of economic recovery.
- Companies can use sensors to monitor the temperature of packages in real time; if it varies beyond a certain tolerance, then an alert can be sent and corrective actions taken, resulting in less waste, lower costs and more on-time deliveries.

In figure 7, we have shown the forecasted growth of shipments in India. These forecasts suggest that the number of shipments will keep growing at a constant rate with major contribution from online retails.

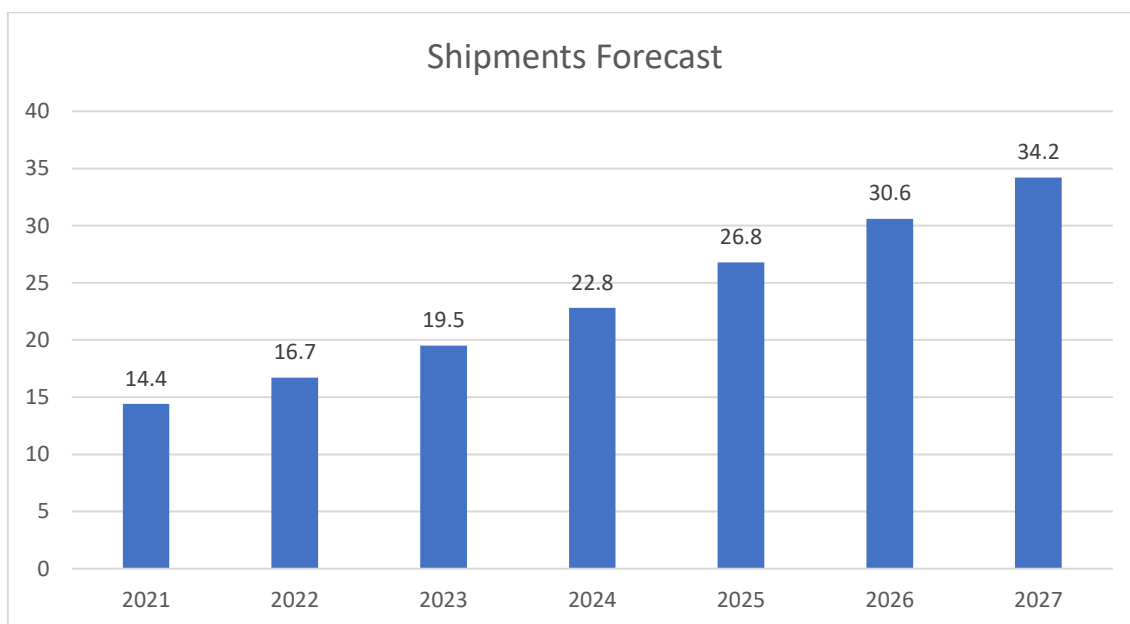


Fig.7: Shipment’s growth (forecasted) per year (2021-2027).

Figure 8 depicts the forecasted increase of smartphone users in India. The upcoming years will see a persistent increase in the number of new smartphone users. From

figure 7 and figure 8, we can infer that, as the number of smartphone users will increase, the number of shipments may also increase.

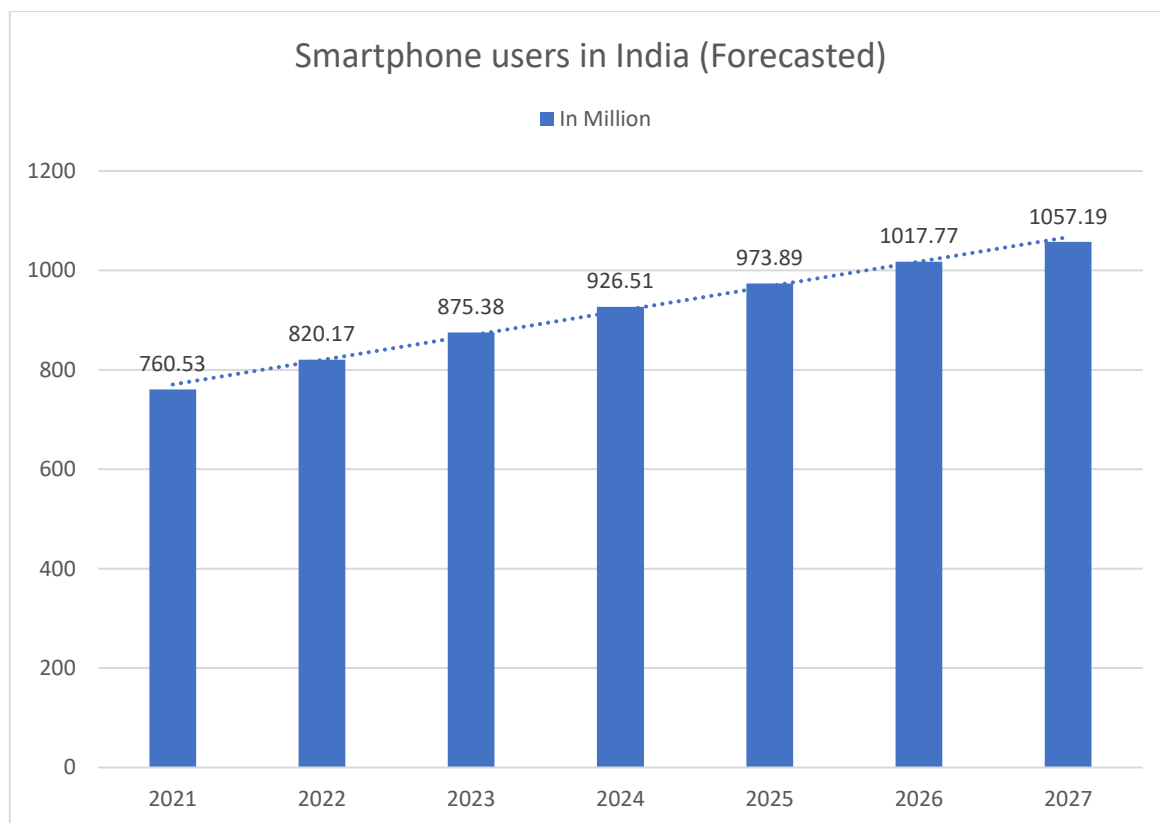


Fig.8: Forecast of increase of smartphone users in India

## VI. CONCLUSION

The coronavirus pandemic has profoundly affected our world this year. It has caused many unexpected disruptions, accelerated some existing trends and forced us to make some changes to how we work and live. Some of these changes will likely last even after COVID-19 is no longer a threat to public health. Many of these transformations will be for the better — such as expanded delivery options for consumers and businesses alike. Easier accessibility of goods and services could make everyone's lives run more smoothly. In this paper we have tried to compare the shipment delivery system in pre COVID-19, during COVID-19 and post COVID-19 (or the new normal) scenarios. We concluded that the estimations which were made for the year 2026 will be achieved in the year 2023 itself due to the pandemic and the burst in the orders for the online retailers. The increase in the penetration of smartphones and internet into the rural India has undoubtedly contributed in the increase in the number of shipments in India. The COVID-19 pandemic has proved to be a boon to the shipment industry as well as the online business.

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# Portuguese Sentiment Analysis Applied to a Reality Show using Twitter and NLP in real time

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**Keywords—** *Computing methodologies,  
Artificial intelligence, Natural language  
processing, LinguaKit*

**Abstract—** *The motivation for this study was to measure the impact that Twitter publications have on voting and the choosing of winners.*

*To this end, an experimental study was carried out based on a set of data collected from tweets (published on Twitter) related to the reality show “Big Brother - A Revolução”, broadcast on a television station in Portugal, TVI.*

*The procedure adopted for conducting the experiment consisted of creating a completely self-contained service, built from scratch for this project, and the correspondent implementation, in order to allow the collection, storage, cleaning, pre-processing and analysis of as many tweets as possible, as long as they are associated with the program. A tool to analyze the polarity (positive, negative or neutral) of the sentiment was implemented and applied to the phrase (or phrases) contained in the tweet and stored in a database. Then, running in the database, the tweets were divided according to how they referred to one or more competitors.*

*Throughout the time that the reality show existed, the results of this experiment were public presented in daily/weekly summaries and posted on Twitter through a “Twitter bot”.*

## I. INTRODUCTION

Twitter [1] emerged in 2006 and its main difference from other social networks is that each information sharing (hereinafter referred to as a tweet) has a maximum of 280 characters. Twitter has been growing very fast, counting with millions of users, and it is used a lot in various moments of our daily lives, from moments of political tension to simple entertainment, being used a little for everything.

An important difference to note on Twitter are hashtags [2], i.e., keywords preceded by the # character, indicating that the tweet refers to a certain topic.

The main goal of this study, was to realize the possible impact of *tweets sentiment* on the decisions made by the general public.

The *tweets sentiment* was measured with LinguaKit [3], a Bayesian classifier trained to output sentiment analysis of sentences in Portuguese language.

To achieve that, the authors used a case study with data in Portuguese, based on a reality show, called “Big Brother – The Revolution”, which was being broadcast on a Portuguese TV channel, TVI [4], in which audience decided which competitors could continue (or not) in the program, every week.

For this we collected tweets with hashtags that referenced this competition/game, with multiple different entities, so that it was possible to do comparative analysis between the entities and get the most-liked and disliked ones in the competition/game. In this project were collected and classified 631902 tweets.

From what people were expressed through daily tweets, after measuring the associated sentiment, we intended to predict the decisions made by the public.

Some of the results were posted during the course of the TV show in a twitter account @AnalyticsPt that can be visited at <https://twitter.com/AnalyticsPt>.

One of the main challenges of this project was the construction of a completely autonomous tool that would allow collecting tweets and storing them so that they could be used later for analysis. In chapter 2 of this paper we briefly explain the main issues related with this tool. In chapter 3, we present the tool created for publish the results online and we give some examples of what was posted. Chapter 4 contains a brief statistical analysis with the aim of validating the results obtained. In the last chapter some conclusions of the study are highlighted.

## II. DATA COLLECTION AND PROCESSING

This project was carried out from September 2020 until the end of the TV show, on January 1st 2021. Data collection and data storage (with the corresponding classification and cataloging) was done from scratch and is part of the work developed in this paper, using the Twitter Search API [5].

### 1. DATA COLLECTION

To get the data and store it, a service (called **rsa-backend**), using **docker** and **docker-compose** [6], was set up in **Scala** [7] using **Akka** [8] and a database in **PostgreSQL** [9]. This service was responsible for collecting, cataloging and classifying the data. The database is used by the service to store the data in tables (called **rsa-db**):

- 1) **ShowRecord**: Information about the show;
- 2) **TweetRecord**: Collected Tweets;
- 3) **CompetitorRecord**: Information about competitors.
- 4) **ClassifiedTweetRecord**: Classified tweets: contains its cleaned text, sentiment polarity, emotions...;
- 5) **CompetitorShowRecord**: Associate the competitor or with the show;
- 6) **CompetitorTweetRecord**: Associate the tweet with the show;
- 7) **TwitterUserRecord**: Information about the twitter user who wrote the tweet.

### 2. PROCEDURE TO RETRIVE CLEAN DATA

For an easy definition of the desired information (and the addition of new information - new competitors, nominations, expulsions, hashtags, etc..) a spreadsheet was

created. To have easy collaboration and editing, Google Spreadsheet was used also due to the existence of Google Spreadsheet API [10].

Here, we can highlight the essential information of all competitors such as:

- 1) Id Competitor
- 2) Name
- 3) City
- 4) Job
- 5) Entrance date
- 6) Characteristics
- 7) Twitter Search Query

The information in Google Spreadsheet is used by the service to search, catalog, classify and store in the database the tweets for each competitor and each show (also informed in Google Spreadsheet).

To search for tweets we use *Twitter Search API* [5] which has a limit by number of requests per time to collect the data. When this limit is reached, it reports the reset time remaining for the limits to be lifted.

According to the time that the API reports that is missing to reset, the service schedules the next data search iteration (**run**). These **runs** are coordinated in order to maximize the number of requests made to Twitter about each competitor, so that the database contains a dataset that represents the Twitter (almost) at the current time. In this way, the load that is placed on the server where the service is located is also kept to a minimum, as the work is distributed over time and not at peak workloads.

The data are thus obtained using the Twitter Search API and search queries that filters the tweets marked with the hashtags. The search queries are a list of keywords that are important in the search of tweet and they are informed in the google spreadsheet. The main hashtag chose for the case study was #bbtvi.

### 3. DATA PRE-PROCESSING AND SENTIMENT ANALYSIS

In this study, it was considered one search query for the show and one search query for each competitor. The search queries were updated during the show because the public gave nicknames to the competitors. The update did not interfere with the tweets already collected because this step was meant to be collected the tweets. Further on, already in the python script, the association between the competitor and the tweet is made again.

Data pre-processing is a very important phase as it is essential to be able to use a sentiment analysis tool. Thus, it





Table.1: Actual Raking of Competitors

Competitor Id	Competitor Name	Real Classification	Classification (positives)	Classification (negatives)	Classification (neutral)	Classification (total)
16	Zena	1	1	2	3	2
6	Jéssica Fernandes	2	3	3	2	3
21	Pedro	3	4	4	4	4
5	Renato	4	6	8	5	7
8	André Abrantes	5	5	7	7	5
11	Joana	6	2	1	1	1
4	Soía	7	10	10	10	10
1	Andréia	8	9	9	9	9
18	Carlos	9	12	14	12	12
14	Brá Pedro	10	8	6	8	8
10	Michell	11	11	12	11	11
3	Carina	12	7	5	6	6
13	Jéssica Antunes	13	13	13	13	13
20	Liliana	14	16	16	16	16
9	Catarina	15	15	15	15	15
7	Sandra	16	14	11	14	14
12	Diana	17	17	17	17	17
17	Ribeira	18	20	21	20	20
15	André Filipe	19	18	18	18	18
2	Bruno	20	19	19	19	19
19	Luís	21	21	20	21	21

The expected rating is also shown if the number of positive, negative, neutral or total twitters determines the rating of competitors. The highest number of positive, negative, neutral or total tweets, the highest ranking.

Just with the table 1, it is possible to see that the competitor who won, Zena, was associated with very positive tweets during the show. Joana, who finished in 6th place, was the most popular one.

It is possible to conclude that the rank (real classification) is very positively associated (correlated) with the classification according to positives, negative, neutral and total tweets (see table 2).

Table.2: Associations between predicted and real Classifications

**Spearman correlation coefficient**

Classification according to	Real Classification
positive tweets	0.945
negative tweets	0.877
neutral tweets	0.929
total tweets	0.929

**2. PRINCIPAL COMPONENT ANALYSIS**

Principal component analysis (PCA) is a very popular unsupervised algorithm of classification, used for exploratory data analysis, in order to identify hidden patterns [12].

In the case of this study, the highly Pearson correlation observed between the features, number of positive tweets, number of negative tweets, number of neutral tweets and number of total tweets allows that this 4 variables could be defined by only 2 principal components that explains together more than 99.5% of total variance presented in the data (table 3).

Table.3: Variance explained by PC's

**Variance Explained**

PC's	PC1	PC2	PC3	PC4
Variance Explained	0.990	0.005	0.004	6.1*10 <sup>-33</sup>

The two principal components are linear combination of the initial 4 features whose coefficients are the normalized eigenvectors associated with the largest eigenvalues of the correlation matrix (table 4).

Table.4: Coefficients of the PC's

**Principal Component Analysis**

Number of tweets	PC1	PC2	PC3	PC4
Positive	0.499	-0.311	0.757	-0.285
Negative	0.499	0.795	-0.124	-0.322
Neutral	0.499	-0.5195	-0.642	-0.263
Total	0.502	0.036	0.008	0.864

A graphical representation of the scores is presented in Figure 3 and Figure 4. In Figure 3 it is possible to distinguish the 3 best classified from the 10 worst classified, based on the 4 variables that were measured: number of positive, negative, neutral and total tweets. In addition, it is possible to notice that the competitor Joana, who finished in 6th place, is close to the winner Zena, standing out a lot from the others. In fact, as has already been said, Zena was a very popular competitor.

In Figure we present the data organized in clusters for a better visualization of the separation between the classification groups.

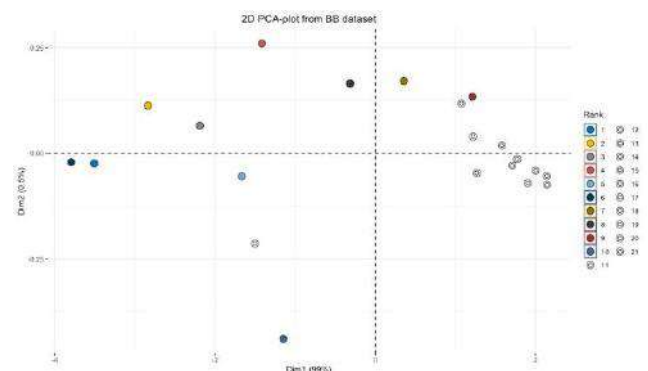


Fig. 3: Classification: Individual Scores of the competitors

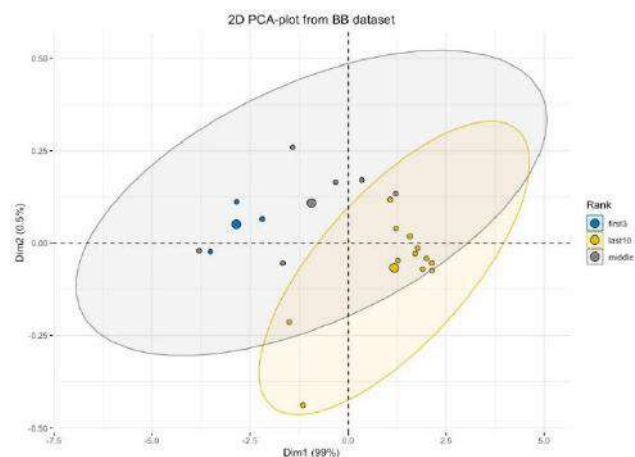


Fig. 4: Clusters: Scores of the competitors

## V. CONCLUSION

In this paper, we aim to explore the influence that posts from general public on social networks have on the decision-making process by the same audience.

It was possible to conclude that there is a strong correlation between what people write on social networks, interpreted with a sentiment analysis tool, and what these people subsequently decide on the topic under discussion.

The choice of Twitter was due to the user-friendly easy use of the API and the amount of documentation available. Besides tweets are a way of communicating with millions of users, whose "uncomplicated" and completely informal character allows the user to express, without reservation, their "feeling" on a certain subject.

However, we cannot say that Twitter is used by the generality of Portuguese and, for that fact, the results obtained may not be representative of the Portuguese population, but this particularity makes the results obtained with this work much more interesting.

In fact, the study presented, with the sentiment analysis carried out, that the classification obtained taking into account this analysis, is highly correlated (positively) with the real final classification. In fact, the best ranked are positively associated with the most commented, with no difference in ranking depending on the type of tweets (negative, positive, neutral or total). Also, it was also possible to see that the total number of positive, negative, neutral and total tweets, allows to separate the best classified from the worst classified, so this is another indicator of the importance that this social network can have in forecasting the big (and small) public decisions.

## ACKNOWLEDGEMENTS

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# A review on Silicide based materials for thermoelectric applications

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**Keywords**— Silicides, seebeck effect, thermoelectric materials, figure of merit (ZT), thermal conductivity.

**Abstract**— Thermoelectric materials are considered prime in converting energy, thanks to its nature to translate heat into electricity openly. Low efficiency and the intricacy in fabrication restrict their applications commercially. Moreover, there are certain thermoelectric materials such as alloys of telluride owing to their toxicity present peril to the environment. There is scarcity in present examination to get an ecological gracious thermoelectric material which is available in abundance to be utilized in large volumes owing to the low efficiency. The paper presents a review of such thermoelectric material which is ecological gracious. In the beginning, a number of techniques employed in advancing the figure of merit (ZT) is offered, then an in-depth review of several thermoelectric materials which are silicon-based is showed. N-type doping of  $Mg_2Si_{0.75}Sn_{0.25}$  among aluminum along with lead at operational temperature of 850 K scaled up the value of ZT by a factor of 2. Considerable addition in carrier concentration resulted in the attainment of figure of merit with peak value of 1.4. Techniques such as nanostructuring and doping have boosted silicides such as HMS to show a remarkable achievement in the attainment of dimensionless figure of merit. Iron disilicide ( $FeSi_2$ ), Chromium silicide ( $CrSi_2$ ) and Cobalt Silicide ( $CoSi$ ) have shown their worth to be employed as thermoelectric materials in industries in near future. It is also recommended to analyze supplementary types of metal oxides and organic materials which exhibit thermoelectric traits.

## I. INTRODUCTION

As the density of the electronic devices is increasing owing to the contraction in the dimensions of components, scientists and engineers are facing an immense challenge in controlling the dissipation of heat in present devices. This leads to the necessity of thermal management right from the beginning of any design procedure. Thin films made of thermoelectric materials have been accepted recently as a vital division of energy materials responsible in converting waste heat into electrical energy. It has opened the doors to possibly and successfully scale down

the dimensions of thermoelectric devices to nano scale with performance analogous to bulk materials. Further, materials of nano-scale are expected to demonstrate exceptional thermoelectric performance over bulk materials. The reason for this is because of the effect of low dimensional quantum size. Hence it is imperative in exploring and developing right category of materials to be employed in manufacturing thermal interface devices with elevated thermal conductivity.

In current scenario, lower utilization of thermoelectric devices is owing to their comparatively high expenditure



and low efficiency. The scarcity of energy and global warming stands as a gigantic problem which has ultimately attracted the issues of energy preserving and diminution of carbon emission. For any thermoelectric material, the translation efficiency is linked to ZT. Figure of merit (ZT) is expressed in Eq. (1) as [1]

$$ZT = \frac{S^2}{\rho k} T = \frac{S^2}{\rho(K_e + K_l)} T \quad (1)$$

Here  $S$  stands for Seebeck coefficient whereas  $\rho$  stands for electrical resistivity. Thermal conductivity is shown by  $\kappa$ . Thermal conductivity defines ability of transfer of heat through a material. Equation 1 clarifies that for attaining high value of ZT, thermal conductivity must be kept low. Thermal conductivity holds two components, electrical thermal conductivity along with lattice thermal conductivity denoted by  $K_e$  and  $K_l$  respectively. For this reason, decrease in thermal conductivity will also result in low the electrical conductivity as well. A method to beat this is by employing phonon scattering [2].

## II. IMPORTANCE OF THIN FILMS

In the previous decade or so, the deposition of thin film has emerged an exceedingly valuable technology which has seeped in every foremost industry. Thin films are nothing but materials of thin layers whose thickness varies from nanometers to micrometers. Thin film technology is used in manufacturing thin film batteries, photo cells and solar cells etc. Thin films are predominantly used in industries such as aerospace and machine tool. The likelihood of fine-tuning of firmness and inertness of thin films guards the materials against both corrosion and oxidation. This in return stretches the longevity of objects significantly.

As per the reports of Hicks and Dresselhaus, the efficiency of materials with low dimensions is far better than bulk. Such nanostructured thermoelectric material with lower dimensions contributes in enlarged density of states of Fermi level and improvement in phonon scattering. Since it is known that sintering blocks is quite tedious to attain the miniaturization of the thermoelectric devices, therefore a large number of deposition techniques have been employed to acquire the thermoelectric thin films to name a few like IBS, MBE, MOCVD and electrochemical deposition. For conducting thin films, it is desirable that atomic structure of thin films to be amorphous with spatial homogeneity to be in nanoscale for device compatibility. This can be seen in super conducting nanowire single photon detectors (SNSPD)

[3]. A classic means to craft amorphous thin films is through sputtering the cooled surfaces [4]. The technique of bombardment of the sample with ions using a focused ion beam can be given nearby by means of nanometer scale spatial resolution to tune normal state resistivity. Narrow weak spots are fashioned when the limit of dose is large demonstrated among cuprites [5] along with niobium nitride [6].

## III. Enhancing figure of merit in thermoelectricity

It is clear from equation (1), those materials which exhibit large values of ZT possesses enhanced seebeck coefficient along with better electrical conductivity, simultaneously keeping lower values of thermal conductivity. For a thermoelectric material electrical conductivity  $\sigma$  is given as:

$$\sigma = \frac{1}{\rho} \eta e \mu \quad (2)$$

Where  $\eta$  is the concentration of carriers and  $\mu$  represents the mobility of carrier. Electrical conductivity can be improved by accumulating chemical dopants. The mobility of charge carrier's will shrink by doping as scattering amid charge carriers and dopants rises. In addition, the density of charge carriers gets augmented due to the availability of extra valence electron in each dopant. So for achieving explicit larger Seebeck coefficient, only one type of carrier remains. The doping polarities of carriers influences the carriers to persistently remain at cool region while other to reverse the effect of seebeck.

To apprehend higher values of ZT, an efficient thermoelectric material must own low values of thermal conductivity. In order to decrease thermal conductivity, scattering of phonon ought to be increased. In a thermoelectric material, the subsequent heat transport by travelling of phonons through crystal lattice [7, 8] leads to thermal conductivity. Equation 3 shows the relationship as

$$\kappa_{tot} = \kappa_e + \kappa_L \quad (3)$$

Electron thermal conductivity as per Weidemann-Franz Law [9] is given away in equation (4)

$$\kappa_e = L \sigma T \quad (4)$$

Here  $L$  represents Lorenz number. From equation 4, it is evident that dipping  $\kappa_e$  is not forever a dependable option because the electrical conductivity gets affected which halts the progress in the value of ZT. Thermoelectric materials which are made of semiconductors, bulk portion of thermal conductivity are contributed by lattice thermal conductivity.



### 3.1 The optimal Seebeck coefficient

In this day and age, efficient thermoelectric materials are customarily semiconductors where by doping acceptor or donor impurities, the concentration of the carriers can be regulated. The impurities decide the polarity of the Seebeck coefficient. Minority carriers diminish the scale of the Seebeck coefficient in addition augments the thermal conductivity all the way through bipolar conduction. In the presence of single polarity carriers, the extent of the Seebeck coefficient increases as the concentration of carrier reduces. The probability of seebeck coefficient scales the order of  $\pm 1000 \mu\text{V/K}$  or even more in larger energy gap. The Seebeck coefficient which facilitates the maximum power factor is nearer to that which provides the maximum figure of merit. It is obvious when the electronic contribution is taken in consideration to thermal conductivity. The optimal Seebeck coefficient does not vary greatly from one material to another. The concentration of carrier intended for a specified Seebeck coefficient rely on effective mass. Higher Seebeck coefficient is often present where carrier concentration is low. Those metals whose carrier concentration is on higher side, attracts higher values of electrical conductivity and poorer Seebeck coefficient [9] values. Review of thermoelectric properties at 300 K is given in table 1.

Table 1: Review of thermoelectric properties at 300 K.

TE property	Insulators	Semiconductors	Metals
Carrier concentration	Low	Low	High
Seebeck Coefficient	$1000 \mu\text{V} / \text{K}$	$0-3 \mu\text{V} / \text{K}$	$200-300 \mu\text{V} / \text{K}$
Electrical conductivity	$< 10^{-6} (\Omega.\text{m})^{-1}$	$10^{-6} < \sigma < 10^5 (\Omega.\text{m})^{-1}$	$> 10^5 (\Omega.\text{m})^{-1}$

## IV. ADVANCES IN ECOLOGICAL GRACIOUS THERMOELECTRIC MATERIALS

Numerous thermoelectric materials that were found with high values of ZT but majority of those efficient thermoelectric materials holds toxicity as well as are ecological ungracious. Silicides and oxides consistent with He, Liu et al [10], are regarded eco-gracious thermoelectric resources owing to less contamination with huge measures within the environment. During this review, scope is merely to silicon-based thermoelectric materials only.

### 4.1 Thermoelectric materials (Silicon-based)

Silicon is the most familiar and extensively used

semiconductors in industries thanks to its ecological gracious, economical and abundance in nature [11, 12]. Owing to large thermal conductivity at 300K, silicon is understood meager having ZT value of 0.01 at 300 K [13]. Nanotechnology eliminates this demerit by reducing the size of the grain. In current time, the dynamic progress in low dimensionality tactic has revealed thrilling effect in enriching ZT and limiting k in silicon based materials alongside restraining capacity of the material jointly amid highly developed IC techniques crafting it further suitable from unrefined materials to realistic integration. Since Si is an excellent semiconductor material, in recent times, numerous bright writings about it's material prospectus is projected. Narducci, et al. [14] in 2015 proposed the utility of nano-precipitates within thermoelectric performance of silicon based bulk as well as films. Nozariasbmarz, et al. [15] concluded that bulk metal silicide thermoelectric materials in depth till 2017. Gadea, et al. [16] in 2018 did the review of superior microstructure silicon based thermoelectric material to put forward application leaning outlook. Nakamura [17] deeply illustrated vivid diminution of  $k$  in the accurate scheming of a silicon base epitaxy.

In 2019, He, et al. [18] orderly reviewed the thermoelectric behavior in relation to the nano bulk structure of silicon along with alloys of SiGe. Furthermore, thermoelectric traits of Si fragment cultivated from wafer production were introduced. Tanusilp and Kurosaki [19] in a few words did the review of silicon base thermoelectric materials along its synthesis by the technique of nano-structuring. Hochbaum, et al [20] showed diminish in lattice thermal conductivity by a factor of 100 in silicon nano-wires. This caused attainment of ZT value to be 0.6 at 300K. The fall of lattice thermal conductivity of nano structured silicon is because of sturdy scattering of phonon.

Bux and Blair, et al [21] in 2009 showed a ZT value equals to 0.7 at operating temperature 1275 K for nano-structured bulk Si with n-type polarity by sinking thermal conductivity and degrading electron mobility. A fall of 90%  $k_L$  was observed due to scattering of interfacial phonon. Yang et al [22] proposed that the value of  $k_L$  in silicon nanocomposites gets minimized as a result of rising phonon scattering. Further reports proposed incredibly small  $k_L$  ( $< 0.1 \text{ W/mK}$ ) at operating temperature 300 K exhibited by nano-porous silicon.

In 2011, Yang and Li [23] utilized nano thermodynamics representation to compute lattice thermal conductivity of nano-porous, nano-crystalline along with nano-structured bulk Si. They found that, nano-porous silicon display lesser  $k_L$  in contrast to silicon nano-wires. Nielsch and

Bachmann, et al [24] forwarded nano-structured silicon a promising substitute intended for high- effectiveness within the thermoelectric applications. Further it was noted that by doping of germanium or manganese, the efficiency of Si nanostructures was improved.

#### 4.2 Thermoelectric materials (Mg<sub>2</sub>Si)

Mg<sub>2</sub>Si- oriented thermoelectric materials are promising within 500 to 900 K. This is because of immense attainment in the values of ZT to 1.3 [25, 26, 27]. Because of the extreme closeness in the boiling value of magnesium and the melting value of Mg<sub>2</sub>Si, treatment of Mg<sub>2</sub>Si is not easy [28]. Method like spark plasma and ball-milling are therefore employed to synthesize Mg<sub>2</sub>Si. Bux, et al [25] in 2011 performed the doping of Mg<sub>2</sub>Si with Bismuth. Synthesis was achieved by mechano chemical method. ZT = 0.7 was reported at temperature 775 K. This increase in ZT resulted by noteworthy drop within the lattice thermal conductivity.

Fusion techniques used were not capable to adjust the composition and feat of silicide owing to the oxidation and volatilization. Spark plasma is employed into nearly all studies at low temperature owing to the exceedingly large diffusion velocity. This is to avoid the oxidation of Mg [29]. SPS method was utilized by Hu, Mayson and Barnett [30] in order to synthesize Mg<sub>2</sub>Si with aluminum as dopant at 750°C. Maximum value of ZT was reported as 0.58 at temperature 844 K.

Hu, et al reported the likelihood of upper electrical conductivity is obtained due to full densification of Mg<sub>2</sub>Si in spark plasma. Tani and Kido [31] performed the doping of the silicide and phosphorus at (300-900K). The outcome was the value of ZT to 0.33 at 865K. Yang, et al [27] utilized the technique of SPS for synthesizing the Bi-doped Mg<sub>2</sub>Si powders. This nano-composite structure trims down conductivity and augment the seebeck coefficient. Taken as a whole, thermoelectric performance improves and a max ZT=0.8 (nearly 63% higher than silicide with no nanocomposite structure) is achieved at temperature 823 K.

#### 4.3 Thermoelectric materials (SiGe)

For elevated temperature applications, silicon germanium (SiGe) is well thought-out a big thermoelectric material. With lower values of vapour pressure, it also offers superior resistance against atmospheric oxidation. For high temperatures (~1173 K) applications such as power generation, SiGe is presently the premium thermoelectric material. For p-type nanostructured bulk Si<sub>80</sub>Ge<sub>20</sub>, Joshi, et al [32] achieved value of ZT to be of 0.95 at 800°C -900°C with boron doping. As per Joshi et al, the

various augmentations in the value of ZT are due to noteworthy diminution of thermal conductivity. In 2009, Zhu, et al [33] showed the value of ZT to be around 0.94 at operating temperature of 900°C. The enhancement of boundary phonon scattering resulted from drop in thermal conductivity. The small quantity of Germanium significantly reduces the total cost of fabrication cost. Modulation doping approach is one more mode to realize high value of ZT in SiGe nanocomposites. As per Yu and Chen, et al [34], doping methodology can be further enhanced by employing a skinny spacer film which ultimately improves measured performance.

In correlation to trial approach, various investigations on properties of SiGe have undergone by numerous researchers. The thermoelectric properties of nanoporous SiGe was obtained by Lee, et al [35] in 2012. In single SiGe nanowires, the ZT value was predicted to 2.2 at temperature 800 K and nearly 0.46 at temperature 450 K. An improved model was projected by Yi and Yu [36]. The thermoelectric traits of highly doped SiGe nano-wires were predicted at various temperature ranges. The obtained result recommends the value of ZT to be 1.9, 1.5, 1.2 and 0.8 is yield at temperature 800 K, temperature 600 K, temperature 450 K and temperature 300 K respectively.

#### 4.4 Thermoelectric materials (High manganese)

Higher manganese silicide (HMS) is known for its composition exceeding the amounts of Si with Mn [37]. HMS is represented by five phases. These phases have analogous properties. The structure is tetragonal crystal structure. The energy gap varies from 0.4-0.7 eV. The thermal conductivity of HMS exhibits lower values. ZT was reported nearly 0.4 at temperature 800 K in a non-doped HMS [38]. Girard, et al [39] in 2014 achieved advancement in the value of ZT to 0.52 ± 0.08 at operating temperature 750 K in an un-doped crystal of HMS. Itoh and Yamada [40] presented mechanical alloying of MnSi<sub>1.73</sub> to achieve maximum value of ZT of 0.47 at temperature 873 K. Numerous experiments have been attempted on polycrystalline HMS to attain growth in thermoelectric characteristics. Polycrystalline HMS were synthesized by SPS by An and Choi, at temperature 1123 K. The maximum value of ZT to be 0.41 was obtained. Luo, et al [41] in 2011 obtained maximum value of ZT to 0.65 at operating temperature 850 K. This was possible due to the doping of HMS with Aluminum.

As per Luo et al, the development in the value of ZT was mainly due to the addition of Al in HMS. It leads to rise in the electrical conductivity and fall in thermal conductivity. As per Ikuto et al [42], the improvement in the thermoelectric properties was due to the doping of HMS with aluminum. Al doping lowers the thermal

conductivity. Aoyama, et al [43] in 2005 set up that by accumulation of Ge into HMS, there is early boost in the volume concentration of MnSi. Zhou, et al [44] in 2009 employed induction melting and hot-pressing for doping polycrystalline HMS among Ge thereby obtaining  $ZT = 0.6$  at 833 K.

#### 4.5 Thermoelectric materials (FeSi<sub>2</sub>)

Thermoelectric devices whose applications falls in temperature range between  $230^{\circ}\text{C} - 630^{\circ}\text{C}$ , iron silicide shows immense possibility in driving instrument.  $\beta$ - FeSi<sub>2</sub> has been distantly acknowledged in thermal sensing applications and also in the fields of optoelectronics. A range of experiment has been conducted to get better thermoelectric performances of  $\beta$ -FeSi<sub>2</sub>. Ware and McNeill in 1964 obtained  $\beta$ - FeSi<sub>2</sub> of n-type by doping  $\beta$ - FeSi<sub>2</sub> with cobalt. Doping  $\beta$ - FeSi<sub>2</sub> with cobalt was also achieved by an experiment conducted in 2002 by Ur and Kim, et al [45] through mechanical alloying. It was observed that finer grain size is obtained by mechanical alloying materials which ultimately reduced the lattice thermal conductivity thereby obtained improvement in thermoelectric efficiency.

Kim, et al [46] in 2003 prepared  $\beta$ - FeSi<sub>2</sub> by the technique of powder metallurgy. It was observed that co-doping with Chromium, Cobalt and Germanium enhanced the ZT value to  $1.3 \times 10^{-4} \text{ K}^{-1}$  at temperature 845 K. FeSi<sub>2</sub> has shown highest  $ZT = 0.4$  in  $\beta$ - FeSi<sub>2</sub> of n-type and  $ZT=0.25$  in  $\beta$ -FeSi<sub>2</sub> of p-type.

#### 4.6 Thermoelectric materials (CrSi<sub>2</sub>)

Using density functional theory Pandey and Singh [47] showed that the thermoelectric properties of doped CrSi<sub>2</sub> can be managed by defect transition levels from dopants. It was also noticed that the accumulation of doping aluminum or manganese in CrSi<sub>2</sub> augments in thermopower and further reported that n-type attain higher thermopower in comparison to the p-type doped CrSi<sub>2</sub>. CrSi<sub>2</sub> exhibits good electrical conductivity and thermopower. It has large thermal conductivity. Highest ZT value is presented to be 0.2 - 0.25 at  $600^{\circ}\text{C}$  in undoped CrSi<sub>2</sub> [48]. A quite a lot of researches have revealed that the thermoelectric properties improve appreciably by doping.

Perumal, et al [49] in 2013 formed the CrSi<sub>2-x</sub> composites (where  $0 < x < 0.1$ ) by varying temperature from 300K toward 800K. It was established that a significant reduction in the value of Seebeck coefficient along with electrical resistivity at  $x > 0.04$ . The peak value of  $ZT = 0.1$  is noticed at temperature 650 K. Several attempts were made to replace manganese and aluminum by polycrystalline CrSi<sub>2</sub> by utilizing the technique of arc melting as well as hot pressing [50]. It was evident that lattice values escalated by the contents of Manganese as well as Aluminum. Perumal, et al [51] suggested numerous ways in the processing of CrSi<sub>2</sub> as (i) forming precipitate by means of solid state phase transformation, (ii) speedy solidification through the technique of melt-spinning, (iii) employing the technique of mechanical alloying. Kajikawa, et al [52] collectively applied both SPS as well as hot pressing in processing CrSi<sub>2</sub> at temperature 1573 K. Further approaches like solo crystal CrSi<sub>2</sub> nanowires were explored to check their effect in enhancing ZT in upcoming thermoelectric areas [53].

#### 4.7 Thermoelectric materials (Ru<sub>2</sub>Si<sub>3</sub>)

The thermal stability of ruthenium silicide is high. It's resistance to chemical exposure is also high. This makes the material well suited for application where the requirement of operational temperature is very high such as space applications. C.B Vining grew an un-doped single crystal of ruthenium Silicide for theoretical analysis. Attainment of higher value of figure of merit by Ru<sub>2</sub>Si<sub>3</sub> was possible in comparison to current state-of-art SiGe as per Vining's report. Further ahead, Vining and Allevato also reported the role of addition of p-type Ru<sub>2</sub>Si<sub>3</sub> in improving the value of figure of merit to a scale of 3 and in contrast to current SiGe standard; n-type Ru<sub>2</sub>Si<sub>3</sub> displayed 50% better results. Ivanenko, et al in 2003, using the technique of floating zone was successful in doping single crystal Ru<sub>2</sub>Si<sub>3</sub> with Manganese. The outcomes reported the effect of doping on the electrical resistivity. Mn-doped Ru<sub>2</sub>Si<sub>3</sub> was found to have much lower electrical resistivity in comparison to the un-doped crystal. It an increase by scale of 2 was noted in the mobility of carrier in Mn-doped Ru<sub>2</sub>Si<sub>3</sub> as compared to undoped Ru<sub>2</sub>Si<sub>3</sub>.

Table 2: Thermoelectric properties of un-doped and Mn-doped single crystal of Ru<sub>2</sub>Si<sub>3</sub>.

Thermoelectric properties	Mn-doping	Without doping	Observations
Electrical Resistivity	15 Ω	22 Ω	Mobility of carrier increases
Seebeck Coefficient at 500 K.	400 μV / K	300 μV / K	Samples without doping showed negative seebeck value in whereas samples with Mn doping showed positive seebeck value.
Thermal conductivity	5 W/ K m	5 W/ K m	Thermal conductivity is same at 300 K in both samples but doped sample below 100 K is much high than other.
Figure of Merit	0.3	0.2	Mn-doping displayed high ZT.

In 2004, Ivanenko et al [54] reported that higher values of Seebeck coefficient are possible by doping pure Mn with Ru<sub>2</sub>Si<sub>3</sub> in comparison to the un-doped Ru<sub>2</sub>Si<sub>3</sub> at 300 K. The (ZT) value at working temperature of 800 K in Mn-doped Ru<sub>2</sub>Si<sub>3</sub> is calculated to be 0.2 and 0.27 for un-doped. Krivosheev et al [55] by the technique of zone arc melting in combination with optical heating successfully doped Ru<sub>2</sub>Si<sub>3</sub> with manganese. The thermoelectric properties exhibited by the experiment are illustrated in Table 2.

#### 4.8 Thermoelectric materials (Mo-Si) based TE

Molybdenum silicide (MoSi<sub>2</sub>) in recent times has acknowledged substantial interest for thermoelectric applications at high temperature. MoSi<sub>2</sub> exhibits high melting point. It also displays higher resistance to oxidation which attracts MoSi<sub>2</sub> as a heating element for the reason that it can endure extended exposure to air. For heating application, it becomes obvious to comprehend the thermal and mechanical traits of MoSi<sub>2</sub> since these traits are fundamental in designing. The mainstream research done till has focused in oxidizing and synthesizing α-MoSi<sub>2</sub>.

As per reports of Krontiras et al., the value of electrical resistivity at operational temperature 300 K was 0.063 10<sup>-3</sup> Ω cm. Vries, et al presented electrical resistivity at temperature 300 K to be 0.06 10<sup>-3</sup> Ω cm whereas Yamada, et al [56] presented 0.75 10<sup>-3</sup> Ω cm of electric resistivity. We can observe a great disagreement in the value of thermal conductivity put forward by Takami, et al, as compared to report by groups. Using a COMSOL simulation program, Takami et al. used the value of thermal conductivity to be 44.1 W/m.K [57] whereas other researchers employed roughly 60 W/m.K at 300 K. Y. Ohishi, et al [58] reports from the powder XRD patterns that the occurrence of peaks in MoSi<sub>2</sub> matches with α-MoSi<sub>2</sub>. The matching indicates that the powder

employed initially was clean α-MoSi<sub>2</sub>. It is very noteworthy that the XRD pattern reported the occurrence of small peaks at an angle of 38°C and 41°C in Pre and Post SPS. The observed peak positions are similar with that of Mo<sub>5</sub>Si<sub>3</sub>. N-type Si nanoparticles were used to fabricate mass Si nanocrystal by sintering process by K. Kurosaki, et al [59]. The thermoelectric properties of mass silicon were presented. Silane gas via a vapor-phase synthetic route was used for synthesis. The report suggested the value of ZT to 0.5 at temperature 1223 K.

## V. RESULTS AND DISCUSSION

Hochbaum, et al showed diminish in lattice thermal conductivity by a factor of 100 in silicon nano-wires. This caused attainment of ZT value to be 0.6 at temperature 300K. The fall of lattice thermal conductivity of nano structured silicon is because of sturdy scattering of phonon. Bux and Blair, et al showed a ZT value equals to 0.7 at operating temperature 1275 K for nano-structured bulk Si with n-type polarity by sinking thermal conductivity and degrading electron mobility. A fall of 90% κ<sub>L</sub> was observed due to scattering of interfacial phonon.

Yang, et al proposed that the value of κ<sub>L</sub> in silicon nanocomposites gets minimized as a result of rising phonon scattering. Yang and Li utilized nano thermodynamics representation to compute lattice thermal conductivity of nano-porous, nano-crystalline and nano-structured bulk Si. They found that, nano-porous silicon display lesser κ<sub>L</sub> in contrast to silicon nano-wires. Nielsch and Bachmann, et al forwarded nano-structured silicon a promising substitute intended for high- effectiveness within the thermoelectric applications. Further it was noted that by doping of germanium or manganese, the efficiency of Si nanostructures was improved



significantly. Bux et al performed the doping of Mg<sub>2</sub>Si with Bismuth. Synthesis was achieved by mechano chemical method. The value of ZT was reported to be 0.7 at temperature 775 K.

SPS method was utilized by Hu, Mayson and Barnett in order to synthesize Mg<sub>2</sub>Si with aluminum as dopant at 750°C. Maximum value of ZT was reported as 0.58 at temperature 844 K. Hu, et al reported the likelihood in upper electrical conductivity due to full densification of Mg<sub>2</sub>Si in spark plasma. Tani and Kido performed the doping of the silicide with phosphorus at (300-900K). The outcome was the value of ZT to 0.33 at 865K. For p-type nanostructured bulk Si<sub>80</sub>Ge<sub>20</sub>, Joshi et al achieved value of ZT to 0.95 at 800°C-900°C with boron doping. Zhu, et al showed the value of ZT to be around 0.94 at operating temperature of 900°C. Yu and Chen et al applied modulation doping approach to realize high value of ZT in SiGe nanocomposites. Lee, et al studied thermoelectric behavior of single SiGe nanowires and predicted the value of ZT to 2.2 at temperature 800 K and value of ZT to be nearly 0.46 at temperature 450 K.

Girard achieved improvement in the value of ZT to  $0.52 \pm 0.08$  at operating temperature 750 K in an un-doped crystal of HMS and. Itoh and Yamada presented mechanical alloying of MnSi<sub>1.73</sub> to achieve maximum value of ZT of 0.47 at temperature 873 K. An and Choi employed SPS at temperature 1123 K for synthesizing polycrystalline HMS. The highest ZT value of 0.41 was obtained. Luo et al doped HMS with aluminum and obtained maximum value of ZT to 0.65 at operating temperature 850 K. Doping lead to rise in the electrical conductivity and fall in thermal conductivity. Zhou, et al applied induction melting and hot-pressing technique for doping polycrystalline HMS with Germanium. Ur and Kim et al utilized the of process of mechanical alloying and vacuum hot pressing for doping  $\beta$ -FeSi<sub>2</sub> with cobalt. It was observed that finer grain size obtained by mechanical alloying of materials. Kim, et al prepared  $\beta$ -FeSi<sub>2</sub> by the technique of powder metallurgy. Perumal, et al formed the CrSi<sub>2-x</sub> composites (where  $0 < x < 0.1$ ) by varying temperature from 300K toward 800K and established a significant reduction in the value of Seebeck coefficient along with electrical resistivity at  $x > 0.04$ . Perumal, et al suggested mechanical alloying technique with ball-milling or Spark Plasma for processing CrSi<sub>2</sub>. Vining and Allevato reported that addition of p-type Ru<sub>2</sub>Si<sub>3</sub> improves figure of merit to a scale of 3.

Ivanenko, et al employed floating zone technique for doping single crystal Ru<sub>2</sub>Si<sub>3</sub> with manganese. An increase by scale of 2 was observed in the mobility of

carrier in Mn-doped Ru<sub>2</sub>Si<sub>3</sub> as compared to undoped Ru<sub>2</sub>Si<sub>3</sub>. The value of electrical resistivity was reported by Krontiras et al. at operational temperature 300 K to  $0.063 \times 10^{-3} \Omega$  whereas Vries et al reported  $0.06 \times 10^{-3} \Omega$  cm and  $0.75 \times 10^{-3} \Omega$  cm by Yamada et al. Y. Ohishi et al reports from the powder XRD patterns that the occurrence of peaks in MoSi<sub>2</sub> match with  $\alpha$ -MoSi<sub>2</sub>. The matching indicates that the powder employed initially was clean  $\alpha$ -MoSi<sub>2</sub>. It is very noteworthy that the XRD pattern reported the occurrence of small peaks at an angle of 38°C and 41°C in Pre and Post SPS. The observed peak positions are similar with that of Mo<sub>5</sub>Si<sub>3</sub>. N-type Si nanoparticles were used to fabricate mass Si nanocrystal by sintering process by K. Kurosaki et al.

## VI. CONCLUSION

Silicides as thermoelectric materials show potential in industrial applications owing to economical in cost, ecological gracious, availability in ample amount. They moreover facilitates in reaching higher values of figure of merit. Silicides such as Mg<sub>2</sub>Si, SiGe and HMS attained high values of ZT in comparison to tellurides such as Bi<sub>2</sub>Te<sub>3</sub> and PbTe. The prospect of obtaining higher values of ZT in silicides can be improved using dopants in single or polycrystalline material and methods such as optimum alloying. CrSi<sub>2</sub> which has lower band gap in recent research has shown increase in the prospect of modifying itself to a beneficial thermoelectric substance in commercial applications. Ru<sub>2</sub>Si<sub>3</sub> can be significantly utilized in elevated temperature applications like space power. It can thus be concluded that there is a large room for improvement in the utilization of silicides as thermoelectric material in achieving superior values of figure of merit (ZT). Although certain silicides have obtained superior values of figure of merit, other silicides possess high anisotropic properties which can be utilized significantly in anisotropic areas. Therefore by perceiving deeply the thermoelectric behavior of silicides, further there opens a large room for improvement in thermoelectric performances.

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# Platform for Distributed Generation Connection Assessment in Brazilian Electrical Grids

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**Keywords—** *Hosting Capacity,  
Accommodation Capacity, Distributed  
Generation, Network Access, Power Quality,  
Network Simulation.*

**Abstract—** *This paper presents the studies and specifications of the development of a computational platform for distributed generation connection evaluation that uses the concept of Hosting Capacity and automated individual analysis of the connection as well as a protocol to utilize this platform. The risks and problems linked to the unbridled and without criteria connection of distributed generation to the network and its connection processes are addressed. Finally, a case study applied to a real network is presented, evidencing the mitigation of potential power quality problems brought by the insertion of distributed generation and other benefits achieved with the use of the solution developed and applied.*

## I. INTRODUCTION

Distributed generation (DG) is the term given to the electricity generated at or near the place of consumption, and commonly uses renewable energy sources such as solar, wind, hydro, among others. Since 2012, the Brazilian consumer can generate its own electricity from renewable sources or qualified cogeneration and even provide the surplus to the distribution network of its locality in exchange for energy credits [1].

The stimuli to distributed generation are justified by the potential benefits that such a modality can provide to the electrical system. These benefits include the postponement of investments in the expansion of transmission and distribution systems, the low environmental impact, the reduction in the thermal load of

equipment in the electrical grid, the minimization of power losses, and the diversification of the energy matrix [2].

Other benefits offered by DG, such as the decrease in the acquisition and implementational costs, as well as the constant incentive given by governments, brought a significant increase in the number of distributed generations connected to the Brazilian electrical grid. However, even with the numerous benefits that distributed generation offers, the unbridled connection without well-defined criteria and the carelessness with which access opinions are eventually treated can bring risks and power quality problems. One possible solution to this problem is the use of computational DG connection tools, capable of providing a fast and efficient treatment of data regarding to the connection. The presentation and characterization of a computational DG connection tools developed by the authors is the main theme of this article, as well as a

demonstration of its potential in an execution applied to a real network.

In the recent period, several studies were conducted on the impact of DG on the electricity grid. These studies produced reports, articles, and even computational tools that address some aspects of the analysis process. A brief review of the main concept of the theme in the literature, Hosting Capacity, will be covered in section II.

In most cases there was no validation of the models through experiences in real situations, involving the measurement of impacts considering a sized installation of a distributed mini generation (generation greater than 75 kW but less than 5 MW). This work has advanced in this sense, incorporating new elements in the analysis through the measurements of a real installation and providing a faster evaluation of the connection. Thus, an original product was obtained that includes information for analysis not yet used in the products on the market.

In this context, this document presents the studies and results regarding the use of a platform for distributed generation connection evaluation that uses the concept of Hosting Capacity [3] and also the automated individual analysis of the connection. The text is divided into six main sections. Section I addressed the current scenario of DGs in Brazil, the problems linked to the unbridled and described connection of DGs to the network are addressed in section II, as well as their connection process in section III. The solution offered to address this problem, including specifications and assumptions adopted in the computational tool developed is presented in Section IV and, finally, a case study example is given in section V while section VI brings the conclusions of this work.

## II. IMPACT OF DISTRIBUTED GENERATION ON POWER QUALITY

According to [4], the power quality criteria of the product are determined by ANEEL so that the supply of electricity is appropriate to all consumers and participants of the Brazilian electrical system. Therefore, these criteria should be met after connecting the DGs [5]. For the study of the impact that these generations have on the distribution network, it is important to look at the criteria that can be affected by it [6] and the concept of Hosting Capacity.

### a. From the Criteria

- **Undervoltage:** It consists of reducing the value of the voltage magnitude over a short period, which should be restored to acceptable levels, defined according to [4]. The DGs are related to undervoltage due to the intermittence that

characterizes this type of generation, which causes a drop in the voltage supply, thus causing undervoltage.

- **Overvoltage:** Criteria very similar to that described above, with the difference that here the voltage reaches levels higher than those established. When the internal consumption of the DG-powered facility is lower than the energy generated, the power is exported to the grid, which causes the voltage to increase at points near the DG connection point.
- **Voltage Variation:** This item discusses the voltage variation in network buses that occur over a certain time interval. Related to the two previous items, the occurrence of undervoltage and overvoltage linked to the connection of DGs to the network, which may damage equipment connected to the network, which was not made to work under such conditions.
- **Regulator Voltage Variation:** It can be seen as a specific instance of the previous item and refers to the consequences that voltage variation can cause on voltage regulators. These are inserted to improve the voltage profile of the grid, however, in the occurrence of overvoltage or undervoltage events, this adjustment needs to be redone, and in this period until its reconfiguration, the network voltage situation is aggravated. In addition, because they are mechanical equipment, it is not desired that its reconfiguration occurs too often, so its joint operation with distributed generation units can damage the equipment, reducing its service life.
- **Equipment thermal loading:** It is a parameter that indicates the amount of power that network equipment supports. With the insertion of the DGs, equipment that had initially been designed to support a maximum power or current may have to work with higher values. Thus resulting in a thermal overload that damages the equipment, reducing its service life.
- **Reverse Power Flow:** It is the situation in which the power flow ceases to be from the substation to the loads and is reversed. The problem of this situation is that the distribution networks were not designed for this power flow inversion so that the equipment and other structures installed in the network can be damaged in the occurrence of this phenomenon. This situation occurs predominantly when there is a high volume of DG generation and low consumption of the facilities around it.



Other criteria such as voltage imbalance, sympathetic trip, and loss of flexibility, although of great importance, were not addressed in this study, because nowadays there are no criteria commonly analyzed by Brazilian distribution utilities in requests for distributed generation connection

### b. Hosting Capacity

A widely used term when it comes to the connection of DGs is the Hosting Capacity of an electrical system, which is defined as the amount of distributed generation that can be connected to it, before changes or improvements to the network are necessary to be able to operate while meeting the required quality limits. [7].

There are three classes of methodologies currently used to determine Hosting Capacity: analytical, stochastic, and simplified [8].

Analytical methods consist of systematic procedures that study the generation effect distributed on all buses of a feeder and determine the Hosting Capacity of each system bus individually. These methods, while very accurate, require a lot of processing time and are always complex due to the level of detail adopted.

On the other hand, stochastic methods, estimate multiple generation scenarios and simulate the many uncertainties related to the integration of DG, such as location and power supply. The complexity and processing time of these methods depends on the type of network being studied, as well as the accuracy desired by the planner – expressed by the number of simulated scenarios.

Finally, the simplified method establishes correlations between the results of more detailed studies and proposes a simplified analysis of accommodation capacity. In this way, the processing time is reduced, as well as its accuracy, especially for more complex systems. Given these considerations, regarding the reality of distribution utilities, the chosen method to be addressed in this work was the simplified method.

It is important to note that Hosting Capacity is not a static value as network improvements are made, the value tends to increase. It is also known that the value of Hosting Capacity will depend basically on the power of the generation, the location of the feeder, and the previous characteristics of the feeder, such as other distributed generations, topology, presence of regulators, number of consumers, etc. [7].

## III. NETWORK CONNECTION PROCESS

According to [9], the process of connecting distributed generation to the Brazilian network takes place in four

steps: access query, access information, access request, and access opinion, which will be detailed below.

Initially, the accessor must make the access query, making sure the criteria and procedures to be met. After this step, it is mandatory to prepare the access information according to the procedures described in [1].

After these initial stages, the access request stage starts, which is characterized by the request formulated by the accessor that, once delivered to the accessed, implies the priority of attendance, according to the chronological order of protocol.

Finally, the last step is to access opinion, which is the mandatory formal document presented by the accessed, in which the conditions of access are informed, comprising the connection and use, and the technical requirements that allow the connection of the accessor's facilities with the respective deadlines.

This document presents the characteristics of the delivery point, accompanied by estimates of the respective costs, conclusions and justifications; the characteristics of the distribution system accessed, including technical requirements, rated connection voltage, and performance standards; budget of the work, containing the memory of calculating the budgeted costs, the responsibility of the distributor and the financial participation of the consumer; the list of the works of responsibility of the access, with corresponding implementation schedule; general information related to the location of the connection, such as type of land, passageway, mechanical characteristics of the facilities, protection systems, control and telecommunications available; the mini generation Operating Agreement model [3]; the responsibilities of the accessor; and any information about equipment or loads that may cause disturbance or damage to the distribution system accessed or in the premises of other accessors.

After the execution of the entire procedure, in the technical evaluation of access, the distribution utility must observe the criterion of minimum overall cost [4] of service. According to this criterion, among the alternatives considered for enabling access, the technically equivalent alternative of the lower overall cost of investments should be chosen, observing the same time horizon for all the evaluated alternatives, considering the connection facilities of responsibility of the accessor; installations resulting from reinforcements and expansions in the electrical system and the costs arising from electrical losses in the electrical system.

After following a series of steps, the accessor will send his proposal to connect the DG to the accessed for the analysis of the feasibility of the process. Considerations such as preventing accommodation from causing power



quality problems to the network and adopting the minimum overall cost criterion will be analyzed internally by the access.

Considering that the connection of DGs may cause necessary improvements on the network, the analysis made by the utility becomes an increasingly difficult process due to the complexity of the analysis and the number of access requests.

Thus, a tool capable of assessing the impact of the connection in an efficient, fast and automated way is fundamental to both the implementation of The DG connections and the maintenance of the power quality provided by distributors.

**IV. SOLUTION**

Given the presented, it is proposed as a solution a computational tool elaborated in C++ language and integrated to the commercial platform of electrical networks simulation, SINAPgrid.

The idea behind the tool is that it must be able to automate the process of issuing an opinion, to speed up and be more assertive in the process of analysis of the possible insertion of DG in the network, guaranteeing that its connection does not cause losses regarding the power quality of other agents connected to the grid. Together with the tool, it is also proposed a protocol to be followed for the issuance of the connecting opinion. Figure 1 shows the suggested protocol for issuing distributed generation access analysis using the tools of Hosting Capacity and Individualized Connection Opinion, represented by light blue the steps related to simulation via software, which are automatic, and by dark blue steps the steps which are of the responsibility of the company.

The process begins when an access request arrives at the distributor, consisting of the power of the generation and the coordinates from which it will be located. The next step is to identify in the company's registration records the feeder(s) to which this generation can be connected and then use SINAPgrid to simulate the necessary electrical networks. The next step is to use the result information of the Hosting Capacity calculation to determine whether it is less than the power intended by the generation. If it is so, then the process must terminate, and the connection should be denied. This step is important for many requests to be processed without the need of thorough analysis.

If the result of the calculation is higher, that is, indicating that the network can accommodate this generation, the process for issuing the individualized connection opinion begins, which occurs as automatically as possible. Within this process, the connection will be

simulated in the network, being able to carry out studies of maximum and minimum load, with and without generation, and also with maximum and minimum generation. For these studies, it will be verified if there was a transgression of any of the criteria of interest to the process, which have already been detailed in Section II. If there is no transgression, the connection is approved.

Otherwise, reinforcements must be carried out on the network so that it can accommodate the new generation. The reinforcements to be carried out will depend on the planner, and their costs and impact on network losses will be accounted for in the calculation of the Global Cost. For each solution alternative of the transgression, the problem will be assigned a Global Cost and then, after the simulation of all scenarios, the alternative with the lowest Global Cost will be determined, and the opinion will be approved.

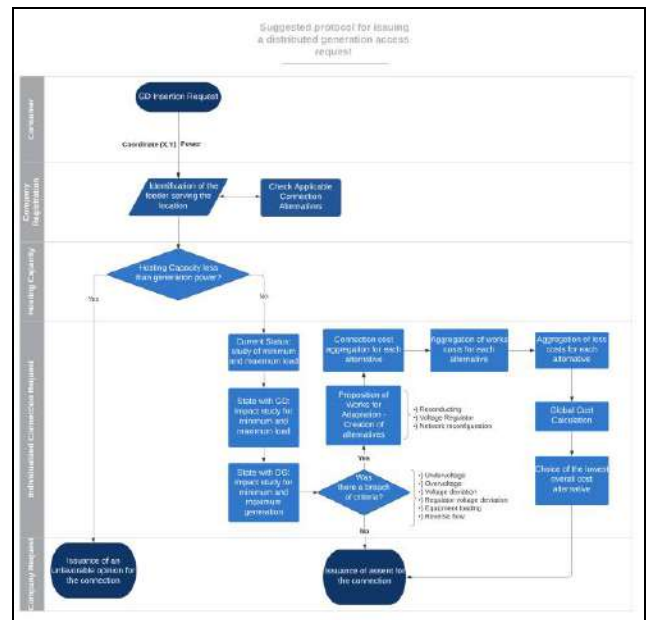


Fig.1: Suggested protocol for issuing a distributed generation access opinion.

The specifications and assumptions adopted in the automated opinion issuing tool were as follows:

- The tool is flexible for analyzing connection requests for mini generation and microgeneration [1].
- The tool works concurrently, as a module of the planning tool of the SINAPgrid power grid simulation platform.
- The implementation of the module should be such that the planner has flexibility over changes in the network, while the process of issuing opinions is

automated enough to quickly meet the high demand for the issuance of these opinions.

- The module should be able to provide an estimate of what the lowest overall cost of each alternative is, either rejected or not and, either, owning works or not.
- The connection of the accessor cannot bring fall to the quality of the energy provided by the distributor. Thus, the connection alternative to be defined should be the one that will bring less risk of damage to all agents connected to the electricity grid.
- About the quality of energy during the operation of the accessing generation, the injected power will have a standard power factor value equal to 1.00 and can be changed depending on the planner.
- It is the responsibility of the accessor to ensure that the limits of harmonic distortions are not violated.
- For the calculation of the minimum overall cost, modular standard costs will be adopted that will be used in cost estimation calculations. The planner may change these values if it deems it necessary. A value for the cost of losses (R\$/MWh) should also be defined, which may be changed.

### V. CASE STUDY

To test the application of the tools and protocol developed, we studied the connection of a photovoltaic generation of 1.5 MWp in a real electrical network belonging to a Brazilian distribution utility.

The first step was to identify the feeder to which this generation would be connected to verify whether it would be able to comport it, by analyzing the result of its Hosting Capacity, as shown in Figure 2 and Figure 3, and the first figure presents the result for the entire feeder and the second only for the vicinity of the bar to which the generation will be connected, bar B\_516.

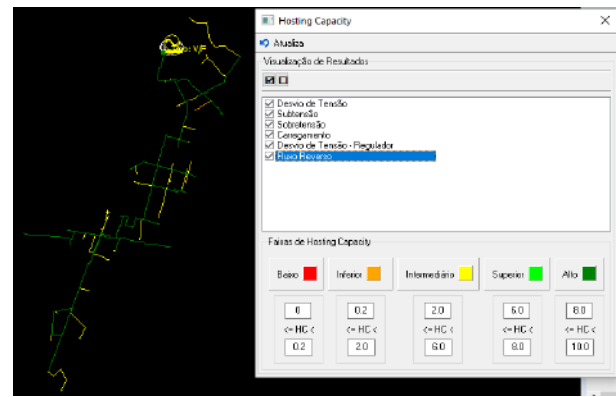


Fig.2: Hosting Capacity result for the feeder to which the generation would be connected.

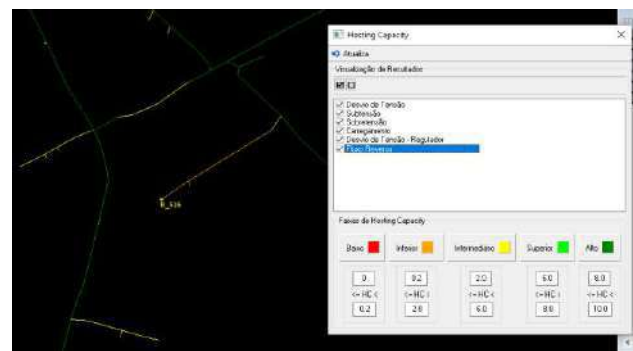


Fig.3: Hosting Capacity result near the bus to which the generation will be connected.

From the figures it is possible to note that the network will be able to support the generation of 1.5 MWp, however, if the generation was greater than 2.0 MWp, this connection request should be rejected, because the Hosting Capacity for a DG in that region was classified as "Inferior", that is, with a value between 0.2 and 2 MW.

Thus, the next step is that of the individualized connection opinion, according to Figure 4, in which it was verified that there was no transgression of any of the selected criteria, which means that the opinion can be approved, with the knowledge that the connection of this generation will not cause damage regarding the quality of the electricity network.

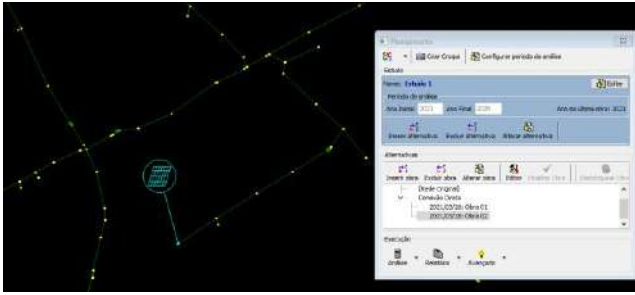


Fig.4: DG simulation to be evaluated in the individualized connection report

However, the network situation before the generation connection presented voltages close to the lower limit of what would be acceptable, the module indicated this, according to Figure 5, and, for this test case, the behavior of a planner who chose to solve this situation was simulated by evaluating the impact of two different works: the insertion of a voltage regulator and the reconductor of the network.

Alternativa	Variação de Perdas (%)	Tensão do PNC no PNC Máx (kV)	Tensão do PNC no PNC Mín (kV)	Variação de Tensão do PNC no PNC Máx (%)
[Rede Original]	0,0	0,925	0,930	0,0
Conexão Dir...	0,0	0,939	0,934	1,6

Fig.5: Results of the evaluation of the generation connection alternative.

For the evaluation of the Global Cost, the costs presented in Figure 6 were used, the results of Global Costs are presented in Figure 7, in which it is clear that for this test case, the connection alternative associated with the reconductoring should be the chosen alternative.

Equipamento	Custo Inserção	Custo Alteração
Capacitor (R\$/uni)	0,00	0,00
Chave (R\$/uni)	30	0,00
Rede (R\$/uni)	0,00	0,00
Regulador (R\$/uni)	100	0,00
Transformador (R\$/uni)	0,00	0,00
Trecho (R\$/km)	120	150

Tipo	Custo
Perdas (R\$/kWh)	0,15

Fig.6: Costs for alternatives.

Alternativa	Perdas Conexão	Perdas Obras	Perdas Perdas	Custos Adicionais	Custo Global
Conexão Direta	30,00	0,00	13,25	0,00	30,25
Conexão Direta - Recondução	20,00	90,39	0,00	0,00	90,39
Conexão Direta - Regulador	20,00	101,03	0,33	0,00	121,33

Fig.7: Overall cost calculation result.

This test case presents a characteristic of the great importance of the tool that is to automate several steps of the process without compromising the expression of the results regarding the quality of energy and presenting sufficient flexibility for the action of the planner.

## VI. CONCLUSION

This paper presented the studies and specifications of the development of a computational platform for distributed generation connection evaluation that uses the concept of Hosting Capacity and automated individual analysis of the connection.

According to what was presented in this article, it is understood that the distributed generation connection should be carried out carefully and judiciously in order to not cause problems for the power quality of distribution networks. An agile and satisfactory way to ensure this is through computational tools to simulate the impact that generation shall have on the network. The computational platform presented in this paper proved to be able to provide fast and satisfactory results, assisting the utility in this process by using the concept of Hosting Capacity and the individual analysis of the connection. Another contribution is the suggested protocol for issuing distributed generation access analysis using the tools of Hosting Capacity and Individualized Connection Opinion that shall assist the utilities in the evaluation of the large number of connection requests with which one must deal.

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# Stabilization at Santinho-Ingleses dunefield, Southern Brazil: What will be the future of sediment input to Ingleses Beach?

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**Keywords—** *Transgressive dune field,  
Overpassing, Sediment budget.*

**Abstract—** *This paper describes the overpassing process using a case study from southern Brazil, that present a decadal pulse of sediment entering in the system. A transgressive dune field extends across a headland from Santinho beach to Ingleses beach. Analysis of precipitation data (1961-2014), wind direction and speed (1964-2014), aeolian drift potential (DP), aerial photographs/satellite images (between 1938 and 2016) and morphological data (2002, 2010 and 2014) make it possible to analyze the decadal-scale dune field evolution. The wind historical data showed southern wind as the stronger, moving the dune crests to north. The rainfall analysis presents an increasing trend leading to a decrease in drift potential and favors dune stabilization by vegetation growth. There is a decadal pulse of sediment inputs to the system, as well. The northern sector of Santinho beach has a positive budget and provides about 6,000m<sup>3</sup>/year of sediment to the foredune. Then, with southern winds, the sediment migrates into the dune field (about 3,000-5,000m<sup>3</sup>/year) reaches Ingleses by overpassing, ensuring a positive sediment budget for the system that occurs at east side of the Ingleses beach.*

## I. INTRODUCTION

Coastal dunes develop landward of areas with an ample unconsolidated sediment supply and the grain size is suitable for onshore aeolian transport [13, 15, 18, 31, 54]. Distributed worldwide in association with sandy beaches, they have a wide range of shapes and dimensions related to spatial and temporal variations in sediment input and wind regime [9, 15, 18, 44].

Several coastal dune systems have become increasingly vegetated in recent decades, for example in Africa [28], United Kingdom [43], Europe [12], China [56], Australia [7] and in Brazil [35] is not different.

Santa Catarina Island is located in southern Brazil. It contains numerous headlands, bays, and beaches with transgressive dune fields. Sediment overpassing by dunes is observed on this coast too [6,25, 26, 27, 41; 42].

The headland sediment bypassing (HSB) and overpassing (HSO) is a process in which sediment is transported by wind or waves from the updrift side of a headland to the downdrift side [26, 27]. Both, HSB and HSO are important components of regional sediment budget of some coasts [27, 34, 42].

[53] has shown a significant influence of overpassing on shoreline position, when the shoreline of the northern coast of Santinho accretes between 1 and > 5m/years<sup>-1</sup>



(1957-1978, 1998-2002, 2002-2007, 2010-2012) there is erosion on the Ingleses beach (between  $-1$  and  $> -5$  m/years<sup>-1</sup>). [6] had showed that this sediment that arrive in Ingleses dune as a result of overpassing, is transported by waves to the west direction.

The aim of this paper is quantify the overpassing process from Santinho's foredune (updrift) to Ingleses beach (downdrift) by aeolian transport and understand the vegetation cover influence in this process. A multi-decadal scale were used to analyze the overpassing process, based in aerial photography/satellite images, morphological and meteorological data.

### 1.1 The Santinho-Ingleses dunefield

Santa Catarina Island in Santa Catarina State, southern Brazil, lies at 27°S;48°W, in the Subtropical Zone [51]. The climate is humid subtropical (Cfa) or oceanic and subtropical highland (Cfb) with average temperatures in the coldest month below 18°C and in the warmest month above 22°C and hot summers with a trend to concentration of rainfall in these months, but with no dry season [10].

Most rain falls in the summer (36%) and spring (27%), followed by winter (19%) and autumn (18%) [35]. The main meteorological systems responsible for the rains on the state are the cold fronts, the cyclonic vortices, the tropical convection, the ZCAS (South Atlantic Convergence Zone) and the marine circulation [40].

The Santinho-Ingleses dune field migrates northward as a result of strong and frequent southerly winds [5, 19, 41, 54], providing a sediment input estimated around 3.000 m<sup>3</sup>/year to 10,000m<sup>3</sup>/year to Ingleses beach [6, 41]. In other words, sand overpassing by the dune field (Fig. 1) provides an important sediment supply to Ingleses beach. [25] analyzing the shore lines, between 1957 and 2012, showed a retraction at Ingleses (about  $-0,49 \pm 0,16$  m/ano) and a progradation at Santinho (about  $0,25 \pm 0,16$  m/ano). [6] using a shoreline model show a retreat about 60 m over a period of 100 years on the eastern part of Ingleses were sediment input will stop and around 50 houses can be threatened by erosion. This dune field is the key fact in sediment budget of the study area.

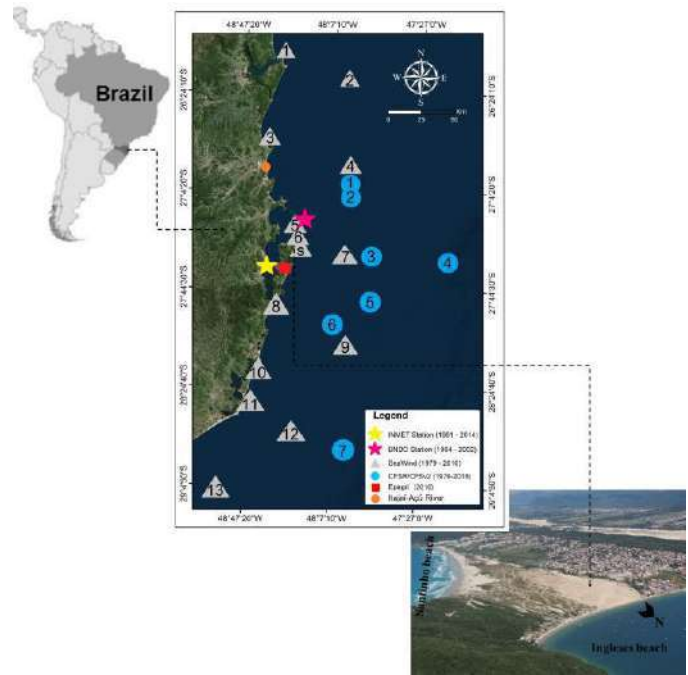


Fig. 1: Study area location, southern Brazil, coast of Santa Catarina State, Santa Catarina Island. The left star indicates the position of the INMET Station which provided the rainfall data (1961-2014), the right star represents the BNDO data (1964-2002) collected hourly (1979-2016) and the square "A" is EPAGRI of the station 2027 ETE - Insular, "B" is EPAGRI of the station 1006 Florianópolis - Automatic (July to December 2010). The Santinho-Ingleses dunefield migrates northward and thus it is that the overpassing process occurs. Photo by Andrew Short/2014

## II. MATERIAL AND METHODS

### 2.1 Wind and Rainfall (1961-2014)

Wind and rainfall databases were compiled using observations and climate simulations from a global reanalysis and atmospheric downscaling. In situ wind speed and direction measurements were provided by the National Oceanographic Data Bank (BNDO), responsible for the meteorological station on Arvoredo Island (pink star in Fig.1). The historical time series from this station covers the period 1964- 2002 and provides values three times a day. The historical series of instrumental rainfall data, relating to 1961 to 2014, was obtained from the National Institute of Meteorology (INMET), represented by the yellow star.

Near-surface wind time series at seven locations were analyzed by the global reanalysis dataset CFSR (Climate Forecast System Reanalysis, [46]), available for the period from 1979 to 2010 and CFSv2 (from 2011 onwards), the blue circles in Fig.1. This reanalysis represents an

improvement in the field of global climate modelling due to this high resolution and advanced data-assimilation techniques. The CFSR global atmosphere resolution is about 0.3 degrees (approximately 32km) for hourly wind data. Beginning in 2011, CFSR has been extended by NCEP's Climate Forecast System Version 2 - CFSv2 [47] operational model.

Meteorological data were also provided by the SeaWind dataset (13 silver triangles), a dynamic downscaling of the atmospheric conditions over the Brazilian Santa Catarina state. This data were developed to providing the best marine surface wind fields following the methodology of [37]. Using the atmospheric limited-area model WR-ARW (Weather Research and Forecasting model with the Advanced Research dynamic solver, [50], the SeaWind wind and rain data were downscaled from the CFSR global model (1979-2010). The model's resolution were define with 42 vertical hybrid levels (14 first levels below the first 1,000 m) and 3km horizontal resolution. This atmospheric database was validated by means of the data from seven stations: two on Florianópolis island, one offshore on an oil platform (which contains records of winds up to 78 meter altitude) and four pluviometers located along the Itajaí-Açú river (orange circle).

The comparison of SeaWind rainfall (in situ observations) indicates that SeaWind data provide a reliable estimation of daily rainfall (Fig. 2).

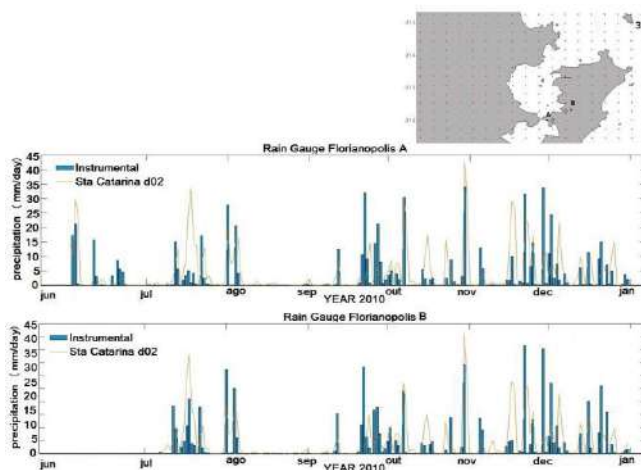


Fig. 2: Comparison between SeaWind rainfall data (silver line) and gauges (blue bars).

In order to check the performance of simulated wind data from the CFSR reanalysis and SeaWind dataset, they were compared with available wind measurements at one area closest to the Santinho-Ingleses dunefield, the 5 months record of the EPAGRI station. This area is at western side of the island, about 20km from the dune field, at 10 m height, therefore a higher spatial resolution would

be required to capture local inland wind anomalies between the mountains of the island.

Fig. 3 shows a comparison of the three wind datasets. A clear improvement of the SeaWind downscaling to global reanalysis is evident. It is possible to observe the SeaWind dataset represents wind anomalies in the study area. Local wind variations at high spatial resolution (e.g. hundreds of meters) would require a micro-scale modeling of the dune field and surrounding area.

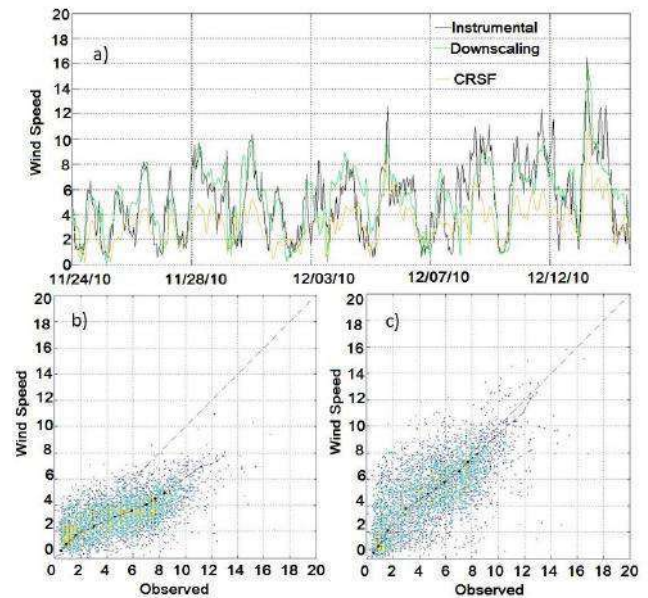


Fig. 3: (A) Instrumental wind time series (red square in Fig. 1) in silver line, SeaWind with blue line and CFSR data at the inland station of Santa Catarina Island with orange line. (B and C) Scatter diagrams and qq plots of measured values (x-axis) versus CFSR (B) and SeaWind (C) simulated data.

These different meteorological climate data were use to describe the wind pattern and the historical behavior of Santa Catarina State and the study area. The winds were divided into several other categories (0-3; 3-7; 7-10; 10-13; 13-16; 16-20, 20-25 and >25m/s).

Linear regression analysis was apply to estimate wind trends. The slope of the linear regression model was used to determine the magnitude of the wind speed trend in meters per second per decade (m s<sup>-1</sup> dec<sup>-1</sup>). The nonparametric correlation coefficient of Mann-Kendall's tau-b [24] was used to measure the statistical significance of annual and seasonal linear trends. The data period examined corresponds to the period covered by topographical surveys, aerial photographs and satellite images.

2.2 Aeolian Drift Potential (DP)

Aeolian drift potential was calculated using data for rainless windy days (with precipitation of less than 1 mm), because wet sediment hides the true results of DP. The equation used was developed by [28] (Equation 1). The results are expressed in vector units (u.v.).

$$q = \left[ \frac{V}{V_t} \right]^2 (V - V_t) \cdot t, \tag{1}$$

where q is the amount of sand carried by the wind in a given period, V is the average speed of the wind at 10 m height, V<sub>t</sub> is the limiting impact threshold wind velocity at 10 m and t is the time during which the wind blew in one direction (the value is the percentile of frequencies for each wind direction).

To calculate the shear stress related to wind speed requires the grain size data (0.199mm to the dune field) and Equation 2 proposed by [1] was used with logarithmic speed distribution:

$$V_{(10)} = 5.75 \cdot (V^*t) \cdot \log Z / (Z') + (V^*t), \tag{2}$$

where V<sub>(10)</sub> is the impact threshold wind velocity (measured at 10 m height); (V\*<sub>t</sub>) is the threshold shear stress (m.s-1); Z is the standard height of the wind data (10 m); Z' = 10\*d (mm) is the roughness factor of the sand grain surface determined by [2], considered as a plane surface; and V\*<sub>t</sub> is the shear speed (= 894 \*d (mm)) proposed by [55]. The result is given in cm/s, converted into m/s. The impact threshold wind velocity was (V(10m)) of 6.16m/s.

To calculate the shear stress threshold, Equation 3, as proposed by [1], was used:

$$V^*t = A \sqrt{((\rho_s - \rho_a) / \rho_a) g d}, \tag{3}$$

where A is a constant equal to 0.1 [1], ρ<sub>s</sub> is sand grain density (2650 kg.m-3), ρ<sub>a</sub> is air density (1.2 kg.m-3), g is gravity (9.8 m.s-2) and d is the median grain diameter (mm), used 0.199mm. The threshold of shear stress (V \* t) of 0.206 m/s.

The drift potential result was classified by [13] is: low energy wind (present values up to 200 u.v.), moderate energy wind (between 200 u.v. – 399 u.v.) and high energy wind (more than 400 u.v.).

2.3 Remote sensing – Analysis of Aerial Photograph and Satellite Image (1938 - 2014)

The Table 1, presents the data used to analyze the dune field evolution.

Table 1: Information about Remote Sensing data.

Data	Year	Provide by
Vertical Aerial Photographs	1938, 1957, 1978, 1994, 1998, 2002 and 2007	Urban Planning Institute of Florianópolis (IPUF)
Satellite Images	2003, 2004, 2009, 2010, 2011, 2012, 2013, 2014, 2016 and 2018	Google Earth PRO

All images were rectified using GIS software (Root Mean Square between 1.4 and 7.2). The boundaries of the dune field, vegetation, water and urbanization were digitalized manually. The occupied areas by these four categories were measured for all the years analyzed. In addition, the location of the dune crest was measured in each aerial photograph/satellite image and compared with the position in previous years.

2.4 Morphological data (2002, 2010 and 2014)

Topographical data are important to understand the sediment budget and to make volume calculations. Thus, altimetry data of study area were derived from aerial photographs of 2002 by the Urban Planning Institute of Florianópolis. In 2010, a digital terrain model were also derived from aerial photographs (with altimetric error about 0.66m), from the Department of Sustainable Development of the State of Santa Catarina. In 2014 field surveys were conducted using a GPS in RTK mode, configured to collect data every 0.5m and transects were spaced at 15 m (on 21, 29 and 30/5/2014). Transects, parallel to Ingleses beach, were also collected every 0.5m with intervals at 30m for the whole dunefield on 14/08/2014 (Fig.4-A).

Once the sediment originates on the Santinho foredune coast, perpendicular profiles were measured every 30m (Fig.4-B) along the beach with transverse lines on the crest and the base of the foredune. The survey data were interpolated to allow volumetric calculations.



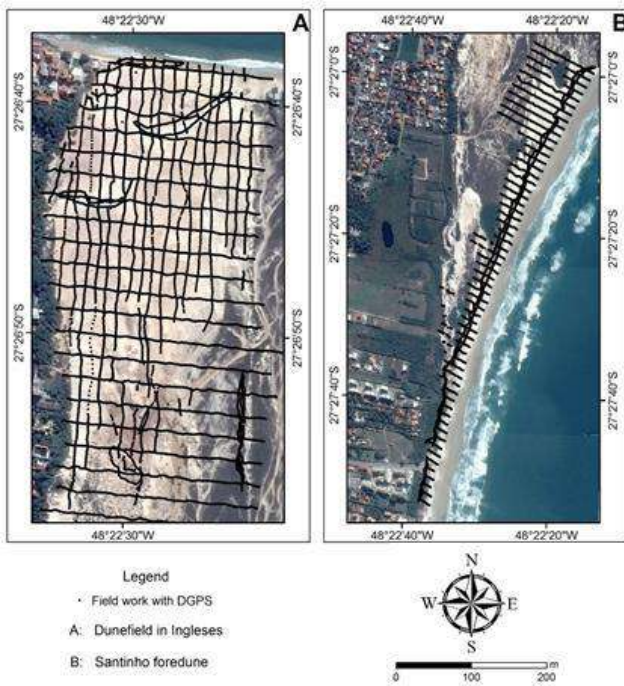


Fig. 4: Survey with GPS collecting data each 0.5m on the (A) dune field and (B) Santinho foredune to analyze the dune crest's migration and the volume.

The interpolation with Inverse Distance Weighting (IDW) were use because presented the lowest RMS (0.08) and the best representation the study environment, presenting a realistic morphology. The dune field volume calculation used the zero level as 1.26m in comparing to the sea level, in order to obtain a same beginning date for the whole area.

### III. RESULTS

#### 3.1. Environmental and Anthropogenic Factors

The annual rainfall index, based on the historical series (INMET) and numerical model (SeaWind), showed an upward trend over the years, as well as, for seasonal analysis. The higher values occurred during the summer (DJF) with 20% and 8% respectively, followed by spring (SON) with 19% and 7%, autumn (MAM) 18% and 6%, and winter (JJA) with 15% and 5% (Fig. 5).

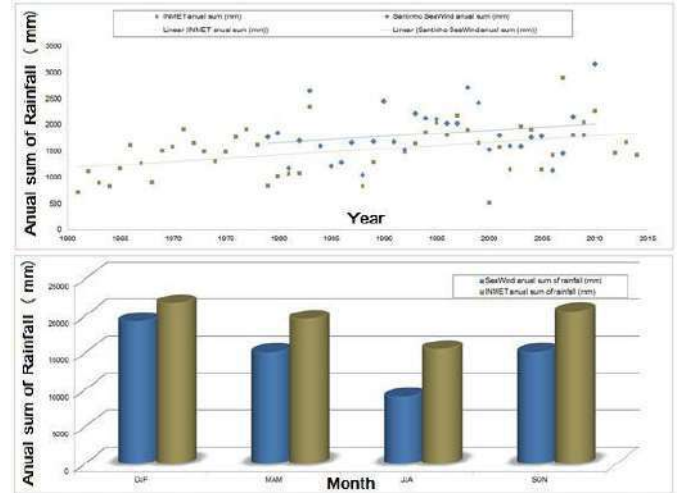


Fig. 5: In (A), an interannual analysis of INMET rainfall data (1961–2014) and SeaWind model (1979–2010), showed an increasing linear trend over the years. In (B), the columns present the rainfall data for summer (D,J,F), autumn (M,A,M), winter (J,J,A) and spring (S,O,N).

In general, the analysis of wind roses for the coast of Santa Catarina State (Fig. 6) presented two striking directions: north-northeast and south-southwest. The wind velocity was higher at the southern than the northern extremities of the island. Around 80% of the data were in the category 3-7m/s.

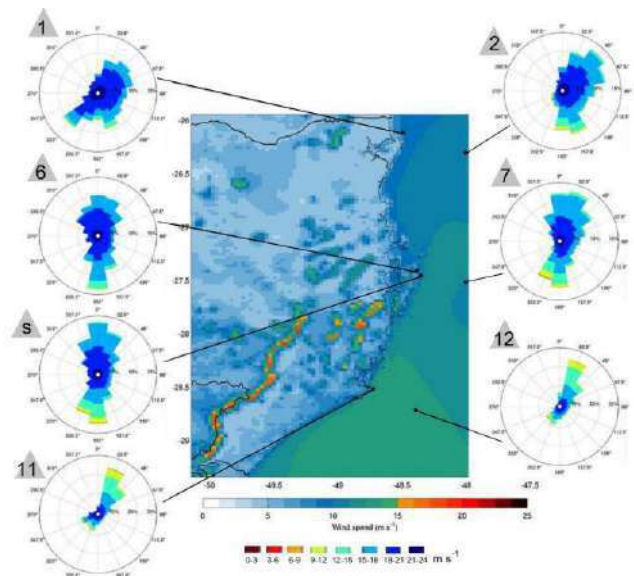


Fig. 6: Wind roses for seven of twenty-one points on the coast of Santa Catarina Island. Warmer colors symbolize higher speeds, as seems usual in southerly and south-southwesterly directions for northern points and a strong northerly wind for southern points (11 and 12).

The wind pattern was similar for those points in the north of Santa Catarina Island. The winds from the south quadrant were stronger and those from the north quadrant were the most frequent. At locations in the south of the island, the pattern is the opposite: the stronger and most frequent winds come from the north quadrant. At the Arvoredo meteorological station, the winds are similar to the pattern observed at CFSR and SeaWind.

As shown in Fig. 7, the most important result from the trend analysis is the increase in southerly winds (shown in yellow/orange). These southerly winds impact the whole study area but have their greatest impact on the Santinho shore.

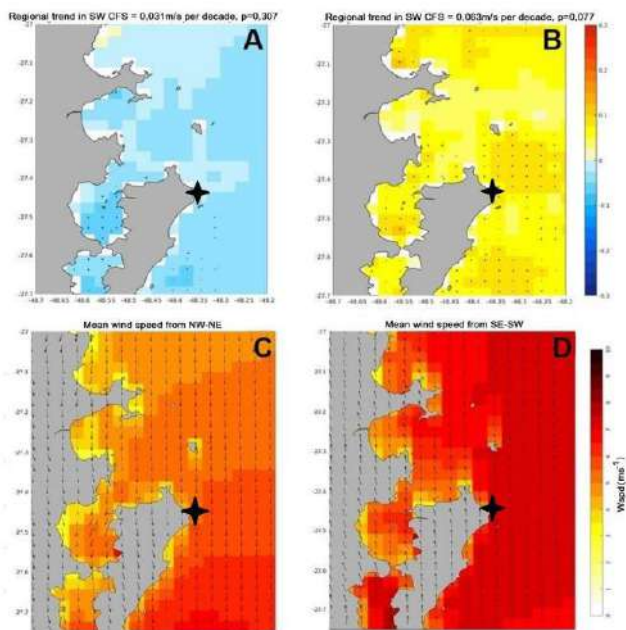


Fig. 7: The black star indicates the dune field place. In A and B, the dots show significant trends in wind direction. Estimated linear trends to the period 1979-2010, using the SeaWind dataset, on the left (A) with northerly winds (sector between 300° and 45°) and on the right (B) with southerly winds (sector between 210° and 135°). Above (in C and D), the wind regime (average wind speed and direction) obtained for the directional sector between north wind (left side) and south wind (right side) under rainless conditions for the same period.

In order to describe the variations of historical wind speed, changes in the Seawind hindcast were analyzed over a region around the target area. Northerly (300-45°) and southerly (135-210°) wind speed anomalies under rainless conditions were selected at each grid-point and trends, yearly and seasonally, were assessed. Results indicate that the variations of historical wind speed, changes in the Seawind hindcast over a region around the target are changes during autumn (MAM months) with an

increase in southerly winds and a decrease in northerly ones. Nevertheless, an evident interannual variability is observed, especially for southerly winds (Fig.8).

Analyzing the seasonal wind roses at the grid-point of SeaWind near Santinho (Fig. 8), the winds from the northern quadrant were more frequent and the southerly winds the strongest, the same patterns observed in Fig. 6.

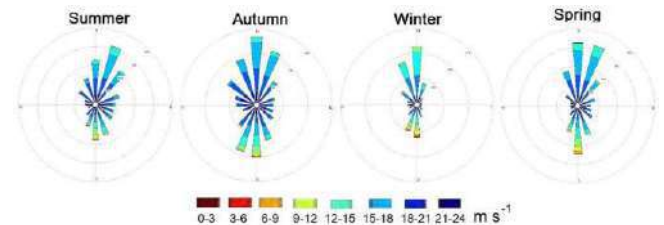


Fig. 8: Wind rose for SeaWind “S”, seasonal: Summer (D,J,F), Autumn (M,A,M), Winter (J,J,A), and Spring (S,O,N).

The Fig. 9, present southerly winds showed peaks in the years: 1983-1984, 1987-1988, 1990-1991, 1993-1994, 1995-1996 and 2003-2004.

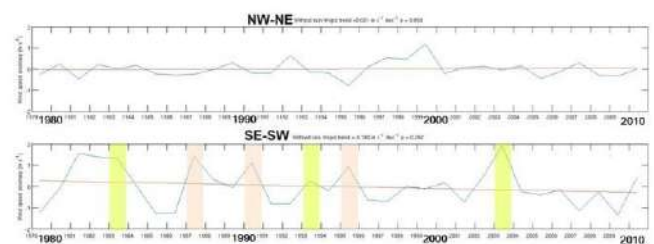


Fig. 9: Annual high wind speed conditions (95-percentile anomaly of wind speed without rain).

The Fig. 10-B, evidence the vegetation grow between 1938 and 2018 (80 years). Visual observation in the field shows that the growth of vegetation (grasses and small shrubs) usually occurs quickly after the rainy period in the lowest areas. T (Fig. 10-C) showed an increase from 1957 to 1978 (about 10,000m<sup>2</sup>), with a decrease in 2004 (about 100,000m<sup>2</sup>), and another significant increase happened at 2007 (about 120,000m<sup>2</sup>) and 2014 (about 150,000m<sup>2</sup>) until 2018. Usually this evident grow happened each decade, the same pattern observed with the sediment pulse.



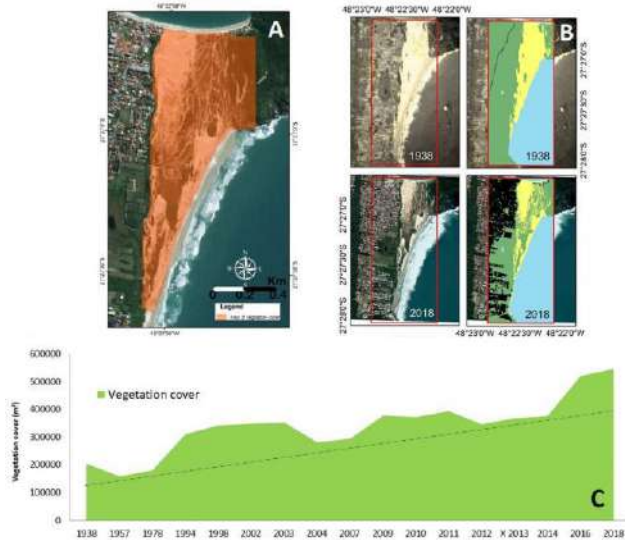


Fig. 10: (A) The delimited area (in orange) on the dune field, represents the location of vegetation cover analyze. (B) Vertical Aerial Photograph from 1938 above and satellite image from 2018 below. (C) Graph represent the temporal change in vegetation cover since 1938-2018, the dotted line is the trend grow.

In 1938, in the western portion of the dune field, were well-preserved vegetated plains, with no houses, streets, resorts, tourists or paths for passages; was possible to see only one road. At 1978 there had arisen a large and growing urban area that persists to the present day (Fig. 11, graph).

In Fig. 11, the red arrow indicates the buildings that are threatened by dune migration. Several houses and restaurants already have sediment inside them, and satellite images indicate areas where others have been completely covered.

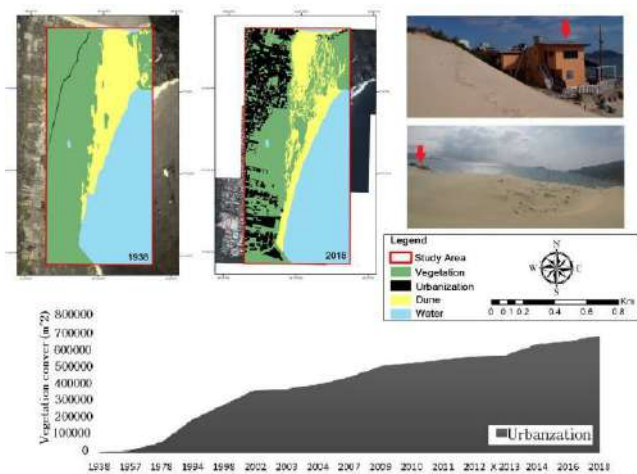


Fig. 11: Satellite image (1938 and 2018) classification (urban area in black). Graph of annual urban growth (m<sup>2</sup>)

between 1938 and 2018. The arrows indicate buildings and remnants in the dune field.

### 3.2. Environmental and Anthropogenic Factors

Drift potential at location marked as SeaWind “S” (Fig. 1) on Santinho beach, shows the dominance of southerly winds in the potential transport (Fig. 12-A) and the red arrow shows the direction of dune field migration (Fig. 12-B).

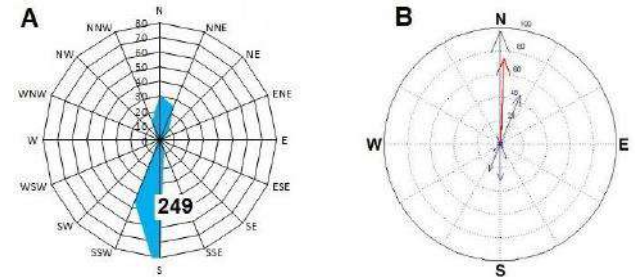


Fig. 12: (A) the Drift Potential shows the most efficient wind comes from the south/south-southwest and in (B) the resulting Drift Potential direction (indicated by the red arrow).

Seasonally, the spring results showed the strongest DP (305); followed by winter (246), summer (234) and autumn (207). Southerly winds are at their most powerful in spring, and weakest in autumn (Fig.13).

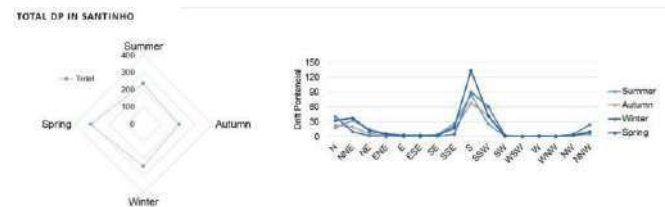


Fig. 13: Seasonal DP and DP separated by direction during each season in Santinho's beach.

In Fig. 14 the seasonal pattern about resulting northward Drift Direction is showed.

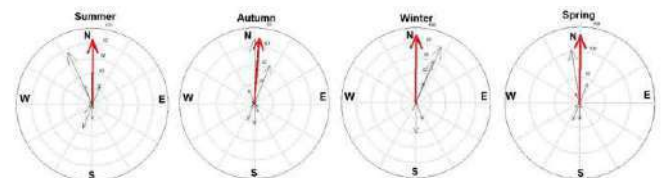


Fig. 14: DRD for each season (red arrow). The greatest DRD occurring in spring and the worst in autumn. All seasons showed a higher occurrence during periods of southerly winds.

Several features were monitored during the fieldwork and on aerial photographs/satellite images. They include parabolic dunes, gegenwalle ridges, blowout, remnant knobs, interdune plains, barcanoid chains, linear extensions and depositional lobes.

During 2002 and 2003, four well-defined crests on the satellite images were analyze and show a northward displacement with a migration rate between 15 and 42m/year and an average of 30m/year. In 2003 and 2004, three dune crests were analyzed, the migration rates being 16-28m/year with an average of 21m/year. Ten years after, 2013 and 2014, the migration rate of six crests ranged were 5 to 40m/year and had the lowest average of the three periods analyzed, 18m/year. Using the 2014 GPS data, an average of 4m/3 months was observed. This estimate is close to the average found for the years 2013 and 2014 (18m/year). At 2016 the average rate was 3,8/year and to 2018 the migration average rate was 4,5/year. Showing an important trend about crest migration is decreasing.

The volume results for the dune field show a decay (reduction) over the years (Fig. 15). In 2002, the demarcated area covered about 3,066,695m<sup>3</sup>. After a further eight years, this decreased to 2,840,979m<sup>3</sup> (7%) and four years later, in 2014, the volume was 2,542,653m<sup>3</sup>, giving an overall 17% reduction.

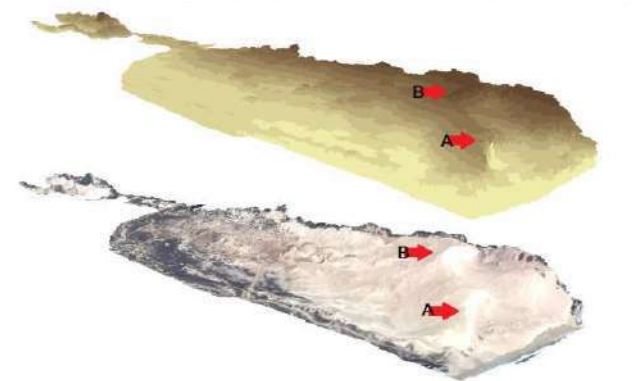


Fig. 15: On the left, interpolations with altimetry data of IPUF-2002, in the middle the digital terrain model of SDS-2010 and at right side GPS collected on the dune field in 2014. The red arrow A and B, show the crests whose volumes were analyzed.

The data collected in 2014 with GPS provided a 3D model for the analysis of the sediment input from the dune field of Santinhos-Ingleses (Fig. 16). Feature A, contained about 87,000m<sup>3</sup> of sediment and B about 51,000m<sup>3</sup>; in 2014 the crests' migration was about 16-18m/year, dividing the volume per migration rate, the sediment input to Ingleses beach was 3,000-5,000m<sup>3</sup>/year.

According to the results shown in Fig. 17, the foredune area does not show a large variations in total volume. Thus, was necessary to analyze the foredune by sector (north, center and south) to better understand the input of sediment into the system.

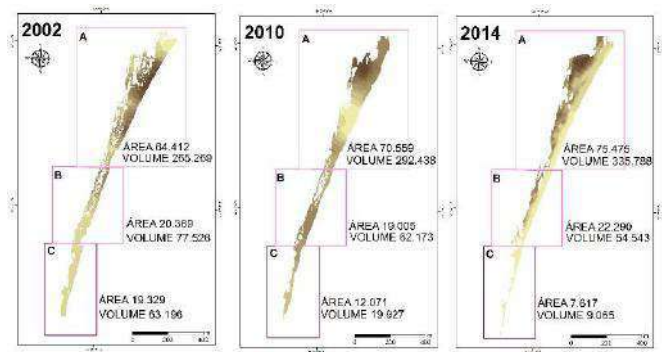


Fig. 16: Santinho foredune shows no large overall variations. When considered in three sectors, however, it is evident where sediment input occurs. The 3D model shows higher volumes, in the darker colors, which represent greater volumes, in the north.

Sector A showed the highest sediment volume in the years 2002, 2010 and 2014 (265,269m<sup>3</sup>, 292,438m<sup>3</sup> and 335,788m<sup>3</sup>, respectively) compared with sectors B (77,526m<sup>3</sup>, 62,173m<sup>3</sup> and 54,543m<sup>3</sup>, respectively) and C (63,196m<sup>3</sup> and 19,927m<sup>3</sup> 9,065m<sup>3</sup>, respectively) as observed at Fig. 17.

The area of the Santinho foredune have the same pattern behavior to all historical data: sector A with biggest area, after B and the C were always the smallest. Another observed patter was at 2002, 2003, 2004 and 10 years later, 2012, 2013 and 2014. During 2002 and 2012, the graph shows a grow at sector A, 2003 and 2013 a decay, 2004 and 2014 another grows, indicating a tendency to a new sediment rate, i.e. a large volume of sediment input occurs each 10 years in the northern sector of Santinho's beach (Fig. 18). The data of 1994 present a high value too, this means, 10 years before the first volume pattern observed at 2004. Thus, over 10 years (from 1994, 2004 and 2014) sector A received at least 70,000m<sup>3</sup> (6,000 m<sup>3</sup>/year), indicating an import sediment pulse in the system.

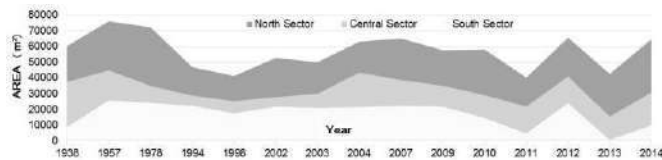


Fig. 17: Difference between Northern, Central and Southern areas ( $m^2$ ) of Santinho foredune.

#### IV. DISCUSSION

##### 4.1. Relationship between environmental factors and dunefield migration

Rainfall has great influence on the dunefield, favoring the increase of the vegetation cover, the stabilization of the system and the reduction of aeolian sediment transport [33]. [45], studying the effect of relief on the formation of convection and rainfall in southern Brazil, showed that the most irregular topography resulted in heavier rainfall. As the dune field is located between two hills, it is subject to heavy rainfall.

The precipitation data showed an increase over the years analyzed (Fig. 5), also observed by [33] and [35]. This trend is due not only to local or regional factors, but is a global condition that influences the weather and climate all over the world, as El Niño and La Niña [35].

[16] explain that during El Niño the precipitation tends to be greater than in La Niña periods. As observed in southern Brazil, during the El Niño years the rainfall is above the normal climatic range, while in the years of La Niña, the opposite is true: dry periods predominate in the south [22].

However, [10] show others two important factors affecting rainfall in Santa Catarina, the South American Monsoon System (SAMS) which is related to the Intertropical Convergence Zone (ITCZ) and the South Atlantic Convergence Zone (SACZ) which becomes more intense during the summer and accounts about 60% of the rainfall in state of Santa Catarina. The other factor is the cold fronts, responsible for the winter rains.

There are many consequences of an increase in rainfall on the island of Santa Catarina, among them being: with more moisture in the sediment, the threshold velocity increases, the aeolian drift potential in the region is reduced, the migration rate is also reduced and the growth of vegetation favored (between 1978 and 2014 the growth was about 65%); so over the years vegetation encroachment and the consequent stabilization of the dune field are inevitable, as possible to observe at dune field.

Overall, it is possible to observe two general patterns, as may be seen in Fig. 6. The first is the behavior of wind components showed at roses as between the northern half

and the southern half. The points located in the north presented a scattering component for all directions, which happens because the area is slightly warmer, thus generating convection effects. The convective clouds result in winds from all directions due to the consequent convergence the air. The points in the southern position suffer the influence of a barocline system, resulting, for example, in cold fronts and extratropical cyclones, presenting dominant and more clearly defined components (NE-SW).

The second pattern observed relates the most frequent (north/northeast) and the strongest winds (south/south-southwest), agreeing with [3, 4, 5], Vintem et al. (2006), [19]. However, at the points situated near the coast, below the southernmost point of the island (in SW-8, 10 and 11), the pattern is the opposite. The winds from the north quadrant were the most frequent and stronger than the southerly ones, as observed by [19].

There are several influences that affect winds along their trajectory; [3, 4] explains how the topography, headlands and mountain ranges of Santa Catarina Island can produce changes in wind flows, thus providing some protection against the north wind.

[3] described the topographical protection from the north and northeast winds, suggesting this as the reason for the effectiveness of winds from the south and southeast quadrants. This is consistent with the behavior of the data analyzed, as well as the direction of the migration of the dunefield.

Several studies have described dunefield stabilization in southern Brazil [5, 20, 32, 33, 35, 36, 38, 41, 48], as well as in Argentina [30] and the northern hemisphere [23, 43]

[39], analyzing the Moçambique dunefield, to the west of their study area, showed an increase (about 70%) of vegetation area between 1938 and 1976 and attributed it to the level of the water table, decreasing sediment supply and local changes in both wind power and precipitation.

A natural stabilization of dune fields as an environmental response and/or as due to climatic factors such as rainfall and level of the water table, wind regimes and waves, sediment supply and variations in relative sea level [17, 21, 49].

The vegetation cover mapped in 1957 and 2014 shows a growth in the vegetation during that period close to the edge of the Santinho beach (on the east side of the dune field). This region is lower and likely offered favorable conditions for vegetation growth, the increase in whose area was of about 40%.



South of Santinho beach, in the subaerial zone, the water table often rises, presenting a moist region; however, this process cannot possibly occur on the dunefield due to the thick accumulation of sediment above the water table.

According to the Catarinense Water and Sanitation Company reports (CASAN; personal communication??), the groundwater has two distinct levels: static (the distance from the surface of the ground to the water level inside the well, located about 12m from the surface) and the second, a dynamic level (the distance between the surface of the ground and the level of the water inside the well when pumped, which can attain 17m). The average time for the water level to return to its static level during its summer use is around 3 hours. Then, in the Santinho/Ingleses system the water table have less significant influence on the vegetation cover.

Urbanization in the study area began in 1980, particularly near the coastal areas. The spread of urbanization promotes changes in the system such, for example, that impermeable surfaces prevent the infiltration of rainwater, making it difficult to replenish the water table and thus reactivating stabilized dunes, leading to a new migration of sediment, demonstrating not only the impact of human occupation on the dunes but also the impact of the occupation on the dynamics of the dune field.

[52] comment that urbanization in inappropriate places has been responsible for the direct/indirect extinction of some dunefields in Rio Grande do Sul. Direct extinction occurs when building occupies the dunes and indirect extinction occurs when the input of sediment ceases, usually on adjacent beaches.

Studies conducted on the Canary Islands have shown an increase of up to 35% in wind speed, sediment deficit and pressure from users, thus reducing the size and modifying the features of the dunefield [8].

The urbanization adjacent to the transgressive dune system of Santinho / Ingleses does not present a big impact, due to the expansion's occurring mainly to the side of the dune field. The shoreline position thus permits the input of sand without any influence of urbanization; even during the strongest (southerly) winds as there is no anthropogenic barrier that affects aeolian sediment transport, on the contrary to Moçambique dune field.

The coastline of Ingleses beach from 1978 to 2012 showed a tendency to equilibrium with short episodes of erosion [53]. Between 1957 and 1978 (when the urbanized area was minimal as well as the vegetated cover) the coastline was stable with occasional accretion [53], showing that the urbanization near the dune field did not greatly affect the aeolian transport. Thus, the factor that most affects the aeolian sediment transport in this dune

field is the vegetation cover and temporal changes in wind velocity, as well the sediment supply in waves.

Vintem et al. (2006) and [5] studying the migration of several dunefields in Santa Catarina state calculated that the DP at Moçambique (to the west of our present study area) was 330 u.v., using the superficial wind data corresponding from Platform PVIX, concluding that these dunes, according to [13], had moderate energy winds (200 u.v. – 399 u.v.), similarly to the results achieved in this present study (249). Using the Arvoredo data, the DP was 70 u.v. Both results were different from those observed by [38] who showed an annual average DP from 1964 to 1998 between 100 and 150 u.v.

In autumn months, the drift potential presented lower values (207 u.v.) than in other seasons; the Spring had the greatest drift potential with 305 u.v. (Fig. 14).

[39] concluded that the Moçambique dunefield shows a decreasing trend in DP coincident with above average rainfall in the early 1970s, thus explaining the initial growth of the vegetation cover, as observed at Santinho/Ingleses dunefield.

According to [13], the values obtained from the DP calculation are not necessarily real, but represent a transport trend. It should be understood that the local environmental features such as vegetation, topographical features, moisture and the coastline, affect the amount of sediment transport significantly.

The drift potential values must be considered a wind energy index for a particular region, and the efficiency of sediment transport will depend on the local surface characteristics of the area in which the wind blows [13], according to this authors the study area has moderate energy winds (200 u.v. – 399 u.v.).

Regarding the resultant drift direction (DRD), the applied method was suited to the Santinho/Ingleses dunefield, resulting in DRD diagrams concordant with the general direction of system migration and with the results of previous studies.

The Santinho-Ingleses dunefield presents different kinds of aeolian deposits such as parabolic dunes, barchans and gegenwalle. There are few studies of gegenwalle in the Santa Catarina dunefields; however, these features were often cited by [14, 32, 33] in the transgressive dunefields of Rio Grande do Sul, as proof of dune migration, as they develop behind barchan dunes.

Northward dune migration under southerly winds yields sediment for the Ingleses beach. This northerly migration was also evident from the analysis of the wind rose (Fig 6) and the resulting drift direction (Fig 12), both agree with the expected pattern on the coast: southerly

winds were the strongest but northerly winds the most frequent.

The data obtained during the fieldwork (16m/year), even though the method of analysis was different, the values obtained approximated to the migration rate observed by Satellite Images (18m/year), as identify at Table 2.

[5] showed the dune migration rate (also on Santa Catarina Island) was of only 2.5m/year. [6] studying a dune field at west side of the study area and about three times bigger), presented migration values between 2.5 and 5 m/year.

The rate of crest migration in Rio Grande do Sul was between 15 and 40 m/year from 1974 to 1999 [33]. According to [35], the dunefields in Santa Catarina state (Moçambique, Lagoa da Conceição, Pinheira, Garopaba and Ouvidor) presented a migration rate of between 4 and 41m/year from 1938 to 2009.

Table 2: Resume about migration rate of dune field in south of Brazil.

Localizatio n	Migrat ion Rate	Avera ge value	Dat e	Aut or	Data
Santinho/Ing leses (SC State)	16- 28m/ye ar	21m/y ear	200 3- 200 4	[41]	Satellite Images
Santinho/Ing leses (SC State)	5- 40m/ye ar	18m/y ear	201 3- 201 4	[41]	Satellite Images
Santinho/Ing leses (SC State)	4m/3 months	16m/y ear	201 4	[41]	Topograp hic measure ments
Lagoa da Conceição (SC State)	49.7m	2.5 m/yea r	197 5- 200 4	[5]	Satellite Images + Topograp hic measure ments
Moçambiqu e (SC State)	2.5- 5m/yea r	-	193 8- 200 7	[6]	Satellite Images
Rio Grande do Sul (RS State)	15- 40m/ye ar	-	197 4- 199	[33]	Satellite Images

			9		
Moçambiqu e, Lagoa da Conceição, Pinheira, Garopaba,O uvidor (SC State)	4- 41m/ye ar	-	193 8- 200 9	[35]	Satellite Images

The dunefield presents a higher elevation as well as greater sediment volume in the western and northern portions. The crests located in this region showed higher migration rates than those on the eastern side which were in a lower region, both moister and under the influence of vegetation. Over the years the average rate of system migration is declining and this implies a lower sediment input to Ingleses beach. [11] explains that the position of the beach influences the dominant wind, favoring both waves and winds from the south and southeast at Santinho beach, moving the active dunes towards the north and providing an input of sediment at Ingleses. Recent studies have also shown that the largest input to Ingleses comes from the dunefield, not by longshore drift, thus bringing out the importance of this system [53].

Rainfall is increasing and thus aeolian sediment transport is being reduced, making the growth of vegetation possible, thus stabilizing and encroaching the dunefield, explaining the reduction of the migration rate.

4.2. Sediment budget and overpassing

[35] identified three evolutionary morphological stages in dunefields in Santa Catarina state. In the Santinho/Ingleses system, it was possible to identify these three stages by the analysis of aerial photographs/satellite images. The first stage between 1938 and 1957 shows an increase in the area occupied by aeolian sediment, suggesting an increase in the system’s volume. The second phase was characterized by an acceleration of depositional lobe migration between 1957 and 1978. The third stage began in 1978 and continues until today, with system stabilization and reduction of migration rates.

The morphological stages involve changes in the environment directly related to the sediment budget, i.e., the difference between the input and removal of sediment. For the system to accumulate sediment, aeolian transport requires a strong wind and available sediment [1].

The sediment volume of the dunefield has been reduced over the years. In 2002, the common area defined for the analysis of the volume was of about 3,066,695m³, after twelve years it had shrunk to 2,542,653m³; i.e., it had lost around 44,000m³/year of sediment (to Ingleses beach).



Different methods of data acquisition (orthorectification and RTK, respectively), and the various errors committed, however, urge caution regarding this conclusion. In order to present data with greater accuracy, sediment volume has been calculated for two major crests in the system using GPS data.

The sediment volume values calculated for two crests in the dunefield were consistent with the rates published by [6], showing that the dunefield supplies about 3.000-5.000m<sup>3</sup>/year to Ingleses beach.

[6] calculated that the dunefield contributes around 10,000 m<sup>3</sup>/year of sediment to Ingleses using the length and the angle of the slip face whereas this study used a more accurate GPS survey method.

The sediment budget also estimated the volume that enters the system through the northern sector of Santinho beach. [53] utilizing shoreline variations showed that, when the northern part of Santinho has presented an accumulation, Ingleses has retreated. The sector A of the foredunes which are more exposed to swell and wind action, presents the greatest width and volume, as compared with sector C. Volume changes in the northern sector of Santinho indicate an input to the dunefield of approximately 70,000m<sup>3</sup> of sediment in 12 years (6,000m<sup>3</sup>/year, assuming that none is lost to marine erosion). This dunefield provides 3,000-5,000m<sup>3</sup>/year of sediment to Ingleses, showing a positive budget indicating the maintenance of the dunefield; as the sediment input is bigger than the output to Ingleses, the system will continue over the years to provide sediment to the beach without suffering any loss.

Regarding the sediment pulse, in 2002 the northern part of Santinho presented lower volume and area, suggesting that a previous pulse of sand had already entered the dune system. In 2010 the volume was getting higher, suggesting a new pulse was imminent. In 2014, the input was confirmed, by the higher volume in sector A than in previous years (2002, 2010 and 2014, 265,269m<sup>3</sup>, 292,438m<sup>3</sup> and 335,788m<sup>3</sup>, respectively).

Figure 9 shows a selection of high wind speed conditions, marked in yellow (95-percentile anomaly), that corroborates with the years when sediment pulses entered in the system (Fig. 17), as well as high values of volume during the years: 1983-1984, 1993-1994, 2003-2004. [6] noted too, a sediment pulse in Moçambique dunefield (on the west side of Santinho beach), but occurs every 14 years, at Santinho/Ingleses the data show about ten years, for being a smaller dunefield system.

### V. CONCLUSION

The Santinho/Ingleses dunefield presents a significant growth of vegetation, an increase of a 40% over the 76 years analyzed, thus changing from a large active dune field to a system with increased stability.

The reduction in the crest migration rate over the years is a result of three factors: the tendency to increasing rainfall, a decreasing trend in drift potential and the stabilization of the dune field by an increase in vegetation. However, this is controlled by the wave of sand that is entering to the coast.

There is a decadal sediment pulse into the system from the north of Santinho beach that provides an overpassing process which the input volume (6,000m<sup>3</sup>/year) is bigger than the output to Ingleses beach (3,000-5,000m<sup>3</sup>/year), ensuring a positive sediment budget for the system (Fig 18).

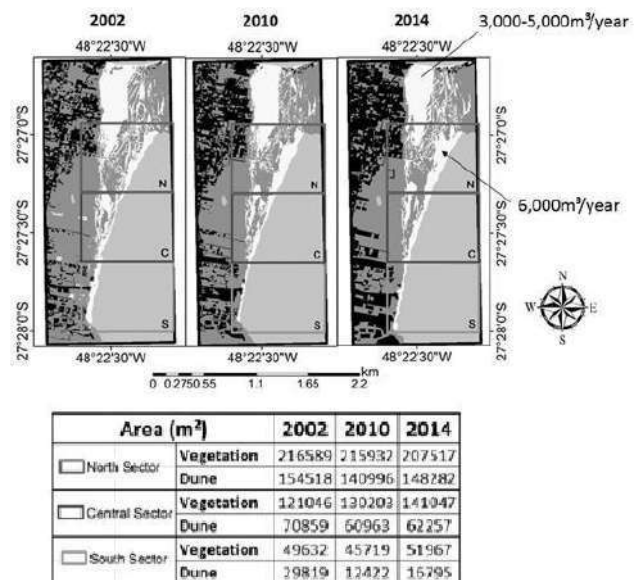


Fig. 18: Illustration of the system with volume data for each sector and sediment pulse rate.

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# Study of the Chemical Composition and Antimicrobial Action of *Dillenia Indica* Peel, Fruit and Leaves Extracts

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**Keywords**— medicinal plants, antimicrobial  
extracts, *Dillenia indica*, bioactivity.

**Abstract**— The use of medicinal plants has grown over the years, this is due to the popular culture that already exists and to the increase in people's knowledge about the benefits of these plants. *Dillenia indica* popularly known as elephant apple or april flower is considered a medicinal plant that, according to studies, has antidepressant, anti-leukemic, anti-inflammatory, antioxidant, anti-diabetic, anti-hyperlipidemic, antimicrobial, cytotoxic and anxiolytic properties. This factor aroused interest in obtaining extracts of this to evaluate the antimicrobial action of these extracts. To obtain the extracts, separate samples of the leaves, bark and seeds were kept in contact with ethyl acetate for 3 days with daily agitation. After this period, the extract was filtered and dried by rotary evaporation. The analysis of the chemical composition of the extracts was performed by a Gas Chromatography coupled with Mass Spectrometry. The antimicrobial effect of the extracts was verified by the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC). The values of MBC and MIC of the extracts of leaves, bark and seeds against the microorganisms in question were 0.1% v/v. Employing chromatography it was possible to identify several organic acids in the three extracts of *D. indica*. These acids are probably the compounds responsible for the antibacterial activity shown by the studied extracts.

## I. INTRODUCTION

According to Maciel, Pinto and Veiga (2002), the popular culture of using medicinal plants and the efficiency of their use, that is, the beneficial effects that their use provides, collaborate in a significant way for the practice of consumption of medicines plants. As a result, this popular culture arouses the curiosity and interest of researchers in developing this natural resource for medicinal purposes. According to Jawla et al. (2009), medicinal plants have provided many clues to fighting diseases since the emergence of civilization.

India is one of the 12 biodiversity centers in the world, with more than 45.000 different plant species (Jawla et al., 2009). There are many species of plants that have been used by tribal communities and in various regions of India, but their pharmacological and phyto-pharmacological importance are still unknown as these plants are rarely available. Among these plants there are several belonging to the family *Dilleniaceae*, which are not very well known, but have considerable medicinal value (Gandhi & Mehta, 2013). According to Bhagyasri et al. (2017), several studies report the potential of *D. indica* (Figure 1) to assist

in wound healing, diabetes, bone fracture, cuts, burns and abdominal pain.

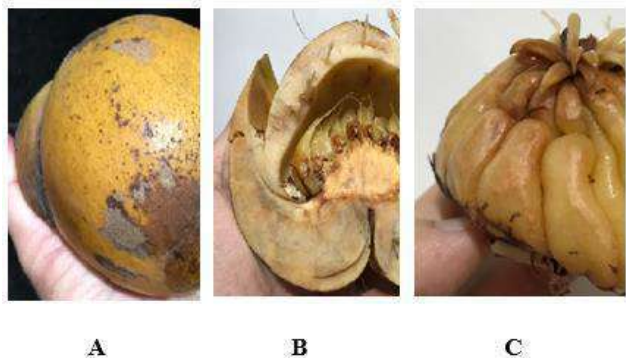


Fig.1: *Dillenia indica*: A- fruit, B- cross section of the fruit, C- fruit pulp.

*D. indica* is known for its antidepressant, anti-leukemic, anti-inflammatory, antioxidant, anti-diabetic, anti-hyperlipidemic, anti-microbial, cytotoxic and anxiolytic properties (Kumar, Kumar and Prakash, 2011). The genus *Dillenia* has 60 species, but only the plants *D. indica* and *D. pentagyna* are considered to have significant medicinal value. The leaf, bark and fruit of these plants are used as traditional medicine and have therapeutic effects (Gandhi & Mehta, 2013). The plant is a small to medium sized tree growing up to 15 m in height. Its leaves are 15 to 36 centimeters long, with a visibly wavy surface with printed veins (Bhagyasri et al., 2017) and the flowers are large, 15 to 20 centimeters in diameter with five white petals and numerous yellow stamens. The fruits are 10 to 15 cm in diameter, with undefined and persistent sepals, fleshy and slightly swollen. The seed contains 5 or more carpels, soaked in compressed, glutinous pulp, with hairy margins. Fruit production occurs from July to August and ripens in November and December. The flowers occur in May and June (Gandhi & Mehta, 2013).

According to Kumar, Kumar and Prakash (2011), the methanolic extract of fruits of *D. indica* L. display significant antileukemic activity in human leukemic cell lines. This finding led to the chromatographic fractionation of the methanolic extract and from this fractionation, the ethyl acetate fraction displayed the greatest anti-leukemic activity. Bhagyasri et al. (2017) comment that the main compound was betulinic acid, and that betulinic acid could explain the anti-leukemic activity of the methanolic extract and the ethyl acetate fraction. Apu et al. (2010) reported the antimicrobial properties of *D. indica* ethyl acetate leaf extract against Gram-positive bacteria (*Bacillus cereus*, *Bacillus megaterium*, *Bacillus subtilis*, *Staphylococcus aureus* and *Scarina lutea*) and Gram-negative bacteria (*Escherichia coli*, *Pseudomonas*

*aeruginosa*, *Salmonella paratyphi*, *Salmonella typhi*, *Shigella boydii*, *Shigella dysenteriae*, *Vibrio mimicus* and *Vibrio mimicus parahemolyticus*). Haque et al. (2008) commented that the ethyl acetate leaf extract had antifungal properties against *Candida albicans*, *Aspergillus niger* and *Saccharomyces cerevisiae*.

Considering the above, the present study aimed to evaluate the chemical composition and antimicrobial activity of the extracts of the *D. indica*.

## II. METHOD

**Sampling:** The fruits of the *D. indica* plant were collected in the months of April, May and October of 2019 in Guar, So Paulo state - Brazil, located at latitude 20°25'42" south and at longitude 47°49'27" west, where there are a considerable number of trees of this species.

**Obtaining the extracts:** For the extraction of *D. indica*, ethyl acetate solvent and three parts of the plant were used: leaves, seeds, and fruit peel. The fruits were separated and cut into small pieces and immediately afterwards were placed in flasks together with each of the solvents separately and sealed so that the volatilization of the solvents would not occur. The leaves were placed in separate flasks with for each of the solvents and sealed. The three parts of the plants were kept immersed in the solvent separately for seven days. After that, the acetate extract was filtered and concentrated. This extraction process was carried out in triplicate, and the extracts were stored in amber sealed amber flasks, under refrigeration until analysis.

**Microorganisms tested:** The reference strains used were *E. coli* (ATCC 35218), *S. aureus* (ATCC 29213) and *B. cereus* (ATCC 11778). The bacterial strain was reactivated using Muller Hinton agar and incubated at 37°C for 24 hours. For this study, bacterial suspensions prepared using the direct suspension method were used as inoculum, in which four colonies were suspended in sterile saline solution and adjusted to the standard 0.5 of the McFarland scale in a spectrophotometer at 625 nm. This procedure ensures that each milliliter of the inoculum has approximately  $1.5 \times 10^8$  Colony Forming Units (CFU) (NCCLS, 2003a). For the extract, saline solution was used as a positive control and chlorhexidine was used as negative control.

**Minimum Inhibitory Concentration (MIC):** The determination of the minimum inhibitory concentration (MIC) of the extracts obtained in this study was performed in microdilution plates with 96 wells arranged in 12 columns and 8 rows. First, an initial standard solution of the extract with a concentration of 8% was prepared using

0.4 ml of the extract, 0.05 ml of Tween 80 and 4.2 ml of sterile distilled water. In the microdilution plate, 6 dilutions were tested for each microorganism. In each of the wells of the plate, 100  $\mu$ L of the Müller Hinton broth were added. Then 100  $\mu$ L of the initial standard solution of each extract was added to the second line (B) and the subsequent concentrations were obtained through serial dilution, resulting in concentrations of 4% to 0.1%. In the end, 100  $\mu$ L of the contents were dispensed in the wells of the last line, so that the volume would be equal to the others. The wells of the 1st row were used as growth control, the extract was not added and the wells of the 8th row as negative control (Chlorhexidine 2%). At the end, 10  $\mu$ L of the bacterial suspension were added to all wells and the plates with the bacteria were incubated at 37°C for 48 hours. MIC was the lowest concentration that completely inhibited growth, that is, in which no turbidity was observed in the medium. The tests were performed in triplicate (Cavalcanti, Almeida and Padilha, 2011, NCCLS, 2003b)

**Minimum bactericidal concentration (MBC):** To determine the antibacterial activity of the *D. indica* extract, the MBC was determined. The analysis consists of adding extract concentrations equal to or greater than that of the MIC to tubes containing BHI broth. Subsequently, bacteria were inoculated into the tubes, which are intended to analyze the antibacterial effect. For control, tubes were produced only with BHI and extract. The tubes were incubated for 16 hours, at a temperature of 37° under agitation. After that, they passed through a centrifuge where the supernatant was discarded, and the bacterial cells were resuspended in BHI broth and inoculated in the plates containing the appropriate culture medium. The plates were incubated at the appropriate temperature and time for the growth of each bacterium, after which the plates were analyzed visually (Santurio et al., 2007).

**Gas chromatography coupled to Mass Spectrometry (GC-MS):** GC-MS analyzes were carried out in collaboration with Ourofino AgroCiência in Uberaba-MG-Brazil. For GC-MS analysis, samples were prepared by weighing 1g of extract in a 10 mL volumetric flask. Then, 5 ml of HPLC grade acetone were added and the system was ultrasound for 10 minutes. The volume of the volumetric flask was measured, the solution homogenized and filtered through a 0.45  $\mu$ m RC filter. The analyzes by GC-MS were performed on a High-Resolution Gas Chromatograph, Shimadzu, model 2010 with Mass Spectrometry Detector. Column: Agilent DB-5MS (30 m x 0.25 mm - 0.25  $\mu$ m). The operating conditions were: Injector temperature: 220° C, Injection Mode: Splitless, Sampling time: 2 minutes, Flow control mode: Linear speed (45.0 cm.seg-1), Pressure: 15.7 psi, Total flow: 19.4

mL min<sup>-1</sup>, Column flow: 1.49 mL min<sup>-1</sup>, Column temperature: Gradient mode, as shown in the table 1:

Table 1 - Data used in the temperature gradient for the analysis of GC-MS.

Ratio (°C/min)	Final Temperature (°C)	Residence time (min)
-	80	2
40	140	-
10	280	-

The Parameters of the Mass Spectrometry Detector were: Ion source temperature: 200° C, Interface temperature: 280° C, Solvent cutting time: 3 minutes, Detector voltage: Relating to the result of the Tuning, Initial detection time: 3.0 minutes, Final detection time: 17.0 minutes, Acquisition mode: SCAN, Acquisition time: 0.25 seconds, SCAN mass / charge ratio (m / z): 40 to 600, Injection volume: 1  $\mu$ l.

### III. RESULTS AND DISCUSSION

#### MIC and MBC

The MIC values of *D. indica* extracts from leaves, bark and seeds against *E. coli*, *S. aureus* and *B. cereus* were 0.1% v/v for the three analyzed extracts. This result was more efficient than the work of Zauli et al. (2004) which analyzed MIC and MBC for *D. indica* against *E. coli* (ATCC 8739), *S. aureus* (ATCC 6538), *S. typhimurium* (ATCC 14028), *P. aeruginosa* (ATCC 25619) *Streptococcus mutans* (ATCC 25175) *S. salivarius* (CDC 262) and obtained in the MIC 95.8 mg/mL for *E. coli* and *S. typhimurium* and 47.9 mg/mL for *S. aureus*, *P. aeruginosa*, *S. mutans* and *S. salivarius* and in the MBC concentration of 71.85 mg/mL for *S. aureus*, *P. aeruginosa*, *S. mutans* and *S. salivarius*, and greater than 95.8 mg/mL for *E. coli* and *S. typhimurium*.

Apu et al. (2010) investigated the leaves of the methanolic crude extract of *D. indica* Linn. (*Dilleniaceae*) for the evaluation of antimicrobial activities. Antimicrobial activity was determined using the disk diffusion method. The mean zone of inhibition ranged from 6 to 8 mm at a concentration of 400  $\mu$ g/disc. Alam, Chowdhury and Mazumder (2011), tested the methanolic extract of the bark of *D. indica* against four Gram positive and seven Gram negative bacteria and remarkable activities against all the tested bacteria were observed. The lowest minimum inhibitory concentration (MIC) value was observed in *Staphylococcus aureus* and was 0.312 %. Reddy et al. (2009), commented that the hexane extract from the seed powder of *D. indica* was evaluated for antimicrobial and antioxidant activities and exhibited a broad spectrum of

antimicrobial activity. MIC values for different bacterial and fungal strains ranged in concentration from 1.0 to 2.0 mg/ml.

**GC-MS of bark extracts**

After the separation by gas chromatography of the extract of the *D. indica* bark, 9 peaks were obtained, as given in Figure 2, which were analyzed by Mass Spectrometry for their structural determination.

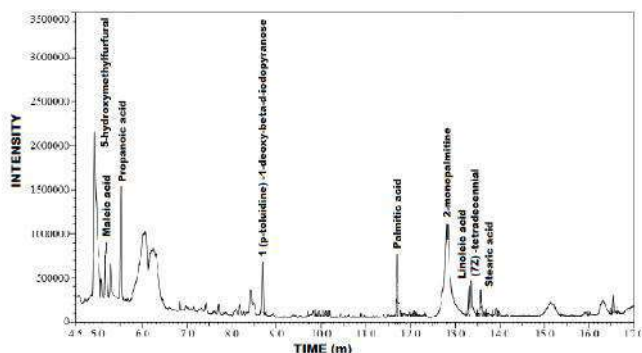


Fig.2: Chromatogram of separation of the *D. indica* bark extract by GC-MS.

**GC-MS of pulp extract (seed)**

After the gas chromatographic separation of the pulp extract of the *D. indica* seed, 9 peaks were also obtained (Figure 3), which were analyzed by Mass Spectrometry for their structural determination.

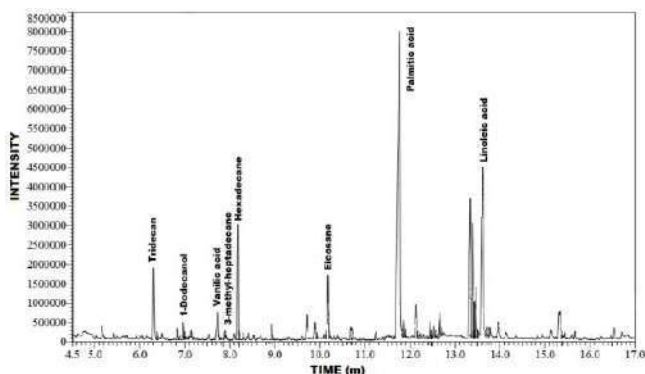


Fig.3: Chromatogram of separation of the *D. indica* seed extract by GC-MS.

**1) GC-MS of leave extract**

After gas chromatographic separation of the *D. indica* leaf extract, 4 peaks were also obtained, as shown in Figure 4, which were analyzed by Mass Spectrometry for their structural determination.

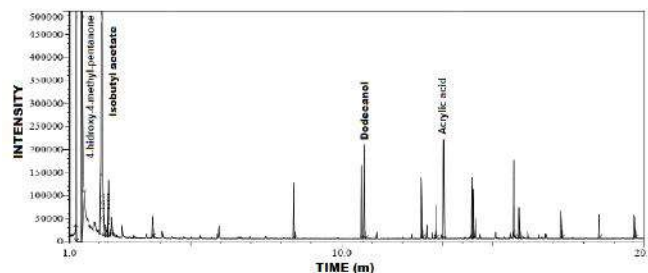


Fig.4: Chromatogram of separation of the extract of the leaves of *D. indica* by GC-MS.

Table 2 summarizes the chemical compounds found in the studied extracts and figure 5 summarizes the chemical structures of the compounds found in the studied extracts.

Table 2. Compounds present in the studied extracts of *D. indica*.

Bark Extract	Pulp extract (seed)	Leave extract
<ul style="list-style-type: none"> <li>5-hydroxymethylfurfural</li> <li>Malic acid</li> <li>Propanoic acid</li> <li>1-(p-toluidine)-1-deoxy-beta-d-iodopyranose</li> <li>Palmitic acid</li> <li>2-monopalmitine</li> <li>Linoleic acid</li> <li>(Z)-tetradecenal</li> <li>Stearic acid</li> </ul>	<ul style="list-style-type: none"> <li>Tridecanol</li> <li>1-dodecanol</li> <li>Vanilic acid</li> <li>3-methylheptadecane</li> <li>Hexadecane</li> <li>Eicosane</li> <li>Palmitic acid</li> <li>2-monopalmitine</li> <li>Linoleic acid</li> <li>Linoleic acid</li> <li>(7Z)-tetradecenal</li> <li>Stearic acid</li> </ul>	<ul style="list-style-type: none"> <li>4-hydroxy-4-methyl-pentanone</li> <li>Isobutyl acetate</li> <li>dodecanol</li> <li>Acrylic acid</li> </ul>



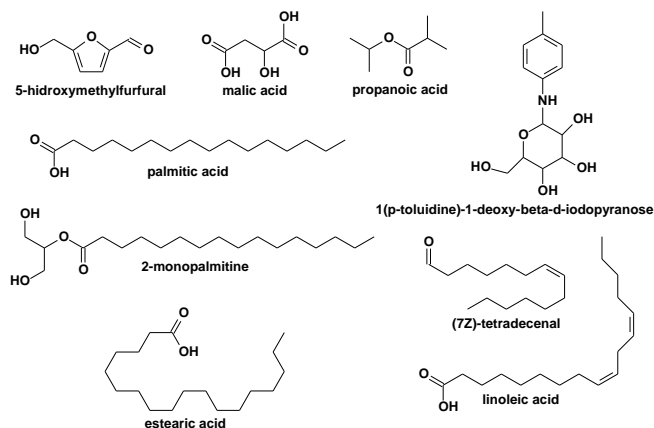
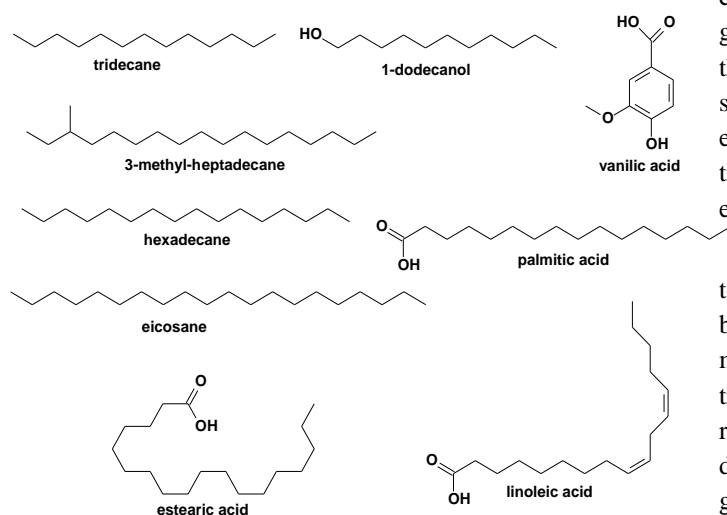
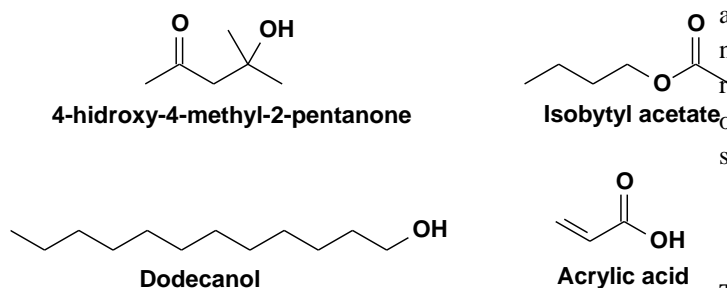
**BARK EXTRACT****PULP EXTRACT (SEED)****LEAF EXTRACT**

Fig.5: Chemical structure of the compounds presents in the extract of the bark of *D. indica*.

Analyzing Table 2 and Figure 5, it is possible to observe the presence of several organic acids in the three extracts of *D. indica*. The organic acids have been used as food additives and preservatives to prevent food spoilage and prolong the shelf life of perishable foods. As a group, these compounds mainly include straight chain saturated monocarboxylic acids and their derivatives (unsaturated, hydroxyl, phenolic and multicarboxylic versions) and are

known as fatty acids<sup>15</sup>. Thus, probably, the organic acids present in the studied extracts are the compounds responsible for the antibacterial activity presented by the studied extracts.

According to Ricke (2003) the potential bacterial targets of biocidal compounds include the cell wall and the cytoplasmic membrane. Although the antibacterial mechanisms for organic acids are not fully understood, there are some proposals for the mode of action of these compounds. Given the weak acidic nature of most of these compounds, pH is considered a determinant of effectiveness, because it affects the concentration of undissolved acid formed. Non-dissociated forms of organic acids can penetrate the lipid membrane of the bacterial cell and, once at the neutral pH of the cell cytoplasm, dissociate into anions and protons. The generation of both species causes problems for the bacteria that must maintain a cytoplasm with a pH close to 7 to support the functional macromolecules. Excess proton exports require consumption of cellular adenosine triphosphate (ATP) and can result in depletion of cellular energy.

As stated by Ricke (2003), organic acids are able to decouple the cytoplasmic membrane. Organic acids are believed to interfere with the structure of the cytoplasmic membrane and membrane proteins, so that electron transport is decoupled, and subsequent ATP production is reduced. Another hypothesis is that organic acids serve as decouplers that generally dissipate pH and electrical gradients across cell membranes.

Less direct antibacterial activities have also been attributed to organic acids and include interference with nutrient transport, damage to the cytoplasmic membrane resulting in leakage, disruption of the permeability of the outer membrane and influence of macromolecular synthesis (Ricke, 2003).

**IV. CONCLUSIONS**

Through this study it can be concluded that the extracts of *D. indica* (leaves, fruits and seeds) showed antimicrobial activity, with antimicrobial efficiency of the three extracts against all tested microorganisms. From the chemical evaluation made with the extracts, there are many organic acids in their constitution and these compounds are possibly responsible for the antimicrobial activity observed in this study. The studied extracts have promising characteristics for use as natural antimicrobial species in both the food, pharmaceutical and cosmetic industries in order to replace synthetic antimicrobials.

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# Breaking Ways, Opening Variants - Cowboy Culture in the City of Andorinha, Brasil

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**Keywords—** Cowboy culture. Oral Narratives. Identity.

**Abstract—** This work deals with the manifestations of cowboy cultures in the Brazilian Semiarid Region, more specifically in the municipality of Andorinha, Bahia. Throughout the work, four cultural manifestations of cowboys are described and analyzed from the perspective of ethnographic practice anchored in the perspective of qualitative research, which allows us, within the ethics, rigor and discipline required by the act of investigating, to portray the life contexts of concrete subjects. Thus, some events will be presented where the observations and their contextualization took place, their inscription in the historical and social fabric, interspersing the perceptions of the subjects about them within the context of their experiences, their cultural practices.

## I. INTRODUCTION

In sertanejo speech, paths, or “varedas”, are paths, tortuous lines, crossed by the passage of cattle, of the creation that grazes freely in the caatinga, following its instincts, drooling over the branches, sniffing out water. The paths are widened by the passing and passing of animals and people, new paths are being opened and they often gain a peculiar layout, which influences the movements of the cowboy's body, on his gestures, on the way he sees and relates with the world.

The variants here are an allusion to demarcation lines, limits interposed by man, to separate and at the same time unite pieces of caatingas, pieces of ground, establishing a distinction between my space and the space of the other within a collectivity.

For us, the metaphor of paths and variants applies to entering the countryside, as we enter it with the spirit of adventure and discovery, of following paths that we didn't know where to go. But that's why it became exciting to allow us to let the instincts guide us in search of elements that could answer the questions that populated our thoughts. Would we find narrators? Would we know how to ask the

right questions to apprehend in depth the color of what might be narrated?

Sometimes we had to leave a variant open to access something that at first sight was not so undiscovered, the unspoken, let the flow of the narrative follow the intricacies of the word, just outlined to understand that sometimes emotion and crying sustained, they had already brought the answer, to questions that we had not even conceived.

Getting into the cowboy's perceptions about the act of narrating, an act that is part of their life contexts, deeply linked to orality, their natural form of expression and a place where they feel fully at ease, leads us to the concern of not only recording the content of their speech, their utterances, as well as apprehending the context where they were happening, the external factors at the time of the interaction.

It is important to highlight that to carry out the research we used ethnography as methodological procedures, with a qualitative approach. In addition, to bring the speeches of the research subjects here at work, we highlight them in italics, in order to differentiate them from the quotes in the theoretical framework.

## II. CULTURAL PRACTICES OF THE COWBOYS OF SWALLOW-BA

Based on the hypothesis that oral narratives passed on between generations of cowboys are an important factor in the permanence of their culture in the municipality of Andorinha - BA, we searched through the situations in which participant observation and interviews were allowed, to insert ourselves in the multiplicity of meanings that constitute the universe, the context of its cultural practices.

We understand cultural practices as everyday actions that gain meaning as they are shared and repeated on a daily basis within a given group or community. Thus, throughout the research, we had the opportunity to register a multiplicity of these practices: Ox picking in the bush; Boi catch in Jiqui; the Argolinha Race; the Cowboy Mass; the Vaquejada; the Cavalcade and the Mutirão; in this sense, we consider it important to contextualize these, establishing a dialogue with a broader historical context and then making approximations with the more specific set represented by the municipality of Andorinha.

## III. OX HANDLING IN THE MATO AND OX HANDLING IN JEQUI/JIQUI

Pega de Boi no Mato, and what we consider its simplified derivation, Pega de Boi no Jiqui (or Jequi) are legacies of the herding activities developed in the colonial period and that were, over time, incorporated into what Câmara Cascudo (1956) called "Traditions of Northeast Livestock".

Ox magpies were part of the sorting activity during the sesmarias regime, where the cattle of all breeders mingled in the middle of the dense scrubland until wintering in June and July, when it was common to gather "tens and dozens of cowboys who spent weeks gathering the scattered cattle ranch in the mountains and capoeirões [...]" (CASCUDO, 1956, p. 13, emphasis added).

The practice continued for a long time, entering the 20th century, being gradually supplanted with the transformation of the caatingas into pastures and the replacement of extensive by intensive farming, demanded by the arrival of "progress" and by the demands of capital.

The large cattle magpies, similar to those described by Cascudo (1956), emerge in the reports of the older cowboys as a reference of a good time that was gone and about which the younger ones only knew from the reports of the older ones, as we can see in the speech of the cowboy Alonso, who, at 53 years of age, only knew this reality through the reports of his father, now deceased. He says that:

*Then, as my father didn't have us... It was like this, we were little, he called some*

*companions, he had his brother, he had Otávio, there was Nequinho da Crema, Raimundo and others, and others... São of the Lameiro. Then, they would gather three, four and go to get those cattle. Then they were going to get someone else's. But there were times, my father told me, there were times when he caught 60 cattle at once. That it was to catch 60 oxen. Then these cowboys got together to catch these oxen, from outside to outside, until they caught these oxen. Sometimes each one on his horse, without changing animals because there was no way, and catch all these oxen. Now, it was difficult, but it was always up to everyone to gather their cattle. (ALONSO, 2018).*

In Alonso's speech, the reference to a not-so-distant past is evident, in which the solidarity relations between the cowboys were still essential for them to overcome together the adversities of daily toil. This was an activity that required experience, in addition to fearlessness and the ability to capture and later identify the oxen on each farm.

The references used to endorse and legitimize the memory of his boyhood also draw our attention in his speech. When talking about this past, he uses as a reference the antecedent "my father told me" as an indication of a safe source from which he extracted the information, as well as the detail of the presentation of the names of the genitor's companions, participants in the narrated event. The fact of reporting this event in front of an assistance formed by other family members also makes us reflect on the meanings that are being re-elaborated by the participants when they narrate and listen to the testimony.

After the capture, came the sorting, which sometimes would only happen after a few days of almost uninterrupted work in the caatinga, where neither horses nor men would rest until the complete collection of the cattle, it being common to happen "of an ox, depending on where, to spend 08 days on foot in the woods because there was nowhere to gather" (ZÉ AMILTON, 2018).

The recognition of so many cattle, belonging to different owners, was done by identifying the signs made with the irons of each farm, and even by the characteristic features such as the mixture of colors in the coat, a birth defect, any peculiar sign that had been engraved in the memory of the cowboy, who had dealt with them daily since they were little calves. This knowledge that the cowboy dominates to this day, was one of the aspects that most astonished the writer of Os Sertões, Euclides da Cunha (2016) when talking about learning to deal not only with his cattle, but also with the neighbor knowing the genealogy, colors, ages, etc.



The ages that Euclides da Cunha refers to are called by the cowboys Eras; each era corresponded to the time the ox stayed in the caatinga, where it stayed until it reached the desired weight for slaughter. The dates of the cattle's release for fattening were recorded on paper by the farmer, but the surest record was the cowboy's memory.

It is in this context that some of the stories full of colors and emotions will manifest themselves, as it was common for some of these oxen to go missing for a long period, ending up "*burrow into the mountains, staying there holed up*" (ZÉ AMILTON, 2018). When any of the cowboys spotted him, he immediately warned his colleagues, including those from other farms, leading to a series of careers that would make him famous and respected, as well as the cowboy who managed to capture him.

The context of careers is also the source from which other beliefs will emerge that will compose the plots, the plots that will enrich their repertoire of stories. Stories where the central character is the ideal ox, enchanted through some prayer or magic formula made in "[...] *at the same time, on the trail...or on the left end...*" so that no one comes to pick up the ox, thus increasing its fame (CABOCLO, 2018).

According to the interviewees, these are mysteries that only a few people know how to do, and undo, leaving the authors of cunning hidden because "*no cowboy wants to carry the reputation of knowing how to do what is no good*" (ZÉ AMILTON, 2018), starting to be seen with looks of distrust and suspicion on the part of fellows

But, at the same time, this is a theme that still exerts fascination, and that produces many reviews and jokes among the cowboys, as we can infer from Caboclo's statement: "*There is ((laughter)). We've already done a review and have already discussed it here, we cowboys. It's nothing, it's a horse, it's a bad cowboy. But it exists, it exists, I believe!*" (CABOCLO, 2018).

Today, the spirit of adventure that involves the capture of wild cattle is still evoked, although less and less linked to the daily practice of the cowboy in Andorinha; it presents some variations, being, in its more traditional version, the oxen released in the forest some time in advance, allowing time for them to spread out before the entry of the cowboys, making their capture more difficult and exciting.

In a more simplified way, and more recently, comes Pega de Boi no Jequi or Jiqui, a fact that has led to the realization of the most performed ox pegadas, where diversified audiences compete, and there is a greater spectacularization of the practice of running after the bull that has just fled terrified from the confinement of the makeshift corral. Previously, the inscription and the draw are made to define the order in which pairs of armored

cowboys will enter the forest in timed pursuit of the cattle; in this way, for agility and dexterity, the pair that overtake the others in the ox's grip, previously identified by a password attached to their neck, are rewarded. The challenge of the project comprises subduing the animal, removing the password and handing it over to the person responsible for the event.

These moments are invested with a festive character, as are all events that involve the cultural practices of the cowboy. There is more and more the insertion of elements of urban culture, such as the insertion of sound cars, and more recently, of the famous walls that dictate the rhythm of the party with music that goes beyond the traditional toada, with a predominance of stylized vaquejada.

#### IV. THE COWBOY MASS

The Cowboy Mass is commonly inscribed in the rites that denote the deep religiosity of the sertanejo people. A religiosity that has in Catholicism the amalgam through which a colorful mixture of beliefs, rituals, superstitions, "knowledge and spirit" inherited from the ancestral practices of the peoples who made it, constituted the sertão as it is.

The celebration takes place in practically the entire northeastern hinterland, despite having its origins fixed in the recent past. The official narrative that founds its origin is that the Missa do Vaqueiro was conceived in 1971, by Luiz Gonzaga, in partnership with Father João Cândia, as a tribute to the cowboy Raimundo Jacó, cousin of the artist, "traiciously murdered in the caatingas of the Sítio das Lages, district of the municipality of Serrita, located in the upper sertão of Araripe, located 553 kilometers from Recife" (FUNDAJ, 2010).

Despite this more traditional version, there are signs that the Mass has its origins located in a more distant past, as we can see in the work of Tapety (2007), who talks about the sociocultural practices and representations of the cowboy in Piauí from 1960 to 2000. According to the author, in 1963, "Cônego Antônio Cardoso de Vasconcelos, [...] celebrated a mass in honor of the cowboys. [...] And every May 31st celebrations were held in honor of the cowboy" (TAPETY, 2007, p. 63).

The fact is that the celebrations quickly spread and were soon invested in a form of representation that characterizes them as a traditional cultural practice of the backcountry cowboy. The Mass is marked by the role of the armored cowboy who prays for souls and exalts the memory of the companions who are gone, companions. At the same time, in which he pleads for protection against the dangers of

dealing, he asks for the blessing of heaven with the mercy of the rains, celebrates and thanks him for his arrival.

For the cowboy, as it is for traditional peoples, faith does not depart from joy, from celebration; seriousness and respect for the divinity and its manifestations are not neglected, but the act of celebrating is also given for the pleasure of singing, dancing, eating and drinking. It is the typical mix between the sacred and the profane that characterizes popular national cultures so well.

This aspect of religion as a cultural system is what, in a way, contributes to maintaining cohesion within social groups, helping to create the value elements, or their "ethos", as well as their worldview that boils down to a picture that each people elaborates "of things as they are in simple reality, their concept of nature, of themselves, of society (GEERTZ, 2008, p. 92).

At the Masses where we were present, this interweaving is very noticeable; generally held outdoors, in front of the churches, or under a more leafy tree in the orderer's yard. They share space with the food, beverage and sound system trade, which are turned on as soon as the signal indicating the end of the religious festivities is given. Often the improvisation of a raised surface for the realization of the sacred, also serves as support after the completion of the mass, for the profane festivities as a stage for musical performances.

However, respect for the time of the liturgy is maintained, including the suspension of alcoholic beverage sales and, despite the difficulty in suspending the laughter and conversations stimulated by meetings with friends, relatives and compadres, we still see serious cowboys, hat on top of the saddle or carried to the chest as a sign of contrition, a gesture that is imitated by the younger ones, especially those who are mounted and armored, denoting a concern to maintain the respect that their prominent position demands in front of the audience.

A fact that caught our attention at the first mass we attended at the invitation of Mr. Milton at Fazenda São João, at the end of April 2018, was the reversal of the purpose of the celebration, usually held in honor of the cowboys who are gone. At the time, the rite was held to commemorate the birthday of a cowherd boy who was 10 years old, a relative of the host. Immediately, our eyes were drawn to the ornamentation of the party, whose main motif was a Marvel© superhero, Iron Man, a motif that was also on the birthday boy's shirt, matching his little leather hat.

When describing the social practices involving the backcountry cowboy, it is common to make this confrontation between the traditional and the modern, and many times, criticisms are made of the "innovations" introduced in events of this nature. However, the picture

formed by the mix between leather costumes and pop culture elements immediately leads us to the hybridization processes developed within cultures in the context of modernity and intensified in the post-modern era, a concept deepened by Néstor Canclini (2008, p.27), and defined by him as a set of processes and exchanges which include:

[...] the "racial or ethnic fusions called mestizaje and updated for identity combinations, the syncretism of beliefs and also other modern mixtures between the artisanal and industrial, the cult and the popular, the written and the visual in media messages ( emphasis added).

Despite the sense of the crumbling of an identity based on traditionality, or of the distortion of the defining traits of the cowboy culture, with the incorporation of elements considered extrinsic to it until recently, we cannot forget that the Mass of the Cowboy itself is a "tradition invented" already in the context of the second half of the 20th century and popularized precisely by mediatization.

The celebrations held at the headquarters, according to oral reports collected from the research participants, began in the mid-1980s, and were being held annually at the initiative of Seu Ananias, a deceased cowboy and mentioned with great respect by older cowboys, as it is the case of Seu Bêlo, who inherited the task.

The figure of Father Luiz Tonetto is also remembered with affection and nostalgia, a charismatic figure who was active in the struggle for land ownership during the institutionalization of pasture fund communities. Masses were always held in the parish church, where the cowboys paraded after going around the city. In the early 2000s, masses began to empty, being held sporadically, the last one, before 2018, held in 2004.

The alleged reasons for the decline of the celebration are based on the lack of support from the public power, always very unstable with the changes in management, and with the extinction of the old association of cowboys also idealized by Seu Ananias, in addition to the difficulties in raising resources to provide feeding, comfort and safety to the cowboys who came from distant points.

However, the rite is maintained in various parts of the municipality's rural area, being held throughout the year, generally following a specific calendar, marked by some form of homage, either to a deceased cowboy or to celebrate some festive event, such as was the case of the anniversary recorded here.

## V. A “RUSSIAN-JAPANESE WAR” IN THE CAATINGAS DO SERTÃO

When we analyze the cultural practices of backcountry cowboys, including those in our locus of study, we realize that most of them have their origin in those old games that used to attract crowds thirsty for emotions and fun.

This is the case of ring races, which are still very common in small towns and especially in rural areas of the northeastern interior. The race, according to Cascudo (2001), was recorded in Dutch Brazil (Pernambuco), when the governor “divided the riders into two squads of Dutch and Portuguese” to compete in a tournament in which riders “in parade” should withdraw with the tip of a spear, a ring that was hung on an “ornate bow or pole”, and, after this process, “the ring inserted in the spear was offered to an authority to the girls and ladies, with prizes” (CASCUDO, 2001, p. 22).

These days, these games continue to attract a large contingent of individuals, whole families who will root for their respective teams, it is common to have members of the same family on rival teams, although it is a rivalry involved in a festive spirit.

However, a fact that draws attention to the practice in Andorinha is the theatricality of the race, which gains a spectacle air with the inclusion of cultural elements that are distinct from other regions. Here, the teams once again represent and even wear the colors of a nation, and give a festive character to the event with the inclusion of music bands and competition from fans who cheer for their favorite groups.

The teams are divided into two nations: “Russians” and “Japanese”, represented by the colors blue and red, colors that are part of the uniform and flag of each nation formed by a minimum of 07 to 20 riders who are commanded by a “boss” and a “counterboss”. These two leaders, who can belong to any of the rival groups, organize the dispute, and, in advance, they invite the girls who will be the “queens” to carry the flag and animate their respective teams.

The reference to the Russian and Japanese nations, there is no way to go unnoticed, leading us to evoke the conflict that occurred between them in 1904, causing us immense curiosity to know the reasons, the origin behind it, something that the research informants were unable to inform, only emphasized that this is a practice carried out “long ago” in the municipality, in addition to others that are neighboring, such as the districts of Quicé, belonging to the municipality of Senhor do Bonfim, and Santa Rosa de Lima, belonging to Jaguarari.

When we searched on sources located on the internet, we found that similar practices carried out in the same mold

were registered in some locations in the city of Juazeiro, with at least one locality that performs it in the same or similar ways. In an article found in the blog “O Sertão” (2019), there is a reference to the coming of this tradition from the state of Piauí, a fact that can perhaps be verified in later studies.

The registration made in the Lagoa da Onça community allowed us to observe two families participating in the research, who at the time were part of the organization of the event, and also ran, taking part in the competition. This one caused us interest, as it denotes the multiplicity of practices in which the participants are inserted, going far beyond working with cattle, also integrating other ways of expressing their identity.

## VI. THE MUTIRÃO – ANCESTRAL PRACTICE

The mutirão is one of the most beautiful forms of expression of sertanejo solidarity, being part of our childhood memories when it was common to see the people of the community gather around bean batters, flours, cleaning water, building and repairing houses, among other activities. The organization of residents of small communities around a common goal represents a relationship of interdependence, mutualism that guarantees the preservation of natural resources and goods of common use in the community.

Once again we turn to Cascudo (2001) to understand other meanings involved behind the word mutirão, which, according to the author, is of Tupi origin, denoting that this is an ancestral practice, inherited from the indigenous custom of gathering men and village women at harvest times, for example. The author also defines the collective effort as “a spontaneous social institution that attenuates the individualistic effects that the land-owning economy has imposed on Brazilian rural life, correcting them” (CASCUDO, 2001, p. 409).

We believe that such “individualistic effects”, alluded to by the author, are the result more of the geographical distance between the large rural properties, than the absence of solidarity ties between them. Among the cowboys, even those from the colonial period, who lived in great territorial isolation, the relationships of interdependence are evidenced when it was necessary to gather in larger groups to capture loose cattle, among other activities.

The absence of the “absentee boss”, in a way, stimulated the individualism of their relationships. According to Medrado (2012), this was a strategy to avoid establishing horizontal relationships of friendship between the cowboys, which could be disadvantageous for them.

However, after the abolition of the large property and with the possession of the territory by the former cowboys, who now became owners of a property in common with their peers, these ties are strengthened, as we could see in the previously presented compadrio relationships.

On the occasion when we had the privilege of following a joint effort carried out by Mr. Olímpio – one of the cowboys participating in our research project – we noticed in the meantime the ties, solidarity, involvement in work and the festive atmosphere between them.

It was surprising to come across this activity as we did not know beforehand that it was taking place. We had arranged to meet the cowboy Dudu, in Vila Medrado, on a Saturday, so that an interview could be held with him and his role as a seed in the region explained. When we arrived at his home, even before the interview started, we were invited by him to meet a friend who was carrying out the task force, to which he had not been able to go earlier due to the care of animals during the drought.

The invitation caused us great enthusiasm and emotion for the spontaneity with which it was made and also for Dudu's sensitivity in realizing that this could be an interesting fact for our study.

We immediately went there, and were introduced to the owner of the house, Mr. Olímpio, who, despite having just met us, immediately invited us to take part in the lunch, served under the shade of an umbuzeiro, a delicious cooked beef mush. , accompanied by a cachacinha, a common aperitif of rich country meals, attesting once again to the legendary hospitality of the simple and generous people of the hinterland.

As soon as we arrived, we were faced with the scene of compadres and friends engaged in the task of raising the fences of the pigsty under renovation. According to the “owner of the service”, that was a service for the expansion of the “corralzinho”, or pigsty, used to arrest “a few goats, or a cow, from time to time...”.

The atmosphere was one of festivity, as there was, in addition to the joy of shared lunch, todas and vaquejada songs were played in an automotive sound, denoting the relationship between the collective work and musicality, the singing that, even in sound mechanic brings out the animation that softens the harshness of the hard work of laying stakes and posts in the noonday sun.

During lunch we didn't interfere in the interactions between them, when they took the opportunity to continue the conversations about amenities, issues related to the drought, among others. We didn't notice mention of any cattle story, nor mention of any activity related to them, but, however, we noticed a lot of jokes and laughter when we

informed the reason for the visit, a fact that aroused a lot of curiosity among them, the jokes were usually about the being cowboy: "Is it, homi, what cowboy likes to tell stories?" “Are you a cowboy, compadre?”, among other sayings that are common among them when we ask about it.

Seu Olímpio, upon learning the reason for the visit, was very enthusiastic and immediately accepted the invitation to give us an interview with his son Neném, who also helped his father in organizing the adjutant. He invited us in and introduced us to a little of his history as a cowboy, and as a cowboy, and a former craftsman who worked in the manufacture of the leather hat, showing us that within the cowboy there are many other identities that intertwine, that define him .

In the context of the task force, we did not prioritize so much to gather the impressions of the other cowboys present there, in order not to interfere in the work being carried out, preferring to observe the interactions that were taking place in that specific situation.

## VII. VAQUEJADA - TO THE SOUND OF THE SEAWALL, THE "STYLIZED COWBOY"

The vaquejada has served as a demonstrative example for how the culture of the country cowboy would be detaching itself from the contexts where they originated, moving away from its popular character and approaching more and more the format advocated by the mass culture characteristic of capitalism.

However, like the ox magpies in the bush, this one will find itself inscribed in cultural practices inherited from the cowboy's daily toils as a resignification of work, of the material conditions of existence. Similarly to them, it had its origins linked to the apartments and cattle tools in the colonial period, before the existence of fenced pastures; times when work becomes game.

The description brought by Cascudo (2001) makes us think that little has changed in this form of entertainment that has traversed the centuries and was able to incorporate elements that make it a great spectacle today in some regions of Brazil. However, a closer look will make us realize that some things are different: in addition to the previously rural, almost unpopulated, and now urban setting, the cowboy and the horse that are part of the modern vaquejada have also changed.

Issues related to changes in the management of cattle, now almost entirely raised in an intensive regime, also act, in this case, as a factor for the reconfiguration of the traditional vaquejada. Research participants also relate the decrease in caatinga areas with these transformations.



A fact that caught our attention was the cowboy's perception of the phenomenon of cultural transformations not only modifying the relationship between men and nature; and how much animals are also affected by them, because, as we can see in the speech of one of them, the oxen raised in captivity would also be unlearning to run in the forest.

*[...] things were coming to an end, or a beginning, which I can't even say what it is, that each one was finding a place to hold their animals, dividing.... So animals today are no longer used to being released like they used to. Animals, today, are released on a more private property (HENRIKY, 2018).*

This factor of the disappearance of the caatingas has led younger cowboys to seek the modern vaquejada, but it is also perceived that, in addition, aspects related to the glamorization that currently involves the practice are also influencing. In one of the last activities we observed, a cowherd held at the municipal headquarters, we could see the clear differences between the so-called track cowboy and the cowboy who runs in the woods.

In the past, in the context of apartments, the act of knocking over oxen in the clean space, in moments of rest between long periods of toil in the caatinga, was seen as a revelry, as bravado and affirmation before the group. At present, the practice takes on other contours and meanings that identify it from the sense of play to sport.

The first sense, that of play, is more limited to family nuclei, smaller parks, where those cowboys who are still learning go, with future aspirations to become one day cowboy professionals. For beginners, there is a high investment in the purchase and maintenance of a necessary structure, with exercises and animal training. In this way, in addition to their own professionalization, they yearn to become, who knows one day, a champion of the vaquejadas.

Cowgirl is also linked to values that involve the definition of the masculinity of the cowboy, both in the past and in the present. The cowherd universe is permeated by this issue, and it is not possible to ignore it. The specters that concern the definition of the cowboy's identity are directly related to concepts such as manliness, virility, pride, bravery, daring, fearlessness, honor, among other concepts evoked in this universe as a way for the cowboy to assert himself and prove his value before the group.

Albuquerque Júnior (2013), when explaining the historical-discursive contingencies that would contribute to trace and fix in the national imagination the figure of the Northeastern goat-male says that this is an identity manufactured in the context of the search for a definition of the cultural traits that would characterize us and distinguish

as a nation. In this sense, the references of an original, authentic culture would be located in the interior of Brazil and, more specifically, in the Northeast region.

It is in this context that a representation of the sertão will be instituted around symbologies linked to the past permeated by characteristic male figures such as the jagunço, the cangaceiro, the colonel, the landowner, the cowboy. The latter, even in the present, has been taken as one of the main characters that would characterize the "finished type" of the sertanejo.

These representations were, by force of repetition, being transmitted to each generation, with the reinforcement of the media, to inculcate an idea of the Northeast that generates and "sells" cultural goods that will serve different interests, especially those linked to the cultural industry.

This factor is very noticeable when one looks at another form of musical expression of the cowboy, traditionally identified by the predominance of the aboio and the toada. In the context of vaquejada, these rhythms no longer find a place among the new generations, who consider them "old", "out of fashion"; in its place, the presence of the famous walls playing at the last volume dictates the rhythm of the party, usually with the consumption of alcoholic beverages, which were always present, but now taking on a sophistication.

The consumption of alcoholic beverages, especially whiskey, also gives the dimension of what happens in the context of social interactions in this universe marked by the tension of knocking the ox down on the track, and thus managing to defeat opponents. The consumption of whiskey, and no longer of white cachaça, or cold beer is indicative of status, of ostentation, which would facilitate the conquest, the euphoric "catch the ladies" for their performance on the track, thus winning, for part of the companions, the certificate of a cowboy who is not soft, proving doubly his virility.

During the observations, in the exploratory phase, these signs were very evident, even in the handling of oxen in the bush, the incorporation of exogenous elements to the traditional handling of cattle in the caatinga, the walls or automotive sounds, the clothing, more similar to from meadow races in other regions of the country, except for the fortuitous presence of an older cowboy more attached to a leather hat.

A singular fact discovered during the interview phase was the number of cowboys who travel through these two universes, that is, they are at the same time cowboys who run with ox in the woods and track cowboys. Of the six participating families, three fit this profile: the Serra Branca, São João and Andorinha families, including runners between the first and second generations.

## VIII. CONCLUSIONS

The impressions that the study arouses are, without a doubt, provocative in the sense of helping us to think about the multiplicity with which backland cultures are constituted.

Thinking about the cultures of cowboys is thinking about the different forms of cultural expressions, identities, representations and belongings. This requires saying that they are plural processes, just as this group of people is plural, which is much more and greater than a bunch of people, it is strength, faith, material and spiritual manifestations of different people who were before, who are now and who it will be in times to come.

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# The Occupational Health and Safety Care Policy (PASS): The Case of the SIASS UNIVASF Unit

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**Keywords—** PASS. Worker's health. Unit of  
SIASS Univasf.

**Abstract—** The aim of this article was to analyze the Health and Safety at Work Policy of the Federal Public Servants (PASS), based on the case study of the SIASS Univasf Unit. The theoretical dialogues in this study were built from the concepts that make up Worker's Health. A qualitative and quantitative research was chosen as a methodological approach. In order to infer its results, we opted for the triangulation process consisting of a combination of three technical collection procedures: documentary research, in-depth particulars and online surveys. Qualitative data were prepared using content analysis based on Bardin (2016) with the support of the Atlas.ti 8 software and quantitative data using univariate descriptive statistics using Microsoft Excel.

## I. INTRODUCTION

There is growing interest in the field of study called Public Policy (PP), aimed at analyzing the relations between governments, governments and citizens. From this perspective, the PP are nothing more than the State in action, which includes the study of institutions, rules and analytical models that govern its political cycle. Furthermore, talking about PP is talking about its social actors (SOUZA, 2012; VIANA; BAPTISTA, 2012).

From a theoretical-conceptual point of view, public policy is not limited to the field of political science, being an interdisciplinary field, object of analysis by other areas of knowledge, such as: administration, law, economics and sociology (SOUZA, 2012).

Studies aimed at economic development have opened a new course of investigation, in which social and health policy are considered within the broader framework of the relationship between the State, economic development and

social protection systems, in the so-called Social Welfare State (DRAIBE, 2001; 2012).

Within the scope of Health Policies (HP), based on integrality, universality, equity and social participation, basic principles of the SUS, a new model of health care for workers emerges, supported by actions of assistance, promotion, surveillance and prevention of related diseases to work, called worker's health. A field that manifests itself at the heart of a democratic society, embodied in the achievement of rights and the free organization of workers (MARTINS et al., 2017).

Despite advances in the field of worker health in the private sector, it is observed that there remains a large gap in the health care of public servants. Only within the scope of the federal public administration is it defined the commitment to build and implement, in a shared way, a policy aimed at federal public servants governed by the Single Legal Regime (RJU), called the Health and Safety at Work Policy of the Federal Public Servant (PASS), a

movement that culminated in the creation of the Integrated Subsystem for Servant Health Care (SIASS), in 2009 (BIZARRIA et al., 2013).

According to the federal government, the PASS is configured as a transversal policy of workers' health, involving the different bodies of the federal public administration in three support axes: health care; health expertise; health promotion, prevention and monitoring. In turn, the institution of SIASS, as a structuring system, represents an advance in health care for federal employees, a way to guarantee and make the policy effective (BRASIL, 2010).

Like all social policies and programs, PASS and SIASS aim to guarantee the best living conditions for federal civil servants, making use of the management capacity of their implementing agents (public managers) to fulfill the wishes of their beneficiary agents (federal public servants).

That said, the Health and Safety at Work Policy of the Federal Public Servants in the perception of its social actors (implementing agents and beneficiaries) becomes fundamental in sustaining this work, carried out at the SIASS UNIVASF Unit. The case was chosen because of its importance for the regional development of the semi-arid Northeast, bringing together federal institutions from three states of the federation: Pernambuco, Bahia and Piauí.

From this perspective, this study proves to be extreme to expand and discuss scientific production in the field of public health policies, which play a fundamental role in the full exercise of citizenship, in the realization of different rights of collectivities and in the construction of a State with greater effectiveness in the field of worker's health, as established in the Federal Constitution of 1988 and in Law No. 8.080, of September 19, 1990, which, among others, consigns work as a determining and conditioning factor in the scope of the objectives of the SUS ( BRAZIL, 1988; 1990).

## II. WORKER'S HEALTH

The field of workers' health, as a public policy, was built on the different combinations of strength between capital, labor and the State. From the practices aimed at health-work relations, a transition process between the three models can be observed: occupational medicine, occupational health and worker health. Models that are present and alternate in hegemonic terms due to prevailing labor relations, the level of organization of workers and institutional policies (RAMMINGER; NARDI, 2007; ANDRADE, 2009).

Occupational medicine, as a medical specialty, emerged in the 19th century, in England, with the Factories Act, being the first legislation to be included in the field of

worker protection. Thus, the presence of a doctor inside the factories represented both an investigation of the causes that led to illness, and a way of recovering the worker's health, which is fundamental for the emerging production and industrialization line. Centered on the figure of the physician, in the context of work, reflecting a propensity to isolate specific risks and act on their consequences, medicalizing their symptoms or associating them with a legally recognized disease. In the same way, the diagnosis of disease in the selection phase works as a way to prevent the contracting of an agreement, whose health is compromised (MINAYO-GOMEZ; THEDIM-COSTA,

In addition to occupational medicine practices, the occupational health model emerges as a more extensive proposal. Despite this reduction and expansion, in practical terms, there are limitations related to the field of occupational medicine, as protective measures end up restricted to specific measures on the most evident risks. The use of individual protection equipment is emphasized, to the detriment of other collective protection instruments. Safety standards are established as a form of symbolic prevention, charging subordinate workers with the burden of accidents and illnesses, resulting in a double penalty (MACHADO; MINAYO-GOMES, 1995).

In this perspective, workers' health arises from the need for the State to intervene more importantly in the relations of the production process, in order to promote more dignified working conditions for workers. In a context of critical reflection, it goes beyond the conceptions and practices of the models in force until then, related to occupational medicine and occupational health, creating a way to deal with the work-health relationship in work environments and to introduce care practices to workers' health. It should be noted that the field of workers' health is under permanent construction, guided by the assumptions of collective health, in terms of the hegemonic conceptions of occupational medicine and occupational health (MINAYO-GOMES; THEDIM-COSTA, 1997; MINAYO-GOMEZ et al. al 2018).

On the other hand, the achievement of civil, political and social rights was responsible for the transformation of the State, expanding as institutions and as PP related to the functioning of Justice, the electoral system and the provision of social benefits, transforming achievements were fundamental for the consolidation of citizenship through the development of social protection systems in the Welfare State (FLEURY, OUVÉRNEY, 2012).

The protection of workers' health in Brazil occurs late compared to developed countries, being intensified from the 1980s onwards, with the promulgation of the 1988



Constitution and the institution of the Unified Health System (ANDRADE et al 2012; BIZARRIA et al., 2013).

Law n° 8,112 / 1990 is established as an important legal framework in the protection of the health of federal public servants, who until then did not have any instrument of protection. Despite advances in this area, the RJU's activities were limited to regulating medical leaves, occupational additional and the granting of disability pensions (MARTINS et al., 2017).

In this context, a Policy for Health and Safety at Work for the Federal Public Servants was born, an initiative, for a time, by the Ministry of Planning, Budget and Management (MPOG), aimed at providing health care to the civil servant based on the health relationship. - work, whose "government emphasis has always been on training and compensating public servants, without prioritizing the relationship between health and work" (RAMMINGER, NARDI, 2007, p. 217).

### III. THE PASS AND THE SIASS

The federal government, with the objective of minimizing the effective costs of the lack of a policy aimed at the health of the civil servant, through the Ministry of Planning, made efforts to institutionally respond to the gaps left in the health care of public servants, establishing the initial milestones for the construction of a health care policy for federal public servants, fulfilling the aspirations of the post-constituent political scenario and of international bodies such as the World Health Organization - WHO and the International Labor Organization - ILO (BIZARRIA et al., 2013).

From this perspective, a collective process of construction of the Policy for Health and Safety at Work for the Federal Public Servants begins through a broad debate carried out by the Federal Public Administration, with the formation of work groups composed of different federal institutions, union representatives and managers working in the area of worker health care (BIZARRIA et al., 2013).

The PASS is a cross-cutting worker's health policy, involving the different bodies of the Federal Public Administration, with actions in the areas of health care, official expertise and promotion, prevention and monitoring of the health of federal public servants (BRASIL, 2010 )

The inclusion of the worker's health field in the Brazilian governmental political agenda, provided by the broad debate in the different established participation forums, results in the creation of the Integrated Subsystem of Health Care for Servants (SIASS). A member of the Federal Administration Civil Personnel System (SIPEC), SIASS was established by Decree No. 6,833 of April 29, 2009,

under the Ministry of Planning, Budget and Management (MPOG), aiming to "coordinate and integrate actions and programs in the areas of health care, official expertise, health promotion and monitoring of the direct federal, autarchic and foundational administration" (BRASIL, 2009, p. 4).

For the federal government, the institution of SIASS represents an innovation in health care for federal public servants, a way to ensure sustainability and give effectiveness as PASS actions. As a structuring system, it enabled the articulation between the different bodies of the direct federal, autarchic and foundational public administration to standardize procedures and collectively create norms, actions, training projects and communication channels (BRASIL, 2010).

From this perspective, it started from a conception restricted to occupational health to the concept of worker's health, in which "work-health relations presuppose interdisciplinarity and the participation of workers as subjects and centers for planning and implementing the actions of processing the processes of work "(MARTINS et al., 2017).

The Ministry of Planning assumes a strategic role in the articulation and implementation of the SIASS Units, with the signing of Technical Cooperation Agreements (ACTs) between the bodies and the optimization of existing and dispersed human, physical and material resources among the various Administration institutions Federal Public (BRAZIL, 2009).

The PASS aims to offer public servants, in particular managers of people and health professionals, a set of parameters and guidelines to guide the development of projects and the achievement of health and safety care actions, which presuppose the development of actions based on the work of a multidisciplinary team, on epidemiological information, on the assessment of work environments and relationships and on the dialogue between its three axes of action (BRASIL, 2010).

Consider the support axes of the PASS pursuant to Article 3 of Decree No. 6.833 of April 29, 2009:

**I - health care:** actions aimed at prevention, early detection and treatment of diseases and also the rehabilitation of the civil servant's health, comprising the various areas of action related to healthcare for federal civil servants;

**II - official expertise:** medical or dental action with the objective of evaluating the state of health of the server for the exercise of their work activities; and

**III - health promotion, prevention and monitoring:** actions with the objective of intervening in the civil servant's illness process, both in the individual aspect and in collective relationships in the workplace (BRASIL, 2009, p. 4, our emphasis).

Given the above, a triad formed by the axes that support the policy must be based on interdisciplinary actions that modify work environments and processes, allowing its social actors (implementing agents and beneficiaries) to become active and central subjects in its planning and execution (MARTINS, 2017).

#### IV. METHODOLOGICAL PROCEDURES

This research stands out as descriptive and exploratory, proposing to know the perceptions of social actors about the PASS in the SIASS UNIVASF Unit and the way in which it is being implemented in federal institutions.

Taking a stand on philosophical, ontological and epistemological conceptions, a social constructivist conception was adopted in this study, which aims to trust the participants' perception of their own reality (CRESWELL, 2010).

To reach the proposed research proposal, qualitative and quantitative approaches are used, understanding that together these approaches are greater than one or the other in isolation. In this sense, the mixed method and the sequential exploratory strategy based on Creswell (2010) were adopted, a procedure determined to be more appropriate to the interdisciplinary nature of this study.

Regarding the sequential exploratory strategy, a qualitative phase was carried out before, aimed at the managers of the institutions and, later, a quantitative phase involving the institutions' federal civil servants, with greater weight being given to the qualitative phase.

The research strategy adopted was the incorporated single case study based on Yin (2015) and included 10 (ten) units of analysis and multiple sources of evidence, through a triangulation process, which forms the development of convergent lines of investigation, consisting of a combination of three technical collection procedures: documentary, private, in-depth individual research and an online survey.

As for the analysis of the results obtained, qualitative data were found in the content analysis based on Bardin (2016) with the support of the Atlas.ti 8 software and quantitative data in the univariate descriptive statistics with the aid of Microsoft Excel®.

Regarding the time frame, a cross-sectional study was carried out during a six-month period, between March and August 2019, at the SIASS UNIVASF Unit.

The scientific research is based on the perception of the social actors of the PASS that make up a SIASS UNIVASF Unit, that is, the implementing agents (federal public managers) and beneficiaries (federal public servants) of the institutions participating in the ACT 2018.

A manager from each participating institution of the ACT celebrated with a SIASS UNIVASF Unit was selected to respond to the individual in depth. The corpus of this research was composed altogether by 10 (ten) individual in depth, and of the 10 managers interviewed, only 01 did not have higher education. In addition, the time in the exercise of the function varies between 08 months and 10 years, depending on the manager.

An online survey aimed at federal public servants participating in the ACT of the SIASS UNIVASF Unit was carried out through Google Forms and concluded with a total of 672 respondents, corresponding to 22.4% of the universe.

It is evident that the institutions with the highest number of respondents were the Federal Institute of Sertão Pernambucano (IF SERTÃO) and UNIVASF, with 212 and 203 participants, respectively, a result proportional to the number of employees working in each institution. Employees working in 33 municipalities belonging to the three States assisted by the SIASS UNIVASF Unit participated in this research: Pernambuco, Bahia and Piauí. The majority (489), located in the cities of Petrolina / PE (336) and Juazeiro / BA (153), a result that highlights the scope of action of the Reference Unit and the study carried out

#### V. THE CASE OF THE SIASS UNIVASF UNIT

The Federal Employee Health Care Integrated Subsystem Unit - SIASS UNIVASF, was established on 06.10.2010 under the Ministry of Planning, through the Technical Cooperation Agreement No. 12/2010 as an integral part of the Health Care Policy and Workplace Safety of the Federal Public Servants (PASS). Headquartered on the headquarters of the Federal University of Vale do São Francisco (UNIVASF), it is a single reference unit in the interior of the State of Pernambuco, operating in three states: Pernambuco, Bahia and Piauí. It currently has 10 (ten) participating federal institutions

As a structuring body of PASS, it coordinates and executes a policy for a total of 3,000 (three thousand) federal civil servants, belonging to the different bodies

participating in the Technical Cooperation Agreement (ACT) signed.

The SIASS UNIVASF Unit has a multidisciplinary team formed by 17 (seventeen) professionals from different areas of activity, including physicians, nurses, psychologists, nutritionists, occupational safety technicians, completing care actions, injuries and health promotion of federal public servants under their responsibility.

Regarding its physical structure, it has its own headquarters, inaugurated with investments from the Ministry of Planning on April 25, 2015, including facilities that are modern and comfortable, with a wellness room, a social room, three rooms for multidisciplinary care, an auditorium with 40 seats, in addition to administrative rooms, to better serve the federal public servant.

## VI. THE IMPLEMENTATION OF THE PASS IN THE SIASS UNIVASF UNIT

The documentary research consisted of verifying, at the local level, the implementation of PASS actions in the participating institutions, through the fulfillment of the signed ACTs and respective work plans, whose supervision and monitoring of actions are the responsibility of an inter-institutional committee by a representative of each participating institution.

It was found that between 2010 and 2018, a total of 8,633 (eight thousand, six hundred and thirty-three) consultations were carried out for civil servants, dependents and visitors in transit in the expert sector of the SIASS UNIVASF Unit.

Based on the basic numbers, it is possible to observe that most demands for official expertise in health come from institutions, to demonstrate the scope of the technical cooperation agreement signed and the full functioning of this axis of the policy.

Based on the accounts of the managers in the depth of people, it was identified that only 02 (two) institutions implemented actions in the three axes of the policy, which indicated the low level of involvement of the implementing agents with the celebrated ACT. It was also evidenced that for the vast majority, the agreement is limited only to material exchanges and existing human resources as a result of the medical expertise carried out by the SIASS UNIVASF Unit.

From the point of view of the beneficiary agents, it was verified, from the online survey, that there is a significant level of ignorance about the PASS in the participating institutions, revealing that although the SIASS Unit is recognized for the importance of its actions for the public servant federal government, is not perceived by its

beneficiaries as the executing agency of a public health care policy.

Based on the triangulation of the results obtained through documentary research, in-depth individual needs and the online research carried out, it can be attested that, in addition to representing most of the demand, the official expertise in health is the only axis carried out by the Reference Unit base for the 10 (ten) participating institutions of the celebrated ACT.

It is also noted that the responsibility for implementing the health promotion and surveillance axes in the SIASS UNIVASF Unit was expressly transferred to the participating institutions, through the work plan drawn up from the celebrated ACT. However, the civic commitment assumed by the institutions themselves is not being fulfilled in its entirety and neither is it supervised by the interinstitutional commission translated to this manufacturer, contrary to the legal precepts contained in Decree No. 6.833 / 2009 that instituted the SIASS in national terms.

It was also evidenced that the PASS is not perceived by managers and federal public servants as a public policy for the health of the public servant. Therefore, it is perceived by its social actors (implementing agents and beneficiaries) as a mere partnership to carry out expertise in health, which reflects a fragmented view of the policy, which should invoke health in its unrestricted and integral sense, embodied in interdisciplinary actions in its three support axes: promotion, health surveillance and official expertise, respectively in that order (MARTINS, 2017).

From this perspective, it is possible to infer an inversion in the general scope of the policy, idealized and conceived within a worker's health model, benchmarks are prevention, promotion and health surveillance, contrary to the conceptions and practices restricted to operations performed after the illness of the civil servant, which refer to the retrograde models of occupational medicine and occupational health (MINAYO-GOMEZ et al 2018).

## VII. CONCLUSIONS

Without intending to exhaust all theories on the subject, the result presented shows a clear gap between the central objective of PASS - preventing illness and promoting the health and safety of the server's work - and the way it is being implemented and perceived by its social actors in the participating institutions in the SIASS UNIVASF Unit. In practice, only the official health expertise axis was fully implemented.

In view of the factual situation, as Martins (2017) points out, promoting health surveillance and promotion actions

that modify work environments and processes, transforming the main causes of illness into information that promote the improvement of health care for federal public servants is the PASS's main challenge pointed out at the SIASS UNIVASF Unit in the field of worker's health.

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# Performance Test on Modified Block Ice Crusher Using Double Crusher System in Sorong West Papua

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**Keywords—** Modification, Ice Crushing Machine,  
Effectiveness.

**Abstract—** The modification of the ice block machine using a double crusher system in this study has dimensions of 100 cm long, 80 cm wide and 115 cm high. Some of the machine components are made using stainless steel and steel. The propulsion engine uses a 7 HP gasoline engine. The working system of this machine is to use two ice block counters that rotate in opposite directions so that it will speed up the process of chopping ice blocks. The number of blades in each chopper is 36 and 42 blades. The engine production capacity at 800rpm shaft rotation produces 117,47 kg/minute or 7.048,2 kg/hour. The results of the chopped size varied from 2 to 7 mm. This machine is very effective with a target output of 3000kg production capacity while the actual output is 7048.2 kg/hour.

## I. INTRODUCTION

Fish is one of the food products with a soft meat structure and has a high water content of about 60 to 70%, so that fish will experience a very fast decay process. So good handling is needed on the ship so that the quality of fish remains good to consumers. One of the handling of fish on the ship is using ice blocks. The method of crushing ice blocks carried out by fishermen is still done conventionally, which is only using wooden blocks as a bat to crush them. This method requires quite a long time and tiring effort. This method produces chunks of ice that are still large, sharp and non-uniform. The chopped results are less effective when used to cool fish because it can injure the physical condition of the fish and the large size of crushed ice cannot directly enter the fish crevices so that the quality of the fish decreases. In previous studies, various designs of block ice crusher machines have been carried out but still use a single crusher system. The disadvantage of this machine is that it still takes quite a long time in the process of chopping ice cubes. The development of fishery equipment technology is still being carried out in order to increase the productivity of fishermen.

The ice block chopper machine using a double counter (Azis, 2006) has provided fairly even chopping results because the counters work separately and each has a filter at the bottom of the counter. The disadvantage of this ice crusher is that it is too heavy and difficult to move. In addition, caution is required when moving the pulley transmission system and gears when changing the ice chopper drum to be used. The ice block machine in this research is to modify the machine using a double crusher system. This chopper uses a gasoline engine driving engine with a power of 7 HP.

The working system of this machine is that one driving machine moves two crushers that rotate simultaneously in opposite directions, so that the ice cubes will be crushed through the two sides of the surface. This system will speed up the ice cube counting process. This machine is very applicable, can be used on ships or in general because it has dimensions of 100 cm long, 80 cm wide and 115 cm high and weighs ± 62 kg. How to operate this machine is very easy and can be operated by one operator.

## II. RESEARCH METHODS

The method used in this research is the experimental method and then trial and learn is carried out, so that in the research the design and manufacture of the tool will be carried out, experiment and direct testing of the tool, then evaluate and repair the machine whether it is in accordance with the objectives to be achieved. This research was conducted in the machinery laboratory of the Sorong State Middle School of Fisheries, West Papua.

### 2.1 tools and materials

The tools that will be used in this research are tools that are in the workshop such as grinding machines, welding machines, drilling machines, lathes, vise, screwdrivers, ring wrenches and fittings, pliers, caliper, roll meter, elbow ruler, scraper, tachometer. While the materials needed in this study were a 7 HP drive motor, 22 cm diameter gears, 5 cm angle iron, 1,2 mm stainless steel plates, stainless steel shafts, pulleys, v belt transmissions, bolts and nuts and bearings.

### 2.2 design

Modifications are changes made to an objects from its original form, either adding or subtracting components without reducing the function of the tool. While the design is the drawing, planning, and sketching or arrangement of several separate elements into a unified and functioning unit (Pressman 2002).

Design Results in 3D Drawings Using the Google Sketch up Pro 8 Application

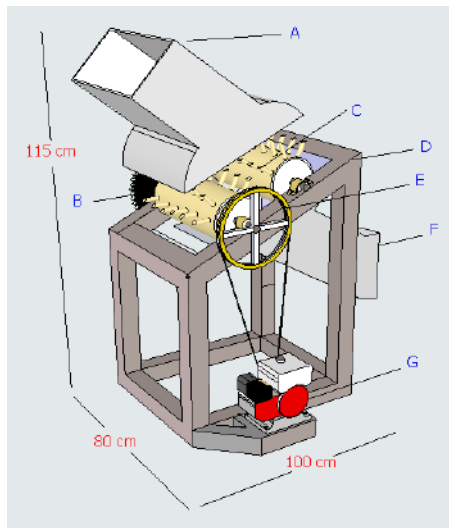


Fig.1: Design sketch of block ice crusher machine using double crusher

Information:

- A. Inlet
- B. Gears

- C. Crusher
- D. Frame
- E. Pulley
- F. Outlet
- G. Drive engine

## III. RESULTS AND DISCUSSION

The design of the modified block ice crusher machine using the double crusher system in this study is the result of collecting data and information about the advantages and disadvantages of the block ice crusher machine that has been designed and made in previous studies. So that the manufacture of components and the addition of several components of the block ice crusher is designed according to the calculations in previous studies.

### 3.1 welding joint strength

In this design, the most critical part is the ice counter. The type of welding electrode used is type E 6013 with a maximum tensile strength of 60,000 psi, of which 414 N/mm<sup>2</sup>. As for the machine parts made of stainless steel using welding electrodes Jnis E 308 S 1.6 mm.

Shear stress (tg)

$$t_{(g)} = F / (0.707 \cdot t \cdot L \cdot N)$$

Where:

tg = Shear stress (N/mm<sup>2</sup>)

T = Welding thickness

F = Load received

N = Safety factor

### 3.2 drive engine power

The amount of engine power can be calculated using the equation:

$$P = Ft_{tot} \cdot V_c$$

Where:

P = motor power (w)

Ft<sub>tot</sub> = Total force (N)

V<sub>c</sub> = Linear speed of shaft (m/s)

$$Ft_{tot} = Mt_{tot} \cdot g$$

Mt<sub>tot</sub> = Total mass (Kg)

G = Gravity

Mt<sub>tot</sub> = Mass of shaft + mass of cylinder + mass of pulley (weighed)

### 3.3 pulley calculation

In the design of the pulleys used are V-groove pulleys, 2 pulleys are used, namely: the driving pulley on the motor

shaft with a diameter of 3 inches (dp) and a driven pulley with a diameter of 12 inches (Dp). The rotation of the driving motor is a maximum of 3600 rpm (n1). So that the final round (n2) can be determined as follows:

$$\frac{n_1}{n_2} = \frac{D_p}{d_p}$$

**3.4 gear calculation**

The gears used are straight gears.

To determine the number of teeth using the equation:  $N = P \cdot d$

Where N = number of teeth

P = Circular pitch in in (the distance measured on the puncture circle between two equal points on two adjacent teeth.

d = diameter of the puncture in

Meanwhile, to determine the radius of the base circle of the gear can be calculated using the equation:  $r_b = r \cos \Phi$

**3.5 number of blades**

The number of blades is 36 and 42 in each chopper. The blade length is 50mm and the diameter is 10mm. Installation of the blades with a distance of 40 mm so that if the two crushers rotate and the blades meet each other it will be 15 mm apart. This distance is to avoid collisions between the blades due to the bending stress on the blades due to the impact load. The shape of the blade really determines the result of chopped ice cubes. The tip of the blade is cut at a 45° angle to create a sharp angle and prevent detarmination

The results of the design of the tool can be seen in the image 02 below



Fig.2: The result of the design of a block ice crusher using a double crusher system

**3.6 performance test**

The performance testing of the block ice crusher machine in this study focused on the turnaround time, so that the

machine performance testing was carried out in three treatments. The time required can be set by varying the rotation of the shaft. In the first treatment using an output of 600 rpm, the second treatment with 700 rpm and in the third treatment using 800 rpm. Each treatment was carried out five (5) times. Machine performance testing is done by crushing 1 ice block in each treatment. The crushed ice blocks measure 18x18x100 cm and weigh approximately 30kg.

The time required to complete the tool testing for each treatment and repetition can be seen in the table 01 below

Table.1: Tool Testing Time

Repeat	Treatment		
	600 rpm	700 rpm	800 rpm
I	21,63 s	18,56 s	16,16 s
II	22,49 s	16,05 s	15,43 s
III	21,95 s	16,79 s	14,14 s
IV	22,03 s	17,63 s	15,45 s
V	22,31 s	18,29 s	15,58 s
<b>Average</b>	22,082 s	17,464 s	15,352 s

From the table above, it can be seen that the completion time of each replication in each test did not occur such a significant time difference, which in the 600 rpm test the test could be completed with an average time of 22,082 seconds, then at 700 rpm can be completed with an average time of 17,464, while at 800 rpm it can be completed with an average time of 15.352 seconds. When compared to a single crusher machine that has been made previously, the test results of the machine are much better than the results of previous studies, where the results of the best research conducted by Syharuddin Rasyid 2017 with a test result of 191 seconds on ice blocks measuring 20 x 20 x 120 cm.

For the production capacity of crushed ice blocks based on rpm and speed of completion of the test can be seen in the table below.

Table.2: Machine Production Capacity

Repeat	Results of the count (weight kg / min)		
	600 rpm	700rpm	800rpm
I	83,21 kg	96,98 kg	111,38 kg
II	80,03 kg	119,60 kg	116,65 kg

III	82,04 kg	107,20 kg	127,29 kg
IV	81,70 kg	102,09 kg	116,50 kg
V	80,68 kg	98,41 kg	115,53 kg
<b>Average</b>	81.52	104.85	117.47
	kg/minute	kg/minute	kg/minute

From the table it can be seen that the production capacity is different for each rpm difference where at 600rpm it can produce an average of 81,52 kg/minute or 4.891.2 kg/hour of crushed ice, then at 700rpm it can produce an average of 104,85kg/minute or 6.291 kg/hour and at 800rpm it produces 117,47 kg/minute or 7.048.2 kg/hour. With this production capacity, this block ice crusher machine will be very effective when used by fishermen because it will greatly save time at work.

Then for the results of the size of the count on the engine performance test, it can be seen in the table below

Table.3: Size of Crushed Ice Cubes

Repeat	Size of crushed ice cubes		
	600 rpm	700rpm	800rpm
I	3 – 7 mm	3 – 6 mm	2 – 6 mm
II	3 – 7 mm	3 – 6 mm	2 – 6 mm
III	3 – 7 mm	3 – 6 mm	2 – 6 mm
IV	3 – 7 mm	3 – 6 mm	2 – 6 mm
V	3 – 7 mm	3 – 6 mm	2 – 6 mm

From the table above, the size of the count is quite uniform in each repetition of the test. At 600rpm rotation, the size of the pieces is 3-7mm, at 700rpm it is obtained with a size of 3-6mm and at 800rpm with a size of 2-6mm.

The recommended size of ice grains is 1-2 cm (Suhana: 2010). Ice chunks that are still large are less effective, because they do not quickly cool the temperature of the fish. However, if the size is too small (in the form of shavings) it will be better because it can cool the temperature of the fish quickly but melts faster. This can be overcome by improving the fish storage container with a better one, so that even though the size of the fish flakes is smaller, it is not easy to melt and will speed up the cooling process of the fish. By using this machine, the results of breaking ice blocks are more evenly distributed,

which is about 2-7mm and the breaking process is faster than the machines in previous studies.

### 3.7 effectiveness level

Effectiveness is usually carried out together with efficiency, although they look the same, they actually have different meanings. Effectiveness emphasizes more on the results achieved, while efficiency looks more at the process to achieve these results well. So to achieve an effectiveness, the following effectiveness formula can be used:

$$\text{Effectiveness} = (\text{Actual Output} / \text{Target Output}) \geq 1$$

If you compare it with the results in the research of T. Azwar and Pribadyo in 2015, the calculation of the production capacity is 33,411 kg/minute or 2004,66kg/hour, so in this study the target to be achieved is 50 kg/minute or 3000kg/hour with a chopped size which is desired. So that the level of effectiveness in this study are:

$$\text{Effectiveness ( Actual output / Target output)} \geq 1$$

$$= 7048.2/ 3000 = 2.3494$$

= 2.3494 > 1 then the level of effectiveness is achieved or the actual output is 234.94% greater than the target output.

## IV. CONCLUSION

By using this double chopper, the time required in the process of chopping ice blocks will be faster than using the previous chopper machine. With relatively small dimensions, this machine is very applicable, can be used on ships or in places in general. In each process, the ice block measuring 30 kg can be completed in 15,352 seconds. With a high production capacity and desired chopping results, this chopper machine is very effective when applied by fishermen. Using stainless steel material, the machine meets food safety standards and does not contaminate fish products.

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# Influence of Physical Activity on Side Effects in Women with Breast Neoplasms Undergoing Chemotherapy Treatment

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**Keywords— Breast Neoplasms, Pharmacological Treatment, Exercise.**

**Abstract—** The aim of this study was to describe the influence of physical activity practice by women with breast cancer undergoing chemotherapy treatment and its side effects. This is a descriptive, cross-sectional study with a quantitative approach, carried out from September to November 2015. Among the women interviewed who practice physical activity, walking was the most prevalent activity (49.5%). There was a predominance of the presence of symptoms in women who do not engage in physical activity, however, among those who do not have symptoms, those who do not engage in physical activity predominated. The most common symptoms reported by them were nausea and fatigue, both corresponding to the group of women who did not perform any activity. It is concluded that the regular practice of physical activity brings with it several beneficial factors for the body and presents itself as a determining factor for the reduction of side effects in patients with breast cancer undergoing chemotherapy.

## I. INTRODUCTION

Cancer is a systemic and multifactorial disease characterized by rapid, abnormal and uncontrolled cell growth that culminates in the formation of invasive and poorly delimited tumors. These anomalous cells can spread throughout the body through the circulatory system and reach different tissues, constituting metastases [1].

With a high incidence and mortality rate, breast cancer is the most common and feared type of cancer among women because it affects the perception of self-

image and female sexuality, in addition to being a large-scale public health problem [2].

Genetics, lifestyle, environment and hormonal issues are factors that, when correlated, present themselves as high risk for the emergence of breast cancer [3].

The treatment of choice for the various types of cancer, which currently has the greatest prospect of cure, is chemotherapy. These drugs are transported to various tissues of the body through the bloodstream, reaching small, difficult-to-access tumor cells and destroying them [1, 2]. The advance of technology in chemotherapy

combined with the early diagnosis of the disease has increased the chances of a cure for breast cancer [4].

However, such treatment carries with it several unwanted consequences that negatively affect the quality of life and are caused due to the cytotoxic effect of drugs on normal cells, since tumor cells behave in a non-specific way, thus making it difficult to isolate from others [5].

The most common side effects of chemotherapy treatment are nausea and vomiting. However, other symptoms may arise, such as mucositis, diarrhea, anorexia, stomatitis, abdominal pain and discomfort [5]. Depression, anxiety and fatigue are also side effects of chemotherapy [1], as well as anemia, general malaise and insomnia [4]. In addition, there is a reduction in steroid hormones in the body that can lead to a precipitous menopause. [1]. Given the variety of adverse symptoms, the individual tends to reduce the practice of physical activity. This inactivity contributes to an increase in personal weakness, intensifying side effects and decreasing their functional and interpersonal capacity [4].

Physical activity is an important protective factor against breast cancer, in addition to alleviating unwanted symptoms resulting from the treatment [3]. It works by directly modifying the body's metabolism, reducing the harmful effects caused by the reduction of steroid hormone levels, stimulating the body's energy balance [3], and increasing the secretion of endogenous opioids that reduce pain levels [4].

The Pernambuco Cancer Hospital (HCP) has been providing health care services in the oncological field for 70 years, and is a reference point for the treatment of cancer, serving about 55% of cancer patients in the state. This study aimed to describe the influence of the practice of physical activity on the most prevalent side effects that affect women with breast cancer undergoing chemotherapy treatment in this hospital.

## II. METHODS

It was a descriptive, cross-sectional study with a quantitative approach. Carried out at the Outpatient Unit of a clinic specializing in Breast Pathology at the Cancer Hospital of Pernambuco (HCP), from September to November 2015. The HCP is characterized by being an institution that began its activities in a philanthropic manner on November 9, 1945. Since its creation until the present day, it has become a reference in its field of action in the North and Northeast of Brazil and, throughout its trajectory, it plays the role of assistance to cancer patients, as well as information to the population about the importance of preventing this injury.

The sample calculation was performed based on the estimated proportion, as it was intended to identify it

for the number of women with breast cancer undergoing chemotherapy.

Considering that the monthly mean of patients with breast cancer undergoing chemotherapy at the HCP was 1800 (N) and some statistical values were constant, such as the 95% confidence level ( $z = 1.96$ ) and the error (e) or (d) 5%, a sample (n) of 317 patients was obtained, having as reference a finite population.

As inclusion criteria, we considered female patients with breast cancer, undergoing outpatient chemotherapy at the HCP, aged 18 years and over and with communication skills for reading and writing comprehension. As exclusion criteria, there were female patients in a different treatment modality from chemotherapy.

The data collection procedure was performed as follows: the Informed Consent Form was delivered, read and explained to each of the 317 women at the time they were undergoing chemotherapy at the HCP outpatient clinic. When they agreed to participate in the research, they signed it showing agreement, and then responded to the collection instrument with information about their clinical treatment.

The clinical profile data were described by analyzing their frequencies (absolute numbers) and isolated and interval percentages in which they were present in the study population. For some variables of these profiles, means, standard deviation and minimum and maximum values were also presented.

The present study is an excerpt from a Master's thesis authored by Cristina Albuquerque Douberin, which was submitted and approved by the Research Ethics Committee of the Pernambuco Society for Combating Cancer under CAAE n° 45583415.0.3001.5205; and defended by the author by the Associate Graduate Program in Nursing at UPE/UEPB, in May 2016.

## III. RESULTS AND DISCUSSION

Table 1 addresses the frequencies and percentages of women who practice physical activity, highlighting the walk as the most performed, indicated by 47 of those who reported performing physical activities (49.5%). It should be noted that the percentages of the types of exercises were calculated based on the responses of the 95 women who responded positively, which may indicate more than one physical activity.

Only a minority of patients reported practicing physical activity (30.0%), and of these, 49.5% indicated walking as the most practiced physical exercise, followed by physiotherapy (45.3%).

Consulting the literature regarding this variable mentioned above, it was found in the study by Evangelista

[6] also that only a minority (37.9%) of patients with breast cancer practiced physical exercise and, of these, 14.4% chose walking as the most common physical activity.

Table 1 – Physical activity and type of physical exercise performed. Recife, PE, Brazil, 2015. (n = 317)

Variable		Frequency	Percentual
<b>Does not exercise</b>		222	70%
<b>Do physical exercise</b>		95	30%
<b>Type of exercise (n=95) *</b>	Walk	47	49,5
	Physiotherapy	43	45,3
	Bodybuilding	05	5,3
	Hydrogymnastics	02	2,1
	Ballet	01	1,1
	Pilates	01	1,1

Source: Survey data, 2021.

Table 2 shows a simple association between the practice of physical activity and the presence of symptoms, demonstrating that there is a predominance of the presence of symptoms in women who do not engage in physical activity. However, among those who do not, predominated those who do not practice physical activity.

It was also possible to notice that 26.2% of the practitioners of physical activity felt or felt some symptom

of the treatment, with fatigue and nausea being the most prevalent with 26.1% and 23.9%, respectively. On the other hand, the rate of women who did not perform physical activity with the presence of symptoms was higher (63.4%). Among these, the preponderance of nausea (52.8%) and fatigue (57.7%) was also quite evident.

Table 2 – Proportions of patients according to physical activity and presence of symptoms. Recife, PE, Brazil, 2015. (n = 317)

Physical activity practice	Has some kind of symptoms		Total
	Has symptoms	No symptoms	
<b>Do physical exercise</b>	83	12	95
	(26,2%)	(3,8%)	(30,0%)
<b>Does not exercise</b>	201	21	222
	(63,4%)	(6,6%)	(70,0%)
<b>Total</b>	284	33	317
	(89,6%)	(10,4%)	(100%)

Source: Survey data, 2015.

Table 3 shows an association between the variable practice of physical exercise with the variables related to the type of symptom presented. In this one, the symptom of nausea stands out, as it was reported by 150 women, and that of fatigue, which appeared with 164 marks, both corresponding to the group of women who did not perform physical activity. Only a minority of patients

reported practicing physical activity (30.0%), and of these, 49.5% indicated walking as the most practiced physical exercise, followed by physiotherapy (45.3%). It was also possible to notice that 26.2% of the practitioners of physical activity felt or felt some symptom of the treatment, with fatigue and nausea being the most prevalent with 26.1% and 23.9%, respectively. On the



other hand, the rate of women who did not perform physical activity with the presence of symptoms was higher (63.4%). Among these, the preponderance of

nausea (52.8%) and fatigue (57.7%) was also quite evident.

Table 3 – Distribution of percentages of women according to the practice of physical activity and who present some type of symptoms. Recife, PE, Brazil, 2015. (n=284)

Physical activity practice	Symptom Type					Total
	Nausea	Vomiting	Mucositis (inflammatio)	Anorexia	Fatigue (tiredness)	
<b>Do physical exercise</b>	68	42	46	37	74	<b>95</b>
	(23,9%)	(14,8%)	(16,2%)	(13,0%)	(26,1%)	
<b>Does not exercise</b>	150	98	114	98	164	<b>222</b>
	(52,8%)	(34,5%)	(40,1%)	(34,5%)	(57,7%)	
<b>Total</b>	218	140	160	135	238	<b>317</b>
	(76,8%)	(49,3%)	(56,3%)	(47,5%)	(83,8%)	

Source: Survey data, 2015.

Prado et al [7] they saw that most women, in turn, performed exercises that would be good for their rehabilitation in reducing sequelae resulting from the treatment, that is, they probably practiced physical therapy. Silva [8] they also found a similar result when they reported that 73.1% of their sample of patients did not perform physical activity. For those who preferred walking as the most common activity, they justified their choice by the fact that this is a “natural” exercise modality and because it does not require great demands, and can be performed outdoors. Another fact that can also justify this preference is that governments base their campaigns to encourage the practice of physical activities on the basis of publicizing the walk [9]

Mock et al [10] suggested that walking, even when practiced at low levels, can reduce fatigue and emotional discomfort and, at the same time, improve the physical functioning and quality of life of breast cancer patients receiving chemotherapy.

The improvement in quality of life related to the regular practice of physical exercises lasting at least 30 minutes, in patients undergoing chemotherapy treatment, corroborates the literature [6], therefore, it is seen as something beneficial, as it reveals a positive psychological effect on mood, improves functional capacity and increases the appetite of patients in general. [7], in addition to increasing the secretion of endogenous opioids, thus decreasing pain [4].

Physical activity, regardless of its intensity, is sufficient to reduce fatigue in breast cancer survivors [11].

It is concluded, therefore, that physically active patients with such neoplasia have less fatigue compared to those who do not exercise, because the absence of physical activity can lead to a decline in physiological and psychological functioning, which may support the fact that they are more prone to symptoms such as nausea and fatigue as identified here [12].

#### IV. CONCLUSION

A minority practiced physical activity, especially walking. Correlating the practice of physical activity with the presence and type of symptoms presented, it appears that physically inactive patients had more side effects to the treatment, with fatigue being the most prevalent of them. Therefore, it is concluded that the regular practice of physical activity brings with it several beneficial factors for the body, and presents itself as a determining factor for the reduction of side effects in affected patients with breast cancer undergoing chemotherapy treatment.

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## Covid-19 effects on cybersecurity issues

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**Keywords—** *Pandemic, Cybercrimes, Vulnerable, Cybercrimes, Technology, Internet, Cyberspace.*

**Abstract—** *This scientific initiation article will bring up current and very relevant questions about the effects suffered in the virtual world after the announcement of a pandemic, with regard to the growing number of crimes committed by virtual means, considering that the use of the internet for practically any and all daily activities became mandatory. We will show the activities that needed to adapt to the new reality, as well as the increase in cybercrime that came to affect, in particular, those whose expertise and technological knowledge do not match reality. We will also talk about the victims of these crimes and conclude with a cybersecurity protocol which can be applied to minimize risks and hinder the actions of opportunistic offenders.*

### I. INTRODUCTION

In the 21st century, the world began to live with a somewhat limited and dark reality, making people, even those with no affinity for technology, feel the need to use digital equipment, especially those connected to the Internet. Such resources minimize idleness, facilitating the maintenance of work, educational, and other activities.

We will show the methodology that was used to develop the research for this paper and why we decided this was the best method.

First of all, we will discuss the use of technologies associated with the Internet in times of pandemics, where the potentialization of online services and the increase in the number of hours of access to the world wide web have awakened in cybercriminals an unparalleled opportunity to practice their crimes, often taking advantage of the vulnerability and lack of knowledge of Internet users.

Next, we will address the issue of criminal opportunity in the face of the new global scenario

scenario, namely, the officialization of a pandemic. In this aspect, we will make a brief analysis of how cybercriminals have taken advantage of the virtual services that have become part of people's daily lives, in order to put into practice their cyberattacks and obtain illicit profits.

In the third part we will expose the criminal opportunity in the face of the new global scenario, since people, due to social isolation because of the pandemic, had the need to resort to technological resources connected to the Internet to perform their daily and work activities, becoming more vulnerable to cybercriminals who took advantage of the moment to practice cybercrime.

Continuing the subject, the fourth part brings a specific explanation about a work model called home office, which consists of obeying social isolation, making company employees work remotely from their own homes. However, we will show that due to the habit of not practicing cybersecurity protocols, they ended up being targets for cybercrimes, which brought irreparable damage to companies and organizations.

The fifth part of the article will bring to the reader a reflection on the greater vulnerability of children and adolescents in face of the greater time spent accessing the Internet in times of pandemics, since this excess, considered as something normal by the vulnerable, can bring about a digital addiction and thus lead to a series of problems, both in terms of mental health and physical integrity.

In the penultimate part, we will address a very relevant point that sometimes gets forgotten, that is, the victim being considered guilty for the cybercrimes he/she suffers. We will show that most victims of cybercrime do participate, but we cannot blame them for not having the expertise to enter the virtual world.

The last one will bring the reader two tables of protocols that can be used, both in the enterprise and in the home, to minimize the chances of being being targeted by cybercriminals.

We will end with a reflection on the consequences brought about by the worldwide spread of a deadly virus called Sars-cov-2, or simply COVID-19 or Coronavirus, which besides causing changes in real life, has brought about major changes in the activities developed in the virtual environment, that is, in cyberspace.

## II. METHOD

The methodology applied was qualitative, characterized by the analysis of other articles and official documents that bring information related to the theme addressed.

From this content, extremely current, we can describe the modification which begins with the user's behavior, as well as the delinquents who, taking advantage of this pandemic moment and of people's great vulnerability, have invested in the practice of cybercrime.

The study relied on a considerable volume of scientific articles, so that the necessary knowledge was extracted from each one to develop relevant information to compose our scientific research.

Based on the explored content, we extracted several information ranging from the association of Internet use in times of pandemic to the main resources to minimize cyberattacks.

Finally, we show the conclusion that was drawn after the study and that will certainly contribute to society in general, since the connectivity, nowadays, reaches a large part of the world's population, regardless of social class.

## III. RESULTS AND DISCUSSION

### USE OF INTERNET-ASSOCIATED TECHNOLOGIES IN TIMES OF PANDEMIC

In face of the new scenario in which the world found itself, that is, the announcement of the spread of a virus called COVID-19, or popularly called the new CoronaVirus (Sars-cov-2), people had the need to adapt to changes in their lives, whether at home, in education, in the family, or at work.

The use of the Internet has become a more than essential tool, due to the prohibition of physical contact between people. Virtual communication has gained strength, so much so that all areas in which our lives are involved have needed to adapt, in order to reduce the damage caused by this dangerous and deadly virus.

The potential of the internet, especially social networks, has brought a series of benefits for people, as they feel the need to keep in touch with each other. Several activities have gained prominence in this current moment, lives have become a word of everyday life, where artists have found space to perform their shows, politicians run electoral campaigns, physical educators promote activities that can be performed at home, many run solidarity campaigns, and a series of entertainments that help to improve the psychological and physiological factor of those isolated by quarantine.

On the other hand, the media started to spread news of chaos and despair all over the world, and every day the news, whether on television or social networks, showed death and more deaths caused by COVID-19. And due to this excess of information, many have acquired anxiety and other psychological disorders. We can still highlight the misinformation, which leads to disbelief in science, with respect to epidemiological knowledge, as well as health guidelines, bringing more risks to the population.

Taking advantage of the intense flow that the World Wide Web is producing thanks to this new context experienced in pandemic times, the cybercriminals' attentions have turned to committing crimes practiced with the help of technological resources and equipment, making, in this moment of crisis, victims all over the world.

Due to people's desperation, and the anxiety to know how the pandemic scenario is, both globally and regionally, the evildoers began to create sites containing fake news and make available applications that had the purpose of showing viral maps, but behind these small programs, available for download, there was malware, responsible for the capture of various types of personal data.



Conferences through videos started to be used to shorten the distance between people, and for this reason the use of platforms such as Zoom increased, which fell victim to cybercriminals who discovered flaws and had access to the data of millions of users.

In Brazil we have the law 13.709/18 (General Law of Data Protection) that had its wording changed in August 2019. This, addresses the topic and provides administrative punishments to companies that do not take the necessary care to protect their users' data. Such objective is brought in the first article of this law, providing

This law provides for the processing of personal data, including in digital media, by natural persons or legal entities of public or private law, in order to protect the fundamental rights of freedom and privacy and the free development of the personality of the natural person.

We infer that technology was and is a fundamental ally for the continuity of daily activities, however, people need to be aware that the misuse of these tools can bring irreparable damage, be it to property or even psychological.

## CRIMINAL OPPORTUNITY IN THE NEW WORLD SCENARIO

Even before it became a pandemic, the world learned that a deadly virus had started in China, and soon Internet users began to search for information on the subject on search engines. Thus, cybercriminals have already started to prepare for their attacks, based on the interests shown by the population in their searches.

It is important to highlight that with the family confinement that had been interrupted, the number of crimes against property and even the illicit drug trade had a considerable decrease. However, this new model of life

has created a virtual refuge, that is, the cyber environment, which has its virtues and its dark side.

According to IBGE (Brazilian Institute of Geography and Statistics), there are currently approximately 220 million active smartphones in Brazil, considering that our population is around 211 million inhabitants. And using these, some services began to be operated in a more common way, such as delivery applications.

These applications have awakened criminals to lure their victims into giving them their credit card data and passwords, using a technique called phishing. This type of fraud is also used to issue fake bank slips, making users believe that they are really paying for a certain product or service, but that the amount is sent to an unknown account.

The Phishing technique has the help of another technique called Pharming, which is to direct the user to a fake site, but showing itself as a reliable copy of the original site. Thinking that he is accessing the real site, the user enters personal data related to his account, and has these stolen.

Still in this vein, a very relevant factor has been the high number of companies going bankrupt and others drastically reducing their staff. Thus, the number of unemployed people has grown, and the evildoers have taken advantage of this to lure and steal data from these people, by means of links leading to sites with false job offers, making them fill out forms with personal data, which would be stolen.

Google's official blog reported that more than 240 million spam messages were sent daily, containing the word COVID in their text, and these often directed users to the 42,000 web sites created from the beginning to the end of March (chart below), which use the same technique mentioned above to illegally capture data.

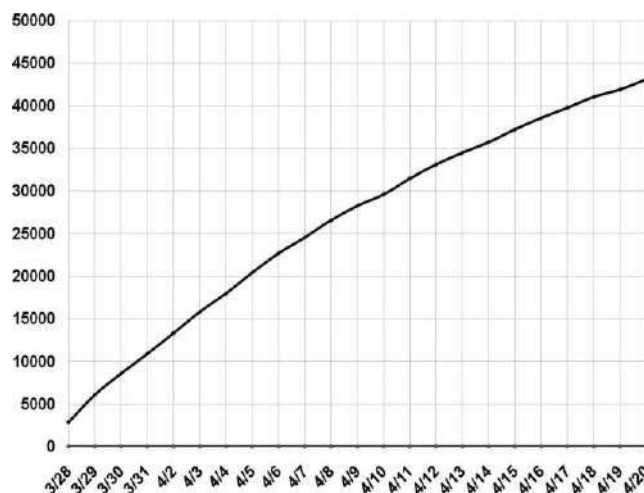


Fig.1: Cumulative number of COVID-related domains that have been registered.

Many were the fraud schemes employed by cybercriminals, characterized by the moment of desperation experienced by the world in a frantic search for the vaccine. Thus, the criminals requested contributions from Internet users so that it would be possible to create the vaccine against COVID-19, which in fact were nothing more than fraudulent gimmicks.

Another resource that has been used to negotiate products is the so-called e-commerce, where people advertise sales of the most varied things. Taking advantage of the data entered on these sites, the criminals manage, through social engineering, to trick the victims into providing codes that are sent to their cell phones, thus causing their WhatsApp application to be cloned, starting the crime of fraud, since they start asking the contacts for money, misleading the victim, because they pretend to be the owner of that account.

Due to the lack of expertise of Internet users, the social engineering technique succeeds in 80% of the scams that are applied. And the pandemic, without a doubt, has provided the ideal opportunity for cybercriminals to act, leading to a significant growth in cybercrime.

We deduce that after the WHO (World Health Organization) declared the pandemic, people started to use technologies more frequently and even unbridled, especially those connected to the Internet, since communication and physical contact became dangerous and even deadly. Thus, the barriers of distance and social isolation were minimized by virtual communications. However, along with this resource, came the problems, especially the increase in cybercrime.

### **THE RISKS OF HOME OFFICE FOR USERS WITH NO TECHNOLOGICAL EXPERTISE**

Small and medium-sized companies were the ones that suffered most from the pandemic announcement, because, to avoid contamination among their employees, they had to take urgent measures, and, one of them was to adopt the work system called home office, which in its literal translation would be work at home.

According to the company Kaspersky, through its senior manager of social media Kaspersky - Brazil, says that "The bad news is that every time something big happens, cybercriminals take advantage of the opportunity", since employees were transferred from companies or offices to their homes without adequate protection for performing tasks over the Internet, making them easy targets to be affected by ransomware.

In an analysis, the director of Kaspersky's global research and analysis team in Latin America states that

What cybercriminals do is attack a hospital or any other entity to steal information. Later, they encrypt it and threaten to make the stolen data stolen data public. Ashamed and afraid of the distrust and fines generated security incident like this, most organizations give in to blackmail.

He further adds "These groups are responsible for attacks on hospitals and healthcare organizations, critical services during this pandemic, but they also target banks, insurance companies, law firms, accounting firms among others and are here to stay."

For experts, these attacks have occurred with great frequency in Latin American countries, especially in Brazil, which had an increase around 350% in the first quarter of 2020, and this is due to the factor of bad corporate online access habits, of which, three stand out: use of weak passwords, use of pirated programs and lack of application of software patches.

Besides ransomware and phishing attacks, there are many other types of cybercrime that can be committed, such as data destruction, fraud, and system downtime, among others. According to specialized reports, these will cost the world \$6 trillion by 2021.

Another malware widely used is the keylogger, which after being installed on the victim's computer, captures the information typed and sends it to the criminal's e-mail, as a recent example of this type of file infected with such a malicious program, we have the Eeskiri-COVID-19.chm (Estonian Rules), which apparently would show sites that help combat COVID-19.

We find that cybercriminals' expertise and opportunism are always on alert. Just as companies have visualized a way to keep their services running in the period of social isolation caused by the pandemic, so too have the criminals perfected their malicious techniques. Therefore, we must emphasize that cybersecurity protocols must always be prioritized before implementing any and all activities that involve technological resources, especially those that are directly connected to the World Wide Web.5.

### **THE INCREASED VULNERABILITY OF CHILDREN AND ADOLESCENTS TO LONGER INTERNET ACCESS DURING PANDEMIC TIMES**

As everything had to reinvent itself in times of pandemic, education could be no different. Teachers have

been forced to use new teaching methods, even though many have never had contact with online classes. On the other hand, students had to adapt to a new classroom model, that is, distance learning, which for many is very difficult to learn this way.

Besides classes, children and teenagers have an excessive amount of time using Internet-connected technologies, and due to the large amount of information about the deadly virus, these vulnerable people can acquire a high level of stress and anxiety, since many are the conflicts that can torment their minds, which can lead to depression.

For the professor and researcher Gustavo Lins Ribeiro, the Internet with its multiple activities can provide a good or bad experience, bringing the following conclusion,

The coronavirus pandemic is the first to be experienced in online time. The Internet, with its multiplication of the capacity of capillary communication, at the same time that it provides a global awareness, creates an expectation and paranoia in the expectation that the large numbers of sick and dead, supposedly defined in a millimeter daily, do not reach with the same intensity the places where we live.

The problem is even worse when these vulnerable people already have compromised mental health, because then the probability of idealization and suicide attempts increases. It is worth pointing out that excessive use can lead to some addictive disorders, such as cyber sex, net gaming, social networks, and others.

Another very imminent risk is that of being a victim of cyberbullying, as a result, especially for teenagers, of exposing their images with the objective of reaffirming an expectation of recognition before other internauts, and who knows, maybe even become famous as a digital influencer. However, constant criticism and insults can cause psychological damage and, not to mention, the configuration of crimes against honor.

Adolescence is a time of many discoveries, which may be accompanied by some psychological disorders, which can generate the desire for self-mutilation and even suicide, and the Internet, at this time, becomes a fertile ground for this idealization. A classic example is the challenge that became known as Blue Whale, where

participants had to perform a series of tasks (challenges) and the last one was suicide.

In this same context of online challenges, in the current situation of the pandemic, where the product alcohol gel became known for being a way to eliminate the virus, they took advantage of the situation and created the "Alcohol Gel Challenge", where participants made videos inhaling, drinking, spitting the product into flames and even setting fire to their own bodies, i.e., extremely dangerous practices for health and physical integrity.

On the other hand, the criminals, using the innocence of children, began to create videos with children's cartoon characters, who communicated in a dissimulated and persuasive manner so that these vulnerable people would provide the credit card data of their parents.

We deduce that children and adolescents can become dependent on the use of technologies, especially those connected to the Internet, and that due to the scenario in which we are directly involved, social isolation associated with cybercriminals' traps can bring harm to both the vulnerable and their parents.

### **THE VICTIM BEING CONSIDERED GUILTY FOR CYBERCRIMES**

In the criminal scenario, the victim plays an important role and should be the target of study, that is why we have victimology, which is a science that will study the role of the victim in crime. In the context of cybercrimes it is fundamental to analyze the behavior of those who have been targeted by cybercriminals.

Within the classification of victims we have: Completely innocent victim or ideal victim is the one who had no participation in the criminal action; Victim by ignorance or victim less guilty than the delinquent is the one who contributes in some way to the occurrence of the offense; Victim as guilty as the delinquent is the one whose participation in the crime is fundamental, i.e., he becomes a victim due to ambition, as much as that of the criminal; and Victim more guilty than the delinquent or provoking victim is the one who brings the blame to himself, i.e., he became a victim due almost exclusively to his own fault .

In Brazilian criminal law, the victim's behavior is taken into consideration when determining the penalty that will be attributed to the offender. However, if the victim is exclusively to blame, no penalty is applied, and the perpetrator is exempted.

As we have already studied, Internet users, especially teenagers, tend to behave inappropriately with regard to some conducts, making them partly to blame for

some of the crimes they have committed. However, we cannot blame the victim exclusively, since the criminal is someone else, and the crime cannot be justified by a possible "mistake" of the inexperienced, careless or uninformed internet user.

In many types of cybercrime, however, there is no participation of the victim, since his actions on the Internet are commonplace, and one fine day, what looked like a file sent by your bank, may be malware that will be installed on your electronic device, making you become a new victim of cybercriminals.

With the pandemic, digital communication networks have had to open up to accommodate a greater number of users, i.e. companies have had to provide access through remote tools, which are connected to the Internet. Thus, the vulnerability and amplification of risks inherent to cybercrime have increased considerably, and because of this digital acceleration in times of COVID-19 propagation, that the challenges related to cybersecurity techniques have multiplied.

With such network openings, the victims have also become more vulnerable, since, due to their lack of preparation for this new model of "virtual life", they are not very concerned about digital security issues or often rely on the structure offered by the companies where they perform their work activities.

We realize, then, that in most cases of cybercrime, the victim has a certain share of guilt, because his or her careless behavior when accessing the Internet comes as a real gift to cybercriminals, who are always on the prowl, waiting for the unwary and careless Internet users. On the other hand, we have the victims who do not contribute to the criminal action, having in their cases security flaws in the systems used.

**CYBERSECURITY PROTOCOL**

The use of any and all technology, especially those connected to the internet, want essential care so that this useful and practical tool does not become a hidden villain in a criminal scenario.

Cybersecurity, especially for ordinary internet users, never seemed so important, until they fell victim to the cybercriminals. And when it comes to organizations, whether public or private, this security that used to be important, is now extremely important and essential for the full functioning of their activities.

Let's start with the protection of personal computers that are used to surf the Internet and carry out everyday activities (bill payments, research, online classes, and others). In the following table we will show the main rules of digital security.

Protection Software	Antivirus and anti-malware programs must always be up to date and ready to detect threats.
Social Engineering	Guidance is the best weapon against this kind of attack. So it should be taught that passwords and other personal data should not be passed on to anyone via the Internet.
Education Protocol	It shows users at least the main types and techniques of attacks used by cybercriminals. These range from care when clicking on unknown links to the expertise in identifying the social engineering technique.
Security Policies	It consists of creating documents that address the policies to be followed to maintain better security. These range from monitoring to audits that will be performed on the organization's computers.
Password Manager	It is very important that users have distinct passwords for each system accessed, and that these passwords are strong, i.e. long and with several types of characters. And in order not to forget them they can use password manager programs.

As seen, it is of great importance that people, before entering the world of technologies connected to the World Wide Web, know the main concepts of security, because the terrain is very fertile for cybercriminals who take advantage exactly of this lack of knowledge to then reach their victims.

With regard to cybersecurity protocols that can be used by companies in this current scenario that makes the home office service available to their employees, we have a short list shown in the following table<sup>1</sup>.

VPN (Virtual Private Network)	The VPN will create a tunnel, where data is encrypted, thus making it harder for intruders to decipher.
Authentication	It is important that all systems are

<sup>1</sup> ABUKARI, Arnold Mashud; BANKAS, Edem Kwedzo. *Some Cyber Security Hygienic Protocols For Teleworkers In Covid-19 Pandemic Period And Beyond*. Recovered in 18 de July, 2020, from [https://www.researchgate.net/publication/341098664\\_Some\\_Cyber\\_Security\\_Hygienic\\_Protocols\\_For\\_Teleworkers\\_In\\_Covid-19\\_Pandemic\\_Period\\_And\\_Beyond](https://www.researchgate.net/publication/341098664_Some_Cyber_Security_Hygienic_Protocols_For_Teleworkers_In_Covid-19_Pandemic_Period_And_Beyond).



	accessed through authentication, requiring strong passwords from the user.
Protection Software	Antivirus and anti-malware programs must always be up to date and ready to detect threats.
Social Engineering	Users should be advised not to give out passwords or any data without being sure that they are talking to the real technical support.
Password Manager	It is important that companies guide their employees to use strong and different passwords for each system accessed, thus making it more difficult for cybercriminals. Password management software can be used as a resource.
Firewall	The importance of using firewall systems, as a way to prevent the invasion of computers, closing the main communication ports used by the systems.

In analysis, we can infer that we all got to know a new world scenario that was changed after the pandemic was announced, thus, both people and organizations, public or private, had to reinvent themselves in order not to enter into an economic crisis and even the decree of bankruptcy. However, due to the short period of time that everything had occurred, there was not enough time to prepare the staff to deal with the new work method, which is the resources connected to the Internet.

#### IV. CONCLUSION

The pandemic scenario brought to the whole world a new vision of life, changing people's behavior in their daily lives, however, the purpose of this article was to show the influences and changes brought to cyberspace, that is, the impact caused in issues related to cybersecurity, considering that the time of access to the World Wide Web has grown in an exorbitant way.

Technologies, especially those connected to the Internet, are increasingly entering our lives, whether to facilitate daily tasks, for school learning, to automate work activities, for socialization and communication between people and peoples, or even for entertainment. However, of one thing we are sure, many can no longer live without these technological resources.

With the tragic announcement of the spread of the Sars-cov-2 virus, or popularly called the Coronavirus or COVID-19, many have been forced to use technological means as, perhaps, the only way out to continue with their daily tasks, and thus ensure, in times of crisis, the support for their families.

On the other hand, due to, many times, the lack of skills and habits with such resources, Internet users have become easy targets for cybercriminals, who take advantage of the moment and of their naivety to apply their techniques and thus ensure success in their criminal enterprise.

Starting from this premise, the subject of cybersecurity began to be more explored and even valued by those who never worried about it. Thus, security protocols had to be created with more rigor, since data integrity became paramount to ensure the full and safe operation of online services.

When it comes to children and teenagers, perhaps more important than cybersecurity protocols is to control the amount of time they spend using the Internet, since their exposure can bring about several harmful consequences, which may even irreversibly affect their mental health.

We conclude then that caution and safety rules should always be observed before diving so deeply into the virtual world, that is, cyberspace, since besides the many benefits it can provide, we have the harms it can bring to life, whether related to physical or psychological integrity.

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## Storytelling in the Bean Threshing: A Form of Struggle and Resistance for Tradition and Ancestral Memory

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**Abstract**— *Storytelling in traditional communities is passed on through orality from one generation to the next, connecting the past with the present by recalling the latent memory of their ancestors. It is a magical and playful moment, told and narrated during the bean threshing, awakening the awareness of aspects related to the care for life and the environment, while establishing the feelings of collectivity, union, and collective organization, making these moments a process of struggle and resistance to keep their traditions alive. Thus, the present study aims to analyze how the ancestral knowledge perpetuated in storytelling contributes to the processes of struggle and resistance of the*

**Keywords—** Ancestry. Storytelling. Bean Threshing. Creole Seeds.

*sociocultural identity of the quilomba community Sítio Veiga, in Quixadá, Ceará. To this end, the production of this article had as its methodological apparatus the exploratory-descriptive typology with a qualitative approach making use of semi-structured interviews whose guiding modality was ethnographic and participant observation, which are fundamental methods for a greater approximation and interaction with the social subjects of the research. The results of this study point to the relevance of these social subjects narrating their stories from their own point of view, placing themselves as the protagonists of their stories, with this place of speech permeated by struggle and resistance, forming a web of meanings that unites them in favor of social organization and by the stories narrated from one generation to the next.*

## I. INTRODUCTION

Storytelling involves the oral teachings transmitted to storytellers and perpetuated among generations. Generally, storytelling brings the history of their ancestors closer to the present, giving new meaning to their culture, their knowledge, beliefs, and values, as well as their relationship with the land and the territory, their struggle and resistance processes to keep alive their traditions, the memories of their ancestors, and their own quilombola identity.

In the storytelling narrated by several generations of the Quilombo Sítio Veiga, in Quixadá, Ceará, the act of telling stories refers to the memory, to their ancestors Francisco Ribeiro Bessa, known affectionately as Father Xigano, along with his wife, Maria Fernandes, also known as "Mãe Véia". They symbolize the strength of keeping their memories alive in the transmission of knowledge inherited and perpetuated among the quilombola generations, being in the sacred ground of Veiga for more than a century.

Thus, the knowledge inherited by their ancestral roots in storytelling remains present in their customs and daily practices, whose orality makes the connection with the land and the territory, such as: the threshing of beans from native seeds and their agricultural practices, the devotion of the dance of São Gonçalo and its sacred rituals, interacting with the dimension of faith and spirituality around a good harvest, but also in the possibility of healing diseases.

In societies characterized by oral tradition, storytelling has a fundamental importance, to the extent that it is constituted as a strong source of knowledge and wisdom and, above all, as a form of transmission of these that, combined with memory, show us and teach us much about the meanings and social significance present in these societies, such as the worship of deities and ancestors, the

relationship with time and nature, phenomena that are crossed secularly and taught from generation to generation. [1].

These are very precious moments, because the different generations come together, that is, the elders recalling the memory of their ancestors, sharing their daily experiences, talking about their struggles for survival, the territory, the physical fatigue, and their dreams. While the children and teenagers wait for someone to tell the old "haunting" stories. In this way, they grow up listening to the stories of their ancestors, which are perpetuated through orality.

It can be observed, therefore, that storytelling is not only playful, magical, and creative moments, but that it also contributes, from a very early age, for the children to learn the craft of farming native seeds through stories, since at these moments they are being socialized; the little fingers help threshing the beans, in the daily activities, contributing to the social organization of the group itself, the lessons of collectivity and belonging, the relationship of caring for the land, the environment, and the territory, with the ancestral beliefs and values.

Thus, this research is justified by my interest in deepening my knowledge about ancestral knowledge and its influence on the storytelling that is intertwined with their way of being and living, their struggles and resistance to keep alive the very memory of ancestral knowledge.

Based on the above-mentioned interests, the following objective was elaborated to guide the research: to analyze how ancestral knowledge perpetuated in storytelling contributes to the processes of struggle and resistance of the sociocultural identity of the quilomba community Sítio Veiga, in Quixadá, Ceará.

The present study is a part of a larger research project entitled: ANCESTRAL KNOWLEDGE AND THE CULTIVATION OF CRIOLA SEEDS: A STUDY IN THE QUILOMBO SÍTIO VEIGA, QUIXADÁ-CEARÁ.



Given the relevance of the various findings collected and the discussions raised throughout the research, we found some narratives that situate the issues inherent to storytelling and the socialization process itself experienced by the social subjects of the research, in addition to the contribution of the book *Contos de antigamente*, written by the Quilombola Rádlei Eugenio Dóroth, from the Quilombo Sítio Veiga, whose plot recalls her childhood experiences and learning, linked to the stories told during the bean threshing by her ancestors.

It is important to emphasize that we will use fictitious names to guarantee the anonymity of the interviewees' speeches, choosing those that make reference in this article to the several varieties of native seeds cultivated in the agricultural activities and perpetuated through ancestral knowledge in the telling of stories in the Veiga Quilombo, such as: 1) Sempre Roxo beans; 2) Pingo de Ouro beans; 3) Fava beans; 4) Espírito Santo beans; 5) Ibra corn; and, 6) Red corn.

Regarding the methodology used, this article followed the exploratory-descriptive typology with field research in primary sources. The prevailing approach is qualitative and the collection/generation of data occurred through semi-structured interviews with the modality of participant and ethnographic observation, which occurred in August 2019, in the Quilombola Community of Sítio Veiga, municipality of Quixadá, Ceará. As for the technique of data interpretation, the critical sociohistoriographical discourse analysis was employed. [2]; [3].

Given the above, the Quilombo Sítio Veiga is a space of ancestral knowledge lived by older and current generations, which needs to be recognized and valued. In this sense, to record the storytelling of these families is to recognize and value their journey inside and outside the territory. It is also to make sure that these memories are not lost through time, not that orality has contributed to the loss of these memories, but to also record them in writing so that this knowledge can reach the walls of universities and society in general.

## II. THE STORIES OF BEAN THRESHERS: A PERPETUATED ORALITY FROM GENERATION TO GENERATION

For Haerter; Barbosa Júnior; Bussoletti [1], the act of telling stories in traditional communities is usually brought by those who have a commitment to the memory of their ancestors, who know their roots and traditions of African influence, representing a way to keep alive their customs and tradition. This act also establishes a way to resist and fight for their stories, their culture, and the way of being of that community, with the transmission of knowledge being

shared and socialized orally, bringing the members of the group and the bonds of collectivity and belonging closer together.

But storytelling in these communities was also, and continues to be, an expressive form of resistance, to the extent that, culturally and historically speaking, the quilombolas resisted through memory and the preservation and re-signification of their beliefs, customs, civilizational values markedly African. [1].

According to Benjamin [4], he emphasizes how worrying is the role that science has played on the state of art, since the rationality of reason establishes a certain distancing from the orality of narratives, putting at risk the very extinction of storytelling, the figure of the narrator, and the communicability of shared experiences.

The aforementioned author [4] emphasizes that the threats to the extinction of storytelling emanate from capitalism itself and from the relations of production that turn human value into capital, materializing social, political, and cultural relations, belittling the old forms of work, as well as their values, customs and tradition, such as the storytelling that has been replaced by the novel, writing, printing and journalistic content, which are more concerned with reporting the facts that most of the time come to us without explanation being poor in surprising stories, or as the author emphasizes: "... In other words: almost nothing that happens is at the service of narrative, and almost everything is at the service of information. Half the art lies in avoiding explanation." [4].

This makes reflect the words of Souza; Silva; Silva, Rosana; Diniz [5], when they state that the act of telling stories for many quilombola communities is a political act and an act of resistance, to reaffirm the role of collective memory, present in the struggle for territory, and the feelings of subjectivities that belong to that place, to the teachings left by their ancestors, the orality that resists time, resignifying their struggles.

The process of narrating stories of those communities is a political act, which reinforces the relationships between people and the territory, through a collective memory, forming an unlimited network of subjectivity, of belonging to that place. Memory that, besides rebuilding the past, prepares the subjects for a political construction in the whole process of land occupation, of belonging to that territory. Memory as actualization and political struggle, materialized in oral narratives. [5],

The aforementioned authors also elucidate that it is in the territory that one finds the expressions of the quilombola communities' feelings of belonging, of their way of being and living, at the same time that it is configured as the fundamental pillar for the construction of the feeling of ethnic identity, a space where these social subjects think about their ancestors (grandparents, parents, ancestors) but also about themselves as a collectivity, parents, ancestors), but also about themselves as a collectivity, about how they organize politically and socially, about how they create their resistance strategies, such as the storytelling told from one generation to the next, from the past with the present, making effective memory, as to address, Feijão Pingo de Ouro (2019):

It is extremely important the knowledge passed on by the elders, holders of wisdom through experience in the land they inhabit, because I believe it is a constitution of knowledge, opinions, tastes, and values of the people who came before me, my *bisa*, grandmother, and so many other ancestors. We are results of knowledge, cultures, beliefs, customs, civilizing values, and even this identity belonging passed on by the elders [...].

In the Quilombo Sítio Veiga there is no way to talk about storytelling without remembering the memory of their ancestors, especially their process of fighting for the territory. Thus, the Sítio Veiga quilombo remnants have ancestral roots, permeated by bonds of collectivity and belonging, being in their sacred soils for over 100 years, being the sixth quilombola generation, where its members set their roots, as well as started their relationship with agriculture, planting their native seeds and perpetuating their ancestral knowledge between generations, as emphasized Fava Espitito (2019) when recalling the process of struggle and resistance for the occupation of the territory.

It was a legitimate occupation process, therefore, it is a territory that by right is ours, because we have been there since 1906. It is in it that we plant, sing, and dance. It is in it that we resist and face all possible difficulties so that we can have, above all, the territory. So, I reaffirm that this land, this territory is legitimate; this space is ours. [...] we are the owners of the land; those who claim to own the land are the invaders. [...]. The space is ours and we prove that it is ours through our struggles, our permanence, insistence, and resistance in the territory, [...].

Therefore, the farming activities of native seeds and bean threshing told in storytelling are of great importance for the preservation of biological and social aspects. Farming with native seeds contributes to the development of a sustainable agriculture, environmentally balanced, in addition to the preservation of memory and cultural identity, leading the various knowledge and techniques of traditional communities not to be lost and/or become excluded or dependent on new technologies, arising from changes in the capitalist mode of production,

which contributed to the disruption of old ways of life and work, habits and values, such as the cultivation of native seeds.

That said, it was in the soil of Sítio Veiga that the memory of their ancestors materializes their oral narratives in storytelling, forming the basis of collective organization throughout the historical processes and that until today is present in the political spaces of decision making; in the occupation of their territories; in the relationship with agriculture and their native seeds, in the daily struggles to stay alive, included and recognized as quilombola communities; of the celebrations of their sacred rituals, as [6] emphasizes:

Territory and territoriality are of utmost importance for our families, since the roots of these families are rooted in the ground through past generations, understood as sacred ground, a place of enchantments and disenchantments. Fertile land where postpartum women bury the umbilical cords of their children, at the request of midwife mother Luzia, under the most beautiful and strong trees in order for the newborns to grow healthy, and in a mystical soil, in which we plant and harvest food, medicine for us and our animals.

Seen this way, the titling of the territory is of utmost importance for these peoples, as it is in this soil that they continue to sow the various native seeds, aiming to maintain their lives and the lives of those around them. It is also a way to keep alive and active their customs and traditions, such as the dance of São Gonçalo, transmitted with the symbolism of the 12 native seeds, which represent life, knowledge, and orality, that will be perpetuated by the next generations as continuity of the quilombola existence.

Saint Gonçalo is a very miraculous saint. Each person who makes a promise with Saint Gonçalo always makes us realize how happy these people come to pay their promises. Look, it is very difficult for a

person who has faith not to get his grace; if he makes it with faith, he really succeeds. Here we have our ancestors, they are close by, they taught us never to lose faith. The dance was left for us to believe that there is faith, there is healing, there is a way to achieve grace. [...]. We dance and sing with São Gonçalo and our promises are achieved. [...]. (MAIZE IBRA, 2019).

In the Veiga, the socialization of ancestral knowledge occurs spontaneously, in the daily conversations during the bean threshing, recalling the memory of their ancestors where customs and beliefs establish the interaction among countless generations. These moments are ritualized by narratives told in circles, bringing the community members closer together and that can be understood by all who are part of these moments, as emphasized by Ana Eugêni da Silva, a storyteller from the Sítio Veiga community, when recalling her childhood moments, as we will see below:

At night, during harvest time, we would sit in a circle to thresh beans and listen to the stories of *trancoso*. [...] That moment made us forget the moments of drunkenness and hunger that took away our peace. (SILVA, A., 2018, p. 25-26) [6].

About the above aspects, understanding the relations and meanings of storytelling in the socialization process of these communities is of fundamental importance, because its meaning establishes relations of an identity historically built by African people who left their legacy and teachings to their descendants in the world. A history marked not only by the struggle for a space to be occupied, but also by the love for the land, the agricultural activities, the cultivation of their native seeds left by their ancestors and perpetuated in the reminiscences of their memories, as we will see below:

[...] always when we go to plant, we are remembering our ancestor. Wow! How I remember that my father loved to plant these seeds so much; he never let them run out. Then we take care to keep them in bottles [...]; only you have them, you plant them, as our ancestor used to do, and then it is spread around the world that you have those seeds, and people go around picking them up and asking: 'So-and-so, do you have those bean seeds? I don't have any more [...]. Can you get a liter or half a liter? Then he'll get that seed for him; he'll plant and plant again, and increase the seed that he didn't have anymore. (FAVA, 2019).

Given the above, in the quilombola community of Sítio Veiga the storytelling remains alive and perpetuated from one generation to the next. The memory of their ancestors is recalled at these moments, articulating the various aspects that complement each other, for example: the appreciation and the struggle for the territory and the way of organizing the families that live there; family farming; and the strong relationship with the land and the environment. These legacies left by the ancestors remain alive as forms of resistance of the families, strengthening the quilombola identity of Sítio Veiga.

### III. TALES OF YESTERYEAR: A NARRATIVE THAT HARKS BACK TO QUILOMBOLA ANCESTRAL MEMORY

The stories surrounding the bean threshing are perhaps one of the most creative and playful aspects, leading the children of the Sítio Veiga quilombo, from the earliest age, to connect with their ancestors, learning this craft. Thus, the writer Rádlei Eugenio Dóroth emerged from within the Sítio Veiga quilombo, her ancestors being her greatest source of inspiration. A source of memory remembered in her writings, in her childhood memories, in the little fingers that were threshing beans while listening to the old stories inherited from her ancestors, as we will see below:

#### Memories

The stories told here, / I've heard them everywhere, / Of our ancestors, / Who will be remembered here, / It was in the quilombo that I heard them, / And the pleasure I felt, / And the privileges. / And about the dance of the trees, / About the cold I felt, / Of the visions of the past, / And the fears I used to have, / It's talking about the past, / All will be restored, / Our books of fantasies. In the threshing of beans, / Stories were told, / Bringing much emotion, / Happiness and memories, / I have nothing to declare, / I'm here to tell you, / How good it is to hear stories.

In *Tales of yore*, [7], highlights four stories: "A velha chata e o pé de pião-roxo", "O alto da Pelelé", "O cachorro que comia ata", and "O homem que não vai ao burial até o fim". In these stories, the author highlights the strong connection she has with her grandfather, an ancestor she considers the inspiration for her characters. She highlights that the haunting stories would be those most appreciated by the children of the quilombo. Furthermore, Dóroth

articulates the teachings of her ancestors with the characters of her daily life in the quilombo, thus giving greater emphasis to animals, plants, and the supernatural.

In societies characterized by oral tradition, storytelling has a fundamental importance, to the extent that it is constituted as a strong source of knowledge and wisdom and, above all, as a form of transmission of these that, combined with memory, show us and teach us much about the meanings and social significance present in these societies, such as the worship of divinities and ancestors, the relationship with time and nature, phenomena that are crossed secularly and taught from generation to generation. [1].

That said, in the story "The boring old woman and the purple spinning top", [7], is very emphatic about her grandfather's memory, alluding initially to his customs and daily practices of the tradition of creole seed cultivation present in storytelling, in which families thresh beans, select their seeds, feed on them, plant them, and save them for the next generations. About this, it is worth bringing what the author says: "My grandfather told many stories in the bean threshing [...]" [7], bringing the young narrator closer to her grandfather and the transmissions of knowledge passed on by him, as we can see in the elucidated work:

The Boring Old Woman and the Purple Lion's Foot

My grandfather told many stories in the bean threshing. The haunting stories were the most appreciated by all. One day he told how there was a very, very bad woman, a nagging old woman who denied everything to everyone, everything that was asked of her was denied. One day this woman got sick and died. Since no one liked her, there was no one who wanted to bury her. But, since the old woman couldn't stay smelling bad in the house, some drunks were called to take her to the cemetery, which was far away. They took the net, put a tree trunk on it, and set off. But there was one problem: the old woman was very fat and the drunks couldn't stand her, so they dropped the old woman on the ground and took a purple top and stomped her until the last leaf fell off. They said that the purple top was sacred and removed the feathers that the old woman had to pay for. The bad smell bothered them a lot, so they took a drink of cachaça and went

on their way. This way the old woman became more mannerly and the drunkards shook the net to and fro and continued on to the cemetery. [7].

In the aforementioned work, the author establishes the relationship between plants and their supernatural power, drawing attention to the dimension of the sacred when referring to the pine-nut tree and its power to remove evil spirits, evilness, to obtain a cure, and to soothe and relieve suffering. The plot of the story shows the drunks taking the branches of the physic nut tree and beating the body of the old woman, a way they found to remove the evil spirits from her body, which overloaded the coffin, allowing it, after this ritual, to be lighter and thus be buried.

From this relationship, one can see the strong role and power that plants and seeds have in the backyards of these families, which are used for food and for sacred rituals. The branch of the pinhão-roxo plants is still a frequent practice that is used with the prayers, serving to remove the quebranto, the evil eye, establishing the approximation with the magics, the supernatural phenomena, substantiating the words of Milho Vermelho (2019):

Well, I know many plants; I learned from my parents. Some are used to cure some diseases [...]. You get sick, you go to the bush, get a wood bark, make a tea and you get cured [...]. Quinaquina is a very good remedy for scars and strengthens the bones [...]. There you learn and pass from generation to generation to strengthen the history of our ancestors.

Thus, it is in the telling of stories and sacred rituals and the dimension of the supernatural that the authenticity of the history of traditional quilombola communities and their African cultural roots is allowed, resignifying their lives and the elements of their original culture, the latent history of their ancestors.

According to Haerter, Barbosa Júnior, and Bussoletti [1], storytelling contributes significantly to the children's teaching and learning process, awakening countless experiences, emotions, and values, such as fear, respect, responsibility, and moral values. Such fact refers to the speech of the interviewees, according to whom the relationship of ancestral teachings about the cultivation of native seeds establishes a relationship beyond planting, awakening the values of respect for ancestral knowledge, the passing on of this knowledge to other generations, the preservation of the environment, and the care at each stage of seed planting, as we will see below:

We were born knowing about seeds [...]; since childhood we were raised learning



from our parents and grandparents. They told many stories of these seeds and said: 'That one is for keeping; that one is for eating,' and that's how we were raised [...]. (FEIJÃO SEMPRE ROXO, 2019).

Following the narratives of the author Dóroth, in the story "O alto da Pelelé" the emphasis is given to the supernatural phenomena, calling attention, once again, to the dimension of the spirits, the field of the unknown and enigmatic. The tale speaks of the crossroads, as well as of the respect and care that we must have with that which we do not know, raising some of those characters existing in the community itself, like the godmother Nena, severely punished when transgressing the supernatural narrated in O Alto da Pelelé.

He said that once upon a time there was a haunted high place, the Pelelé high place. It was common during the day, but when midnight came, anyone passing by would see a pestle roll up and down behind them. People had to run very fast, because whoever didn't run, the pestle would run over them and rip their legs off. Whoever had to go through there had to go before or after midnight. One day, godmother Nena had left in the afternoon and only returned at night. She forgot that it was forbidden to walk at that time. When she arrived at the crossroads on top, she looked both ways and started to run. She ran, she ran a lot, until she got tired. When she looked back, there came the pylon almost in front of her. She went into the house, locked the door and told everyone what happened. When she opened the door, she saw the pestle up there. She ran her hand over her eyes and looked again, then she saw nothing more. [7].

The relationship with the supernatural emphasized above is also perceived in the story: "The man who wouldn't go to the funeral until the end". The author's narrative shows a man who did not comply with the funeral rituals, being left with the curse and punishment of having his body heavy after death, not being able to be carried and being necessary a beating of pine kernels to bring lightness to his body and thus be able to be buried.

Once, my mother told me why we should always go to the funeral all the way to the end and never just halfway. There was a man who always went to the funeral, but never to the end. When he got to a certain place, he would stop and always say that he

had to come back. He invented many reasons and in every funeral this man stopped in the same place and with some pretext returned home. Years went by, and this man was getting old and always doing the same thing. People paid attention to his behavior. One day, the man died and everyone went to bury him. When they got to a certain place, the coffin was so heavy that no one could hold it and it fell to the ground. No one could get up anymore. An old lady who knew the man's behavior understood what was happening and said: - It's no use you trying to lift the coffin, because it won't come out! Do you remember that this man went to all the funerals, but always came home from the same place? He won't go any further. So the experienced old lady told them to bring a purple topiary [sic] and they did, she stepped on it until the last leaf fell off and only then did they lift the coffin to the cemetery and bury him. [7].

It is in this space, therefore, that the storytelling narrated here establishes a relationship with the mysteries of life, the supernatural, and the sacred rituals, the relationship with nature, whose oral teachings transmitted by ancestors to storytellers establish the link between the living and the dead, resignifying their cultures, knowledge, beliefs, values, and memories.

#### IV. CONCLUDING REMARKS

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.

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# A Review of Remote Sensing Applications on Very High-Resolution Imagery Using Deep Learning-Based Semantic Segmentation Techniques

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**Keywords—Remote Sensing, Deep Learning,  
Semantic Segmentation, Convolutional  
Neural Networks, State-of-the-art, Review.**

**Abstract**—*Semantic Segmentation is a technique in Computer Sciences (CS) to extract information from images. Recent advances in Artificial Intelligence, particularly in Deep Learning, Semantic Segmentation combined with techniques such as convolutional neural networks, have presented better results and exciting results. Due to its power and better results than classical approaches, there has been an increase in research articles in Remote Sensing that propose using deep learning-based semantic Segmentation to extract information from satellite or airborne imagery. In this paper, we surveyed the state-of-the-art of Semantic Segmentation in Remote Sensing from 2010 until 2020 by identifying the research topics and the number of publications and citations. Furthermore, we also pointed out the fundamental algorithms, the main convolutional neural network architectures, backbones, and the most used evaluation metrics. In addition, some datasets were highlighted, as well as some frameworks that can be used to train semantic segmentation deep neural networks. Finally, we have shown some applications of the showcased techniques and concluded the paper by pointing out some research opportunities of Remote Sensing Semantic Segmentation, concerning some bleeding-edge scientific papers published in 2020 in CS.*

## I. INTRODUCTION

The extraction of information from remote sensing images has been an active research field, with essential applications for urban planning, urban dynamics modeling, and disaster damage assessment. Semantic Segmentation is the process of assigning a label to each pixel of an image and decompose a scene into semantically meaningful regions [1]. Traditionally, semantic Segmentation is performed either pixel-wise or with object-based approaches. The latter is known as Geographic Object-Based Image Analysis (GEOBIA) [2] and usually outperforms the former. These approaches typically consist of two separate steps: Segmentation followed by classification. Because the second step's accuracy usually

relies on the first step's quality, image segmentation is critical for GEOBIA.

However, image segmentation is not a trivial task, given that most algorithms rely on subjective and arbitrary parameters setting. The incorrect choice of parameters may lead to undesired results, such as under-segmentation and over-segmentation, which may impact the classification accuracy. Moreover, segmentation techniques' generalization capability is limited because they cannot deal with the objects' complexity present in an image. For example, a given set of parameters can provide good segmentation results at homogeneous regions (e.g., agricultural fields) and unsatisfactory results in heterogeneous areas like urban environments.

Thus, image analysts usually try several parameter combinations to achieve a suitable outcome for an entire scene, a time-consuming task. Adaptive segmentation algorithms were proposed to deal with the diversity of image objects [3, 4] or automatic tuning of segmentation parameters [5, 6]. However, these methods are complex, rely on human-made reference images, and are designed for specific applications.

Recently, improvements in computation power and parallel processing algorithms using graphics processing units (GPUs) favored the development of deep learning (DL) [7, 8], particularly convolutional neural networks (CNNs), a type of DL method introduced by [9], have become exceedingly popular for classification, object localization, and semantic segmentation of remote sensing images [10]. CNNs are designed to automatically extract spatial patterns (e.g., shapes, edges, texture) of images using a set of convolutions and pooling operations, hence learning object-specific characteristics in an end-to-end fashion.

Particularly in the context of semantic Segmentation, neural networks have achieved outstanding results [11, 12, 13, 14, 15, 16, 17, 18]. Unlike traditional pixel-wise classification, semantic Segmentation using CNNs can preserve the object boundaries producing sharp, fine-scale Segmentation. Fully convolutional networks (FCNs) were the first approach that employed deep networks for semantic Segmentation. The rationale behind FCNs relies on transforming the fully connected layers into upsampling or transposed convolutional layers [19] to perform dense pixel predictions. The pioneering work of [19] adapted well-known CNNs models such as AlexNet for semantic segmentation tasks.

In semantic Segmentation, the smallest segment can be a single pixel, which is not adequate for most applications of information extraction using high-resolution remote sensing images because, in these images, it is improbable to find a target with the dimensions of a single pixel. To overcome this problem, instance segmentation combined object detection and semantic segmentation can be used to classify an object at the pixel level and outline its exact shape [20]. Both semantic Segmentation and instance segmentation networks provide the opportunity to simultaneously detect and classify building footprints without the need for a previous segmentation step, thus vanquishing the limitations of GEOBIA.

This paper will cover the latest state-of-the-art (SOTA) of semantic Segmentation in very high-resolution remote sensing, focusing only on methods that use convolutional neural networks (CNNs). We also want to identify research opportunities in RS by briefly analyzing the latest

trends on CS. To fulfill this goal, this review is organized as follows: in section 2, we show the SOTA of semantic Segmentation in RS and CS papers; in section 3, we cover the basic concepts of DL and semantic segmentation techniques, the primary neural network architectures, the available datasets and frameworks and finally some raster to vector methods; and in section 4 we sum up the concepts presented in this paper, as well as cover the opportunities of research in geosciences based on the comparison of the SOTA semantic segmentation methods.

## II. LITERATURE REVIEW

We conducted a literature review on remote sensing to identify the most relevant deep learning techniques and methods employed to extract information from remote sensing imagery, presented in section 2.1.

Moreover, to identify possible new techniques from computer sciences, we carried out a brief literature survey on review articles and also pointed out the best results on popular benchmarks showcased on Papers With Code [21], shown in section 2.2.

### 2.1. Literature Review on Remote Sensing

To perform our literature review, we searched the knowledge database SciELO Citation Index (Web of Science) to investigate further what are the main research topics, the number of publications per year, and the most cited papers. This information was used to try to delineate the most relevant papers so that we could further analyze them so that we could extract more helpful information, such as the most popular methods employed.

The term "Semantic Segmentation" was searched using the time range 2010-2020 as the filter, and there were 10,145 results, then were filtered once more, considering only the "Remote Sensing" field, yielding 718 results. To identify the main research topics, we built a word cloud, shown in figure 1, with the keywords of these results. Analyzing the picture, we can infer that the research conducted from 2010 until 2020 has used neural networks, particularly convolutional neural networks (CNNs), to extract or identify features using high-resolution satellite or aerial imagery. Common ground features extracted by the considered papers are roads and buildings.



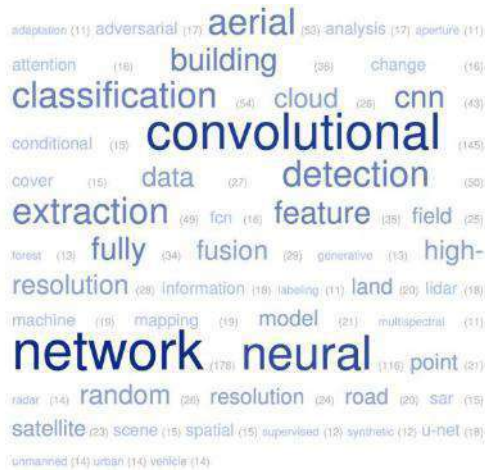


Fig. 1: Word cloud built with the keywords of the results of the search Semantic Segmentation on the Web of Science database, from 2010 to 2020, considering only papers in Remote Sensing. Larger words mean more recurring terms in the research papers' keywords.

During the considered time range, there has been a nearly exponential growth in the number of papers in remote sensing that covers semantic Segmentation that can be visualized in figure 2. The years 2015 and 2016 have presented a slight increase in the number of publications that might be a consequence of the papers published in CS, such as [22, 23, 24]. From 2017 until 2019, there has been a significant increase in the number of research papers, peaking at 140 in 2019. Since 2020 is not over yet, we can expect an even more substantial number than 2019, since the number of research papers published in 2020 is much higher than 2018's and only 40% smaller than 2019's.

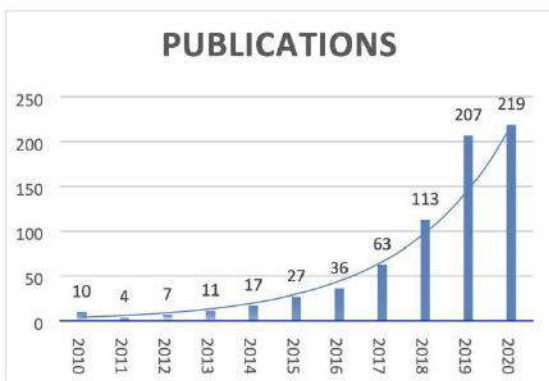


Fig. 2: Number of publications in Remote Sensing with the subject Semantic Segmentation from 2010 to 2020 registered on Web of Science.

We further narrowed our chosen papers by cross-referencing our search results with data from a GitHub repository ([https://github.com/thho/DLinEO\\_review](https://github.com/thho/DLinEO_review)), which is under the license CC-BY-4.0 and contains data

used in [1, 25]. Using this info, we have only considered semantic Segmentation, resulting in 261 papers to analyze. Then, we built the graph in figure 3 to find out the most popular architecture. We concluded that the most famous architecture in RS papers is the U-Net, followed by custom architectures and then Fully Convolutional Networks (FCNs).

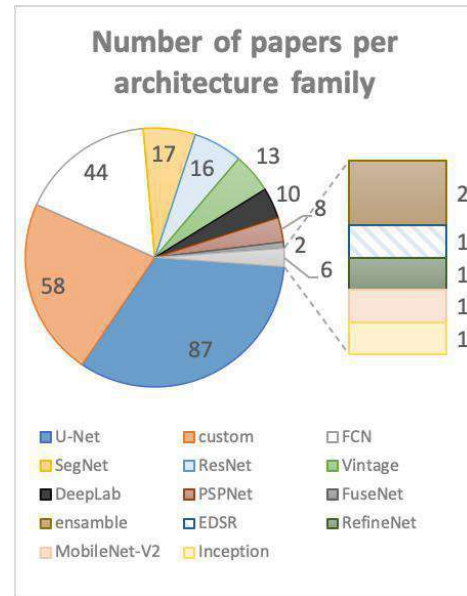


Fig. 3: Papers grouped by architecture family.

Then, to evaluate the backbone usage, we built a word cloud shown in figure 4 to find out the most popular backbones, and we found out that ResNets, VGG-16, and the Inception series are very popular.



Fig. 4: Family architectures used in Semantic Segmentation papers in Remote Sensing in the considered papers. Larger names represent more popular family architecture.

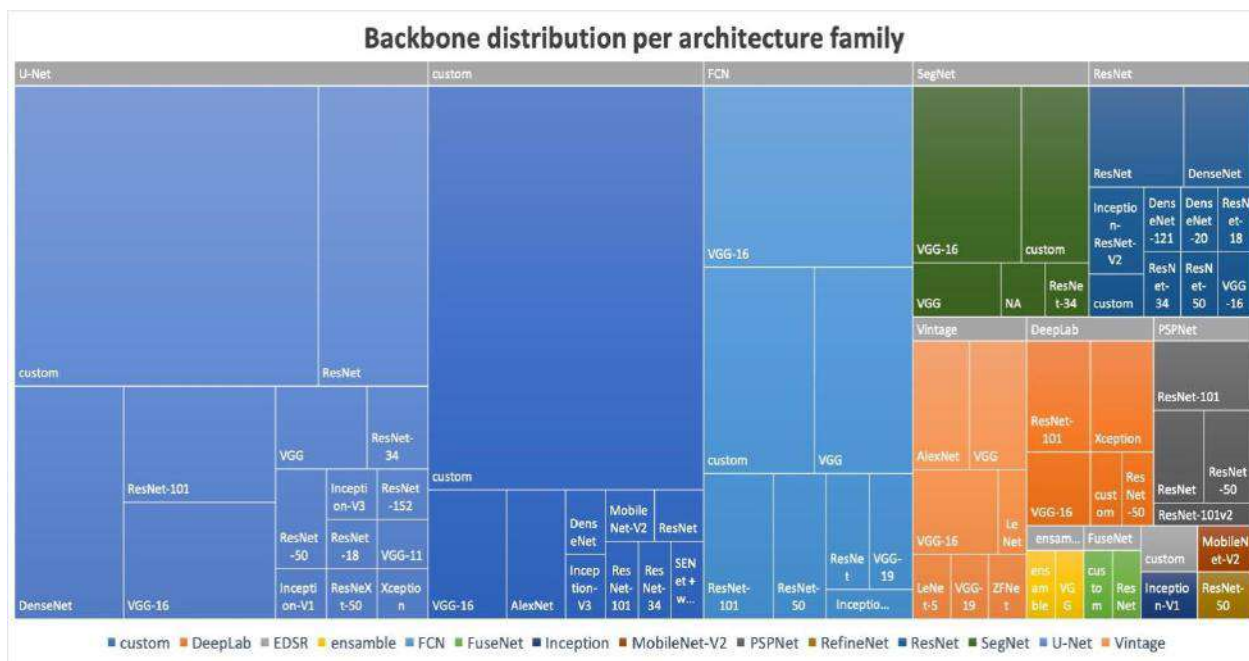


Fig 5: Tree Map representing the backbone distribution for each type of convolutional neural network architecture used in the considered papers.

To understand the relationship between the backbones and the architectures chosen in each paper and presented in the data here analyzed, we built a tree map shown in figure 5, which leads us to conclude that U-Nets with custom and ResNet backbones are very popular, followed by custom backbone and custom architecture, then by VGG-16 backbone with FCN architecture, and finally, VGG-16 backbone with SegNet architecture.

**2.2. Brief Literature Review on Computer Science**

There are several review articles in Computer Sciences [26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42] that portray the evolution of deep learning-based semantic segmentation methods. Common research fields on CS that use the mentioned techniques are research on self-driving vehicles [43, 44], pedestrian detection [45, 46] and computer aided diagnosis using medical images [47, 48].

The surveyed papers cover similar architectures and backbones already listed on 2.1. The novel backbones that were not identified in section 2.1 are the ones from the EfficientNet family, ResNeSt [49], and SE-ResNet family [50]. The training datasets used in CS applications are one of the main differences from RS studies. As examples of common datasets used in CS, we can cite the Cityscapes dataset [51], the PASCAL VOC (PASCAL Visual Object Classes Challenge) [52], and its extension, the PASCAL Context [39].

There is a platform called Papers With Code [21] that gathers results of several papers, as well as codes that are

available online to reproduce such study considered papers. On this website, the results of each benchmark are ranked, and the best models are presented. Some of the models with the best results on the previously mentioned datasets are shown in table 1:

Table 1: Best models on some available datasets, according to Papers With Code [21].

Dataset	Best Model	Paper Title	mIoU
Cityscapes test	HRNet-OCR	Hierarchical MultiScale Attention for Semantic Segmentation [53]	85.1%
PASCAL VOC 2012 test	EfficientNet-L2+NAS-FPN	Rethinking Pretraining and Self-training [54]	90.5%
PASCAL Context	Channelized Axial Attention (CAA) with Simple decoder (Efficientnet-B7)	Channelized Axial Attention for Semantic Segmentation [55]	60.5%
Cityscapes val	HRNetV2-OCR+PSA	Polarized SelfAttention: Towards High-quality Pixelwise Regression [56]	86.95%

Other worth mentioning techniques found on the cited review papers and the research shown in table 1 are self-training [57], Channelized Axial Attention [55], and

Polarized Self-Attention [56].

### III. MAIN CONCEPTS AND METHODOLOGIES IN SEMANTIC SEGMENTATION

From the SOTA review carried out in section 2, we identified some of the main concepts and techniques that we need to understand when studying semantic segmentation techniques applied to remote sensing.

Furthermore, considering the selected papers and regarding the ideas highlighted in the SOTA review, we will present some basic concepts in section 3.1, some training improving techniques in section 3.2, the main convolutional neural network backbones in section 3.3, the main architectures on section 3.4, some applications on RS and examples of some available datasets on section 3.5, and finally, some frameworks and tools on section 3.6.

#### 3.1. Main Concepts of Convolutional Neural Networks

The convolution layer is one of the building blocks of Deep Learning. It can be defined as a combination of linear and nonlinear operations such as convolution and activation functions [58].

Convolution is a mathematical operation that applies an array of numbers (kernel) to the input, enabling feature extraction operations [58]. On the other hand, the activation function is a mathematical resource to introduce nonlinearities in the convolutional neural networks. Some examples of them are the sigmoid function, the hyperbolic tangent function, the rectified linear unit (ReLU) [58], the leaky rectified linear unit (Leaky ReLU) [59], the exponential linear unit (ELU) [60], the scaled exponential linear unit (SELU) [61], the gaussian error linear unit (GELU) [62], the Mish [63] and the Softmax [64]. Their mathematical definitions can be seen, respectively, on equations 1, 2, 3, 4, 5, 6, 7, 8, and 9. It is worth mentioning that Softmax is often used as an output function on convolutional neural networks.

$$sigmoid(x) = \frac{1}{1 + e^{-x}} \quad (1)$$

$$tanh(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}} \quad (2)$$

$$ReLU(x) = \begin{cases} 0 & \text{if } x < 0 \\ x & \text{if } x \geq 0 \end{cases} \quad (3)$$

$$Leaky\_ReLU(x) = \begin{cases} 0.01x & \text{if } x < 0 \\ x & \text{if } x \geq 0 \end{cases} \quad (4)$$

$$ELU(x) = \begin{cases} \alpha(e^x - 1) & \text{if } x \leq 0 \\ x & \text{if } x > 0 \end{cases} \quad (5)$$

$$SELU(x) = 1.597 \begin{cases} 1.67326(e^x - 1) & \text{if } x < 0 \\ x & \text{if } x \geq 0 \end{cases} \quad (6)$$

$$GELU(x) = 0.5x \left( 1 + \tanh \left( \sqrt{\frac{2}{\pi}} (x + 0.044715x^3) \right) \right) \quad (7)$$

$$Mish(x) = x \cdot \ln(1 + e^x) \quad (8)$$

$$Softmax(x_i) = \frac{\exp(x_i)}{\sum_j \exp(x_j)} \quad (9)$$

The difference between filters that use convolutions (common in image processing tasks) and the convolutional layers of CNNs is that, instead of applying a pre-determined kernel to the input, it learns the best parameters of the kernel to extract features due to the training process [33, 39, 34].

Another critical concept in CNN theory is the pooling layer, which replaces a small neighborhood of a feature map with some statistical information, such as mean or max [39]. This process is vital because it sub-samples images, reducing the dimensionality of the feature maps by introducing a translation invariance to small shifts and distortions and decreasing the number of learnable parameters [58].

The combination of convolutional layers, activation functions, and pooling operations is usually called Convolutional Backbone, and its role is to extract high-level features [1].

Usually, a CNN used to classify an image is composed of input, the convolutional backbone, and a classifier head. This last one is typically composed of fully connected artificial neural networks (ANN), which have several perceptrons connected among each other.

The process of finding the best weights of the neural network has two steps: a forward stage and a backward stage [27]. According to [27], the first step uses the current weights and biases of the network to process the input and calculate a prediction. Then this prediction is compared to the expected output (ground truth) with a function called loss. After determining the loss, the gradients of each parameter are updated in the backward stage using the chain rule, a method called backpropagation [9].

The objective of the training process is to minimize the loss function, which means that the outputs of the trained neural networks are similar to the ground truth. To carry out the training, the weights of the neural network need to be initialized, and the way they are set can impact the training time.

According to [65], two popular initialization methods are Glorot (a.k.a. Xavier initialization) [66] and He (a.k.a. Kaiming initialization) [67]: the first has as its primary goal achieve faster convergence and better accuracy by scaling the neural network weights so that the variance of the input is equal to the conflict of the output [65]; the second aims to achieve depth independent performance by modifying the scaling factor to account rectifier nonlinearities [65]. The weights of a neural network can also be initialized from a previously trained network, a technique that is known as transfer learning. [68] defines four types of transfer learning: instance-based, mapping-based, network-based, and adversarial-based.

To achieve convergence faster during the training process, some algorithms with adaptative learning rates can be used. In neural networks studies, these algorithms are usually gradient-based and are called optimizers [69]. Some examples of them are Stochastic Gradient Descend (SGD) [70], AdaGrad [71], Nesterov Accelerated Gradient (NAG) [72], Adaptative Moment Estimation (Adam) [73], Rectified Adam (RAdam) [74], Adaptative and Momental Bound (AdaMod) [75] and Adaptative Second Order (AdaHessian) [76].

Regarding loss functions, [77] summarizes some of the available ones that are usually chosen for semantic segmentation tasks. Among those, it is worth mentioning the ones that are commonly used in semantic segmentation papers: the Cross-Entropy (CE) [78], the Weighted Cross-Entropy (WCE) [79], the Dice [80], the IoU/Jaccard [81], the Tversky [82] and the Focal Tversky [83]. The mathematical formulation of each cited loss function is

described respectively in the equations 10, 11, 12, 13, 14, and 15, where  $N$  is the number of pixels,  $g_i^c$  is the binary indicator of whether the class label  $c$  is correctly classified for pixel  $i$ ,  $s_i^c$  is the corresponding predicted probability,  $\alpha$  and  $\beta$  are hyperparameters used to control the balance between false positives and false negatives, and  $\gamma$  is a coefficient in the interval [1,3].

Some metrics can be used to evaluate the quality of the trained neural networks. According to [84], overall accuracy (OA), precision, recall, and the  $F_1$  index are helpful for evaluating the quality of the training, and they are defined by the following equations:

$$OA = \frac{TP + TN}{FP + FN} \tag{16}$$

$$precision = \frac{TP}{TP + FP} \tag{17}$$

$$recall = \frac{TP}{TP + FN} \tag{18}$$

$$F_1 = 2 \times \frac{precision \times recall}{precision + recall} \tag{19}$$

where TP, TN, FP, and FN are, respectively, the true positives, the true negatives, the false positives, and the false negatives.

According to [31], the Jaccard Index, also known as intersection over union (IoU), can be defined by:

$$IoU = J(A, B) = \frac{|A \cap B|}{|A \cup B|} \tag{20}$$

where A e B are, respectively, the ground truth and the predicted data.

$$L_{CE} = -\frac{1}{N} \sum_{i=1}^N \sum_{c=1}^C g_i^c \log s_i^c \tag{10}$$

$$L_{WCE} = -\frac{1}{N} \sum_{i=1}^N \sum_{c=1}^C w_c g_i^c \log s_i^c \tag{11}$$

$$L_{Dice} = 1 - \frac{2 \sum_{i=1}^N \sum_{c=1}^C g_i^c s_i^c}{\sum_{i=1}^N \sum_{c=1}^C g_i^{c2} + \sum_{i=1}^N \sum_{c=1}^C s_i^{c2}} \tag{12}$$

$$L_{IoU} = 1 - \frac{\sum_{i=1}^N \sum_{c=1}^C g_i^c s_i^c}{\sum_{i=1}^N \sum_{c=1}^C (g_i^c + s_i^c - g_i^c s_i^c)} \tag{13}$$

$$L_{Tversky} = \frac{\sum_{i=1}^N \sum_{c=1}^C g_i^c s_i^c}{\sum_{i=1}^N \sum_{c=1}^C (g_i^c s_i^c) + \alpha \sum_{i=1}^N \sum_{c=1}^C (1 - g_i^c) s_i^c + \beta \sum_{i=1}^N \sum_{c=1}^C g_i^c (1 - s_i^c)} \tag{14}$$

$$L_{FT} = (1 - L_{Tversky})^{\frac{1}{\gamma}} \tag{15}$$



Also, according to [31], the mean intersection over union index (mIoU) can be defined by:

$$mIoU = \frac{1}{m} \sum \frac{A_{pred} \cap A_{true}}{A_{pred} \cup A_{true}} \quad (21)$$

where  $m$  is the number of expected classes,  $A_{pred}$  is the prediction set, and  $A_{true}$  is the ground truth set.

### 3.2. Convolutional Neural Networks Training Improving Techniques

Convolutional Neural Networks usually take a long time to train, even when using a GPU. This occurs due to the fact of the large number of weights that have to be adjusted in the process of backpropagation: the larger the number of parameters of the model, the longer it will take to train. This can be overcome using distributed training on several GPUs and increasing the batch size.

In addition, the time spent on the training process also depends on the number of samples that the training dataset has. On the one hand, if there are not enough images on the training dataset, the neural network will not "see" a significant number of patterns to learn and perform poorly on the training dataset. This below-average learning is known as underfitting. On the other hand, if the number of images is not high enough, the neural network can memorize the data and perform well on the training dataset, but poorly on the test dataset, known as overfit [64, 85].

Moreover, the performance on test datasets can be improved by using regularization techniques, which are defined by [64] as any modification made to a learning algorithm that is intended to reduce its generalization error but not its training error. Some examples of regularization techniques are weight decay, label smoothing, early stopping, dropout, batch normalization, and data augmentation. Each of these is described below:

- Weight decay (a.k.a. L2 Regularization) is a method that modifies the weights of a neural network in such a way that the loss to be minimized is added a penalty of the  $L_2$  norm of the weights [64].
- Label smoothing [86, 64] is a technique that adds noise to the label, mitigating the effect of some incorrect label that the dataset may have. It also has the advantage of preventing the pursuit of hard probabilities without discouraging correct classification [64].
- Early stopping consists of stopping the training when the neural network stops learning, in other words, when the validation metrics stop improving [64].

- Dropout [87] is a technique used to reduce the dependency of some neurons on neural networks. At each training step, it is calculated a probability of the neuron to be shut down, and if it is larger than the set threshold, this element is turned off (outputs zero). This has a regularizing effect since it forces the network to learn patterns with other connected neurons.

- Batch Normalization [88] is a model reparameterization technique that introduces both additive and multiplicative noise on the hidden units at training time by normalizing the inputs to outputs with zero mean and unit variance [64].

- Data augmentation is a technique that uses image manipulation to create new training samples [64, 89]. Common data augmentation operations are random crop, random flip, and random color jitters. Furthermore, a novel data augmentation technique that has been recently employed in CS papers is Mixup [90], which consists of building synthetic images composed of a weighted sum of random pairs of the training data. According to [64, 89], data augmentation also has a regularizing effect, and it may contribute to avoid overfitting. One step further on data augmentation is using self-supervised techniques to learn from data the augmentation procedures that can achieve better metrics. As examples of such methods, we can cite AutoAugment [91], Faster AutoAugment [92], and RandAugment [93].

Furthermore, there is another approach to training optimization, which is the usage of Learning Rate Scheduling [94]. This technique changes the value of the learning rate according to some heuristic to try to improve the neural network accuracy and reduce training time [95, 96]. Some examples are Time Based Exponential Decay [97], Exponential Decay [98], Linear Warmup, Cosine Annealing [96], Cosine Power Annealing [99], and One-Cycle Learning Rate Scheduling Policy [100].

Finally, the last training improving technique that we will cover is Stochastic Weight Averaging (SWA) [101, 102], which is a procedure used to optimize the neural network that averages multiple points along the trajectory of Stochastic Gradient Descent (SGD), with specific learning rate procedures, that can be either cyclical or constant. The usage of this technique can help the optimizer to find a better optimization landscape, which might lead to better optimization results.

### 3.3. Main Convolutional Neural Network Backbones used on Semantic Segmentation Tasks

In this subsection, we will briefly present the key ideas regarding the main convolutional neural networks used to perform semantic segmentation tasks in RS. From our bibliographic research carried out in 2.1, we analyzed the results shown in figures 3 and 5, and then we identified key backbones to be explained in this section. The chosen backbones were AlexNet [22], ZFNet [23], GoogLeNet [24], VGG-19 [24], the ResNet family [103], Inception [86, 104], Xception [105] and MobileNet [106, 107, 108]. From the bibliographic research done in Computer Sciences, we came across the following worth mentioning backbones: ResNeXt, ResNeSt, and EfficientNet.

According to [1, 109], convolutional neural networks (CNNs) were introduced by [9] and in 2012, [110] used them in a model called AlexNet to win the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) [22]. According to [8], in 2013 and 2014, ILSVRC were also won by CNNs, with models respectively called ZFNet [23], GoogLeNet [24]. [1] define the architectures AlexNet [110], ZFNet [23] and VGG-19 [24] as Vintage Architectures.

In 2015, the family of architectures called ResNets [103] introduced skip connections to address the vanishing/exploding gradient [66, 111], which prevented deep neural networks from having a large number of layers. Due to this idea, deeper models were possible, and then the 2015's ILSVRC was won by a ResNet-152. The ResNet family has the ResNet blocks as its basic building blocks, a series of convolutions and activations stacked. There is a concatenation operation by the end of the block (also called skip connections) to preserve some of the input information.

To further push the boundary regarding the performance of the ResNet family-based algorithms, [86, 104] developed a family of architectures called Inception, which has as its basic block the inception block. Different from ResNet blocks that only concatenate the input of the block with the output, the inception block has several outputs: each output is the result of a different stacking of convolutions and pooling operations. Further advances on such idea were also proposed by the Xception family [105] and the MobileNet family [106].

Thus, [112] evolved the idea of the Inception Block by proposing a backbone called ResNeXt: in this method, a cardinality value to the blocks is proposed, which widens the block with more branches of stacked convolutions, enabling further representation learning. Other backbone architectures that are worth mentioning are the SE-ResNet [50] and the ResNeSt [49]. The first method proposes the usage of an attention mechanism at the beginning and the end of the ResNet block, composing the Squeeze and

Excite block, which performs dynamic channel-wise feature recalibration, to improve the representational power of the network. The latter method proposes the usage of Split-Attention Block, which adds the same idea of cardinality to the SE-Net-Block proposed by [50].

Recently there have been some breakthrough architectures using Neural Architecture Search (NAS) [113, 114, 115], which is a reinforcement learning technique to find out the best architecture to perform tasks on object detection and semantic segmentation [1]. Using NAS techniques, in late 2019, researchers at Google have created a series of backbones called EfficientNet [116]. In 2020, another group from Google had published a paper called EfficientDet: Scalable and Efficient Object Detection [117], in which they improved EfficientNets and proposed a weighted bi-directional feature pyramid network (BiFPN). According to [117], with these improvements, the research team achieved 4x smaller networks that used 13x fewer FLOPs, with a gain of 0.2% of mean average precision (mAP) of state-of-the-art mAP on the COCO dataset.

### 3.4. Main Convolutional Neural Network Architectures Used on Semantic Segmentation Tasks

In neural network applications, the convolutional backbone is often combined with other structures depending on the task that we want to perform. It can be used with a design such as fully convolutional layers to perform classification. In the case of semantic Segmentation, there are some approaches, as using naïve encoders and encoder-decoder structures [1]. There are also Generative Adversarial Networks (GAN) [39, 118, 119] and Recurrent Neural Networks (RNNs) with Long Short-Term Memory (LSTM) [30] approaches to perform semantic segmentation tasks, but we will not cover those techniques in this paper. More information on those techniques can be found on [1, 30, 42].

Naïve decoders normally use a convolutional backbone and trained deconvolutional layers to perform the upsampling task to generate the segmentation mask, combined with some interpolation method such as bilinear. Some examples of this type of architecture are Fully Convolutional Networks (FCN) [120], DeepLabV1 [121], DeepLabV2 [122], ParseNet [123], PSPNet [124] and DeepLabV3 [125].

Encoder-decoder models, in contrast to naïve decoder, instead of using an interpolation method to upsample the feature maps, use a more complex decoder, with shortcuts or skip connections to maintain information from the encoder to the decoder and gradually perform the upsampling [1]. Some examples of this type of model are the DeconvNet [126], the SegNet [127], the U-Net [79],

the U-Net++ [128], the DoubleU-Net [129], the MultiResUNet [130], the RefineNet [131] and the DeepLabV3+ [132]. The architecture of an encoder-decoder architecture called U-Net is shown in figure 6.

A novel type of encoder-decoder architecture is the HRNet (or High-Resolution Net) [133] and the HR-Net OCR[53], both of which are featured on top positions of the Cityscapes benchmark, as shown in table 1. This method aims to maintain high-resolution images at every stage of the process by combining different parallel chains of convolutions and strided convolutions. Object-Contextual Representations (OCR) is an attention mechanism [134] that considers the context of the considered pixel instead of it alone. OCR can be combined with different backbones such as ResNet-101 and Xception and different architectures such as DeepLabV3+ to improve segmentation results, as shown by [135]. When OCR is combined with HR-Net, we have the HR-Net OCR architecture.

Another type of attention mechanism that can be combined with HR-Net is the Polarized Self-Attention (PSA) [56], which has two main operations in its design: the polarized filtering and enhancement component. This type of attention mechanism not only looks at spatial features but also channel representations.

Finally, another worth mentioning set of techniques is the usage of EfficientNet backbones with Feature Pyramid Networks (FPN), combined with self-training techniques such as noisy student, which is a semi-supervised learning technique that improves the training results [57]. Table 1 shows that the best method on PASCAL VOC 2012 test dataset is the usage of EfficientNet trained with noisy student technique (a.k.a. EfficientNet-L2) with FPN architecture and Neural Architecture Search (NAS) [54]. On the other hand, the best model on PASCAL Context is the combination of a plain EfficientNet-B7 with an attention mechanism called Channelized Axial Attention (CAA) [55].

### 3.5. Applications on Remote Sensing and Examples of Available Datasets

Deep Learning (DL) plays an important role in nowadays science is particularly geosciences. There are several RS research papers such as [136], [137], and [138] that compare classical computer vision techniques to DL techniques, and they show that DL can achieve better accuracies.

DL-based techniques can solve several problems in Geosciences. Among those problems we can cite object detection [139, 140], hyperspectral image classification [10, 141], super-resolution [142, 143, 144], change detection [145, 146] and semantic segmentation.

Regarding Semantic Segmentation [84, 147, 148, 149], there are some use cases, such as building footprint extraction [11, 12, 150, 13, 14, 15, 16, 17, 18], road extraction [151, 152, 153] and land use and land cover (LULC) analysis [154, 155].

To train neural networks that can solve LULC problems, data from the ISPRS Potsdam and Vaihingen [156, 157] can be used. This is a dataset with airborne photogrammetric imagery of Potsdam, covering six classes (impervious surfaces, building, low vegetation, tree, car, and clutter/background).

Moreover, to perform training of deep convolutional neural networks that can extract building footprints, some of the open datasets available online are listed below, and the details are shown in table 2:

- SpaceNet [158, 159]: dataset with satellite imagery of the following cities: Rio de Janeiro, Las Vegas, Paris, Khartoum, and Shanghai.
- Massachusetts [160]: dataset with satellite imagery of the city of Boston.
- WHU building [161]: dataset with airborne photogrammetric imagery of New Zealand.
- INRIA aerial [162]: dataset with satellite imagery from the following cities: Austin, Chicago, Kitsap County, Western Tyrol, and Vienna.
- LandCover.ai [163]: dataset with satellite imagery of Poland.
- AIRS [164]: dataset with satellite imagery of Christchurch City in New Zealand.
- CrowdAI [165]: a simplified version of the SpaceNet Dataset, with only RGB images.

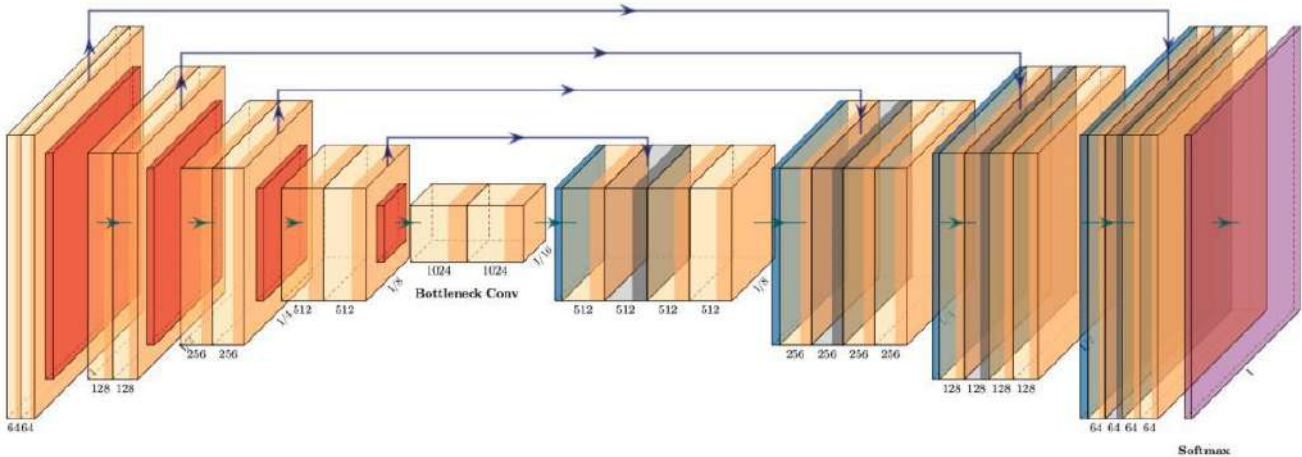


Fig. 6: Basic structure of a U-Net. Figure built using <https://github.com/HarisIqbal88/PlotNeuralNet>.

Table 2: Comparison between building footprint datasets

Dataset	# of buildings	# of tiles	Tile Size	Spatial Resolution
LandCover.ai	12,788	41	33 tiles with the size 9000 x 9500 px and eight tiles with size 4200 x 4700 px	25cm and 50 cm
INRIA	216,418	360	5000 x 5000 px	30 cm
Massachusetts Buildings	310,425	151	1500 x 1500 px	1 m
Spacenet	462,091	17,533	512 x 512 px	35 cm
WHU building dataset	220,000	25,577	512 x 512 px	7.5 cm and 2.7 cm
AIRS	220,000	1,047	10,000 x 10,000 px	7.5 cm
CrowdAI	Unknown	280,741 training images, 60,317 validation images and 60,697 test images	300 x 300 px	Unknown

### 3.6. Available Frameworks and Tools

The two most famous deep learning frameworks are Tensorflow [166] and PyTorch [167]. Both are open source, have large communities, are very well documented, and have outstanding performance. Tensorflow has an underlying library called Keras [168], enabling a higher level and more readable code. On the PyTorch side, PyTorch Lightning [169], FastAI [170], and Catalyst [171], among others, are frameworks that provide similar improvements given by Keras.

Considering segmentation models tools openly available, there are two frameworks developed in Python that use Tensorflow and PyTorch, respectively segmentation models [172] and segmentation models PyTorch [173]. To train segmentation models without coding skills, users can build a JSON file with the parameters of the training and use a Python package called segmentation models trainer [174], which was built using Tensorflow, Keras, and segmentation models. [175] has also created a training framework using PyTorch and PyTorch Lightning called PyTorch segmentation models trainer, which instead of using a JSON to fill the hyperparameters, uses a YAML file using configuration composition, which enables users to reuse settings. To build training masks from vector data, a QGIS [176] plugin called DeepLearningTools [177] can be used.

There are also tools to help to build and to inspect datasets, such as FiftyOne [178]. With this tool, data scientists can visualize the labels overlapped to the images and calculate image similarity indexes to assess the quality of the dataset and identify missing labels.

Concerning data augmentation, each library has built-in operations. As external options, we can cite Albumentations [179], a Python package that is framework



agnostic and works only on CPU. Another option on the PyTorch ecosystem is Kornia [180], a package that works on either CPU or GPU.

#### IV. CONCLUSION

In this paper, we presented the SOTA of Semantic Segmentation in Remote Sensing, an ever-growing field of research, with an almost exponential increase in the number of publications, as shown in section 2.1. We identified that the most used backbones on RS tasks are the ResNet family, VGG-16, Inception-V3, and AlexNet. Furthermore, we identified that the most famous architectures used in RS are the U-Net, DeepLabV3+, FCN, and SegNet. We also briefly showed the main theories, algorithms, and neural networks architectures and backbones.

This paper has also briefly presented how convolutional neural networks work and the techniques used for training such structures, like weight initialization, popular optimizers, some of the loss functions available, and the often-used metrics in RS papers. We also showed some of the existing regularizing techniques such as weight decay, label smoothing, early stopping, dropout, batch normalization, and data augmentation.

Then, we also presented some learning rate scheduling methods and stochastic weight averaging. We also listed the most famous backbones and architectures found on the RS papers surveyed and presented some applications of such techniques on RS. We also showed some available datasets and popular frameworks and packages to train deep learning convolutional neural networks.

There are many research papers in CS that propose several neural architectures, and some have been used in RS applications. Deep Learning is an ever-growing field, and in 2020 there have been many promising and exciting new backbones, such as the EfficientNet family, the ResNeSt-269 [49], and the SE-ResNet family [50].

Moreover, we have identified a research opportunity in RS to combine the mentioned backbones with popular architectures such as U-Net, FPNs, and PSPNet. Another research opportunity is the usage of HRNet-OCR [53], HRNetV2-OCR+PSA [56], EfficientNet-B7+CAA [55], and EfficientNet-L2+NAS-FPN [54], which are in the leader board of Papers With Code [21], but was not observed in the surveyed papers regarding remote sensing applications.

In addition, another research opportunity that we identified is to perform an extensive comparison of the accuracy of trained models with several combinations of neural networks architectures and backbones to define the

best method to extract information from very-high remote sensing images. We can also highlight other research opportunities, such as determining the best loss function to be used in training and the best inference method to improve validation data accuracy. The suggested loss function for such a study is the Focal Tversky [83] since it handles class imbalance problems, a common problem in remote sensing datasets, especially building footprint extraction datasets.

Additionally, even though new optimizers such as RAdam, AdaMod, and AdaHessian have been proposed, few papers in remote sensing have tested them. The same principle can be applied to activation functions such as Leaky-ReLU, ELU, SELU, GELU, and Mish. So, we also identify research opportunities of the influence of optimizers and activation functions in the training time and the test metric scores.

Finally, other aspects that we did not find in the surveyed papers and that can be researched is the usage of stochastic weight averaging [101, 102], novel augmentation techniques such as Mixup [90], AutoAugment [91], Faster AutoAugment [92] and RandAugment [93].

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# The Tax Waiver Impact on Profits and Dividends as an Economic Efficiency Instrument

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**Keywords – Tax Justice, Tax Waiver, Public  
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*Abstract – The tax waiver, which is an increasing discussion in Brazil, motivated this study, that objectified investigate what is the tax waiver impact on profits and dividends as an economic efficiency instrument. It also searches to identify if there is a statistic correlation that can explain the maintenance of this public expenditure. The quantitative approach research, used two independent scenarios. In the first one, it was verified in relation to the period of 2007 to 2016, the tax expenditures and tax waiver correlation, with economic growth, GDP and investments indicators. In the second one, it was verified through a multiple regression, the correlation between tax waiver and profits and dividends, with economic growth, GDP and investments indicators. It was shown that in regime of exception, as it is in the current recessive economic period, the tax waiver on profits and dividends economic efficiency find itself compromised. Affected by the constant inflation raises, it was verified that the waived values are not explained by the variable that, in 1995, justified their institution – the investments. As of those results was possible to identify that the budget balance pass through a tax policy similar to the successful examples observed in OECD country members, that is capable of balance the taxation profit, corporate production and that contribute to companies' cash flow production capacity and more investments. This study aims to not only contribute to draw tax restructuring plans, but also to instigate the proposes in Brazilian tax legislation changes debates that finds horizons to clear the Sistema Tributário Nacional, that in time, through an effective and efficient taxation, contribute to a tax justice and budget balance. Future researches can evaluate these results in a context with a more representative sample of these data and obtain more statistic sensibility.*

## I. INTRODUÇÃO

The tax waiver is a lasting subject in Brazilian society and that gains a horizon even more critical and controversial. The debate does not derive of a tax waiver itself, but of the object where it concerns. A historical question in Brazil, that in these does not find couples in developed countries, is that the Brazilian taxation system

customarily promote tax break on the income and the more privileged property, and immunize typical behaviors of this class. In counterpart, significantly encumber the income on the work and consume, colliding with a taxation system of more progressives' bases, that under the optic of many specialists, among them Gobetti e Orair (2016),

would be necessary to the economic and social development, besides finding amparo in the constitution.

The activities and governmental decisions are economic fundamental determinants of the economic establishment, growth and social wellness of a country. To this mission, the main macroeconomic instruments to the Govern disposal are tax and monetary policies. As center of this research, stands out the tax policy that manifest through public expenditure, investments and collection, this last one, in turn, delimited in this study by the main government revenue resource: the taxation.

Facing the power to tax, the Govern must respect the constitutional principles current in Magna Carta, that has as essential function, through the imposition of Govern limitations, guarantee to the homelands taxpayer rights that preserve their integrity. In this context stands out the contributive capacity principle, that in tight syntheses can be defined as the economic possibility to pay tributes.

As this contributive capacity indicator, the legislator disposes to definition the tax system rule, income, assets and taxpayers' consumption. Derived from the contributive capacity principle, the progressivity concept defends the incidence of a bigger taxation for those who has bigger income, that in ideal conditions can be associated to the distributive function of tax collection.

In the last years, the debate about the taxation ideal model earned a more complexed outline. In one side, defends that the tax adjustment, much needed in Brazil, must primarily pass by the taxation profits and dividends return, in strict obedience to the contributive capacity principle. On another perspective, driven by a macroeconomic imbalance nature changes analysis, provoked by the recent financial-economic globalization evolution, characterized by commercial relations expansion between the companies, exists defending chains a modern taxation system evolving to a bigger consume taxation.

Is a general understatement that Brazil needs to suffer a structural reform in taxation system that reaches tax justice and budget balance. On this background, stands out the main measurement forces points that subside the present work. As an example of this pole, it can be quoted the recent IPEA researchers work, Gobetti and Orair (2016), which the title is "Progressividade Tributária – A Agenda Negligenciada". In this study, by making an income tax and profit in Brazil critic analysis, the authors defend that the income tax exemption on profits and dividends spread to the shareholder is the main reason to this distortion, because contribute in bigger proportion to the existence of a high degree income concentration in the top of the distribution, low progressivity and equity

principles violation, that restrict the income tax distributive role.

As counterpoint to these arguments, exist the defending pole to, once the profits are taxed in company, the income tax taxation on profits and dividends, in shareholders transfer occasion, would incur in double taxation. Including, this was one of Govern proposes biases, that in the occasion, in unifying the profits tax in only one phase, it was pretended to simplify the control, inhibit the evasion, besides promoting incentives to investments in productive activities. Besides that, the tax waiver is always revested by an incentive character and must be analyzed based in their results, marked by its existence propose. This context, is more than reasonable to make the effort to search tangible arguments to justify the participation of tax incentives with tax waiver as supportive in economic development (AMARAL FILHO, 2003).

The restructuration in the taxation system must derive of these polarities confrontation. The urgency sense is strengthened by the current recognition of both poles that the distributive potential of tax policy by expenses side, give exhaustive signs, especially in fiscal crisis scenarios. The recessive moment does not allow any measure being excluded in the sense to guarantee the economic efficiency of tax expenditure with tax waiver. In this way, this research aims to investigate which is the tax waiver impact on profits and dividends as an economic efficiency instrument. Besides that, views contribute not only to draw tax restructuration, but also without the pretension to burn out in its reading, instigate the technical debate of changes in Brazilian tax legislation propositions, that finds horizons to clear the Sistema Tributário Nacional, that in time, through an effective taxation, contribute to a tax justice and budget balance.

This study justify itself by its relevance in academic world and the society. The tax justice and budget balance are persevering challenges that concern taxpayers and governs in many parts of the world. The debate about the tax agenda in Brazil must approach how the tax system works, besides problematize tax waiver as an expense way and counter with the progressive concept derived of the contributive capacity principle predicted in the constitution. However, it must get away from a simplistic position, and sometimes just moralist, to approach with transparency the motivation of such expenses and debate about the necessity of a restructuration in the Govern collection and expenses system that can emerge from a wider comprehension about the theme, that recovers the utility, the form and impacts caused by tax incentive concession. To Giambiagi and Além (2011), the distributive function, as the Govern tax policy, is

associated to adjusts in income distribution that allow that the prevailing distribution can be the one considered to be the fairest by society.

This study has as general goal to investigate if there is a correlation that can explain, through GDP ( $X^1$ ) and the Public and Private Investments, ( $X^2$ ), the Tax Waiver maintenance. As specific goals, it investigates if there is a correlation that can explain through GDP ( $X^1$ ) and the Public and Private Investments, ( $X^2$ ), the Income Tax Tax Waiver on Profits and Dividends paid to the companies' shareholders and associates.

## II. LITERATURE REVISION

### 2.1 Teoretical referential and research hipoteses

The financial management in public sector, as well as in private companies, deals with essentials subjects to the accounts harmonization and balance. Among them, stands out the collection way and the resources allocation, that, in short, must be realized in an efficient and effective way, generating results that by public management nature, attends the various interests and needs of the society. In other words, a financial management in front of a macroeconomic, political, social, technological and others scenarios, that are quickly changeable, in an imperfect capital market; in an asymmetrical information world to the multiple economic agents; in a country that has contradictory legislations Kasnar (2014).

To Dalton (1972), the public financial subject is one of those there are in the partition line between the Economy and Politics, and handle the public power expenditure and profits, as well as its coordination. Meanwhile in privates financial is the revenue that determinates the amount of the its possible expense, in public finances is the expense that determinate the needed collection. To be defined as collection and expenses rules, the Govern needs to obey the constitutional principles, besides performing their activities with tax discipline. This Govern activity consist in raising and spend only what is approved by law, as manager and provider of public welfare, because is the State attribution to offer what is the society interest.

Is fact that the governs exists and affect the life of each person. The existence of the Govern is necessary to guide, correct and complement the market system that, by itself, is not capable to perform every economics function (GIAMBIGI; ALÉM, 2011). However, these economics function demand expenses that are originated from individuals and collectives needs of each citizen, being assigned, as Adam Smith (1996) observed, to each citizen, as well as private companies' expenses are to associates.

1) This duty to contribute, that before already was volunteer, today has compulsory character, and particularly in Brazil is surrounded by a complexity that is in constant changes, affecting the taxpayers purchasing power. These changes are provoked by the need to more control of elision and evasion, or by the efficiency loss or the matter, besides the changes that happen in virtue of the measures that are needed to promote the tax adjustments and economic balance maintenance. However, even surrounded by interest conflicts, resistance and complexity, the taxation is constituted in the main Govern collection way. In this base there is a principle that can be forgotten, called The Principle of Maximum Social Advantage (DALTON, 1972).

When argument about the distributive function of a tax policy, where the Govern uses the transfer as instrument, Giambiagi e Além (2011) observe that the Govern can promote a direct income redistribution, when taxing in bigger measure the individuals belonging to a higher income layer of the society, while subsidizing individuals of lower income. In light of this concept, it can be observed that an efficient income redistribution can emerge from a bigger taxation, for example, of the profits generated by companies, or on the richer individuals' income, while the common worker income, the basic needs grocery items and the commodities derivatives, defined as consume items, are unencumbered. As counterpart to this argument, Rezende (1996) observe that the deeper transformations promoted in global tax systems break down old beliefs regarding to evolution tendencies of the tax structure for the next millennium. For him, the strong trait of this transformation in course is the bigger emphasis in general tax on consume, as the tax progressivity on income started to be shown as more perverse.

Another principle that deserves to be highlighted is the equity principle. It isn't always that the law cold expression finds, in a concrete case, a constant and unchanging relation. When elaborating a law, the legislator hopes that it can translate a conduct pattern that reflect at least the majority behavior. To guarantee the compliance of this principle in a taxation right matter, the item IV, of the Law 5.172, 108 article from October 25, 1966 (Código Tributário Brasileiro), predict, in the absence of express disposition, the equity application in tax legislation interpretation and application.

According to Arienti (1987), the tax justice has as base the equity principle and, from then on, two chains present the criterium to the equal treatment application of revenue. In one side, there is a criterium that the equality between the individuals must be evaluated, to taxation purposes, according to the benefits received by the taxpayer of the services provided by the State. The other chain, that

without a doubt is the theoretical base of most of the current tax systems, considers that the treatment must be according to contribution capacity of the individuals. The classic author Adam Smith, in his work "The Wealth of Nations", when making a reflection about the tax system of his time, presents the equity as one of the principles of an ideal taxation (SMITH, 1996).

The traditional public finances manuals, highlighting Dalton (1972), teach, in one of his chapters about taxation theories, that the tax justice has as base the equity principle. This principle has as goal the guarantee of an equitable distribution of the tax burden by individuals, that can be defined in two ways: in first place, the tax burden should have been divided between the individuals according to the benefits that each receive related to the assets and service offered by the Govern; in second place, the tax distribution should have as base the contributive capacity. The contributive capacity principle is dated to a long time. Historic registers and classical literature references indicate it being prior to the benefit principle. Gomes (2006) stands out that in a society that isn't fully mercantile, based in a work still not free, the taxation management according to the paying capacity was most appropriate, but the only conceivable.

However, the capitalist mercantile society and of a State, over the years evolved to wider functions than the needed to this principle maintenance. This amplitude, that can be exemplified by stagflation, that is the coexistence of the unemployment with high inflation rate, provoked in the tax systems deep changes to be adjusted to economic evolution and society demands to more tax justice. In the 70's, the supply-side economics these, which the adepts defended that the economic growth could be obtained with tax incentives that induced the companies to perform productive incentives, gained strength in media and had accession of United States of America during the Ronald Reagan government. Driven by this theory, Arthur Laffer, with his theoretical representation of the relation between the collected value with a tax in different aliquot, the called "Laffer curve" illustrated the "Elasticity and tax incidence" concept, considering the collecting value obtained with aliquot between 0% to 100%. Starting from the premise that one aliquot of 0% does not generate collecting, the Laffer curve affirm that an aliquot of 100% also wouldn't generate revenue, once it wouldn't have production incentive. It is concluded that the aliquot of 0% and 100% does not generate revenue, must exist an aliquot in which achieve the maximum collecting value. For Rezende (1996), although the supply-side economics theory, if it weren't well received in the academics' environments and north-american public administration, it

anticipated the debate about tax changes that came to be implemented later.

The macroeconomic scenario analyses enable the elaboration of answers to some of the big questions related to economic life of a nation and the whole world. Questions like the growth rate, employment, investments, govern role, inflation, public expenditure, and in this case, tax waiver, must be analyzed under the economic changes prism that are capable of affecting it. The macroeconomy can also raise the capacity to evaluate the proposes of the leaders to the tax policies, public expenditure and other policies that affect in a crucial way the national and international economy. These questions are important not only to the nation economic well-being, but also the people.

As observed by Sachs and Larrain (2000), the macroeconomy evolved with time, in the question nature studied as well as in the kind of offered answer. According to those authors, these alterations derive of an action of two forces: in first place, as well as any other science, occurred theoretical advances and the old theories will be abandoned, for not being proven, or by the appearance of new theories. In second place, the global economy evolved, generating new questions and demanding new answers.

Mankiw (2004) observe that, to some economist, the economy has an inherent instability and need a stabilizing tax policy, capable to move in a sense to stimulate the economy when it is depressed and reduce the rhythm of economy when it finds overheated. While for some economist the economy has a natural stability, others blame the bad economic policies for the big and inefficient oscillation that some time is experimented. However, is possible to affirm that independently of the adopted premise, the tax policy must be conducted with high tax responsibility level. The balanced use of public resources must view the gradual reduce of net debt as GDP percentual, in a way to contribute to stability, the growth and economic development of the country.

Facing all the exhibit, having as purpose sequence the theoretical referential extensive brought as backdrop to this research, has as goal, starting from a study of correlation of tax waiver with GDP, the Public and Private Investments and the Primary Result, instigate a wider comprehension about the theme, including important aspects as utility, the way and impacts derived of tax incentives concession, refining by its weight and relevance with the proposed theme the correlation of tax waiver of income tax retained in the sources of profits and dividends paid to the associates and shareholders, with the same variables proposed in the macro scenario. With this



research it is desired to reject or accept the following hypotheses:

H1 “The tax waiver on profits and dividends in Brazil contribute to the budget imbalance, by its inefficiency to contribute for the economic growth”.

### III. METHODOLOGY

To accomplish this study purpose, it was used a quantitative research approach. To cross the methodologic rout will be used as base to research classification the systematic presented by Vergara (2016), proposing two criteriums, in terms of purposes and means. About purposes, the research is classified as descriptive, for showing aspects related to the collection way and tax expenses promoted by the Federal Government, through their tax system and code exam, besides confronting macroeconomic data with the collection methodology, using data provided by OECD, IPEA, Brazilian Federal Revenue, besides a theoretical referential immersed in the finances and public management principles.

About means the current research will be classified as bibliographical, because it will be performed a systematic study about the theme, developed with base in material published in books, magazines, newspapers, electronic networks, in other words, material accessible to the public in general, that provide analytic instrumental to any other kind of research, but also can burn out in itself. As documental, because besides the referenced sources and legislation, will be used data published by public and private bodies in any nature and *ex post facto* because refers to an already occurred fact, applied when the researcher, can't or doesn't pretend to control or manipulate variables, because his manifestations already occurred, or the variables are not controllable. (Vergara, 2016).

As statistic instrument, will be used the multiple regression, for existing two or more random variables at the same time, X and Y, the goals being to measure the correlation between those variables and what they represent. Favero & Belfiore (2017) stand out that the econometry consist in the application of mathematic and statistic methods to economy problems, having in regression analyses the most important method, when needed to know the effects that a variable exercise or seem to exercise in another variable. It was used to data treatment the *software IBM® Statistics 22*.

Stand out here a relevant subject that will guide the next steps of this research, that consist in observing the motivation to this tax benefits concession, in front of factors that determine or motivate a tax waiver, or evaluate

the participation of such incentives as one of economic development process factors. To Amaral Filho (2003), there is no reason to deny tax waiver participation in economic development of one region, however, is more than reasonable to make an effort to search palpable arguments that justify this participation.

The Lei de Responsabilidade Fiscal in article 14° item I, express that the tax waiver, besides to be considered in budget law revenue estimative, shouldn't affect the targets of budget guidelines tax law. In thesis, is possible to affirm that the tax benefits concession must have temporary function and objectify the investment attraction and/or economic development. As a way to measure this relation, the present study will investigate two scenarios. In the first one, the tax waiver predicted in Tax Expenditure Statements (TES), denoted as variable (Y), will be correlated with GDP ( $X^1$ ) and Publics and Privates Investments, ( $X^2$ ). In the second scenario, the tax waiver of income tax on profits and dividends paid to companies' shareholders and associates, denoted as variable (Y), will be correlated with GDP ( $X^1$ ) and Publics and Privates Investments, ( $X^2$ ).

The Organization for Economic Co-operation and Development – OECD, through its efforts in organizing and spreading data related to its country members taxation, presented in May 02, 2018 a document having the effectives-imposed taxes on the dividends distribution to shareholders, considering the corporative tax, the personal income tax, also considering any kind of mechanism to integrate or reduce the double taxation effects.

The following Table 1, show based in data made available by OECD in 2018, a comparative picture of nominals aliquots referred to legal person's profits taxation, concomitantly with the nominals aliquots referred to income tax on profits and dividends distributed to shareholders. It can be noticed that when compared to countries (United Kingdom, United States, Chile), Brazil presets a smaller aggregate aliquot in comparison to others countries, especially the more developed ones. This difference is derivative of tax waiver of income tax on profits and dividends distribute to associates and shareholders.

Table 1. Taxation on profits exercise of 2018

Taxation on Profits and Dividends (%)				
Countries	Distribute Profits	Taxes/ Profits	Taxes/ Profits	Total Tax
	Before Tax (A)	Companies	Shareholders (C)	(B+C)/A
United Kingdo	123,46	23,46	38,10	49 ,86

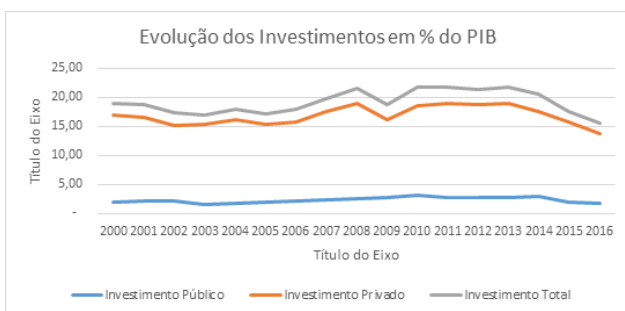
m				
United States	134,84	34,84	29,24	47,52
Chile	133,33	33,33	13,33	35,00
Brazil	151,52	51,52	-	34,00

Source: research data – OECD

The data above, although bring evidences that Brazil has a peculiar income distribution and tax progressivity way, in isolation doesn't respond to the critical question of this study, that is the tax waiver impact as an instrument of economic efficiency. This element, only reenforce the motivation that trough a quantitative research, considering the weight and the relation of tax waiver and tax waiver of income tax on profits and dividends, correlated with public and private investments and GDP, become possible to an exam of the characteristics and motivations to the existing tax waiver in Brazil, inside its reality and economic context.

According to the data published by IPEA, it verifies that the long recession in which Brazil finds itself in almost three years, brought down the investments to the lower level since the early 2000. This reduction is potentialized by retraction of private sector that reached its lowest indices since 2000, 13,7%. Lining with privates' investments retraction, the public sector investment rate, that was already low, dropped to 1,8% of GDP in 2016, the lowest level since 2004.

In front of this scenario, the added investment to public and private sector, ended in 2016 in its worst mark since the year 2000. The following graphic (Figure 1) show the public and private investments evolution in Brazil, in historical series of 2000 till 2016.



Source: research data – IPEA

It is determinate that the total investments line receives significantly impact of privates' investments, being this one not only its most valuable parcel, but also one conditioner of its evolution. In one study published by IPEA, Orair (2016) arguments that the economic thinking

schools presents divergencies in its analyses about public expenditure impacts or about the Govern function as economic developer inductor. However, recognizes the strategic role that the public sector investments can perform in our economy, mainly when oriented to infrastructure segments.

Table 2 contemplate the study construct, which is segregated in two variables groups (dependent and independent), describe its definition, calculation formula, source of data collection.

Table 2 – Research Construct

Variable	Definitio n	Formula	Collection	Source
<b>Dependent Variable (Regression)</b>				
Total Tax Waiver	Total of Governm ent expenditure	$\sum$ of governm ent expenditure	Federal Governme nt	Year of reference PLOA
Tax waiver on profits and dividends	Waiver of total profits	Profits and dividend s x 15%	Federal Governme nt	Receita Federal do Brasil (CETAD )
<b>Independents Variables (Regression)</b>				
Gross Domestic Product (GDP)	Total of wealth generate d in the country	$PIB=C+I+G$ $(X-M)$	Federal Governme nt	Year of reference PLOA
Investme nts	Total of investme nts	$\sum$ of Investme nts	Federal Governme nt	IPEA

**Legend:** CETAD: Centro de Estudos Tributários e Aduaneiros; PLOA: projeto de Lei Orçamentária Anual; IPEA: Instituto de Pesquisa Econômica Aplicada - **Source:** Research data

The tax policy result can be evaluated under different angles that can go since the quality of public expenditure measurement until the tax policy impacts to the well-being of citizens and to the economy. As an example, stand out the primary tax result, that is the difference between the primary revenue and primary expenses during a given period, executing the interest payments. Therefore, in thigh

syntheses, it is spoken that the Govern has a tax surplus, to the interest payment on its debt, when revenues exceed the expenses in given period, on the other hand, there is deficit when the revenues are smaller than the expenses. To teste the proposed study model, it was formulated the following regression equation:

$$Y = \beta_0 + \beta_1 \times X^1 + \beta_2 \times X^2 + \epsilon$$

Where Y = is the predicted waiver;

X<sup>1</sup> = is the year of reference GDP;

X<sup>2</sup> = are the year of reference Investments;

β<sub>0</sub>, β<sub>1</sub>, β<sub>2</sub> = are the multiple linear regression coefficient.

ε = regression error

Table 3 - Pearson Correlation – Scenario 01

Pearson Correlation – scenario 02

Variable	RFT	GDP	INV	Variable	RFL	GDP	INV
TTW	1	0,000*	0,002*	TWP	1.	0,000*	0,000*
GDP	0,000*	1	0,000*	PIB	0,000*	1	0,000*
INV	0,002*	0,000*	1	INV	0,000*	0,000*	1

**Legend:** TTW: Total Tax Waiver; PIB: Gross domestic product; INV: Investments; TWP: Tax Waiver on Profits.

**Notes:** \*Significance to level of 1%, \*\*Significance to level of 5%, \*\*\*Significance to level of 10%

Source: Research Data

Referent to Pearson Correlation it is perceived the correlation existence between the variables. Not only TTW but also TWP, has positive and significant correlation with GDP and INV, in this way the Tax Waiver is correlated with the GDP and Investments variables.

### 3.1 Scenario 1 (Total Tax Waiver)

To reach the stablished goals in this research it was analyzed two macroeconomic scenarios. Based in data to multiple regression, it was used in the first scenario the total value of taxation expenditure, identified as total tax waiver, in a series of 10 years, comprehended between the years of 2007 to 2016, as showed in Table 4.

Table 4. Total Tax Waiver (Data Bases)

Scenario 1 data bases – Total tax waiver in billions			
Period	Tax waiver (Y)	GDP(X <sup>1</sup> )	Investments (X <sup>2</sup> )
2007	52,74	2.299,47	455,29
2008	76,06	2.744,83	592,88
2009	101,96	3.186,64	599,34
2010	113,88	3.326,52	725,18
2011	116,08	3.892,48	848,56
2012	145,98	4.537,48	971,02
2013	170,02	4.973,61	1.079,27
2014	249,76	5.242,91	1.080,04
2015	282,44	5.733,44	1.009,09
2016	271,01	6.253,18	969,24

Source: research data – Federal Government: PLOA; IPEA.

Will be presented now the multiple regression results resume to the construction of a model capable of stablishing a relation between the presented variables.

Table 5 - Regression Result Scenario 1

Variables	Predict ed Signal	Model 1 Coefficie nt	Value- P	Beta Standart
_Cons	+/-	-77,104	0,0461 **	
GDP	+	0.0725***	0,0015 *	1,168
Investments	+	- 0,0851***	0,3522	-0,232
Significance		0,0001*		
R <sup>2</sup>		0,92		
N		10		

**Notas:** \*Significance to level of 1%, \*\*Significance to level of 5%, \*\*\*Significance to level of 10%

Source: Research Data

The significance of regression test is used to determinate if there is a linear relation between the variable answer Y and some of regression variables, X<sup>1</sup>, X<sup>2</sup>

etc. To be considered any relation evidence, is necessary that the value-p of test F be < than 5%. As it was observed, it is possible to suggest that is statistic evidence that at least one variable is related to tax waiver. From the finding through the global significance, that at least one independent variable is related to the dependent variable, it become necessary to identify which variables are directly related to tax waiver. To be considered any relation evidence, is necessary that the value-p of the test is < than 5%.

As highlighted in Table 5, is possible to affirm that there is statistic evidence that only the variable X<sup>1</sup> GDP is related with total tax waiver. Also, from the relation consideration between variables, it must be observed the R<sup>2</sup> results to test how the variable together explain the variability of total tax waiver. Stands out that R<sup>2</sup> presents significantly relation of variables with the tax waiver variability.

### 3.2 Scenario 2 (tax waiver on profits and dividends)

To the second scenario, it was isolated as data bases to multiple regression the total value of tax waiver of tax income on profits and dividends, found through the percentual application of 15% current until December 31, 1995 according dispose in Law 8.849/1994 on value of profits and dividends received by associates and shareholders, informed to Brazil' Federal Revenue. It was used the same temporal series of 10 years, comprehended between the years of 2007 and 2016.

Table 6. Tax waiver on profits and dividends (data bases)

Scenario 2 data bases - Tax waiver on profits in billions			
Period	Tax waiver (Y)	GDP(X <sup>1</sup> )	Investments (X <sup>2</sup> )
2007	16,13	2.299,47	455,29
2008	22,46	2.744,83	592,88
2009	23,43	3.186,64	599,34
2010	28,86	3.326,52	725,18
2011	34,46	3.892,48	848,56
2012	38,16	4.537,48	971,02
2013	43,10	4.973,61	1.079,27
2014	48,03	5.242,91	1.080,04
2015	50,10	5.733,44	1.009,09
2016	52,54	6.253,18	969,24

Source: research data – Federal Government: PLOA; IPEA e CETAD - RFB

It is now presented a resume of multiple regression results, to the construction of a model capable to establish a relation between the presented variables.

Table 7 - Scenario 2 Regression result

Variabl e	Predi cted signa l	Model 1 Coeffic ient	Valor – P	Beta Standard
_Cons	+/-	-6,6944	0,007*	
GDP	+	0.0074 *	0,00001*	0,785
Investme nts	+	0,012*	0,0295**	0,227
Significa nce		0,0001 *		
R <sup>2</sup>		0,99		
N		10		

Notes: \*Significance to level of 1%, \*\*Significance to level of 5%, \*\*\*Significance to level de 10%

Source: Research data

It is kept the same methodology of scenario 1 and stands out the data capable of verifying the pre requisite adequation of an analysis by multiple regression. As already highlighted in this study, the regression significance test is to determinate if there is a linear relation between the variable answer Y and some of regression variables, X<sup>1</sup>, X<sup>2</sup> etc. To be considered any relation evidence is necessary that the value-p of test F is < than 5%. As it was observed, it can also be affirmed that in the second scenario has statistic evidences that at least one variable is related to tax waiver. Therefore, the regression analyses will have utility, also to scenario 2. From the finding through the global significance test that at least one independent variable is related to dependent variable, it can also identify which variables are directly related to tax waiver on profits and dividends. To be considered any relation evidence, is necessary that the value-p of the test is < than 5%.

As highlighted in Tabel 7, it was possible to affirm that there are statistic evidences that all variables are related to tax waiver on profits and dividends. In comparison to scenario 2, also considering relation between variable, it was observed the R<sup>2</sup> results to test how the variable together explain the tax waiver variability. Stands out in Table 7 that the R<sup>2</sup> significantly evidences the variables relation, with tax waiver on profits and dividends variability.



### 3.3 Statistic Significance Test

When proposed in a research that a new approach to certain matter, it becomes necessary to add information to statistical significance concept. Therefore, considering that independent variables are continuous, it was used the Cohen  $F^2$  test, to estimate the effect size that describe the variability proportion of continuous dependent variable that is due to each independent variable. The Cohen  $F^2$  is appropriate to calculate the size effect inside of a model where the interest independent variable and dependent variable are both continuous (Lindenau & Guimarães, 2012). Cohen  $F^2$  is calculate by the following equation:

$$f^2 = \frac{r^2_{AB} - r^2_A}{1 - r^2_{AB}} = \frac{r^2_{AB} - r^2_A}{1 - r^2_{AB}}$$

Where:

$R^2_{AB}$  = the determination coefficient of moderation (GDP x INV)

$R^2_A$  = the determination coefficient of original model

To test the moderation effect of the proposed study, it was formulated the following regression equation:

$$RF_t = \beta_0 + \beta_1 PIB_t + \beta_2 INV_t + \beta_3 PIB_t \times INV_t + \varepsilon$$

In both scenarios, it was observed by Beta standard that the GDP has a bigger influence in Tax waiver variable, than investment variable. The statistical significance test results show that the moderate effect of variable is medium, but significant.

### 3.5 Result analyses

The dynamic of tax waiver economic impact, where it wight the observed measures by GDP with investment correlation result, find less relevance when analyzed the scenario 1 statistic result. It is noticed that the total taxation expenditure with tax waiver, according to the used statistic model, although in the variable group has one  $R^2$  of 92%, that means, as already stand out, how two independent variables together explain dependent variable, the dependent variable (tax waiver) can be explained in isolation only by GDP. Consequently, it is observed that there is no statistic evidence of relation between the investments variable and total taxation expenditure called tax waiver, in other words, it can't be affirmed that the investments evolution can statistically explain or justify the total tax waiver. However, it can be observed the positive linear relation found in the GDP and tax waiver correlation suggest that, in economic term, such expenditures it would be shown efficient only in the measure that contributed to GDP growth, being the optic and allegation of Government authorities than justifying the waiver.

That being said, it is considered after all that was presented about the subject tax waiver, that the growth or reduction of such expenditure must be conceived as one of determinant factors in economic development of one region, or even one country. However, is hard to precise the factors that determine the results of an isolated variable impact on the growth of an economy, in front of incentives or chance accidents, inside of this uncertainties and indetermination world. Therefore, an efficient tax policy must promote results not only in short period, in the longing to keep under control its budget goals, but being capable of, over time, reach results that can promote the growth in sustainable way.

In the second scenario, according to results of correlation with GDP and investments it is observed that exists bigger relevance in tax waiver of income tax on profits and dividends economic impact. As the used statistic model, it is observed that, together, the two independent variables, GDP and investments, justify or explain 99% of the variance value of tax waiver of income tax profits and dividends. It also turns out that, in isolation, each independent variable keeps strong statistic evidence of relation with dependent variable, in other words, statistically, the growth of both variable, GDP and investments, would be capable to explain of justify the permanence of tax waiver of income tax on profits and dividends.

By its nature, tax waiver of income tax on profits and dividends was originally conceived to, through a complete integration between legal and physical person, where the income tax taxation on profits and dividends would have incidence exclusively in the company exempting when receipt by beneficiaries, could stimulate, in reason of leveling the treatment and applicable aliquots, the investments in productive activities. Therefore, from the presented results in this study it was possible to suggest that, statistically, the increase in investments and the consequent GDP increase, justify such taxation expenditure under the economic efficiency aspect. In this way, it is rejected the hypotheses that "the tax waiver on profits and dividends in Brazil contribute to the budget imbalance, by its inefficiency to contribute for the economic growth". Considering the moderation effect size, it was observed that the influence in dependent variable is medium. In future studies, a bigger statistic sample, as well as insertion of another variables, can contribute with more significant moderating effects.

## IV. CONCLUSION

The study presented important limitations about the researched sample. The first limitation refers to a difficulty

to obtain a more significant sample. Until the study conclusion, the Federal Revenue, disposes of a historic series of only 10 years regarding to informed profits and dividends. This factor contributes to this study limitations, because certainly a more significantly and representative sample of these data would allow a bigger statistic validation. The second limitation is related to the lack of studies with the same goal of this work and the same data sample. The study exploratory character significantly limited in terms of literature revision and result comparison with others conducted studies.

The present study finds substantial relevance in the current economic and politic Brazilian scenario. In this way, to strongly contribute to the proposed theme debate, it is recommended to, in the future, apply the measuring instrument used in this study to a bigger data sample, in the effort to obtain a closer to reality result and, because of that, more conclusive. It is also recommended correlate the tax waiver values with the interest rate of the selected period. The Brazilian interest rate is a key variable in the country public indebtedness, once the gross debt increase related to GDP is provided, among other factors, by the interest increase. The importance to measure the interest variable is potentialized in this context mainly due to the gradual decline occurred in the last 15 months, period where the interest basic tax passed 14,25%, in August 2016, to 6,5% a year in August 2018. On such scenario, it could increase the sample statistic sensibility to measure the interest basic tax variations impacts, and, in this way, obtain a successful contribution.

As business management and accounting sciences contribution, this research is characterized as an incentive instrument to the reading and debate of a theme that approach, in a macroeconomic view, the tax policy with tribute waiver impact, in strategics subjects to the companies. It was observed a literature gap in the administration and countability field, that could objectify face the labyrinths of our economic and taxation system, to instigate thoughts that determinate the governing, legislators and businessman, actuation borders, in their managers role.

It is also highlighted, that the literature absence, provoke in the majority of managers, a mistaken distance and in consequence a substantial unawareness, of the tax agenda maze. Notably, such condition, show itself potentially capable to restrict the strategic decisions efficiency, besides compromise the expectations of future projections. It is hoped, however, that the present study wakes the academic community and other professionals that act in business management and accounting sciences field interest, to collaborate with a construction of a more

amplified and strategic view of this tax policy economic impact.

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# Effect of Storage on Quality of Spirulina Snack Bars

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**Keywords**— *Snack bar, spirulina, storage, quality.*

**Abstract**—*Ready to eat snack and health bars have sturdily occupied space in the global market and are high in demand as nutritional supplements for people on the go and weight watchers especially people consuming calorie-controlled diets. Spirulina is a unicellular micro alga grown in water bodies containing 50-70% protein including all essential amino acids, fatty acids, vitamins and minerals. The soy protein isolate is good source with high bioavailability of protein (90%) and it is easily digestible too. Bengal gram is an old pulse with high protein ratio about 80% with several vitamins like vitamin A, C, E, K and B-complex and minerals like phosphorous and magnesium. Peanuts are essential source of protein, lipid and fatty acids and called as poor man's protein due to its low price. It contains essential vitamins and minerals useful for healthy immune system, nerve function, blood coagulation mechanism, bones and teeth formation. In present investigation snack bars prepared with bengal gram, peanut, oats, puffed rice, desiccated coconut, soy isolate, spirulina, cardamom powder and binding syrup were analyzed for organoleptic properties and stored at room temperature after packaging with butter paper and polypropylene pouch for 90 days to record changes in nutritional, functional, organoleptic and microbial quality attributes. The results showed increase in moisture content whereas decrease in ash, fat, protein and fiber content in stored snack bars. The microbial count (Total plate count, yeast and mould) was increased throughout storage period at room temperature from 45th day of storage and sensory score for all the sensory parameters (Colour and appearance, flavour, taste, texture and overall acceptability) was decreased with the advancement in storage period. The snack bars with spirulina could be stored for the period of 90 days in polypropylene pouch at room temperature in good condition.*

## I. INTRODUCTION

Energy bar or snack bar is a portable, convenient and proportioned health food with minimally processed, rich in nutrients and excellent in taste which fulfils consumer demand for health foods (Mridula et al., 2011). Snack bars contains mainly cereals and other high energy ingredients having carbohydrate, lipids, proteins and minerals in them, which deliver good sensory and nutritional characteristics to it. (Padmashree et al., 2018).

The low moisture content food items with longer time span of usability and less microbial decay are effectively used for their functional nutrients. Snack bars are commonly reinforced by utilizing different protein, fiber or vitality rich ingredients (Siddique et al., 2018).

The faster developing change in life style leads to rapid increase demand for the processed and convenience foods. Energy bars are one of the nutritionally balanced convenient food which has foothold since after 1980s (Mridula et al., 2011 and Yadav and Bhatnagar, 2015).

Considering increase in participation number of physical activities, snack bars with good range of nutrients with satisfactory amount of proteins, fats, carbohydrates in little packet has been a great source of energy (Yadav and Bhatnagar, 2015).

Protein is important for development and repairing of body cells. The deficiency of protein may lead to different health complications like kwashiorkor, marasmus, impaired mental health, oedema, organ failure, wasting and shrinkage of muscle tissues, and weakness of immune system (Khan et al., 2017). Though protein is considered as an important component of human diet its scarcity is the widest problem in the world. According to global production scenario the ever-increasing world population cannot be lean only on agriculture to nourish them. This leads to identify another protein sources and the best potential of protein source have been found in microbial protein (Usharani et al., 2012). In the last few years, the special properties of microscopic organism have attracted people and scientists from all over the world (Palaniswamy et al., 2018).

Spirulina which is a uni-cellular microphytes contains all essential amino acids with quite amount of methionine, cysteine, and lysine than meat, egg or milk, but comparatively higher than all plant protein. It has a 36% of polyunsaturated fatty acids ( $\gamma$ -linolenic acid, linoleic acid, stearidonic acid, eicosapentaenoic acid, docosahexaenoic acid and arachidonic acid) and 1.5–2.0% of total lipids (Jung et al., 2019). Spirulina have significant effect on reducing serum cholesterol levels in human beings by 4.5% and significantly reduces body weight. It also reduces hepatic damage, inflammatory response, cells degeneration, anaphylactic reaction. It also prevents eye diseases, hypoferric anemia and pernicious anemia due to its vitamin A, iron, and vitamin B12 content spirulina extract induces the tumor necrosis factor in macrophages, suggesting a possible tumor destruction mechanism (Saranraj and Sivasakthi, 2014).

The efforts were undertaken to develop protein rich snack bar using protein rich ingredients like spirulina, bengal gram, peanut and soy isolate and to study the effect on their quality during storage.

## II. METHODOLOGY

### 2.1 Development of snack bars using spirulina

The spirulina snack bars were prepared by using bengal gram (15%), peanut (15%), soy isolate (4%), desiccated coconut (4%), puffed rice (2%), corn syrup (25%), honey (20%), cardamom (1%) and variable combinations of oats (10-14%) and spirulina (2- 6%). The developed spirulina

snack bars wrapped in butter paper and packed in polypropylene pouch were stored at room temperature (90 days) to record changes in nutritional, functional, organoleptic and microbial quality attributes for 15 days of time interval during storage period.

### 2.2.2 Quality analysis of spirulina snack bars during storage

The moisture, ash, fat, proteins, crude fiber contents, carbohydrates were determined by standard methods suggested by Ranganna (2015) and Thimmaiah (2016).

For determination of total phenolic contents 1g of ground sample was dispersed in 10 ml of 80% ethanol and centrifuged at 1500 rpm for 15 min. After centrifugation, supernatant of sample, supernatant was evaporated to dryness. The dried extract was dissolved in water and different aliquots were taken to made final volume upto 3ml. 0.5ml of FCR and Na<sub>2</sub>CO<sub>3</sub> were added in it and the absorbance was measured at 650nm against a reagent blank. Total phenol content was expressed in mg of GAE/100g (Thimmaiah, 2016).

The antioxidant potential was assessed by using DPPH method. 1g of sample per 100ml ethanol was dispersed thoroughly with the help of vortex mixer. It was allowed to remain still overnight and centrifuged at 3000 rpm for 10min to facilitate separation of sample extract. The 0.2ml of eluted supernatant was taken in a test tube covered with aluminum sheet and 1ml of freshly prepared DPPH solution (80 $\mu$ g/ml ethanol) was carefully added. A control was set up with 0.2ml distilled water as blank and 1ml of DPPH solution was added to it. The sample test tubes were allowed to remain in the dark for 30min and absorbance of the samples and blank sample were measured against ethanol at 517nm (Kumar, 2018). The percentage of inhibition was calculated using the formula (Tailor and Goyal, 2014).

$$\text{Inhibition (\%)} = \frac{(\text{Abs}_{\text{control}} - \text{Abs}_{\text{sample}})}{\text{Abs}_{\text{control}}} \times 100$$

### 2.2.3 Microbial analysis of snack bar

The total plate count and yeast and mould contents were determined by the standard pour plate method (Aneja, 2003).

### 2.2.4 Sensory analysis

Sensory analysis of prepared snack bars samples were done using 9-point hedonic scale rating (Ranganna, 2015).

### III. RESULTS AND DISCUSSIONS

#### 3.1 Nutritional and functional characteristics of stored snack bars

Table 2. Effect of storage period on moisture content (%) of spirulina snack bars

The changes in moisture content of stored snack bars

Raw material	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Crude fibers (%)	Carbohydrates (%)
<b>Bengal gram</b>	10.71 ± 0.49	2.5 ± 0.03	5.1 ± 0.31	22.50 ± 0.35	1.02 ± 0.02	58.06 ± 0.98
<b>Peanut</b>	1.80 ± 0.28	2.8 ± 0.06	49.73 ± 0.36	24.42 ± 0.40	8.43 ± 0.03	21.23 ± 0.51
<b>Oats</b>	8.02 ± 0.35	1.8 ± 0.05	8.4 ± 0.32	11.72 ± 0.44	9.99 ± 0.04	59.98 ± 0.76
<b>Soy isolate</b>	1.06 ± 0.02	5.3 ± 0.15	0.2 ± 0.06	91.20 ± 0.02	0.02 ± 0.02	2.18 ± 0.16
<b>Spirulina</b>	3.52 ± 0.39	6.7 ± 0.02	9.5 ± 0.56	63.56 ± 0.58	3.18 ± 0.07	13.49 ± 0.42

depicted in Table 2 indicated gradual increase in moisture content of snack bars with advancement of storage period. The moisture content in freshly prepared snack bars was observed in the range between 11.31 and 11.35%. During room temperature storage, moisture content in snack bars was increased to 12.95-13.04% at the end of 90th day of storage. Increase in moisture content during storage might be due to higher vapour transmission rate of PP films (Padmashree et al., 2018 and Ekafitri et al., 2020). The results are in agreement with the results reported by (Mridula et al., 2011, Padmashree et al., 2018, and Kumar et al., 2018). The storage period had non-significant effect on the moisture content of snack bars at 5% level of significance.

#### 3.1.1 Changes in moisture content

Table 3. Effect of storage period on ash content (%) of spirulina snack bars

Sample	0 days	15 days	30 days	45 days	60 days	75 days	90 days
S0	1.01 ± 0.05	0.92 ± 0.04	0.84 ± 0.03	0.75 ± 0.03	0.69 ± 0.02	0.62 ± 0.07	0.57 ± 0.04
S1	1.38 ± 0.02	1.31 ± 0.03	1.23 ± 0.04	1.14 ± 0.04	1.08 ± 0.03	1.02 ± 0.04	0.97 ± 0.03
S2	1.56 ± 0.04	1.48 ± 0.04	1.40 ± 0.05	1.31 ± 0.06	1.25 ± 0.07	1.18 ± 0.05	1.13 ± 0.02
S3	1.77 ± 0.02	1.70 ± 0.02	1.62 ± 0.06	1.53 ± 0.04	1.47 ± 0.04	1.41 ± 0.03	1.36 ± 0.02
Mean	1.43	1.35	1.27	1.18	1.12	1.06	1.01

The changes in ash content of stored snack bars are presented in Table 4. As regards room temperature storage, there is progressive decrease in ash content of all snack bars throughout the storage period. The highest ash content (1.77%) was recorded in freshly prepared snack bars with 6% spirulina followed by 4% spirulina (1.56%) and 2% spirulina (1.38%). Whereas the lowest ash content (1.01%) was observed in control bars without spirulina. The more ash content in spirulina bars might be due enormous mineral content associated with spirulina (Kumar et al., 2018). The ash content showed declining trend in all snack bars throughout the storage period and recorded 0.57% (Control bars), 0.97% (2% spirulina), 1.13% (4% spirulina) and 1.36% (6% spirulina) ash content at the end of 90 days of room temperature storage. Decrease in ash content during storage might be due to higher degree of deterioration rate associated with PP films (Padmashree et al., 2018 and Siddique et al., 2018). The storage period had significant effect on the ash content of snack bars at 5% level of significance.

#### 3.1.2 Changes in ash content

#### 3.1.3 Changes in fat content

Table 4. Effect of storage period on fat content (%) of spirulina snack bars

Sample	0 days	15 days	30 days	45 days	60 days	75 days	90 days
S0	9.15 ±0.7 9	9.07 ±0.8 7	9.01 ±0.8 9	8.93 ±0.8 8	8.85 ±0.7 0	8.79 ±1.1 7	8.74 ±0.7 1
S1	9.17 ±0.9 3	9.08 ±0.9 7	9.02 ±1.0 1	8.94 ±1.0 6	8.86 ±1.1 7	8.80 ±0.7 1	8.76 ±0.9 4
S2	9.19 ±1.0 0	9.11 ±0.8 2	9.05 ±1.0 4	8.97 ±1.1 6	8.89 ±1.2 0	8.83 ±1.0 1	8.77 ±1.0 0
S3	9.21 ±1.0 0	9.14 ±0.8 1	9.08 ±0.9 6	9.01 ±0.9 3	8.92 ±1.0 9	8.84 ±1.0 0	8.79 ±1.1 7
Mean	9.18	9.10	9.04	8.96	8.88	8.82	8.76

The changes in fat content of stored snack bars tabulated in Table 5 indicated gradual decrease in fat content with advancement of storage period. The fat content in freshly prepared was recorded in the range between 9.15-9.21%. During room temperature storage, fat content in the snack bars was decreased to 8.74-8.79% at the end of 90 days of storage. The decline in fat content during storage may be due to degradation products of hydroperoxide which is directly related with moisture content of product (Mridula et al., 2011, Siddique et al., 2018 and Padmashree et al., 2018). The storage period had non-significant effect on the fat content of snack bars at 5% level of significance

3.1.4 Changes in protein content

Table 5. Effect of storage period on protein content (%) of spirulina snack bars

Sample	0 days	15 days	30 days	45 days	60 days	75 days	90 days
S0	12.7 2±0. 83	12.5 0±0. 96	12.3 3±0. 95	12.1 8±0. 87	12.0 3±0. 89	11.8 8±0. 81	11.7 1±0. 70
S1	13.7 5±0. 77	13.5 3±0. 99	13.3 6±0. 82	13.2 1±0. 75	13.0 6±0. 73	12.9 1±0. 73	12.7 5±0. 61
S2	14.7 8±0.	14.5 7±1.	14.4 3±0.	14.2 8±0.	14.1 4±0.	13.9 8±0.	13.8 1±0.

	96	01	81	76	68	61	66
S3	15.8 3±0. 88	15.6 1±1. 03	15.4 4±0. 88	15.2 9±0. 79	15.1 4±0. 79	15.0 0±0. 63	14.8 2±0. 54
Mean	14.2 7	14.0 5	13.8 9	13.7 4	13.5 9	13.4 4	13.2 7

The Table 6 showed gradual decrease in protein content of snack bars throughout the storage period. The highest protein content (15.83%) was recorded in freshly prepared snack bars with 6% spirulina followed by 4% spirulina (14.78%) and 2% spirulina (13.75%). Whereas the lowest protein content (12.72%) was observed in control bars without spirulina. During room temperature storage, protein content in snack bars showed declining trend and found to be decreased to 14.82% (6% spirulina), 13.81% (4% spirulina), 12.75% (2% spirulina) and 11.71% (control) at the end of 90th day of storage. Decrease in protein content during storage might be due the lipolytic and proteolytic activities related to higher moisture content leading to loss in protein content (Butt et al., 2003 and Siddique et al., 2018). The similar decrease in protein content during storage was reported by (Siddique et al., 2018). The storage period had significant effect on the protein content of snack bars at 5% level of significance.

3.1.5 Changes in fiber content

Table 6. Effect of storage period on fiber content (%) of spirulina snack bars

Sample	0 days	15 days	30 days	45 days	60 days	75 days	90 days
S0	3.06 ±0.0 4	3.02 ±0.0 4	2.97 ±0.0 6	2.94 ±0.0 3	2.92 ±0.0 5	2.91 ±0.0 5	2.90 ±0.0 4
S1	2.94 ±0.0 3	2.88 ±0.0 3	2.83 ±0.0 4	2.80 ±0.0 6	2.78 ±0.0 4	2.77 ±0.0 6	2.76 ±0.0 3
S2	2.80 ±0.0 1	2.75 ±0.0 4	2.70 ±0.0 3	2.67 ±0.0 2	2.65 ±0.0 5	2.64 ±0.0 4	2.63 ±0.0 4
S3	2.67 ±0.0 2	2.62 ±0.0 5	2.58 ±0.0 1	2.55 ±0.0 4	2.53 ±0.0 6	2.52 ±0.0 3	2.51 ±0.0 3
Mean	2.87	2.82	2.77	2.74	2.72	2.71	2.70

Changes in fiber content of stored snack bars depicted in Table 7 indicated significant effect of storage period on



fiber content of snack bars. The fiber content in the freshly prepared snack bars was found to be in the range between 2.67 and 3.06%. During room temperature storage, fiber content in snack bars was decreased to 2.51 and 2.90% at the end of 90th day of storage. The decrease in fiber content during storage might be due to higher degree of deterioration rate associated with PP films (Padmashree et al., 2018). The findings are in close conformity with the results reported by (Siddique et al., 2018). The storage period had significant effect on the fiber content of snack bars at 5% level of significance.

3.1.6 Changes in total phenolic content

Table 7. Effect of storage period on total phenolic content (mg GAE/g) of spirulina snack bars

Sa mp le	0 days	15 days	30 days	45 days	60 days	75 days	90 days
S0	1.07 ±0.0 7	0.94 ±0.0 6	0.81 ±0.0 4	0.71 ±0.0 3	0.50 ±0.0 5	0.34 ±0.0 5	0.16 ±0.0 2
S1	3.02 ±0.0 8	2.75 ±0.0 4	2.50 ±0.0 6	2.36 ±0.0 4	1.97 ±0.0 3	1.53 ±0.0 9	1.09 ±0.0 5
S2	5.12 ±0.0 5	4.82 ±0.0 3	4.67 ±0.0 5	4.49 ±0.0 6	4.05 ±0.0 4	3.60 ±0.0 8	3.19 ±0.0 4
S3	7.20 ±0.0 5	6.88 ±0.0 4	6.62 ±0.0 4	6.47 ±0.0 5	5.98 ±0.0 7	5.57 ±0.0 9	5.03 ±0.0 6
Me an	4.10	3.85	3.65	3.51	3.13	2.76	2.37

The changes in total phenolic content of stored bars tabulated in Table 8 indicated significant effect of storage period on total phenol content of snack bars. The total phenolic content of freshly prepared snack bars was found to be increased with increase in spirulina level and recorded as 1.07mg GAE/g, 3.02mg GAE/g, 5.12mg GAE/g and 7.20mg GAE/g for snack bars containing 0%, 2%, 4% and 6%, spirulina respectively. Noticeable decrease in total phenolic content was seen in stored snack bars and recorded as 0.16mg GAE/g, 1.09mg GAE/g, 3.19mg GAE/g and 5.03mg GAE/g in snack bars containing 0%, 2%, 4% and 6%, spirulina respectively at the end of 90th day of storage. The higher phenolic content in spirulina variants is associated with more phenolic content of spirulina powder (Kumar et al., 2018). Carvalho and Silva (2018) and Siddique et al. (2018) reported decrease in total phenolic compounds in stored bars throughout the storage period. The storage period had

significant effect on the total phenolic content of snack bars at 5% level of significance.

3.1.7 Changes in antioxidant activity

Table 8. Effect of storage period on antioxidant activity (%) of spirulina snack bars

Sa mp le	0 days	15 days	30 days	45 days	60 days	75 days	90 days
S0	9.33 ±0.7 2	8.05 ±0.5 1	7.12 ±0.1 4	6.32 ±0.2 2	4.83 ±0.4 2	3.66 ±0.3 1	2.33 ±0.1 9
S1	20.1 6±0. 44	18.1 5±0. 43	16.1 0±0. 23	14.0 4±0. 38	11.8 3±0. 21	8.85 ±0.4 9	5.99 ±0.5 0
S2	33.3 3±0. 82	31.2 4±0. 33	29.3 0±0. 22	27.3 7±0. 55	24.9 1±0. 43	22.1 4±0. 24	20.0 0±0. 32
S3	46.6 1±0. 98	44.1 2±0. 21	42.1 8±0. 23	40.0 9±0. 55	37.9 2±0. 32	35.0 2±0. 75	32.8 1±0. 28
Me an	27.3 6	25.3 9	23.6 8	21.9 6	19.8 7	17.4 2	15.2 8

The antioxidant potential of stored snack bars was assessed by % DPPH inhibition as free radical scavenging activity and findings are recorded in Table 9. The antioxidant potential of freshly prepared snack bars was found to be increased with increase in spirulina level and recorded as 9.33%, 20.16%, 33.33%, and 46.61% for snack bars containing 0%, 2%, 4% and 6%, spirulina respectively. The antioxidant activity showed declining trend in all snack bars throughout the storage period and recorded 2.33% (Control bars), 5.99% (2% spirulina), 20.00% (4% spirulina) and 32.81% (6% spirulina) at the end of 90 days of room temperature storage. The better the antioxidant activity is associated with high amount of phenolics (Kumar et al., 2018). Carvalho and Silva (2018) and Siddique et al. (2018) reported similar decrease in antioxidant potential of stored bars throughout the storage period. The storage period had significant effect on the antioxidant potential of snack bars at 5% level of significance.

3.1.8 Changes in hardness of stored snack bars

Table 9. Effect of storage period on hardness (g.sec) of spirulina snack bars

Sample	0 days	15 days	30 days	45 days	60 days	75 days	90 days
S0	3630.3 ± 1.52	3656.67 ± 1.20	3668.00 ± 1.00	3688.33 ± 2.08	3714.33 ± 1.52	3723.00 ± 2.00	3729.00 ± 1.00
S1	3628.3 ± 1.52	3652.00 ± 2.00	3666.67 ± 2.50	3686.67 ± 1.50	3710.33 ± 1.50	3716.00 ± 2.00	3720.00 ± 2.00
S2	3625.0 ± 2.00	3648.67 ± 1.50	3665.33 ± 3.50	3684.67 ± 2.00	3706.33 ± 2.00	3714.33 ± 1.50	3720.00 ± 1.00
S3	3621.67 ± 2.50	3642.67 ± 2.50	3662.67 ± 1.50	3681.33 ± 2.30	3703.00 ± 2.00	3712.00 ± 1.00	3718.67 ± 1.50
Mean	3626.3 ± 1.50	3650.67 ± 1.50	3665.67 ± 1.50	3685.25 ± 1.50	3708.50 ± 1.50	3716.33 ± 1.50	3722.67 ± 1.50

The changes in hardness of stored snack bars tabulated in Table 10 indicated gradual increase in hardness with advancement of storage period. The hardness of freshly prepared snack bars was recorded in the range between 3621.67-3630.33g.sec. During room temperature storage, hardness of snack bars was increased to 3718-3729g.sec at the end of 90 days of storage. Increase in hardness during storage might be due to thiol-disulphide interchange reactions during storage which lead to protein cross linking aggregation and network formation (Silva et al., 2013). The hard texture development in protein rich bar may also be due to the migration of moisture as well as formation of most ordered secondary structure and lower surface hydrophobicity of protein particles (Padmashree et al., 2012). The storage period had non-significant effect on the hardness of snack bars at 5% level of significance.

3.2 Organoleptic characteristics of stored snack bars

3.2.1 Colour and appearance

The colour and appearance score of fresh bar was found in the range between 7.1-7.5. Throughout the

storage period there is no marked difference in colour and appearance score of snack bars. The highest colour and appearance score (7.4) was observed with control snack bars followed by 4% spirulina bars (7.3) after 90th day of storage. Whereas, 6% spirulina snack bars showed lowest colour and appearance score (6.9) at the end of 90th day of storage. The storage period had significant effect on the colour and appearance score of snack bars at 5% level of significance.

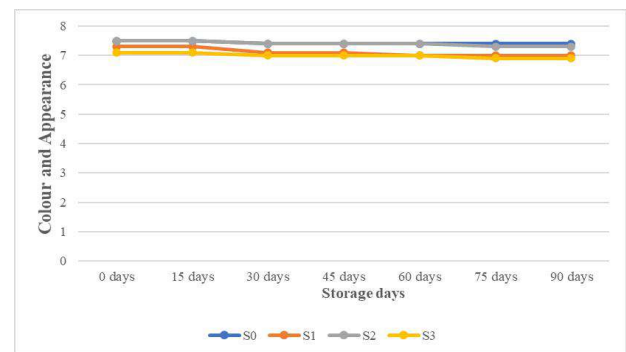


Fig. 1 Changes in colour and appearance of stored spirulina snack bars

3.2.2 Flavour

The flavour score of fresh snack bars was found in the range between 6.9 and 7.4. Throughout the storage period there is no marked difference in flavour score of snack bars. The highest flavour score (7.0) was observed control snack bars followed by bars with 4% spirulina (6.9) after 90th day of storage. Whereas, snack bars with 2% and 6% spirulina exhibited lowest score (6.4) and (6.0) at the end of 90th day of storage. The storage period had significant effect on the flavour score of snack bars at 5% level of significance.

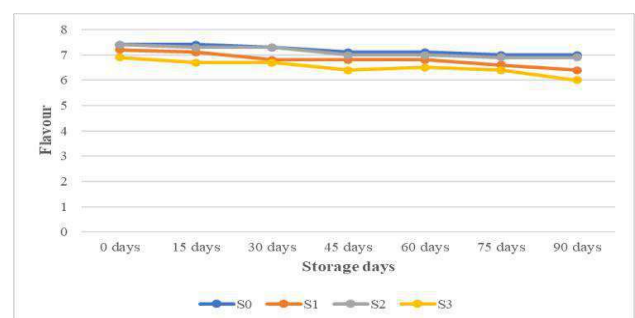


Fig. 2 Changes in flavour of stored spirulina snack bars

3.2.3 Taste

The data tabulated in Table 13 reflects on the effect of storage on average taste score of developed snack bars. The taste score of fresh snack bars was found in the range between 6.9 and 7.5. The snack bars with 4% spirulina and

without spirulina were observed to be with higher taste score (7.1) as compared to 2% and 6% spirulina snack bars which depicted lower scores (6.5 and 6.3) at the end of the 90 days of storage. The storage period had non-significant effect on the taste score of snack bars at 5% level of significance.

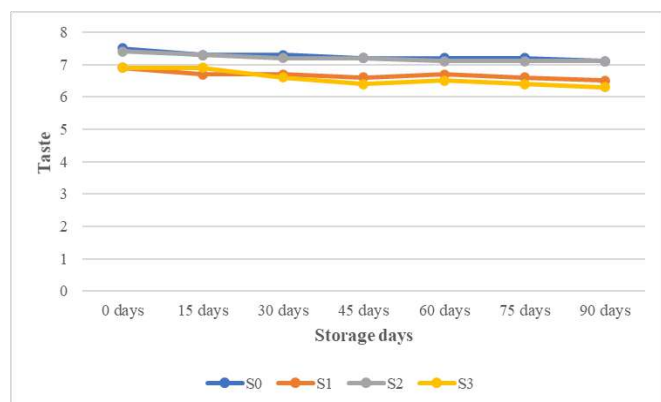


Fig. 3 Changes in taste of stored spirulina snack bars

### 3.2.4 Texture

The Table 14 represents changes in texture score of snack bars during storage. The texture score of fresh snack bars was recorded as 7.1-7.5. At the end of 90 days of storage, snack bars with 0% and 4% spirulina recorded higher texture score (7.1) followed by bars with 2% spirulina (7.0). The lowest texture score (6.7) was observed with 6% spirulina snack bars. The storage period had significant effect on the texture score of snack bars at 5% level of significance.

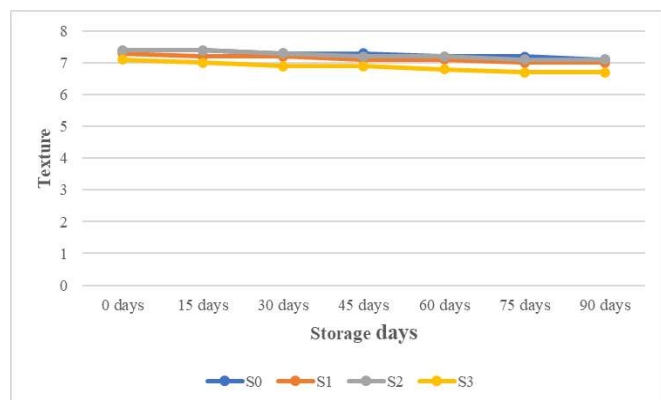


Fig. 4 Changes in texture of stored spirulina snack bars

### 3.2.5 Overall acceptability

The data tabulated in Table 15 represents effect of storage period on overall acceptability of snack bars. The overall acceptability score of fresh snack bars was recorded as 7.0, 7.3, 7.5 and 7.6 respectively. It was found to be decreasing

throughout the storage period in all snack bar samples. The highest overall acceptability (7.4) was recorded with snack bars containing 4% spirulina followed by control bars (7.3) at the end of 90 days of storage. Whereas the lowest overall acceptability was observed with snack bars containing 6% spirulina (6.8). The storage period had significant effect on overall acceptability of snack bars at 5% level of significance. The snack bars with 4% spirulina justified its suitability on the basis of highest organoleptic score for colour and appearance, taste, flavour and texture and overall acceptability throughout the storage period of 90 days.

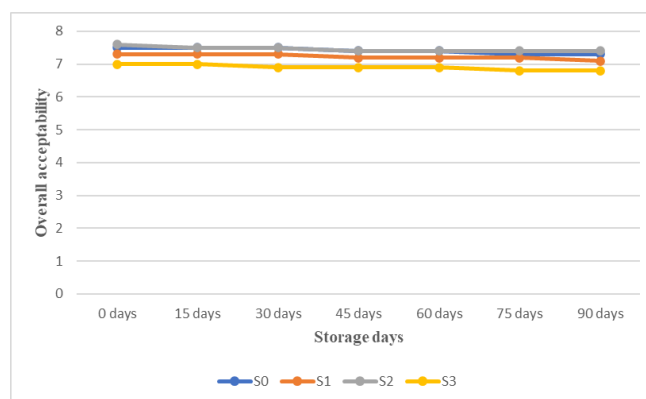


Fig. 5 Changes in texture of stored spirulina snack bars

## IV. CONCLUSION

In the study, protein rich snacks bars were developed by replacing oats with spirulina by 2%, 4% and 6% and effect of room temperature storage on nutritional, functional, sensorial and microbial quality was assessed for 90 days. The ash, fat, protein, crude fibers, carbohydrates, total phenolic content and DPPH free radical scavenging activity of snack bar was decreasing whereas moisture content was increasing throughout the storage period of 90 days. Organoleptic characteristic viz., colour and appearance, flavour, taste, texture, and overall acceptability were decreasing during storage of snack bars. The total plate count and yeast and mould counts were not detected up to 30 days of storage, thereafter increasing trend was observed from 45th day to 90th day of storage at room temperature. The protein rich snack bars could be stored for the period of 90 days in polypropylene pouch at room temperature.

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# Remote Sensing for Risk Mitigation in Agricultural Financings: Multitemporal Change Detections in Agricultural Areas using the Delta NIR and Delta NDVI Models

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**Keywords**— *Delta NDVI, Delta NIR,  
LimiriZC, Nanosatellites, Python,  
Remote Sensing.*

**Abstract**— *Agribusiness is one of the main pillars of the world economy, where the agriculture sector is fundamental to the economy of countries and contributes strongly to poverty reduction, positive balance of trade and inflation control. The countries have government policies that subsidize agricultural credits with low financing rates in order to encourage the sector. With the expansion of agricultural areas to meet the growth in the world population, its necessary a technological revolution in the field, as is increasingly necessary to mitigate risks in the financeable area, with quick and transparent inspection. Thus, a tool in Python language was develop containing a methodology for monitoring the cycle of cultivation in agricultural areas with emission of alerts messages in cases of deviations in the behavior of the planted area. Delta NDVI and Delta NIR models were developed to monitor agricultural cycle and were able to perform remotely the multitemporal detection of changes. The study was in an area in Brazil, using 9 images from the Nano Satellite Planet, from 2017 to 2019. The results were assertive, because the classifications of methods detected changes in the patterns of agricultural, emitting signals in cases of deviation from behavior with alerts for loss of vegetation from initial cycle, full and final of maturation. As the variation between models was not expressive, Delta NIR was an attractive alternative for change detections because uses only one band, the processing is less costly, with low response time and good performance, with execution in less than half time. Thus, the models were assertive and 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 visits only for areas of large hectares.*

## I. INTRODUCTION

Agribusiness is one of the main pillars of the world economy. The importance of the sector goes beyond the food factor, where agriculture is one of the main responsible for the positive balance of trade in several countries. Thus, the agriculture sector is fundamental to

the economy of developing countries, where the agricultural progress contributes strongly to poverty reduction [3] [45].

According by [61] there has been a significant growth in the world population, where by 2050 60% more food, 50% more energy and 40% more water will be needed to

supply the consumption of the planet's population. In the 1950, a world population was 2.6 billion people, having increased to 5 billion in 1987, 6 billion in 1999 and 7 billion in 2011. For the next 30 years, there is an expectation of an increase of 25%, around 2 billion people, with a forecast of 9.7 billion in 2050, with 70% of the urban population having higher income levels than today. For the 2100 year, predictive scenarios indicate an increase of around 43% in the world population, totaling 11 billion people. Thus, it has been observed that after the Industrial Revolution, the population has grown exponentially, which has resulted in a greater demand for food with the need for technologies to reduce costs and expand opportunities, making it increasingly necessary to digitize the field with productivity gains in a sustainable way [1] [28] [60] [61].

According by [59], 85% of the global growth of agricultural production in the coming years will be due to improvements in the production process, such as better use of inputs, investments in technology and better cultivation practices. Therefore, the digital revolution in the countryside will bring greater intensification of land use, where scenarios indicate that the expansion of agricultural area will be only 5%, improving the productivity and sustainability of agriculture, doing more with less.

There are few countries that still have uncultivated areas that can be used for agriculture, with 90% of them in South America and Africa. However, most countries do not have technologies for production in uncultivated areas, in addition to the lack of qualified professionals and economic resources. Given this scenario, the medium and long-term perspectives, they place Brazil as an important global producer to supply as business opportunities and responsibilities in the production and supply of food in the world. Currently, only 34% of its area is used in agribusiness (with 23% in agriculture and 77% in pastures) and has around 49% in forests or protected areas. Still, it participates with only 4% of the world trade in agribusiness and can supply a portion of the future world demand for food [74].

Brazil is the 4th largest grain producer in the world (rice, barley, soybeans, corn and wheat) accounting for 7.8% of world production and only behind China, the USA and India. Furthermore, it is the 2nd largest exporter of grains, with 19% of the international market, in addition to accounting for around 50% of the world trade in soybeans. In relation to grain, Brazilian exports totaled US\$ 30 billion in 2020, and US\$ 346 billion in the last two decades [27].

The Brazil concentrates around 14% of the world's fresh water, is a country with a diversified climate and regular rainfall, in addition to having a value close to 400

million hectares (ha) of fertile agricultural land, it has in agribusiness a pillar for expressive growth of the economy. In the last decades, agricultural areas in the country have grown, due, in large part, to the increase in the regions of pastures and expansion of soy and sugar cane [54] [65].

Brazil is one of the main producers of agricultural commodities in the world, and agribusiness is considered one of the most important sectors of the Brazilian economy, representing almost a quarter of all national production. In 2019, the sector's share of the economy's total Gross Domestic Product (GDP) was 21.4%, having contributed over the years to the trade balance and inflation control [10] [29].

In recent years, the sector has seen an increase of around 110% in Government Federal investments, from 107.2 billion in the 2011/2012 harvest to 225.59 billion in the 2019/2020 harvest [53]. Because it is a dynamic sector and due to its capacity to promote other areas, agribusiness occupies a prominent position in the global scenario, having an increasing importance in the economic development process. In general, there are several lines of investment and financing focused on agriculture, from costing to marketing, involving the entire production cycle. According to data from the Confederation of Agriculture and Livestock of Brazil (CNA) and the Centre for Advanced Studies in Applied Economics (CEPEA), in 2019 there was an increase in the GDP of Agribusiness by 3.81%, meeting the projection of the National GDP that growing 1.1% in 2019, this being the smallest advance in the last three years. Thus, if it were not for Agro growth and Government Federal investments, could be a retraction in the economy in the country [10].

For the coming years, the predictive scenario indicates an increase in federal incentives, in view of a harvest forecast for 2028/2029 with an increase of close to 45% in grain production. The perspective contemplates the production and development dimension of planted areas considering the fifteen products surveyed monthly by CONAB in crop surveys [53]. Brazil is the second world exporter of soybeans and among Brazilian regions, the Midwest accounts for more than 42% of the country's total production, with approximately 90 million grains - including cereals, legumes and oilseeds - followed by the South region with production around 35%, Southeast with 10 %, Northeast 9% and 4% of the North region [15] [33] [40].

Soy, corn and rice are part of the so-called Annual Cycle, or short-cycle crops, whose periodicity of the production cycle is completed in a period of one year or less, with the need for new planting after harvest. In addition to the crops mentioned, annual crops include

peanuts, wheat, beans, cassava, sugar cane, barley and sunflower. Also, in the category are fruit and vegetable production, such as melon, papaya, watermelon, potato, tomato, onion, carrot and garlic, which have short development cycles with several harvests throughout the year, being the Brazil is the third world producer in the segment, behind China and India [8] [15] [26].

As agribusiness is important in the world economy, whether due to the surplus in the balance of trade or inflation control, not only Brazil but 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. Thus, governments attach great importance and support to agricultural development through financial investments [62] [79] [84].

Countries such as Egypt, Morocco, Nigeria and South Africa have strategic government policies for agricultural financing in emerging markets [62]. On the European continent, countries like Serbia have strict rules for releasing bank credits for agricultural financing and have state support. Loans are subsidized by the Ministry of Agriculture and since 2004 they have been supported by banks with low interest rates. In 2017, the budget for agriculture represented 4.78% of the planned budget revenues of the Republic of Serbia [79]. In France, the government adopted a series of measures to accelerate agricultural development through Financial Agencies aimed at agricultural policies with national financial incentives, where support for agricultural credit played an important facilitating role in agricultural modernization in France. In Japan, government subsidy investment in agriculture has increased in recent years, which plays an increasingly significant role in agricultural development. The Japanese government has issued several financial policies and regulations to strengthen Government support in agriculture and to regulate the sector's investment policies [84].

In view of this scenario, with the increasing evolution of public incentives and investments in the agricultural sector in different countries, in addition to the significant importance in the GDP of the economy, 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.

Proof of this is the recommendation of the Brazil Central Bank (BACEN) for Banks and Financial

Institutions, liable to rural credit operations, to make use of Remote Sensing to contract and inspect agricultural operations credit operations [4]. Although there have been some advances in recent years, such as the inclusion of UAVs (Unmanned Aerial Vehicles) for monitoring agriculture, the inspection methods are almost entirely in loco, which makes monitoring costly and often with reactive actions and not the proactive actions on the verge of eventual problems. Thus, a tool in Python language was developed, called LimiariZC, where modules 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, using models of seasonal differences bitemporal through Delta NIR and Delta NDVI, thus contributing to risk mitigators in the financeable area and remote inspection instead of in loco, with the possibility of quantifying areas of anomalies as well as analyzing the vegetative cycle of the crops. Thus, the methodology aims to monitor the development of cultures, reducing face-to-face work. The models were applied in a study area in Brazil but can be used in any region of the planet for monitoring areas with agricultural financing or that will be financed and thus have greater control.

## II. THEORETICAL REFERENCE

### 2.1 Change Detection

According by [52], the change detection can be defined as changes that occur over time on the Earth's surface, where comparisons are made between images obtained at different times. The monitoring of these changes can be performed using visual and / or digital analysis techniques, using multitemporal data, by Remote Sensing systems [6] [11].

In the study by [51], the diversity of change detection techniques developed in the last decades is demonstrated, mainly due to technological advances. Thirty-one change detection practices grouped in a macro way into seven categories were presented: Algebra (including different algebraic operations), Transformation (with Principal Component Analysis and Chi-Square, reducing redundant data), Classification (concentrating post-classification, spectrum, hybrid detections and neural networks), Advanced models (such as reflectance, spectral mixing and biophysical parameter estimation models), GIS (GIS-based change detections), Visual Analysis (includes visual interpretation of the operator in multitemporal images as well as the digitization of areas of change) and Other techniques (which do not fit into the previous six categories). However, several studies and authors

corroborate that there is no method capable of solving all problems [25] [51] [81].

To [3], carried out a study to detect changes in forest degradation by mining trajectories in the land cover, and through the monitoring and characterization of forest changes it was possible to map the environmental and social processes that influenced the changes. The model was developed in C++ language using the free TerraLib library [9], where four grouping classes were defined, the methodology being applied in a region located in the state of Pará, in the Amazon Biome, in Landsat images 5. The results showed that it was possible to infer that as forest degradation is a dynamic and long-term process, it is necessary to have at least data with annual intervals for assertive detection, with the proposed model being effective in characterizing the trajectories of changes.

[39] used NDVI time series, extracted from Sentinel-2A for monitoring and detection of sugarcane management zones in a region located in the interior of the state of São Paulo. Six different dates from the satellite were analyzed, where it was found that there was spatial dependence on the vegetation indices in all scenes. The analyzed method allowed, through the interpolation of NDVIs, to delimit different management zones in addition to the vegetative development cycle of sugarcane, having been assertive in the monitoring and detection of agricultural practices.

[14] made use of a Nano Satellites Planet time series for monitoring and detection in an indigenous village in Rio Grande do Sul, where the results indicated lower values of environmental degradation compared to regeneration, indicating a conservation trend in the region.

In [67], change detections in land use and cover and landscape fragmentation were monitored in a region located in Western Bahia, over a period of ten years. ALOS and Landsat-5 images were used where it was found that in the period studied, agriculture and livestock grew over 200%, while natural vegetation decreased by around 26% in the region.

In the work presented by [77], a change detection technique with predictive analysis on land use and land cover in the Pantanal region was demonstrated. The methods were classified by object-oriented analysis where, using the Hierarchical Process combined with Markov Chain and Cellular Automata, a predictive detection scenario was generated until the year 2050. The multitemporal analysis indicated a tendency to reduce natural areas, such as vegetation and water bodies, with increased grazing areas and exposed soil, indicating possible degradation of the Pantanal landscape.

In the midst of different studies and techniques for detecting changes, in recent years the use of deep learning

and machine learning has become popular, mainly for recognizing patterns in the medical field. As an example, the techniques have supported automated diagnoses on radiographs, as in the analysis of pneumonias, serving as a possible basis for further identification by Covid-19 [46] [75] [78]. However, for the effective assertiveness of models, monitoring and detections, there is a need for a significant volume of data for training and consequent quality of detection. Thus, in view of different techniques, the method must be selected according to the appropriate approach in solving the study problem [48] [85].

In view of the different techniques, particularities and technological developments, the monitoring of agricultural crops - whether for estimating and forecasting crops with different crops, for different climatic conditions or for computational tools - represents a challenge to entities related to the agricultural sector and official bodies governmental organizations, such as IBGE and CONAB [16] [41].

In the literature, techniques for detecting changes in land use and land cover are preferentially categorized in terms of their use, usually belonging to two categories: one relating to the monitoring of incremental and decremental change processes, such as multitemporal analysis and time series work [38] [71] and another related to comparative analyzes, focused on dynamic and cyclical changes, such as studies in relation to planted area and crop comparisons [20] [58].

Over the past few decades, different studies and agro-environmental monitoring programs have emerged, with different methods involving the production cycle, from predictions of planted area estimates, pest monitoring to predictability of productivity for agricultural areas. Among the programs presented to the scientific and academic community, are the GeoSafras and SigaBrasil projects, coordinated by CONAB [37]. It is also worth mentioning RadamBrasil, which was the first government initiative in monitoring and mapping vegetation in the country and aimed at mapping mineral resources, vegetation and soil cover. The project focused on the Amazon region and the Northeast, being conducted between 1975 and 1980 using airborne radar images, where there was an onerous effort in the visual interpretation of information [19].

The National Institute for Space Research (INPE), in conjunction with the Ministry of Science and Technology (MCT), coordinates the CanaSat project, which since 2003 has been monitoring the annual growth of sugarcane cultivated areas in the south-central region of Brazil, through images from the Landsat, CBERS and Resourcesat-I Satellites [43] [73].



The Anti-rust Consortium has an Alert system for monitoring soybean crop, where it monitors the dispersion of the fungus that causes Asian rust. The alert system arose due to the need of farmers and entities linked to agricultural practices for a tool that would alert the rural community in a practical and efficient way regarding the occurrence of pests in crops in order to mitigate the spread of the disease [37] [56].

Through Project MARS (Project Monitoring Agriculture with Remote Sensing), crop monitoring and crop estimates have been carried out in the scope of the participating states of the European Union. The information is extracted from the combination of agrometeorological models, a trend function with technological improvements and spectral data, through NOAA / AVHRR and SPOT / VGT images [21].

The European Environmental Agency, in conjunction with Research Centers, launched the CORINE program (Coordination of Information on Environment), with the aim of making an inventory of the physical environment and soil cover in Europe, through 44 classes with a minimum mappable of 25 ha using Landsat-5/7/8, SPOT 4/5, IRS P6 LISS III, Rapideye and Sentinel-2 images. Monitoring has been carried out over the last few decades, and in 2018 the thematic accuracy extracted was over 85%, considering 39 countries involved in monitoring [2] [21] [30].

Different crop monitoring and detection solutions have emerged in recent years, aiming to find methods and alternatives to solve particularities of agribusiness as technological evolution and digital transformation progressed. Thus, there is a growing trend in the implementation of methods, models and Agro-Environmental monitoring programs. According to data from the United Nations (UN) for food and agriculture, there is an expectation of a 70% growth in agricultural production for the next decades. Therefore, the processes related to the monitoring of agriculture will need to be increasingly productive and efficient, with the innovation of technological means to monitor agricultural practices [23].

## 2.2 Anomaly Models: Delta NIR and Delta NDVI

In the monitoring of vegetation, in a healthy foliage there is expressive reflectance in the region of the Near Infrared (NIR), with significant spectral response also in the Green band of the visible, in comparison with the bands in the wavelength of Red and Blue. Thus, the analysis becomes a strong indicator of the stage of development of the culture. In stressed foliage, there is a significant reduction in reflectance at NIR, approaching reflectance at Green. In general, stress is caused by water

scarcity, exposure of exposed soil to deforestation and degradation of vegetation. In dry foliage, however, the spectral responses of the visible and infrared bands become very close [63].

Over the years, more than 50 indexes used in monitoring vegetation have been proposed, one of the most used being the Normalized Difference Vegetation Index (NDVI) [44] [55].

NDVI is an index of significant importance in the characterization of vegetation, where from satellite images it is possible to enhance vegetation by mathematical operations between the bands of the sensor satellites. Thus, the index assists in estimating biomass, carbon sequestration by vegetation, vegetation cover and in detecting changes in land use and land cover patterns, by monitoring seasonal dynamics [32] [76].

The NDVI calculation is performed from the ratio between the difference in the reflectance of the near and visible infrared bands with red, by the sum of the reflectance of these bands, according to Equation 1 [44]:

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)} \quad (1)$$

The index represents the normalized magnitude that varies between -1 and +1, resulting from the difference between the reflectance of the spectral bands. Thus, the closer to the value 1, the greater the probability of the presence of vegetation. The closer to -1, the greater the indication of the presence of exposed soils and rocks in the analyzed area [44] [76].

In the Fig. 1, it is presented in (a) the reflectance of the vegetation in the bands of the electromagnetic spectrum for healthy, stressed and dry vegetation. In (b) the approximate emission percentages for healthy and dry vegetation.

In annual crops, there is a standard profile in which the NDVI values show low initial values in the initial vegetative cycle (similar to the exposed soil values) being increased as the plant grows due to the increase in biomass. Thus, with the full development of the crop, where there are characteristics of dense vegetation and in good water conditions, agricultural practice reaches the highest NDVI value. From then on, due to the reduction of vegetative vigor in the plant, the maturation process, or senescence phase, begins, where the NDVI values regress to the initial level of exposed soil at the beginning of the cycle [22] [50].

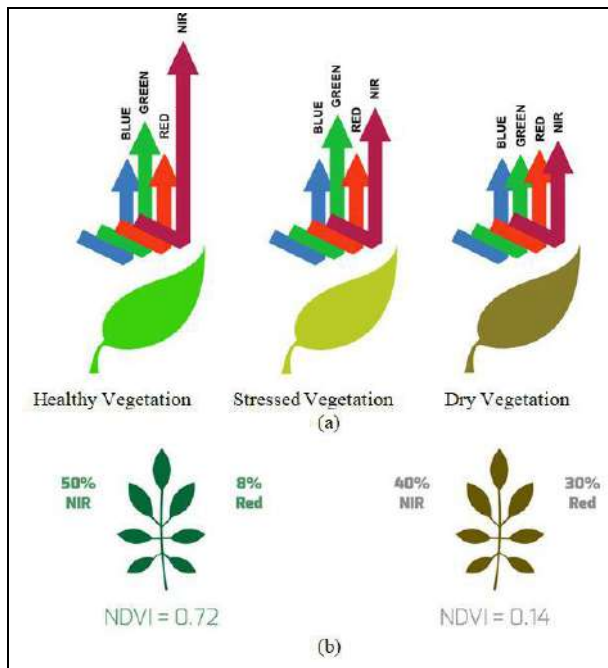


Fig. 1: Different types Reflectances in the Vegetation Stages. Adapted from [63].

In the visible red region, chlorophyll absorbs solar energy, causing low reflectance. In the near infrared range, both the internal morphology of the leaves and the structure of the vegetation, cause a high reflectance of the incident solar energy. Thus, the greater the contrast, the greater the vigor and incidence of vegetation in the imagined area [49].

According by [47], the NDVI index allows monitoring the amount of vegetation, and as there is an increase in vegetation in the green, there is an increase in the reflection of the near infrared band and a decrease in the reflection of the red band [64]. Thus, there is an increase in the ratio, expressed in Equation 1, enhancing the vegetation and making it expressive in the scene.

For [35], the NDVI index can be used to classify vegetation cover and map land use capacity. Still, there are studies that use the indicator for monitoring degraded areas, as well as for detecting environmental changes, as presented in the works by [66] [80]. In conjunction with geoprocessing tools and customized algorithms, it is also possible to perform the analysis of the temporal evolution of a given region, by comparing the current and past vegetation cover, thus estimating the percentage of devastated areas and being useful in monitoring activities photosynthetic, in addition to comparisons of seasonal and interannual variations [5] [69] [72].

In the Delta NDVI model, after extracting the NDVI from the input images, the algebraic subtraction operation is applied to the results of the NDVIs of the images, in

order to find possible anomalies in the scenes by highlighting the differences. In Equation 2, the NDVI Delta is broken down, where the NDVI pixel by pixel is subtracted from the most recent image (NDVIMR) in relation to the NDVI of the oldest image (NDVIMA):

$$\Delta NDVI = NDVI_{MR} - NDVI_{MA} \quad (2)$$

Similarly, in the Delta NIR model, pixel-by-pixel subtraction of the NIR bands is performed, with the most recent image (NIRMR) in relation to the oldest image (NIRMA), according to Equation 3:

$$\Delta NIR = NIR_{MR} - NIR_{MA} \quad (3)$$

For the Delta NIR, the mathematical operation of the subtraction between the bands of the images can be performed through the different bands of the same image or the same band of different images, being useful to highlight small spectral nuances, reflected by the difference of the digital numbers of the scene. In multispectral images, the band difference can be used to characterize small differences in spectral behavior of certain targets. Still, it can be applied in the identification of different types of vegetation cover, amount of vegetation in the scene, in addition to detecting patterns of changes in soil cover [18].

For [44], in the generated difference images, the pixels in which there are intensities close to the average, identify areas without change detections. At the ends of the histograms, the pixels that had significant changes during the temporal evolution of the images will be concentrated. Still, there are studies that define a cut-off value, or threshold, for pixels as indicative of areas of change for each band in the difference image, as well as more refined parameters for monitoring changes [17].

Although simple, compared to other methods, the difference in bands makes it possible to monitor the loss of large vegetation with high precision. However, when there are differences in shading in the scene, caused by variations in lighting, or even the need for monitoring of undergrowth, where there are different soil moisture conditions, the detection may not be as accurate. Thus, it is possible to apply the method of differences on the transformed values of the original gray levels [47].

According by [17], of the techniques for detecting changes in land use and cover, image subtraction is one of the most used and with significant results. Still, the mathematical operations of subtraction and band ratio in multitemporal analyzes are widely used in the detection of deforestation and changes in land use [12].

For [49], the subtraction operation in the images allows to analyze the change in vegetation cover, or biomass

vigor between the images, and the higher the value in the difference image, the greater the increase in the representativeness of the photosynthetically active elements among the analyzed images, that is, of vegetation incidence. Thus, the greater the negative value in the regions, the greater the loss of vegetation. Regions with difference values close to zero, on the other hand, correspond to areas without significant changes.

For the Delta NDVI and Delta NIR models, in the histograms of the difference images, from the statistical analysis based on the values of minimum, maximum, mean and standard deviation of the subtraction image, it is possible to verify the oscillation of the standard deviation around average.

According by [57], when the difference in bands in wavelength ranging from 0.8 to 1.1  $\mu\text{m}$  is used, changes to the standard deviation varying between 0.35 and 0.60 are detected. [24] values of  $1\sigma$  indicate the anomalies detections, and the interpretation of changes will depend on the method used, the nature and the time scale used, as intra / interannual variations for the detection of seasonal differences in land use or for monitoring expansion of different agricultural practices.

In the Fig. 2 a Normal Distribution curve is shown, with mean ( $\mu$ ) 0 and standard deviation ( $\sigma$ ) of 1, where the red and green highlights are respectively the explanations for negative anomalies (degradation of vegetation cover) and positive (regeneration of vegetation cover). The regions of the histogram with oscillation lower than  $-1\sigma$  around  $\mu$  are called negative anomalies, while oscillations greater than  $+1\sigma$  are considered as positive anomalies. The regions without significant changes in the comparison are called areas between anomalies, arranged between  $-1\sigma$  and  $+1\sigma$ .

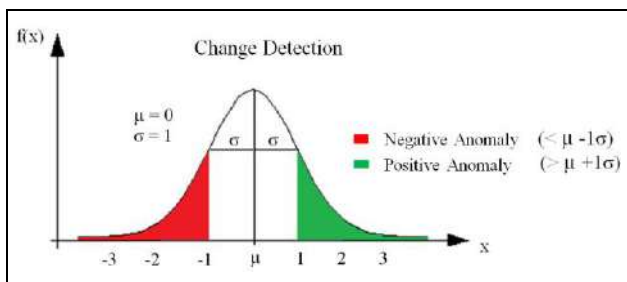


Fig. 2: Change Detection with Negative and Positive Anomalies.

By analyzing the results of extracting the attributes in the images, the knowledge model was defined so that rules could be established for detecting seasonal changes in the bitemporal analysis of the scenes, so that the multitemporal monitoring of changes was performed. Thus, it is possible to quantify the percentage of changes

in vegetation loss between the scenes (negative anomaly) and consequently issue change signals from a maximum acceptable alert threshold stipulated, which can assume any value defined by the user. Because the objective of this study is to detect changes in the polygons / plots and not in the completeness of the scene, the threshold of  $1\sigma$  around  $\mu$  will be adopted for the change detections, according to the results described in section IV.

### III. MATERIALS AND METHOD

#### 3.1 Study Area and Materials

The study region is concentrated in the eastern portion of the Federal District (DF) around the region called PAD-DF, the Federal District's Directed Settlement Program, close to 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 the Fig. 3.

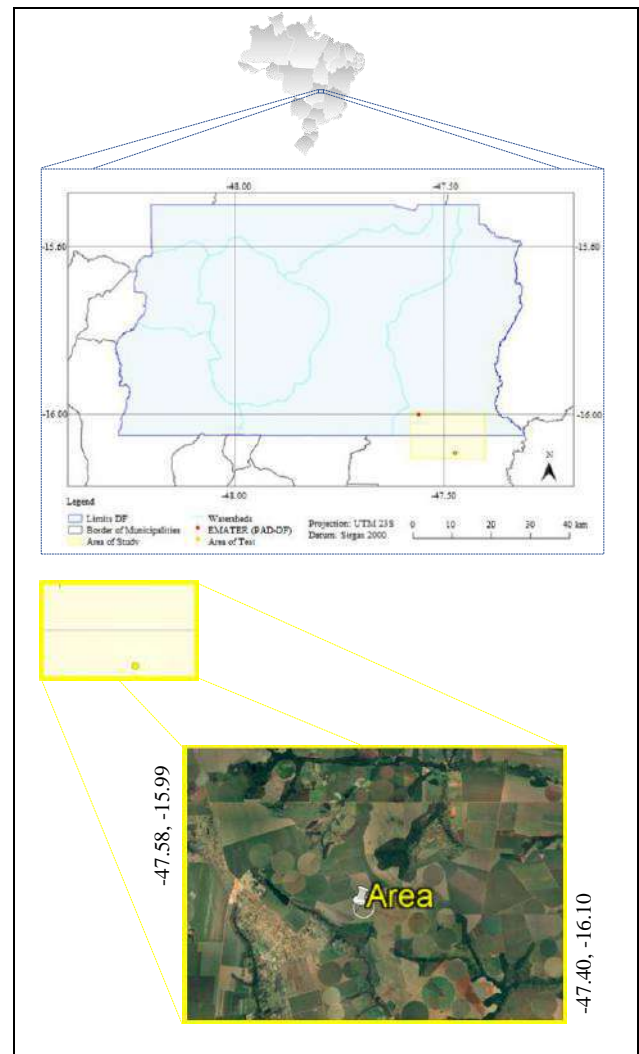


Fig. 3: Study area around PAD-DF: Google Earth image from April 10, 2020.

According to information from the Agricultural Census and Land Structure in the country [41] [42], of the total of 6.5 MM of rural properties, about 86.5% have less than 100 ha. Considering the DF dimension, the value rises to 94.3%. Thus, the dimension of the study polygon used in the application of the models, covers the largest number of Brazilian rural properties.

The polygon was chosen because it visually presents different nuances in the field throughout the monitoring of the culture development cycle. According to the field visit carried out on 10/23/2019, in the stand there is the diversification of Horticulture crops. In this way, the tests were applied to the polygon in order to analyze the use of the models for emitting signals in an automated way in the seasonal bitemporal variation of the scenes.

The PAD-DF is a program implemented in the 70s, with the purpose of leveraging agribusiness in the Brazilian Cerrado. The region covers more than 60 thousand ha, containing several types of economic initiatives and some of the main crops in the country, such as soybeans, corn, wheat, cotton, beans, onions, potatoes and carrots [7] [36].

For multitemporal monitoring of change detections, the monitoring of the agricultural development cycle in the field was carried out, where nine images of the Planet Nano satellite were used, as shown in Table 1.

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

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

The Planet images were defined as the scope of this work by the imaging characteristics of the nano satellites, with a significant daily and spatial temporal resolution of 3 meters, allowing for possible traceability needs of the plots with agricultural financing in an agile way, being essential for monitoring the vegetation cycle of the cultures. As the images are made available daily with repetition of the scenes by the sensor system, in case any abnormality is detected in the monitoring, it is possible to adopt timely actions in an agile and effective way, such as, for example, on-site inspection for the cases that were effectively carried out inconsistency is detected. Thus, it was adopted

as a premise that the better the temporal spatial resolution, the better the monitoring.

The analysis and selection of the images were based on the criteria of availability of scenes, dates based on the phenological periods of the cultures present in the plot, the absence of clouds and visual inspection that indicated significant seasonal changes in the scenes, aiming to find periods with greater contrasts to assess the differences and consequently apply and validate the proposed methods with assertive signs for the cultures. The images used are the Analytical Ortho Scenes level 3B, which are made available by the supplier with geometric, radiometric, orthorectification corrections, in addition to being made available geo-referenced, normalized and scaled with Radiance at the Top of the Atmosphere (TOA), being delivered in the analytical products for the 4 bands (Red, Green, Blue, NIR) [68].

The applications QGIS 2.18 and Envi 4.8 were used respectively to cut the test areas in the images and validate the accuracy of the classifications performed in the tool developed in Pyrhon. Thus, the proposed methods were implemented in Python 3.6. The use of open source geotechnologies in this work, for data processing, has the purpose of minimizing costs, making the proposed methods of the Delta NIR and Delta NDVI models affordable, propagating their use, making possible the technical financial viability of research, in addition to have a wide academic community of study and support to doubts [82]. All processing was performed on a microcomputer with an Intel I-7 processor, with a processing speed of 2.8 GHz, RAM memory of 16 GBytes, 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. 4.

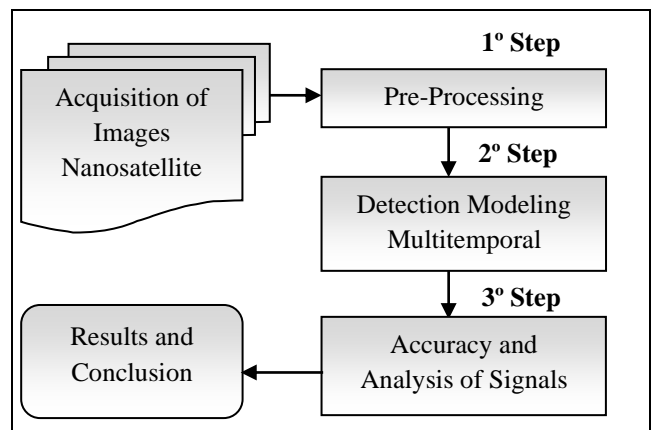


Fig. 4: Macro flowchart of Methodology.



### 3.2.1 Methodology – 1° Step

In the 1st stage, pre-processing of the images was carried out in order to allow the detection of seasonal bitemporal variation in the scenes. Thus, the selection and cuts of the study area were carried out, as well as the necessary treatments in the scenes for the complete effectiveness of the proposed methods. Thus, in the clippings, masks were created to delimit only the field of interest, in addition to converting the scenes to 8 bits. After several tests, it was decided to convert the images in order to improve performance and optimize the processing time when executing the models to detect anomalies.

### 3.2.2 Methodology – 2° Step

In the stage, a Multitemporal Detection Modeling was developed, where the method proposed in Python was implemented with the automated monitoring models Delta NDVI and Delta NIR. The stage aims to quantify the regions with positive, negative and between anomalies, in order to support the seasonal variations for decision making. Thus, according to the analyzed statistical criteria, an alert of message (signal) should be issued to signal possible loss of vegetation in the seasonal difference of the scenes, from pre-planting to harvest, going through the different stages of cultivation during the development of the culture, involving the entire production cycle.

In the Fig. 5 shows the macro task flowchart of the proposed and developed Anomalies models.

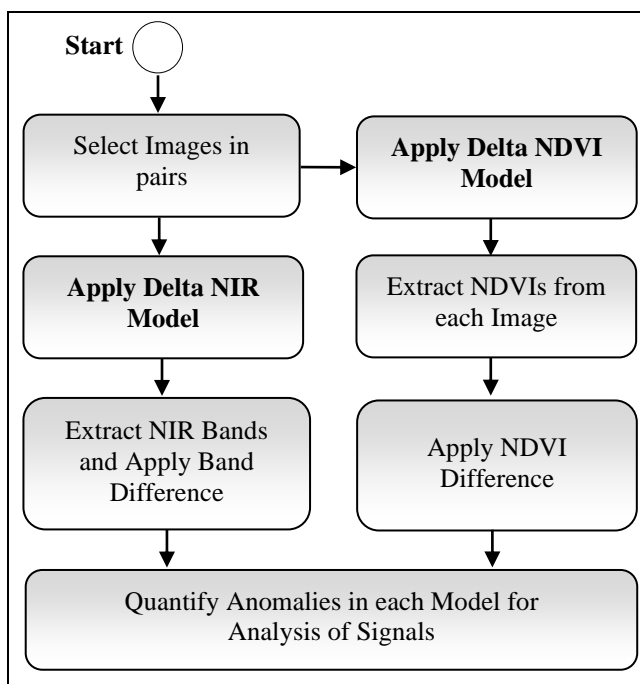


Fig. 5: Macro flowchart of the Anomalies Models.

For both models, the issuance of change detection warning signals will be carried out by measuring the

tolerable loss of vegetation index, that is, the amount of negative anomalies in the difference image. Thus, the user will be able to customize in the tool a maximum acceptable range of vegetation loss for the monitored images. For each of the models, if the difference image shows a number of pixels for negative anomalies that is higher than the acceptable threshold of vegetative evolution defined by the user, the alert of message will be issued.

#### 3.2.2.1 Delta NDVI Model

In the Delta NDVI model, after selecting the pair of images to analyze the temporal change detections, the NDVI of each scene will initially be extracted, according to Equation 1. The vegetation index is generated from the loading of the metadata containing the band correction coefficients, in order to optimize the NDVI generation with a more assertive extraction. Then, the seasonal difference of NDVIs will be applied, where the mathematical operation of subtraction pixel by pixel between the most recent and the oldest scene will be performed, according to Equation 2.

In the generated Delta NDVI map, the greater the positive value of the analyzed areas, the greater the NDVI gain. However, the greater the negative value of the regions, the greater the loss of NDVI from the monitored areas. The regions with difference values close to zero correspond to the areas without significant changes, that is, with behavior according to the pattern they had been having [49].

If in the generated difference map there is a percentage of anomalies in the monitored areas, with a value higher than the defined acceptable% of changes, an alert will be issued in the model. In the histogram of the difference image of NDVIs, the range from  $\mu - 1\sigma$  to  $\mu + 1\sigma$  will contain pixels without significant occurrences of changes, according to the established standard deviation threshold ( $\pm 1\sigma$ ). Out of the range, at the ends of the histogram, are the pixels with significant changes during the temporal evolution between the images, being classified as negative and positive anomalies.

Negative anomalies are areas with probable loss of vegetation, with dark shades in the difference image, close to the nuances of black, indicating that in the older scene there was a higher positive NDVI index, compared to the most recent image. Thus, in the subtraction of NDVIs, the areas present low values, indicating the presence of vegetation in the oldest scene. Positive anomalies, on the other hand, are areas with a probable incidence of vegetation, being regions that present clear tones in the difference image, close to the white tint, indicating that in the oldest image there was a lower NDVI index, compared

to the most recent one. Therefore, when subtracting the NDVIs, the areas present high values, suggesting the presence of vegetation in the most recent scene compared to the oldest. As an example, they can be characterized as areas of regeneration of vegetation cover or cycles of agricultural practices. The regions between the anomalies, on the other hand, are areas without the significant presence of changes, that is, which maintained the behavior they had already been having according to the  $\sigma$  defined, presenting gray tones, oscillating between black and white [31].

In order to follow the vegetative cycle of crop development, in Table 2 are the expected values for healthy (in full force) and dry vegetation, as explained in the Fig. 1, in addition to the reflectance in the NIR and Red bands.

Table 2: Expected Values of Reflectances in the Vegetation Stages (HV: Healthy Vegetation, SV: Stressed Vegetation e DV: Dry Vegetation).

	HV	SV	DV
<b>NDVI</b>	0.72	0.43, oscillating: 0.72 < Stressed < 0.14	0.14
<b>NIR</b>	50%	45%, oscillating: 50% < Stressed < 40%	40%
<b>RED</b>	8%	19%, oscillating: 8% < Stressed < 30%	30%

From the values listed for healthy and dry vegetation, as shown in the Fig. 1, the average intermediate estimates between the two vegetation extremes were derived, in order to characterize estimates for stressed vegetation. While a healthy vegetation, in the full cycle, has an expected NDVI value close to 0.72, a dry vegetation has a value around 0.14. Thus, based on the extreme values of healthy and dry vegetation, for an intermediate vegetation - in this case the stressed one between the two types - the average value of NDVI between the vegetations will be used. Thus, a stressed vegetation would probably have an average value close to 0.43, with average reflectance around 45% in the NIR and 19% in the Red Band. Therefore, it becomes possible to monitor the oscillation of vegetation quality through the values presented, performing a temporal monitoring in the vegetation growth cycle. While a crop has its maximum NDVI in the full cycle, in the initial cycle the value is minimal and is increased until the full cycle, after which it begins to regress, returning to the initial levels.

In the Fig. 6 shows the NDVI ranges for each type of vegetation, as shown in Table 2, making it possible, in addition to detecting anomalies, to verify the trend in vegetation quality based on the values indicated in the literature.

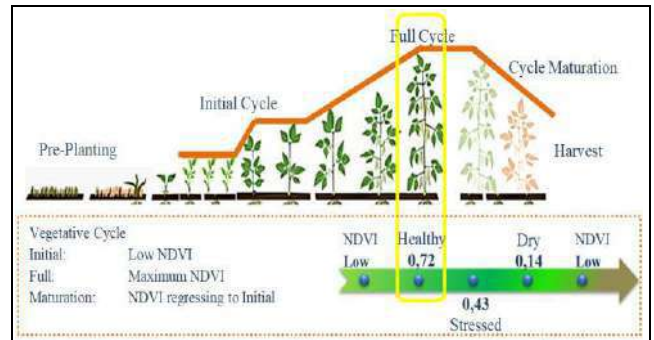


Fig. 6: Vegetation Cycle with values adopted.

### 3.2.2.2 Delta NIR Model

In the Delta NIR model, after selecting the pair of images for analysis of the temporal change detections, the NIR band will be extracted from each of the scenes, being band 4 of the Planet image. Then, the seasonal difference will be applied in the NIR bands, where the mathematical operation of subtraction pixel by pixel between the most recent and the oldest scene will be performed, according to Equation 3.

In the mathematical procedure performed, the subtraction represents a linear operation, in which the results will produce intensities outside the range of 0 to 255 pixels, requiring a contrast adjustment in order to avoid distortions in the statistical treatment when analyzing anomalies between the images. Thus, the range that represents the calculation of the operation, will be within the range of -255 to +255. In the implemented adjustment, the value of a constant of 255 will be added to the result, thus producing a new range from 0 to 510, and later, the range will be divided by 2, where the final range will be from 0 to 255, assuming a variation 256 shades of gray. Thus, when subtracting bands, values close to the mean of the difference interval will indicate regions of no change [18].

Similar to the Delta NDVI model, on the Delta NIR map generated from the difference in bands, in histogram around the average the pixels will be located without occurrences of changes. At the ends of the histograms, the pixels that had significant changes during the temporal evolution of the images will be concentrated. Thus, the generated subtraction image will be classified according to the standard deviation ( $\sigma$ ) around the mean ( $\mu$ ), where the thresholds will be  $\{[0, \mu - \sigma], [\mu - \sigma, \mu + \sigma], [\mu + \sigma, 255]\}$ . Thus, the values of (0 to  $\mu - \sigma$ ) are areas of negative

anomalies, with probable loss of vegetation, crop cutting or deforestation, of  $(\mu - \sigma$  to  $\mu + \sigma)$  are areas between anomalies, that is, without the significant presence of changes and  $(\mu + \sigma$  up to 255) are areas of positive anomalies with probable areas of regeneration of vegetation cover [31].

The total number of pixels of the likely classes of changes will be compared with the acceptable threshold of changes defined, in order to detect anomalies. If the model detects changes in the monitored areas with a value greater than the acceptable% of changes stipulated, an alert will be issued in the model as a strong indication that there have been changes between the scenes.

### 3.2.3 Methodology – 3° Step

In the 3rd stage, the accuracy validation of the anomaly classifications and the analysis of Alerts signaling emissions were performed.

The anomalies classifications, obtained by the Delta NDVI and Delta NIR models, will be validated by means of a reference image. Such an image will be constructed through a visual classification by means of digitalization of the difference image of the scenes on screen, where each monitored scene will have the vectorized matrix representation. Therefore, the construction of the reference image aims to characterize the classes of positive, negative anomalies and regions between anomalies, according to the detection of light nuances close to the white tone (positive anomaly), dark ones close to black (negative anomaly) and oscillating in the gray tone (regions between anomalies without significant changes in temporal evolution). With the generation of each reference classification, the accuracy of the classifications pertinent to each model will be evaluated. The result of the classifications will be validated through a confusion matrix, where the accuracy of the classifications obtained by the implemented method will be verified. Thus, agreement and disagreement indices will be extracted - global accuracy, producer accuracy / omission errors, user accuracy / inclusion errors, Kappa and Tau indices, in addition to quantity and allocation disagreements - to validate the correct classified pixels or incorrectly in the model ratings. In addition, hypothesis Z tests will be applied in order to validate the null hypothesis of equality of the coefficients of agreement of the classifications.

The analysis of the signals will be performed by visual interpretation of the input images. The results will be compared in order to verify whether the signs should actually be emitted visually and / or if in the evaluation areas there were signs of some undetected signaling, in order to avoid false positives and / or negatives of detecting changes. Thus, the agricultural areas of the

multitemporal application will be analyzed individually, being evaluated by means of interpretation keys as to color, shape and texture [34].

## IV. RESULTS AND DISCUSSIONS

The Fig. 7 shows the monitoring for the vegetative cycle of the stand from the initial, full, maturation to cut for the Delta NDVI Model. For each image comparison, the difference NDVI image was extracted (both in gray level and in colored composition, in order to facilitate visual interpretation), the percentage of anomalies resulting from the difference image, as well as the analysis of the vegetative cycle for the crop with vegetation quality indicators in the healthy, stressed and dry categories, according to the premises adopted and provided in Table 2.

Delta NDVI's developed method takes an average of 25 seconds to process areas up to 100 ha. The oscillation values around the mean were tested with standard deviation of 1 and 2, where it was detected that for the value of  $2\sigma$  practically 100% of the pixels were labeled as areas without the presence of anomalies. Thus, in order to be as sensitive as possible to signaling the change detections, in addition to providing for the use of smaller plots (which encompass most rural properties in the country), where the use of a larger standard deviation could not detect changes, we chose to use  $1\sigma$  for the Delta NDVI and Delta NIR models.

As can be seen in the Fig. 7, in the NDVI images difference for vegetative cycles 1 to 8, the areas where in the color difference image, have nuances of medium to darker green, according to the color legend with the scale in the figure, are regions with vegetation incidence in the most recent image compared to the oldest, being classified as positive anomalies. Still, in the NDVIs images, difference between the scenes, in the gray level image, the anomalies have nuances close to the white tint, as can be seen.

Negative anomalies are areas in which the color difference image has shades of medium to darker red, according to the color scale in the figure. In the NDVIs images, the difference between the scenes, in the gray level image, the anomalies have dark nuances close to the black tint. The areas between anomalies, in the color difference image, have colors ranging from light red, through yellow to light green. In NDVI images, difference between the scenes, in gray images the anomalies have nuances close to the gray tone, oscillating between black and white. Thus, it is possible to observe in which regions of the field the NDVI value decreased in relation to the analyzed period and in which it increased, being an indication of growth or loss of vegetation in the crop.



For all simulations, a tolerable percentage of up to 1% of vegetation loss was established, that is, of a negative anomaly, aiming to capture any change that occurred between the scenes. Thus, as the number of negative anomalies was higher than the percentage established in all images, differences from Cycles 1 to 8, due to the standard deviation applied, automated warning signals were issued for all classifications. Also, according to Fig. 7, in all classifications the percentage of regions without significant changes was greater than 50%.

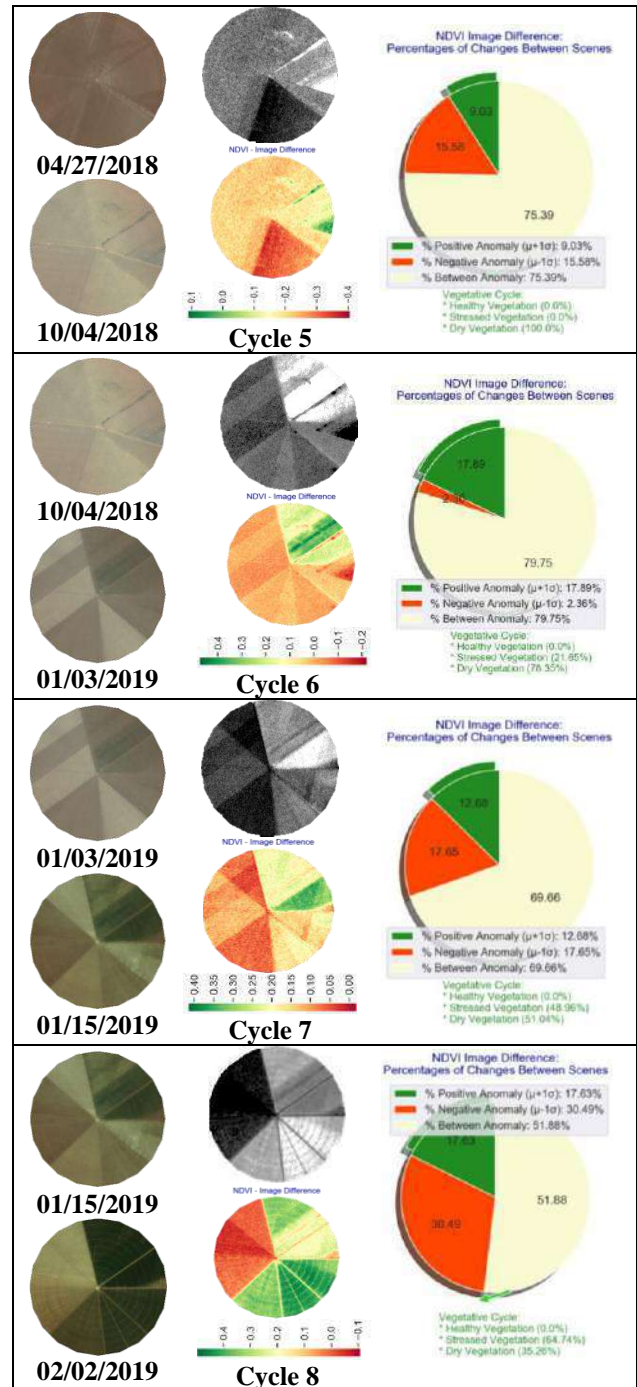
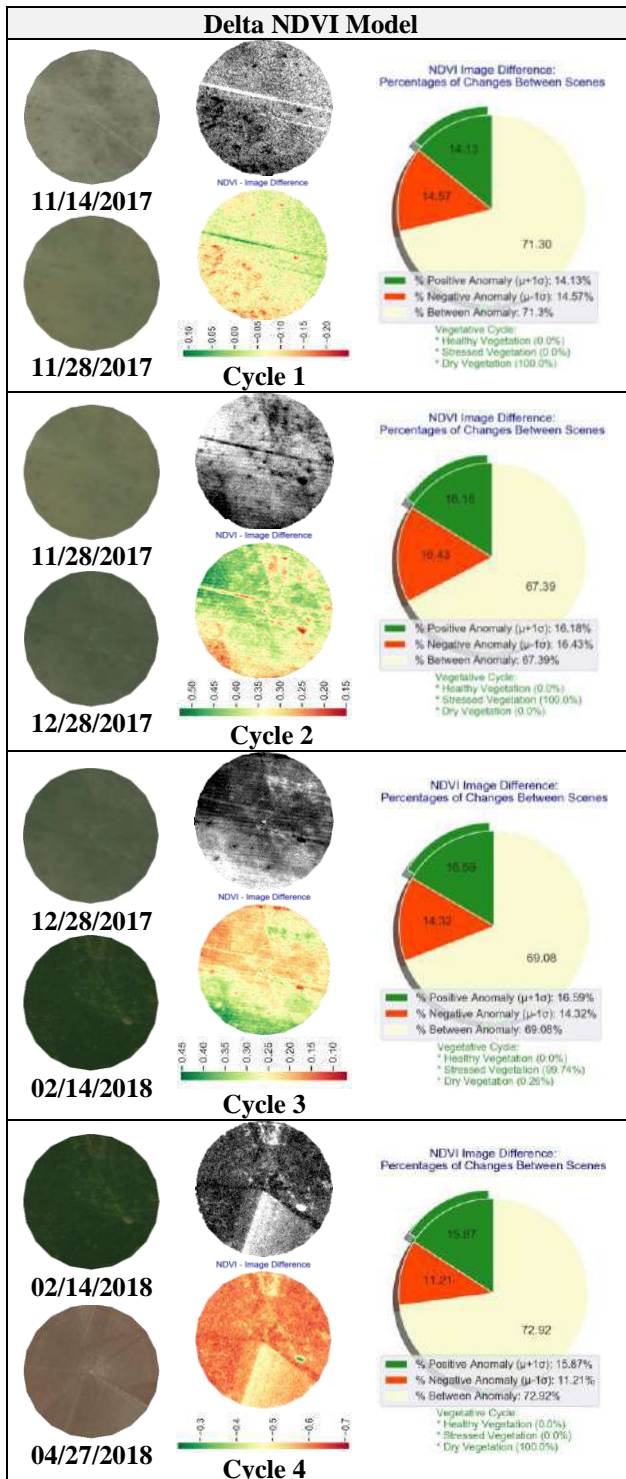


Fig. 7: Delta NDVI Model with Vegetative Cycle, from initial, full, maturation and cutting.

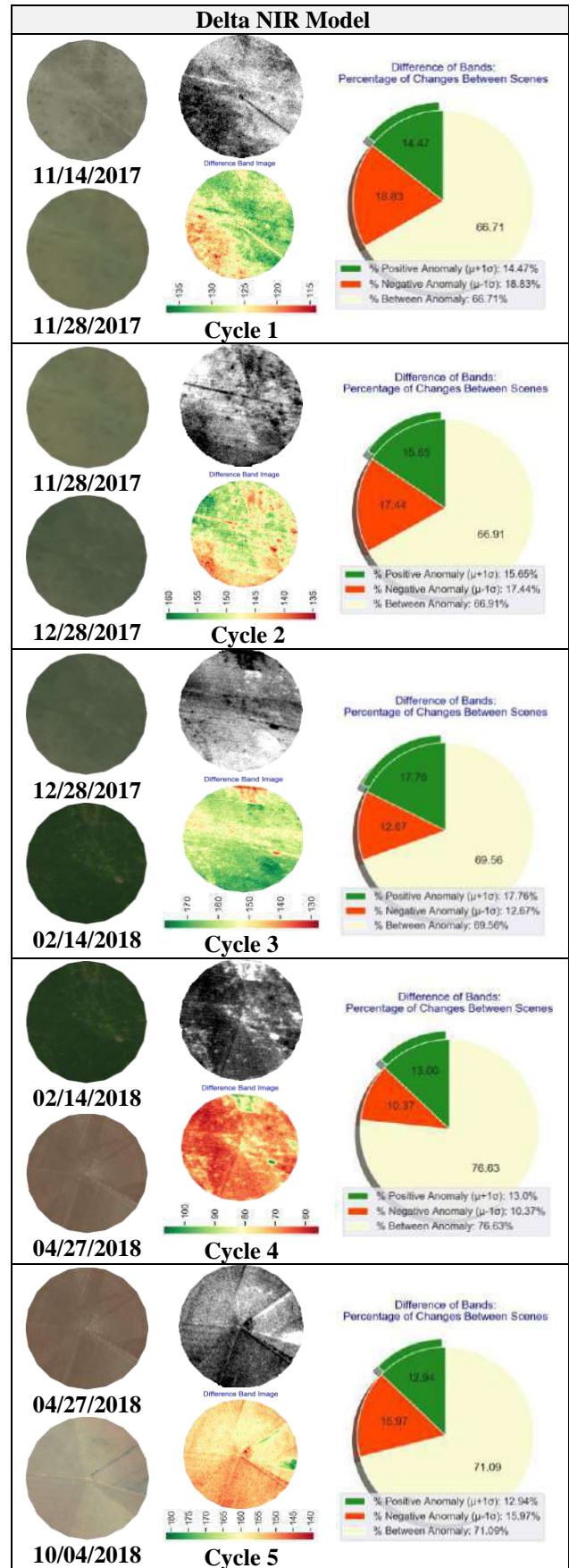
Through the vegetative cycle, it was possible to capture the vegetational quality between the scenes, where from the difference image of NDVIs it was found that the vegetations were found largely in the vegetative cycle of dry and stressed foliage, the latter being a classification intermediate between healthy and dry state. Still, according to the scale with the NDVI values of the scenes, the lower values represent absence of vegetation, thus being in the initial vegetative cycle, and the maximum values are an indication that the crop has reached its full



stage of development, where the process begins maturation in which the levels begin to regress until the harvest, when the preparations for the beginning of a new cycle begin. As can be seen in Cycle 1, the maximum NDVI value of the difference image is around 0.10, indicating low presence of vegetation in the scene and an exposed soil that may be being prepared for planting. In Cycle 2, with imaging one month after Cycle 1, with an image difference between the scenes of 11/28/2017 and 12/28/2017, the maximum value becomes 0.50, thus indicating a planting in development of the crop with stressed vegetation, using the parameters shown in the Fig. 6, towards the full vegetation stage. In Cycle 3, with a difference image with an image of two months after the previous cycle, the maximum value becomes 0.45, indicating a probable achievement of the full stage during the period and decreasing the values in the possible stage of crop maturation. In Cycle 4, the maximum value becomes 0.30 indicating probable harvest and soil being prepared for planting, in line with the elucidated in Cycle 5 with a maximum value of 0.10, as interpreted in the scenes in the Fig. 7. In Cycles 6, 7 and 8 there are indications of the different nuances of vegetation and exposed soil, with maximum values of 0.40 indicating the development process of horticultural farming practices in the stand.

Through the automated extraction of anomalies, as in the Fig. 7, for different types of crop development, it was possible to monitor changes and monitor the development cycle, sending signals of either loss of vegetation or forest degradation based on the percentage of negative anomalies, regarding the monitoring of vegetation growth or areas of regeneration of vegetation cover and cycles of agricultural practices, through the percentage of positive anomalies, in addition to the predominance of foliage in the vegetative cycle. In the images of Cycle 5, although both Planet scenes indicate the presence of exposed soil, the most recent image appears lighter nuances and closer to white indicating less remnants of vegetation in the comparison between the scenes. Thus, one of the possible causes may be the soil being prepared for planting with products in the soil.

In the Fig. 8 shows the monitoring for the vegetative cycle of the stand from the initial, full, maturation to cut for the Delta NIR model. For each image comparison, the difference scenes of NIR bands were extracted (both in gray level and in colored composition, in order to facilitate visual interpretation). Also, similarly to the Delta NDVI Model, the percentages of anomalies resulting from the difference image were extracted.



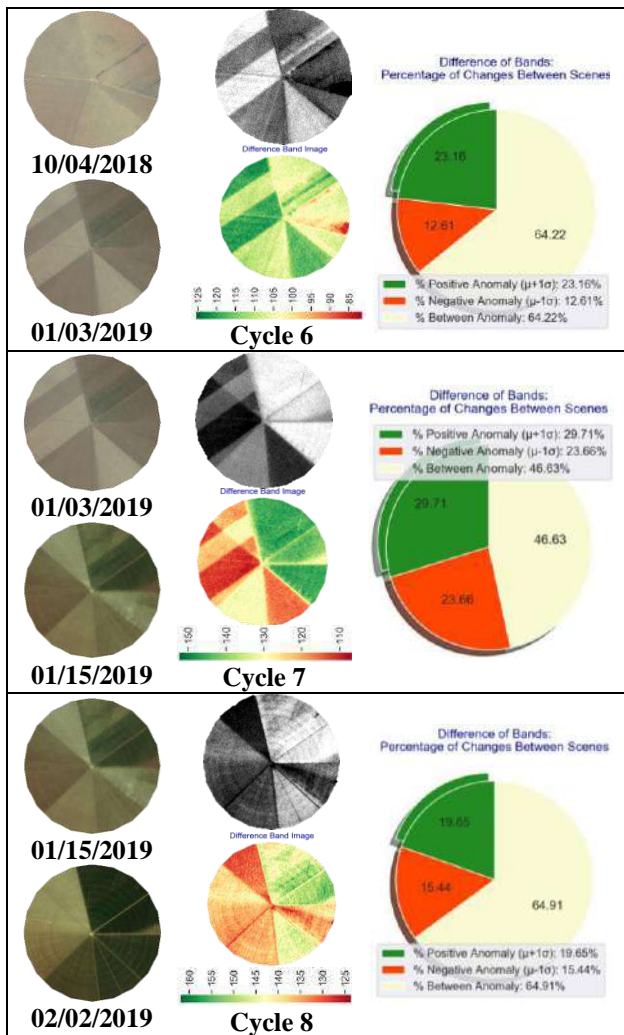


Fig. 8: Delta NIR Model with Vegetative Cycle, from initial, full, maturation and cutting.

The implemented Delta NIR method takes an average of 11 seconds to process areas up to 100 ha. Therefore, in terms of performance, the processing time is less than half that performed for the Delta NDVI model. When it comes to a few areas, seconds can be irrelevant. However, in the monitoring schedule for a significant volume of areas, the response time becomes relevant for eventual inspection of the areas and decision making.

As can be seen, in the NIR images difference for vegetative cycles 1 to 8, the areas in which in the color image, have nuances of medium to dark green, according to the color legend with the scale in the figure, are regions with vegetation incidence in the most recent image compared to the oldest, being classified as positive anomalies. Also, in the NIR images the difference between the scenes, in the gray level image, the anomalies have nuances close to the white tint, as can be seen in the figure.

Negative anomalies are areas in which the color difference image has shades of medium to darker red,

according to the color scale in the figure. In the NIR images, difference between the scenes, in the gray level image, the anomalies have dark nuances close to the black tint. The areas between anomalies, in the color difference image, have colors ranging from light red, through yellow to light green. In NIR images, difference between scenes, in gray level images, anomalies have nuances close to the gray tonality, oscillating between black and white. Thus, analyzing the difference in NIR bands, it is possible to observe in which regions of the field the value of NIR decreased in relation to the analyzed period and in which it increased, being an indicator of the quality and incidence of the culture, where according to Table 2 a healthy vegetation has higher levels of reflectance in the NIR (50%) compared to dry vegetation (40%) or even absence of vegetation.

In order to establish comparisons with the Delta NDVI model, in the same way as for the model, for all simulations, a tolerable percentage of up to 1% of vegetation loss was established, that is, of negative anomaly, aiming to capture any change that occurred between the scenes. Thus, as the number of negative anomalies was higher than the established percentage of 1% in all images, differences from Cycles 1 to 8, due to the standard deviation applied, automated warning signaling was issued for all classifications.

In comparing the difference images for each of the cycles of Fig. 7 and Fig. 8, considering the model Delta NDVI and Delta NIR, it was observed that when there is greater homogeneity in the plots, as it happens for Cycles 1 to 5, for regions without significant changes in changes (between anomalies), the comparative variation between models was less than 10%. Thus, it is concluded that both models similarly detected the number of regions without changes in the temporal variation, as shown in Table 3.

It is important to inform that when there is a greater diversity of cultures in the field, according to the difference in Cycles 6 to 8 of Fig. 7 and Fig. 8, the variation between the models was greater than 10% for regions between anomalies. Thus, a possible cause for the variation was due to the influence of the red band of the visible complemented to the near infrared in the Delta NDVI model, which were more sensitive to the radiometric variation of the study target in the time comparison, being that the Delta NIR model considered only the near infrared band.

For the detection of positive and negative anomalies, the percentage variation between models was also smaller for polygons with greater homogeneity. The greatest variation occurred in the difference image of Cycles 6 and 8, as shown Fig. 7 e Fig. 8. For Cycle 6 Delta NDVI



detected a negative anomaly of 2.36% and a positive one of 17.89%, whereas for Delta NIR the anomalies were respectively 12.61 % and 23.16%. For Cycle 8, Delta NDVI detected a negative anomaly of 30.49% and a positive one of 17.63%, while for Delta NIR the anomalies were 15.44% and 19.65%, respectively. Thus, the greater variation between models for plots with greater crop heterogeneity, indicate that the distinct nuances within the plot produced more sensitive spectral responses when aggregating the red band information of the Delta NDVI model, compared to the Delta NIR model.

Table. 3: Variation of Anomalies in the Models.

	Anomalies: Variation ( $\Delta$ ) of Models Delta NDVI x Delta NIR		
	$\Delta$ Between Anomaly	$\Delta$ Negative Anomaly	$\Delta$ Positive Anomaly
Cycle 1	-6.88%	24.96%	2.35%
Cycle 2	-0.72%	5.79%	-3.39%
Cycle 3	0.69%	-13.02%	6.59%
Cycle 4	4.84%	-8.10%	-22.08%
Cycle 5	-6.05%	2.44%	30.22%
Cycle 6	-24.18%	81.28%	22.75%
Cycle 7	-49.39%	25.40%	57.32%
Cycle 8	20.07%	-97.47%	10.28%
Mean	2.66%	13.01%	-7.70%
Median	4.12%	8.43%	-3.38%

Considering the average and median values of variation ( $\Delta$ ) between the models, as shown Table 3, for the eight development cycles of the field presented in the Fig. 7 and Fig. 8, in the areas without significant changes in the changes, the oscillation between the models was 2.66% on average and 4.12% in median. For the negative anomalies of the cycles, the values were an average of 13.01% and a median of 8.43%. As for positive anomalies, the variation between the models was on average -7.70% and -3.38% in median, thus showing little variation between the models.

With the extraction of the classifications of the Delta NDVI and Delta NIR models, the accuracy of the anomaly classifications was verified, according to the results presented in the Fig. 9. The validation of the classifications was performed with the reference image obtained by vectorization by visual interpretation, where studies show

that when the visual classification is used as a reference map of the real scenario, it allows the reduction of the classification error with a consequent increase in global accuracy [70] [83].

In the Fig. 9 shows, for each of the eight vegetative monitoring cycles of the field, the anomalies classifications extracted for the Delta NDVI and Delta NIR models, in addition to the reference image used in the validation of the classification of each cycle. In red color are the regions of negative anomalies, in green are the regions of positive anomalies and in blue color are the regions between anomalies.

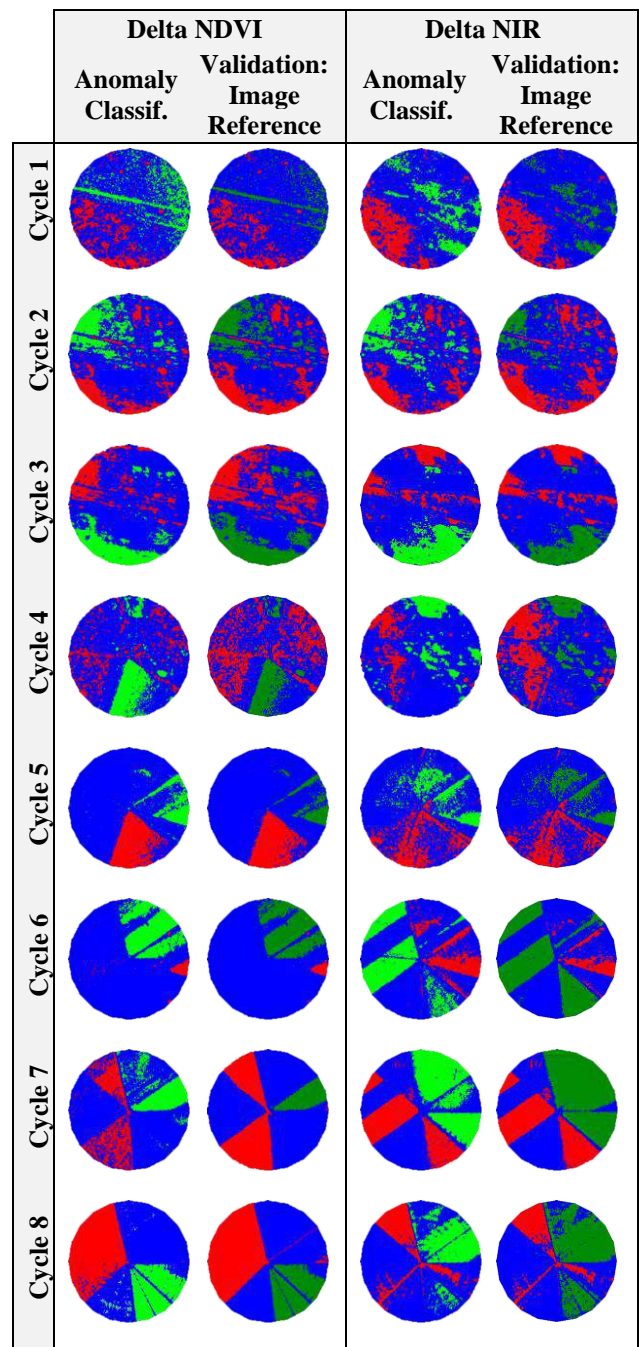


Fig. 9: Anomalies Classifications with the respective reference images for Validation of Accuracies.

When comparing Fig. 7 and Fig. 8 with the Fig. 9, it can be seen that the light nuances, close to the white hue in the image resulting from the difference between the scenes, indicate growth of the vegetation being classified in the green hue. The darker areas, close to black, indicate loss of vegetation in the image resulting from the difference between the scenes, being classified in red. The regions oscillating in gray, are regions that did not have significant changes in the temporal evolution between the images, being classified in blue color.

For all bitemporal classifications performed, the accuracy metrics were extracted, as shown in Table 4. Therefore, the Global Accuracy (G.A.), Kappa (K), Tau (T) and Global Disagreement measures were generated of the classifications, being obtained by the sum of the Quantity Disagreement (Q.D.) and the Allocation Disagreement (A.D.). To test the statistical significance between the Kappa indices, 95% confidence intervals for the coefficient were constructed for each classification, where bilateral Z hypothesis tests were performed in order to verify possible equalities between the classifications at the 5% significance level. Thus, the null hypothesis was tested in order to analyze whether it would be accepted or rejected based on the comparison of the p-value with the adopted significance level, where considering the tabulated Z value of 1.96 for the 5% significance level, the results of classifications with Z tests greater than 1.96 or less than -1.96 would be considered statistically different. Therefore, for classifications with Z calculated between -1.96 and 1.96, the hypotheses of equality between the classifications would be accepted.

Analyzing the information, especially in the Z test, it became evident that the confusion matrices of the Delta NDVI model classifications are different from the Delta NIR model classifications, considering the same parameters of the classifications and study regions. Although the premise of the models is similar for the detection by anomaly classification, whether for positive, negative anomalies and regions between anomalies through the use of ratio and difference of bands between the images, it was possible to infer that at the 5% significance level none of the confusion matrices of the classifications is statistically equal, based on the calculated Z value and the p-value. Also, considering the calculated Z, the p-value for the classifications was less than 0.002, less than the 5% significance level, the result being statistically significant and rejecting the null hypothesis of equality between the classifications.

Considering the mean and median values of the indices presented in Table 4, the greatest global accuracy was obtained in median and when the Delta NDVI model was used, obtaining a G.A. of 92.31%. Thus, the Delta NDVI

model presented results of classification of detection of higher changes in relation to the Delta NIR model, considering G.A., Kappa, Tau, in addition to a smaller global disagreement error considering the sum of the disagreements of quantity and allocation.

Table. 4: Accuracies of Delta NDVI and Delta NIR Models for the Classifications.

Cycle	Delta NDVI (ND) x Delta NIR (NI)						Z-Test	
	ND	G.A.	K	T	Q.D.	A.D.	Z	95%
	NI	(%)			(%)	(%)	Score	Conf
1	ND	92.59	0.83	0.89	7.4	0.0	-28.04	≠
	NI	95.73	0.91	0.94	4.3	0.0		
2	ND	92.03	0.85	0.88	8.0	0.0	37.19	≠
	NI	86.25	0.73	0.79	7.7	6.0		
3	ND	84.92	0.72	0.77	15.1	0.0	-72.92	≠
	NI	96.72	0.93	0.95	1.6	1.6		
4	ND	82.65	0.67	0.74	15.0	2.3	-18.75	≠
	NI	88.01	0.74	0.82	12.0	0.0		
5	ND	97.00	0.92	0.95	2.1	0.9	-43.87	≠
	NI	100	1.0	1.0	0.0	0.0		
6	ND	97.93	0.94	0.97	1.2	0.9	73.76	≠
	NI	85.11	0.72	0.78	9.6	5.3		
7	ND	84.96	0.7	0.77	9.6	5.5	-49.74	≠
	NI	90.38	0.85	0.86	9.6	0.0		
8	ND	95.08	0.92	0.93	3.9	1.0	63.57	≠
	NI	85.86	0.75	0.79	12.1	2.0		
Mean	ND	<b>90.90</b>	<b>0.82</b>	<b>0.86</b>	<b>7.79</b>	<b>1.33</b>	G.D. 9.12%	
	NI	<b>91.01</b>	<b>0.83</b>	<b>0.87</b>	<b>7.11</b>	<b>1.86</b>	G.D. 8.97%	
Median	ND	<b>92.31</b>	<b>0.84</b>	<b>0.89</b>	<b>7.70</b>	<b>0.90</b>	G.D. 8.60%	
	NI	<b>89.20</b>	<b>0.80</b>	<b>0.84</b>	<b>8.65</b>	<b>0.80</b>	G.D. 9.45%	

\*ND: Delta NDVI; NI: Delta NIR; G.A.: Global Accuracy; K: Kappa Coefficient; T: Tau; Q.D.: Quantity Disagreement; A.D.: Allocation Disagreement; G.D.: Global Disagreement; 95% Conf: 95% Confidence; ≠: Classifications are Different; =: Classifications are Equals.



With the results of the classifications there were variations between the different agricultural practices present in the short and annual cycle plot in terms of accuracy where in general more homogeneous areas with less transformation in the time of the crop development cycle had significant assertiveness as in Cycle 5 with exposed soil transitions with 97% G.A. for Delta NDVI and 100% for Delta NIR. Still according to the results of the classifications the more heterogeneous the crops within the field that is the diversity of cultures there is a tendency of less being the global accuracy and agreement indexes in comparison to the cultures in the field with homogeneous areas as in Cycle 7 with 84.96% G.A. for Delta NDVI and a Kappa of 0.7 and Tau of 0.77.

In Cycle 4 the difference image of the NDVI model showed the lowest G.A. among the classifications with 82.65% for a Kappa of 0.67 and Tau of 0.74. Although it appears to have low diversity in the field visually and there are characteristics of transition from vegetation to exposed soil different nuances are observed in the field due to the color transition in the gray level. Thus, it is likely that the extracted accuracy was impacted by mixtures within the plot such as soil being prepared for planting.

Although the Delta NDVI model has obtained superior results in relation to the Delta NIR, according to a median of 92.31% for the eight cycles, the Table 5 it can be observed that there were few variations in the accuracy in the general comparison of the mean and median values for the classifications extracted from both models.

Considering the average values of the classifications Delta NIR presented results slightly superior to the Delta NDVI Model, with G.A. of 91.01% versus 90.90%, according to the Table 5. Thus, the Delta NDVI classifications had an overall accuracy variation of 0.12% lower while for the Kappa and Tau indices the oscillation was around 1% lower.

However, the median as it is a measure of central tendency and less sensitive to outliers compared to the average can represent in a more assertive way the real general result of the classifications. Even so although Delta NDVI showed higher values compared to Delta NIR the variation was low.

For overall accuracy Delta NDVI ratings were 3.49% higher while Kappa was 5% higher. Considering the global disagreement, the variation was around 9% when comparing the models.

Table. 5: Comparisons of mean and median values for the Delta Models Classifications.

		Delta NIR	Delta NDVI	$\Delta$ NDVI x $\Delta$ NIR
Mean	G.A. (%)	<b>91.01</b>	90.90	-0.12%
	<i>Kappa</i>	<b>0.83</b>	0.82	-1.20%
	<i>Tau</i>	<b>0.87</b>	0.86	-1.15%
	Q.D. (%)	<b>7.11</b>	7.79	9.56
	A.D. (%)	<b>1.86</b>	1.33	-28.49%
Median	G.A. (%)	89.20	<b>92.31</b>	3.49%
	<i>Kappa</i>	0.80	<b>0.84</b>	5%
	<i>Tau</i>	0.84	<b>0.89</b>	5.95%
	Q.D. (%)	8.65	<b>7.70</b>	-10.98%
	A.D. (%)	0.80	<b>0.90</b>	12.5%

$\Delta$ NDVI x  $\Delta$ NIR: Variations between Delta NDVI and Delta NIR Models.

In the Fig. 10 show the 95% confidence intervals (I.C.) for each of the Kappa coefficients obtained for the classifications performed. The I.C. takes into account the standard error which is obtained by dividing the standard deviation by the square root of the sample size. The classification with maximum Kappa value was obtained for Cycle 5 in the difference image of bands with Delta NIR where the confidence interval had a value of 0.98 at the lower limit demonstrating the excellence of the classification at the level of significance adopted.

The lowest Kappa index was for Cycle 4 in the difference image with the Delta NDVI with a value of 0.67. With the 95% confidence interval, the range of value for that classification ranged from 0.65 to 0.69. By visual inspection of the scene in the Fig. 8 and Fig. 9, although initially it appears to have low diversity in the plot and there are characteristics of transition from vegetation in the image from 02/14/2018 to soil exposed in the image from 04/27/2018, it is observed Fig. 9 shows that due to the reference image used in the validation the greatest confusion was due to classes that should be classified as negative anomaly with loss of vegetation (red color) and were classified by the model as regions between anomalies that is without significant changes the temporal evolution (blue color). Thus, it is likely that the extracted accuracy

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.

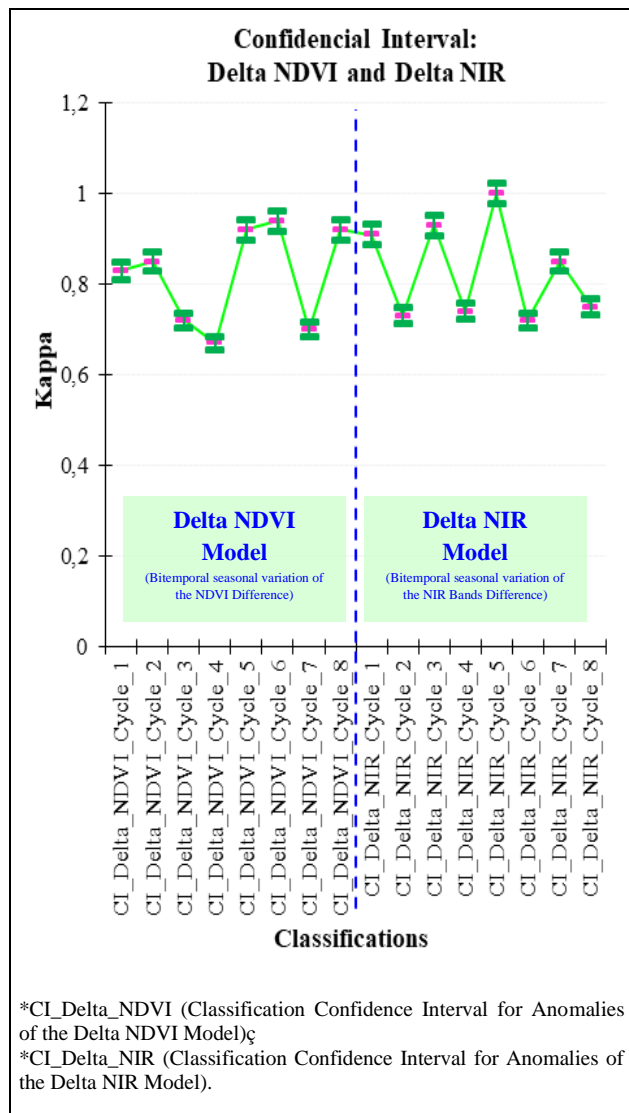


Fig. 10: Confidential Interval: Comparative of the Delta Models.

### V. CONCLUSION

The application of tool developed in Python, called LimiariZC, with the development of modules for Delta NDVI and Delta NIR models, allowed the percentage of positive negative anomalies and areas without significant changes to be quantified by seasonal differences in addition to metrics of the vegetative cycle of the crop (indicating the percentage of healthy stressed and drought) presenting what actually happened in the field and aggregating information for decision making, by those responsible for the release of agricultural financings.

Although the proposed models of Delta NDVI and Delta NIR have the same assumptions and guidelines for detecting anomalies through the image resulting from the bitemporal seasonal difference between the scenes it was found that the classifications are statistically different when compared to each other being that the statistical tests applied showed that the models are different. In addition, the seasonal difference applied to the images causes and brings the normalization of the data. Therefore, it provides for possible atmospheric attenuations with the models benefiting from normalization.

The results obtained in the anomaly classifications indicate that the Delta NDVI model presented slightly superior results in relation to the Delta NIR. In this way the probable potentiation of the ratio between bands when NDVI extraction (which highlights the vegetation making it expressive in the scene) preceding the delta difference between the images makes it possible for the classifications to be more assertive on average.

However, it should be noted that the variation was not significant in addition to the fact that on average the Delta NIR classifications obtained superior results which leads to the conclusion that depending on the desired purpose the Delta NIR applicability is an attractive alternative for detecting changes. Due to the model using only one band in the detection it makes the processing less costly with lower cost with low processing time and good performance and the tests indicated that the method was executed in less than half of the model execution time Delta NDVI.

The results obtained from anomaly detection both in the Delta NDVI model and in the Delta NIR model, showed that the models can be used as a significant indicator of oscillation and multitemporal trends in land use and cover. Still, it was found that the percentage values of anomalies and regions without significant changes are strongly correlated to the dispersion value around the adopted average that is the standard deviation around the average. Thus, it is concluded that the lower the standard deviation value the higher the percentages of positive and negative anomalies the smaller the region with areas of non-changes. Therefore, for the sensitivity of the models in order to emit conservative signals the lower the standard deviation value adopted the greater the detection of the quantity of anomalies and consequently more easily signals of changes in the vegetation cover will be triggered.

In addition, the low response time in processing (around 25 seconds for Delta NDVI and 11 seconds for Delta NIR) for executing of the models on the tool developed, when use areas of up to 100 ha (which represent almost 90% of the rural properties from country

used as test), add reduced operating and investment cost by not requiring on-site inspection, add innovation and differential making the proposed models effective and attractive for detecting changes without necessarily carrying out on-site visits and in line with the Government Consultancy for agricultural financings with the recommendation of 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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## **Predominant Leadership Style in the 1<sup>st</sup> Military Police Battalion in the State of Rondônia, Brazil**

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**Keywords—Leadership Style, Military Police  
Environment, Military police.**

**Abstract**—This research aimed to identify the predominant leadership style among the leaders of the 1st Military Police Battalion of Rondônia, among the leadership styles focused on Relationship, Task or Situation. As for the methodology, the research is classified as quantitative-descriptive since a questionnaire was applied to the respondents to identify which leadership style was perceived by the followers. The questionnaire was distributed electronically, using a link sent by the Slack application, means of communication used by the battalion. The questionnaire was based on the Management Style Assessment Scale (EAEG), developed by Melo (2004). This questionnaire consists of 19 statements about how leaders act, which must be evaluated by the respondents and rated from 1 to 5, with the respective extremes: Never acting like this and Always acting like that. The results achieved showed that the style focused on the Task presented an average of 4.314, while the style focused on the Situation presented an average of 4.231, finally the style focused on the Relationship presented an average of 4.009. Therefore, it can be concluded that the 1st Military Police Battalion of Rondônia presents the style that is expected in a military institution based on respect for hierarchy.

## I. INTRODUCTION

Living in a community has some characteristics that serve for its maintenance and progress, among them we can mention the presence of a leader. Man has always nurtured the need to improve himself so that he can be accepted in his environment, lead and be fulfilled.

For Hunter (2004) leadership is the ability to influence people to work towards common goals, transmitting confidence through character. For Rauch and Behling *apud* Benevides (2010), leading is the process of influencing the activities of an organized group towards the achievement of a goal. Leadership can then be seen as the influence that an individual can exert over another, or over a group, in order to achieve common goals. This ability to lead has become increasingly important for organizations to efficiently achieve their goals and targets. Thus, leadership is of paramount importance for organizations to achieve the expected performance, leading many researchers to study and try to understand this complex phenomenon.

As an individual reaches certain levels within organizations, the ability to lead becomes essential for him to continue to develop. It is noteworthy that some organizations have principles of respect for the leader persuaded from their base. Among them, we will focus on the Military Police, which already in the Federal Constitution has highlighted the value of leadership in its article 42, declaring that the Military Police is an institution “organized based on hierarchy and discipline” (BRASIL, 1988). The hierarchy within the military organization is what defines the levels of command and subordination, that is, leadership is vested in the superior.

Considering this, Batista (2017) highlights that it is extremely important to carry out studies that deal with leadership in the military environment, as it is essential that the commander knows how to deal with his men and listen to them. Silva and Gomes (2016), in a study that sought to identify the prevalence of the leadership style adopted by leaders in a military organization, analyzed that despite the prevalence of authoritarianism, the leaders of this institution had been showing changes in the way they dealt with their subordinates. .

These changes represent great importance for organizations, considering that society is constantly changing. Thus, it is necessary for corporations to adapt to these transformations in order to achieve their goals. Although still small, these changes already portray the need to care for human capital, so that the established goals and targets are achieved. Thus, this research is justified by the relevance of leadership in military organizations, proposing to verify whether, over the years,

this military leadership, which in principle is based on order, has experienced development.

For this work, leadership styles focused on profiles with a focus on Relationship, Task or Situation were analyzed. These profiles were chosen and analyzed using the Management Style Assessment Scale (EAEG), developed by Melo (2004). The relationship factor is the one in which the leader values interpersonal relationships, such as support, guidance and facilitation; the task factor is the one in which the leader seeks to emphasize the work, defining the role of the subordinate; and the situation factor is a combination of the previous items, in which the leader adapts his leadership according to each situation and the needs of his subordinate.

Given the above, the research problem is: *Among the leadership styles focused on Relationship, Task or Situation, what is the predominant leadership style within the structure of the 1st Military Police Battalion of Rondônia?* Seeking to answer this problem, this research has as general objective: Identify which is the predominant leadership style among the leaders of the 1st Military Police Battalion of Rondônia, among the leadership styles focused on Relationship, Task or Situation. To achieve the proposed objective, the specific objectives and structure of the work are: defining what leadership is, knowing the evolution in studies on leadership, presenting characteristics of the military police environment, how the study was applied in the 1st Police Battalion Military of the State of Rondônia and finally, the presentation of the results found.

## II. THEORETICAL FRAMEWORK

The theoretical framework will be presented as follows: Definitions on Leadership, which will bring definitions from other researchers, as well as the importance of leadership within organizations; Evolution of Studies on Leadership, which will present developed theories seeking to understand the phenomenon of leadership; The Military Police Environment, which will aim to characterize this environment; and finally, the Military Police of the State of Rondônia will be approached, seeking to demonstrate a little about the study environment.

### 2.1 Definitions of Leadership

There is no total agreement on the concept of leadership, but some authors tend to a common sense, the idea that leadership is deeply linked to the influence of one individual over another with the intention of achieving a common goal (SOUZA; DOURADO, 2016). According to the concept adopted by the Brazilian Army, leadership is:



Military leadership is a process of interpersonal influence of the military leader over his followers, as it implies the establishment of affective bonds between individuals, in order to favor the achievement of the objectives of the military organization, in a given situation (BRASIL, 2011, p. 23).

Analyzing both considerations, it is noted that for a leader to efficiently direct his team, he must maintain its harmony, in order to reach common goals efficiently. Without a leadership that meets these needs, achieving the organization's expected future is increasingly distant, as the lack of effective leadership will cause the corporation to lose control (CUNHA; BEZERRA; MEDEIROS, 2014). Shirley *et al* (2015) emphasizes that a leader must know how to motivate and lead his followers to achieve the goals and reach the expected results, and through their perception must identify the needs of each team member, as the motivation of a group member it may not be someone else's.

Leite and Lopes (2018), in turn, highlight the importance of the work team feeling encouraged to develop a good job. The organization's success depends on the motivation of this team, since the institution is in a world of constant transformation, in which the role of the leader must be emphasized, to accompany the changes of today and also of the future.

It is remarkable that the way a leader leads his team impacts the organization's growth, positively or negatively. Given the complexity of this topic and its importance for organizations, several studies have been developed in order to understand this issue.

## 2.2 Evolution of Leadership Studies

Over the years, there have been several studies on leadership. Among them, this research highlights three theories, following an evolutionary/temporal line: the theory of traits, behavioral theory and contingency theory, the latter comprising situational leadership.

### 2.2.1 Theory of Traits

Initially, studies on leadership sought to identify traits and characteristics of leaders, as well as their behavior and styles. The approach presented by the theory of traits brings leadership as a consequence of the traits presented, highlighting the particular characteristics of the leader with a focus on their essential attributes. According to the theory of traits, leaders are born made, without the need to develop leadership skills (HÜNING; KLAM; BENCKE, 2014). In this classic approach to leadership, efforts were focused on identifying the innate, personal qualities and

characteristics that would distinguish true leaders (SOUZA; DOURADO, 2016).

With the evolution of society and consequently of studies on leadership, new questions about the theme arise, in which new theories begin to be raised, thus leading to the evolution of learning. In this sense, the Behavioral Theory is born, based on the assumption that leadership can be learned.

### 2.2.2 Behavioral Theory

According to Melo (2004), this trend was based on the assumption that productivity, quality of performance and followers' motivation results from the leader's behavior. Hüning, Klam and Bencke (2014) mention that behavioral theory emerged opposing the theory of traits, as it defends the idea that appropriate behaviors can be learned and leadership developed, making it possible for trained people to effectively develop leadership .

Behavioral theory presents as main styles of leadership, the authoritarian leader, the democratic leader and the liberal leader. In the first, the leader makes the decisions, and enforces them. In the second, he makes decisions together with his followers. In the third, he delegates to his followers, who act as they want (MASSARO *et al*, 2015).

According to Melo (2004), studies at Ohio State University, initiated after World War II, sought to identify independent dimensions of leader behavior. More than 1800 statements about the behavior of leaders gave rise to two factors that represented most of the behaviors of leaders, the first being called "initial structure", referring to the probability that the leader has to define and structure his role and those of those led in pursuit of the achievement of goals; and the second was called "consideration", referring to the extent to which a person had work relationships characterized by mutual trust, respect for the ideas of those led and interest in their feelings.

At approximately the same time as the studies at the University of Ohio, according to Melo (2004), a survey was developed at the University of Michigan seeking to identify the characteristics of the leader's behavior linked to its effectiveness. The studies from the University of Michigan that stood out were those by Bowers, Scashore and Likert, which resulted in two dimensions of leader behavior, "employee orientation", which highlights interpersonal relationships such as support, guidance and facilitation, and "production orientation" that highlights the work and the accomplishment of the tasks.

Blake and Mouton developed in 1964 a two-dimensional representation of leadership styles, resulting in the managerial grid. On the Cartesian plane, X

represents the concern with production and Y represents the concern with people. Each axis was divided into 9 points and, according to the intersections of these points, there were managerial styles combining the two orientations, production and people. According to the authors, the ideal style is represented by style 9.9, which pays equal attention to dimensions (MELO, 2004).

Blake and Mouton's thesis states that there is a hierarchy in the effectiveness of these different styles, ranging from 1-1 to 9-9, or from a lower degree of attention to subordinates and tasks to a greater degree of attention to both (VALADÃO, 2009).

Figure 01 shows the two-dimensional representation made by Blake and Mouton.

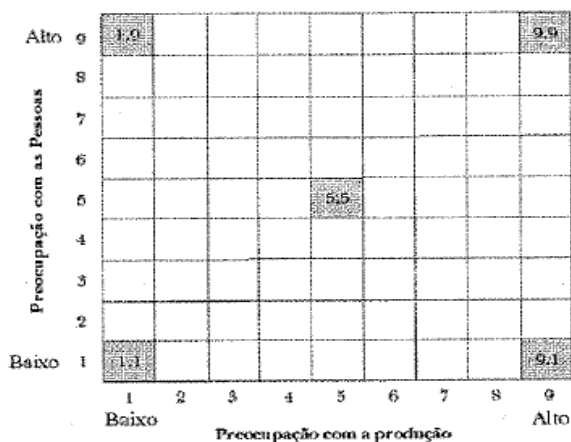


Fig.1 - Blake and Mouton's management grid

Source: Blake and Mouton, 1964

Behavioral theory was a major advance in leadership studies. However, as they do not take into account changes in the situation, new approaches to leadership have emerged, called contingency approaches.

### 2.2.3 Contingency Theory

According to Melo (2004), the model sought so far sought to demonstrate the relevance of established concepts, such as participation and democratization at work, the manager's constant and motivating presence in the group, employees' self-direction and self-control, and other concepts that induce the manager to forward their procedures and attitudes in a specific direction.

However, the evolution of studies on leadership shows the complexity of this, not being enough only certain traits or behavior to have a promising leadership profile, it is necessary to take into account the situational conditions. Thus, some authors proposed leadership models that sought to isolate situational conditions.

Some of these models, according to Melo (2004), are: Fildler's contingency model, which treats the leadership

style as something fixed, requiring the leader to be placed in situations where he would best bring results, according to his style; the path-goal-approach developed by Rober House in 1971, in which it is stated that the leader must help his followers achieve their goals by providing them with the necessary direction and support, as well as ensuring that these are compatible with the group's goal; George Graen in 1973 developed the approach of leader-member exchange, arguing that people do not receive the same treatment as the leader, as the leader establishes a special relationship with only a small part of his followers, according to Robbins and Judge (2014) these relationships Special effects occur because of time pressures.

From the contingency theory, situational leadership is born, which leaves aside the focus on tasks and people and starts to focus on the eventual situation to define the best leadership style to apply in a given situation.

#### 2.2.3.1 Situational Leadership by Hersey and Blanchard

The approach taken by Hersey and Blanchard in 1974 is part of the contingency approaches. In this approach, the leadership dimensions focused on Task and Relationship Behavior are used, combining these dimensions with the "high" and "low" indicators, resulting in four behaviors: Determine (high task - low relationship) - the leader says what must be done; Persuade (high task - high relationship) - the leader provides both directive behavior and supportive behavior; Share (low task - high relationship) - the leader and the follower share the decision making and the leader's main role is to facilitate and communicate; Delegate (low task - low relationship) - the leader provides little direction or support (MELO, 2004).

For situational leadership, there is not just one way to influence people. The leader must take into account the maturity level of individuals or groups in order to define which leadership profile to use. Therefore, it is not about finding the best style, but which is the most effective for a given situation (LOPES; LEITE, 2018).

The leader must have the personal flexibility and range of skills needed to vary his behavior. If the needs and motives of their subordinates are different, they should be treated differently (CUNHA; BEZERRA; MEDEIROS, 2014). The maturity of the subordinates is the element of the approach, which refers to the extent of people's capacity to perform certain tasks. Thus, four stages were determined: able and willing; able and unwilling; incapable and willing; incapable and unwilling (MELO, 2004).

Massaro *et al* (2015), highlight that in Situational Leadership, the leader must study the situation and his subordinate in order to apply the most appropriate type of leadership. Hersey and Blanchard (1986) say that maturity should be seen in terms of two fundamental aspects, work maturity and psychological maturity. The first is related to the technical knowledge of task execution, the second to the motivational factor. In this way, the subordinate can have high work maturity to perform a task, but due to various factors, such as lack of recognition, the subordinate can reach an immature level in the psychological sense, and this can negatively affect the entire team (LIBERATO; MATOS, 2018).

Figure 2 illustrates the elements of Situational Leadership developed by Hersey and Blanchard (1986).

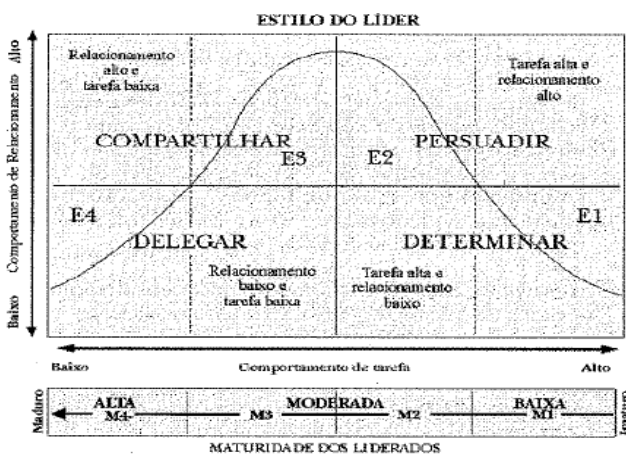


Fig.2 - Situational Leadership Model

Source: Hersey, P. and Blanchard. K., (1986)

Implicit in Situational Leadership is the idea that the leader must help subordinates to mature to the point where they are able and willing to do so. This development of the followers must be carried out by adjusting the leadership behavior, that is, going through the four styles along the prescriptive curve (LOPES; LEITE, 2018).

Liberato and Matos (2018) mention that to be a high-impact leader it is necessary, in addition to assertive actions, to have knowledge of techniques and know how to identify how your team is composed, that is, the degree of maturity of each member, as well as knowing himself as a leader. Changes can occur in the behavior of the subordinates or the team, regardless of their level of maturity. When these changes are regressive and their capacity or motivation decreases, the leader must reassess their level of maturity and return to the prescriptive curve, giving them the socio-emotional support necessary for the proper direction (LOPES; LEITE, 2018).

In situational leadership, one must always be aware of changes that have occurred, seeking to assess the level of maturity of the team members so that it is possible to provide them with the appropriate support and instruments for the level identified, necessary to achieve the goals and objectives established by the organization .

### 2.3 The Military Police Environment

The Federal Constitution (1988) defines that the structure of military organizations is based on hierarchy and discipline. As these are the pillars that support military organizations, they become extremely rigid environments. This explains what Cantone Junior (2018) declares, saying that "in common sense, the military is much more seen as autocratic, for being part of a recent war past, and especially for its involvement in the democratic revolution of 1964". According to the study by Silva and Gomes (2016), what is expected from the military environment is that it has mostly task-oriented leaders, that is, the authoritarian style of leadership remains prevalent.

In view of this, Army General "De Oliveira" (2012), cited by Souza (2017), states that "There are no weak platoons, only weak leaders". The General also lists some leadership principles, in which he stands out: serving as an example to his subordinates, knowing the profession, seeking his own improvement, taking responsibility for his actions, among others. On the other hand, the lack of ethics, the lack of dignification to the authority of the investiture of his position, the little demand of himself and much of others, the centralizer, the bad time management, the fact of not being proactive and not having empathy, among others, are pointed out by Gen. Salvador as indicators of lack of leadership (SOUZA, 2017).

With regard to the police service, this has an extensive field of action, in which members are called every day for the most diverse situations, without knowing the level of risk and the scenario they will encounter (BRITO, 2017). In these circumstances, it is essential that the leader knows how to lead his team towards the best resolution of the situation, and the adopted leadership style is often based on the responsibility assigned to him (CANTONE JUNIOR, 2018).

It is also worth noting that in military corporations, leadership is exercised according to the seniority of the military, and it is defined, as a rule, by the criterion of meritocracy, obtained during the training course to which the soldier was submitted. Within the military structure, hierarchical degrees are essential to define the levels of command and subordination. The promotion of military personnel, as a rule, takes place for length of service, sometimes requiring improvement courses so that they can

exercise their new functions (SOUZA, 2017). This improvement seeks to prepare the military to assume new responsibilities towards the group they will lead, and it is

extremely important that they are able to lead mainly by example, and not only by the power instilled in them,

Thus, Figure 3 below illustrates the ranks of ranks of ranks within the military environment.



Fig.3- Hierarchical Degrees

Source: Sued Santos Rocha de Souza, 2017

As a particularity of the military environment, it is worth noting that sometimes the military will be superior, sometimes it will be subordinate, depending on the situation in which it is. For example, a Sergeant can be with the commander of a troop, and when a Lieutenant arrives, he will pass command of the troop to the Lieutenant, becoming commanded along with the rest of the troop.

**2.4 Military Police of the State of Rondônia**

In order to know the object of study, the 1st Military Police Battalion of Rondônia, it is necessary to bring some historical factors about the Military Police of the State of Rondônia. The creation of the Federal Territory of Guaporé, currently the State of Rondônia, took place in 1943 during World War II by then President Getúlio Vargas. The territory was formed with dismemberment of land in the state of Amazonas, currently municipality of Porto Velho, and the state of Mato Grosso, currently municipality of Guajará-Mirim. On February 11, 1944, in the government of Aluísio Ferreira, the Civil Guard Territorial Guard was created through Decree No. 01,

popularly known as GT. Its objective was to maintain public order and manpower to carry out public works of all kinds. On February 1, 1947,

The Military Police of the State of Rondônia (PMRO) was created on November 26, 1975 (still Federal Territory of Rondônia), through Federal Law No. 6270. Two years later, on September 9, 1977, Decree No. 864 extinguished the Territorial Guard of Rondônia, transferring its entire patrimonial, financial, budgetary and extra-budgetary assets, as well as ensuring the entry of its components to the Military Police.

Through Decree 717, on December 7, 1982, there was the creation of Military Organizations of Rondônia, among these organizations we highlight the creation of the 1st Military Police Battalion of the State of Rondônia, called Batalhão Rondon. More than 36 years after its creation, this military organization will be our object of study.

The organizational chart in Figure 4 below represents how the Rondon Battalion is currently structured.



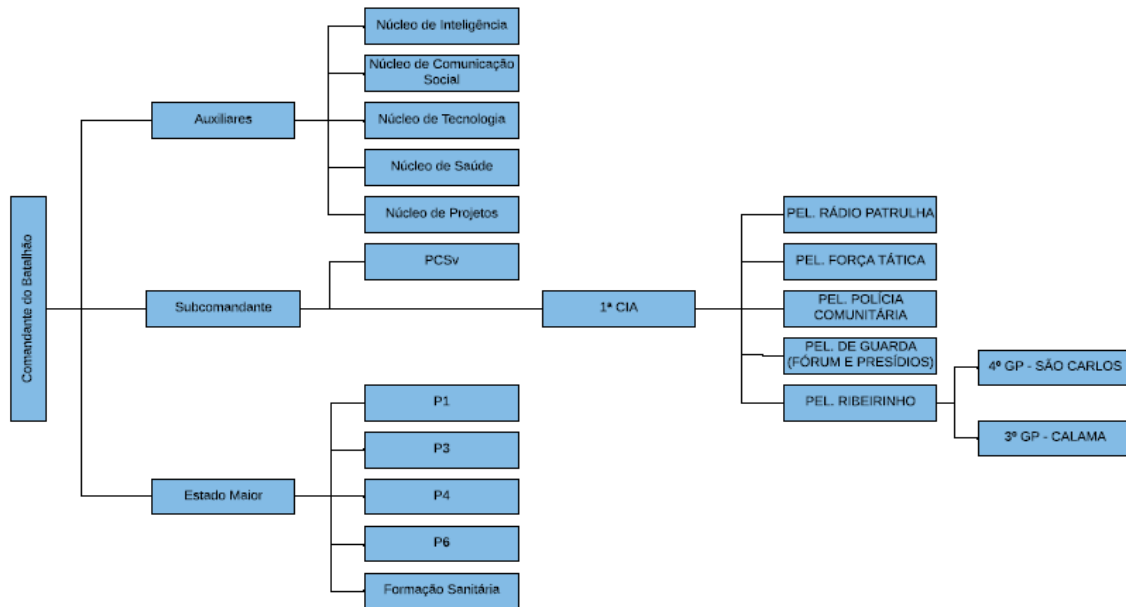


Fig.4 - Organizational Chart 1st Military Police Battalion of Rondônia

Source: 1st Military Police Battalion of Rondônia

To better understand this structure, below are the functions performed by each department of the military organization, we seek support from the head of the Administrative Division. Thus, the Rondon Battalion currently has a staff of 207 police officers who are ready for military police activity, performing the functions as per the organization chart.

The Battalion Commander is responsible for coordinating and supervising all areas related to the unit's activities, dealing with relations with other units and external bodies, assisted by the deputy commander who focuses his actions on a subsidiary basis to the commander, but in the internal area of the Battalion, the latter also is responsible for the disciplinary part of the staff.

The Auxiliary and General Staff departments are directly subordinate to the battalion commander, as follows: The Intelligence Nucleus responsible for producing information and safeguarding it in order to support the actions of the command; Social Communication Nucleus, assigned to the contact with both internal and external audiences, through the dissemination of articles, control of the unit's social media, registration and monitoring of all battalion activities; the Technology Nucleus, designated for the IT support, maintenance and development function, aiming to facilitate the accomplishment of the missions; Health Center, responsible for carrying out a physical training program and campaigns related to the physical and mental health of the unit's military police; the Project Nucleus, it

has the responsibility to create and implement new services or modalities of preventive and ostensive actions; Administrative Division (P1) is responsible for managing the battalion's human resources, responsible for registering and updating the soldier's entire life while he is in the unit; in the Operational Division (P3), activities inherent to operations, teaching and instruction of the unit's troops are carried out, from its planning, execution and subsequent registration; the Budget and Assets Division (P4) is responsible for all the battalion's physical and military material, logistics, facility maintenance, and supply of funds; the Justice and Discipline Section –SJD (P6) is responsible for the disciplinary aspect of the troop, carrying out process instruction and investigative procedures.

The 1st CIA is composed of the Patrol Radio Platoon, responsible for the ostensible policing of social proximity and for dealing with incidents arising from calls to 190; by the Tactical Force Squad, which carries out the mesh-covering policing, acting at times where there is a greater probability of occurrences and with a repressive character; by the Community Police Platoon, which acts in a differentiated manner by being together with representatives of localities (Security Council - CONSEG), this policing is aimed at the origin of the problem and focuses its action on the demands passed on directly by the local population; by PelotãoRibeirinho, which is responsible for carrying out police functions in the 3rd Group located in the District of São Carlos and in the 4th Group located in the District of Calama.

After presenting the theoretical knowledge that guided this study and the environment where it will be carried out, the procedures for the development of the research will be described below, seeking to respond to the objective proposed by the work.

### III. METHODOLOGICAL PROCEDURES

In this section, the methodology used in the construction of this research and the methodology for applying the questionnaire in the 1st Battalion of the Military Police of Rondônia will be presented.

The research was carried out in the 1st Military Police Battalion of the State of Rondônia, located in the city of Porto Velho. The command of this battalion, knowing the need to know and understand the predominant leadership profile in the military police, considering the importance that the hierarchy has in the institution, and having an interest in the research results, made access to the military police viable, also authorizing the application of the quiz.

As for the classification, this research has a quantitative approach, that is, the results can be quantified using the questionnaire that was applied to the police officers. According to Fonseca (2002), research of a quantitative nature is considered representative of the population, that is, its results are taken as if it were a real portrait of the research's target audience. In this regard, Fonseca (2002) says:

Quantitative research focuses on objectivity. Influenced by positivism, it considers that reality can only be understood based on the analysis of raw data, collected with the help of standardized and neutral instruments. Quantitative research uses mathematical language to describe the causes of a phenomenon, the relationships between variables, etc. The joint use of qualitative and quantitative research allows collecting more information than could be obtained in isolation (FONSECA, 2002 *apud* GERHARDT; SILVEIRA, 2009, p.33).

Furthermore, this type of research collects data under control conditions, emphasizing objectivity. It then analyzes the data collected through statistical procedures (POLIT *et al*, 2004 *apud* GERHARDT; SILVEIRA, p. 35, 2009).

As for the objective, this research qualifies as descriptive, as it exposed the characteristics of a certain population, demanding, for that, standardized data collection techniques. According to Padronav(2013, p. 52), descriptive research is characterized by the simple recording and description of the facts observed by the

researcher, without his interference. This type of research also seeks to “describe the characteristics of a given population or phenomenon or the establishment of relationships between variables”.

As for the sample, which is a conveniently selected portion of the universe or population studied, this research had a total of 26 respondents from a population of 207 qualified police officers. With this sample it is possible to obtain 90% reliability of the answers. All calculations were performed using the *Survey Monkey* sampling calculator . available

at: <https://www.surveymonkey.com/mp/sample-size-calculator/> . The sampling analysis will follow the principle of the law of statistical regularity, which determines that in “a set of  $n$  units taken at random from a set  $N$  will probably have the characteristics of the larger group” (GIL, 2008, p. 90).

As for the data collection method, we used the survey (*survey*). According to Gerhardt and Silveira (2009), this type of research is ideal for the direct approach of people whose behavior one wants to know and analyze through some type of questionnaire. “In general, information is requested from a significant group of people [...], and then, through quantitative analysis, we obtain the conclusions corresponding to the collected data” (GERHARDT; SILVEIRA, 2009, p. 57 -58). Considering the above, the technique used for data collection was the questionnaire.

The questionnaire was distributed by the researcher electronically. The researcher sent a link that directed the respondent to a website to answer the requested information. For the distribution of the link, the *Slack* application was used, used by BatalhãoRondon as a communication tool among its members. For tabulation and analysis of the data was used the *software IBM SPSS Statistics Trial Subscription (Classic)* and spreadsheets *Microsoft Excel software*. The method of analysis of the questionnaire was through general averages of the answers, also taking into account the standard deviation.

After collecting the data, the analysis and statistical interpretation of the collected data was carried out, seeking answers to the questions presented in this research. The questionnaire applied was based on the Management Style Assessment Scale (EAEG) developed by Melo (2004), which divides the leadership style into the following factors:

a) **Relationship-** Refers to the extent to which the leader will have work relationships that are characterized by mutual trust, friendship, human warmth in relationships, respect for subordinates' ideas and interest in their feelings. The leader values individuality and

emphasizes interpersonal relationships, such as support, guidance and facilitation;

b) **Task** – Refers to the probability that the leader has to define and structure his role and that of his subordinates in the pursuit of achieving goals. The leader emphasizes the job, the technical aspects of the role, adherence to standards, communication channels, hierarchy, procedures and methods, as well as the performance of;

c) **Situation** – Refers to the manager's ability to identify the reality of their work environment and adapt their style to the demands of that environment. The leader is flexible to vary his behavior according to the needs and motives of his subordinates.

#### IV. RESULTS AND DISCUSSIONS

This study used the application of a questionnaire divided into two parts, the first sought to identify the predominant leadership style among military police officers who play the role of leader, and the second sought to collect data on the interviewees.

To understand the leadership profiles, the questions used were based on the study by Melo (2004), in which the Management Style Assessment Scale (EAEG) was developed. This scale has 19 questions where respondents must value assertions about the actions of superiors, between 1 and 5, according to the way of acting, namely: 1 – Never act like that; 2 – He rarely acts like this; 3 – Occasionally acts like this; 4 – Often acts like this; 5 – Always act like this. In order to know the demographic profile of the sample, information on gender, age group, education, length of service and post/graduation was sought.

The results found for the demographic profile were stratified according to the tables 1a, 1b,1c, 1d and 1e below:

Table 01a - Demographic data of the sample

Sex	The amount	Percentage
Male	24	92%
Female	2	8%

Source: Prepared with research data

Table 01b - Demographic data of the sample

Age Group	The amount	Percentage
23 – 27	4	15%
28 – 32	8	31%

33 – 37	7	27%
38 – 42	4	15%
43 – 47	2	8%
48 – 53	1	4%

Source: Prepared with research data

Table 01c - Demographic data of the sample

Education	The amount	Percentage
High school	5	19%
Incomplete Higher Education (Attending)	7	27%
Complete Higher Education	12	46%
Specialization	2	8%

Source: Prepared with research data

Table 01d - Demographic data of the sample

Service Time	The amount	Percentage
Upto 5 Years	10	38%
6 - 10 Years	6	23%
11 - 15 Years	5	19%
16 - 20 Years	3	12%
Mais de 25 Years	2	8%

Source: Prepared with research data

Table 01e - Demographic data of the sample

Posto/Graduação	The amount	Percentage
Soldier	11	42%
Cable	9	35%
3rd Sergeant	3	12%
2nd Sergeant	2	8%
1st Lieutenant	1	4%

Source: Prepared with research data

Below, the demographic data will be related to the perceptions about the leadership profile.

The number of male respondents represents 92% of the sample, and 8% female respondents, reflecting what is provided for in the legislation that deals with entry into the Military Police of Rondônia, which establishes female staff at 10% of the total number. All female respondents identify leadership as Situational. The average found was 4.00 for this factor, that is, according to the questionnaire

criteria, it is assumed that leaders often act like this, which can demonstrate that they are given freedom to act as the situation presents itself.

Analyzing the data regarding the age group, it can be seen that most respondents are in the range of 28 – 32 years, followed by the range of 33 - 37 years, both representing 31% and 27% respectively. The Situational factor was mostly perceived by respondents who are in the range of 28 – 32 years. The Task factor was mostly perceived by respondents aged 33 to 47 years.

As for length of service within the corporation, most respondents are in the range of up to 5 years of service, representing 38%, followed by the range of 6 – 10 years of service with 23% of the sample. These respondents, for the most part, identify leadership as Situational. This may indicate that they present a new look and a new perspective on the leadership of the Military Police. Respondents with more than 11 years of service, on the other hand, see leadership focused on the Task. This is in line with what was analyzed in the age group, that is, police officers with more years of service and age see leadership as a task.

Relating the length of service with the level of education, we can identify that in the range of up to 5 years of service in the corporation there are 50% of those with higher education, demonstrating that they have already joined the corporation with their academic training completed or in progress. It was possible to identify that most respondents have higher education, representing 46% of the sample, those with some type of specialization represent 8%, those who are attending some type of graduation represent 27%, and respondents who have only the high school represent 19%. For the corporation, it is extremely important that there are more and more professionals with academic backgrounds, so that this knowledge can be opportunely added to police work, bringing benefits to the institution.

With regard to hierarchical levels, the highest representation was that of Soldiers, with 42% of respondents, followed by Corporals with 35%. Relating this result to the perception of leadership style, it is noted that the Soldiers identify this mostly as Situational. Cabos, on the other hand, identify it mostly as Task-oriented.

To analyze the reliability of the questionnaire, *Cronbach's alpha* coefficient was used. Freitas and Rodrigues (2005) mention that although the use of this coefficient is broad and comprehensive, there is no consensus among researchers on the interpretation of the reliability of a questionnaire based on the coefficient value. However, they emphasize that, in general, values

of  $\alpha \leq 0.70$  are considered satisfactory. Below, Table 02 brings the classification according to these authors.

**Table 02 - Reliability classification based on the Cronbach  $\alpha$  coefficient**

Reliability	$\alpha$ value
Verylow	$\alpha \leq 0,30$
Low	$0,30 < \alpha \leq 0,60$
Moderate	$0,60 < \alpha \leq 0,75$
High	$0,75 < \alpha \leq 0,90$
Verytall	$\alpha > 0,90$

Source: Freitas, André LP; Rodrigues, Sidiline G (2005, p.4).

Using the *IBM SPSS Statistics Subscription Trial* (Classic) software, it was possible to extract the *Cronbach's Alpha* values shown in table 03. All obtained Alpha values satisfied the parameters for the questionnaire to be considered consistent, thus giving reliability to its result.

*Table 03 - Reliability of Results Extracted from EAEG*

Factor	<i>Cronbach's Alpha</i>	Reliability
Relationship	0.877	High
Assignment	0.861	High
situational	0.822	High

Source: Prepared with research data

According to the classification of *Cronbach's Alpha coefficient*, it is possible to consider the reliability of the questionnaire as high, since the values obtained and shown in Table 3 are  $0.75 < \alpha \leq 0.90$ . After validating the reliability of the questionnaire, with the minimum reliability coefficient being exceeded, the average of the responses was then carried out so that it was possible to identify the leadership style perceived by the subordinates, as well as the median of the responses and the standard deviation presented by each factor. Table 04 presents the results obtained.



Table 04 - Mean, Median and Standard Deviation of Results Extracted from the EAEG

Factor	Average	Median	Standard deviation
Relationship	4,009	4,056	0.665
Assignment	4,314	4,583	0.633
Situational	4.231	4,250	0.655

Source: Prepared with research data

Figure 05 shows the graph constructed based on the average values obtained from the questionnaire responses, which aimed to identify which leadership style was perceived by the led.

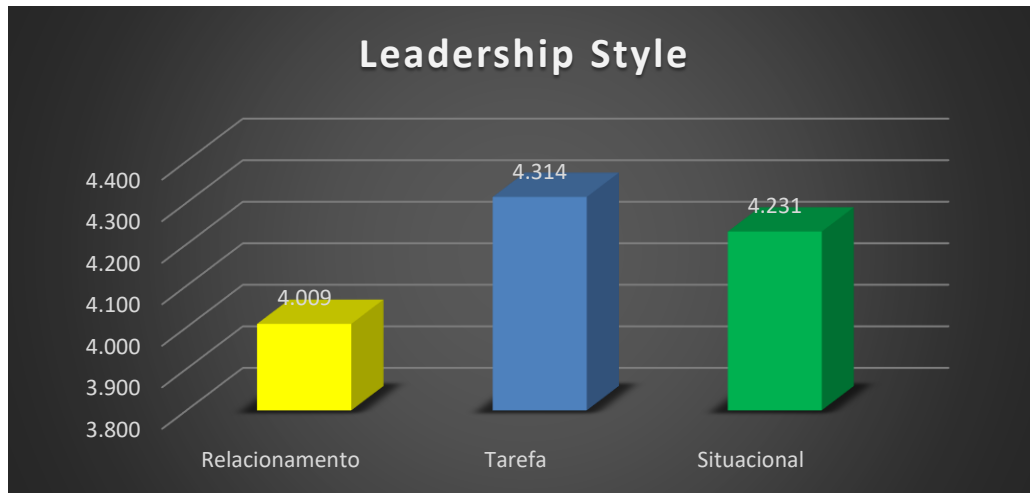


Fig.5 – Leadership style

Source: Survey data

Regarding the identification of the predominance of the leadership style, analyzing the figure above, it can be seen that the Relationship factor had an average of 4.009, being the least perceived by those led. This factor as proposed by Melo (2004) concerns the establishment of interpersonal relationships, aimed at guidance and aiming to establish a relationship of mutual trust and friendship in the leader-leader relationship. One hypothesis for this result is the rigid structure that military institutions present.

The factor most perceived by the followers was the Task factor, with an average of 4.314, showing that the leader seeks to emphasize work, fulfillment of tasks and technical aspects of the function, defining and systematizing their role and that of their followers to achieve the organization's goals. Possibly this factor was appointed as the most present for bringing items that value the hierarchy and fulfill tasks, which are characteristic of military organizations.

The Situational factor had an average of 4.231, in this factor, leaders seek to use flexibility to be able to adjust according to daily situations, and adapt their behavior according to needs. Thus, it is evident that occasionally

the organization's leaders make use of this leadership style. This demonstrates that the institution has shown considerable changes in the way it leads.

### V. FINAL CONSIDERATIONS

We saw that leadership is of paramount importance in organizations, as it is one of the tools to achieve objectives and goals. This importance is even more accentuated in an institution like the Military Police, which has integrated respect for hierarchy in its training base. Considering this hierarchy, it is expected that a military institution has leaders with more authoritarian profiles, that is, task-oriented. However, researches have shown that there is heterogeneity in the profiles of Military Police leaders, demonstrating that this institution has followed the development of leadership theories.

In response to these studies and responding to the proposed research problem, this research identified that the predominant leadership style within the structure of the 1st Military Police Battalion of Rondônia is mainly Task-oriented. However, the result found for the Situational profile was very close to that, thus demonstrating that the analyzed organization has evolved

with regard to the way of leading, seeking whenever possible to adapt the needs of its employees to that of the institution, providing support necessary for the development of its followers.

The Relationship factor, in spite of having the lowest average, was not so far from the others, being above 4.00. This shows that the corporation has shown interest in its employees. However, it is still necessary for leaders to explore this form of leadership more, seeking to demonstrate more interest in the wishes of their followers. In this way, it will be possible for this average value to be closer to the other factors, generating a balance to meet both the institution's and its collaborators' aspirations.

This research found the low number of respondents as the main limitation. This low number was possibly due to the fact that many police officers do not follow the *Slack* communication app during their days off or because they do not have access to the app for some other reason. As a suggestion for further studies, research is suggested to analyze whether there are implications of each leadership profile for society, that is, whether the population has felt the change in the profile of military leaders or whether there are different impacts according to each profile.

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# Interculturality and Meaningful Learning: Indigenous Schooling Education in Natural Sciences Teaching

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**Keywords—** Decolonization, Indigenous Teaching, Interculturality, Meaningful Learning, Natural Sciences, Teaching Materials.

**Abstract—** *The objective of this paper is to analyse the possibility of an intercultural dialogue in Natural Sciences teaching; the study is centered in David Ausubel's Meaningful Learning Theory and geared to indigenous students. It highlights the concepts that guide the meaningful learning concomitantly to the conceptual pillars of interculturality, treasuring the indigenous knowledge during the entire journey, and also, the premise that Maths and Sciences teaching must take place out of necessity and/or concrete situations. This study points the great didactic conceptual advantage of the utilization of the ethnophysics knowledge to represent and model the main concepts of Natural Sciences, it yet discourses about local conceptions and the pedagogical practices of teachers; the elaboration of an alternative school material contextualized with the indigenous reality, and the comprehension of the process that was fundamental to a meaningful answer of the indigenous students concerning Mathematics and Natural Sciences teaching. Reflections were proposed to enable the Teaching of Mathematics and Natural Sciences from an intercultural perspective, as it brings the possibility of analysis, aiming at the decolonization of knowledge and, therefore, the imagery that supports it.*

## I. INTRODUCTION

In our study, we will seek theoretical support in David Ausubel's Theory of Learning, the relationship of interculturality in the student's cognitive development in the search for a meaningful student learning in Natural Sciences. The importance of this study will enable indigenous teachers to seek transversal pedagogical strategies that value sustainability, in order to maintain their leadership, their traditional customs and values added to the contents covered in the classroom and beyond.

It should be noted that indigenous teachers demand the development of new pedagogical and curricular proposals applicable to their schools to replace the general model of the current educational system. The reason, as recorded by the Ministry of Education and Culture (2002, p.11), is that

“such models never corresponded to their political interests and the pedagogies of their cultures”. Furthermore, it is a viable proposal in the current context of the classroom, as teachers and students become constructors of an educational practice for an inclusive and intercultural school.

We can also consider, based on the few found researches, that these seek to motivate learning in Natural Sciences when they try to somehow relate traditional knowledge in Natural Sciences to school knowledge in the classroom and beyond.

In order to establish a relationship between the proposed Teaching of Natural Sciences with the intercultural context in indigenous communities, that is, culture, territory and sustainability, it is primarily necessary to understand the



concept of each one of them, given to their relevance for the development of the theme. The clarification of these concepts aims at the interrelationship between them, pointing to the issue of sustainability of indigenous school education.

As a consequence, we gathered up our experience. Therefore, the text is organized in three parts: at first, we will deal with David Ausubel's Theory of Meaningful Learning, because in our conception, his theory reaches a fundamental point in the teaching/learning process, where the individual is the subject of their learning, which depends on their prior knowledge and interactivity with the environment, which provokes significant new meaningful knowledge. Then, we will approach the concept of Interculturality in the Teaching of Natural Sciences, a concept defended here that proposes the mutual recognition of all cultures, without hierarchization and superiority of knowledge. In the third part, we develop the implications of the concepts of Meaningful Learning Theory and Interculturality in the cognitive development of the indigenous student, enabling a meaningful intercultural learning.

## II. AUSUBELIAN LEARNING MODEL

In the mid-1960s, David Ausubel proposed the Meaningful Learning Theory, through which he sought to explain the internal mechanisms that occur in the human mind in relation to learning and the structuring of knowledge, through an organization of the individual's cognitive structure. Ausubel focused on an issue that no researcher had ever been concerned about: the learning that took place in the classroom, valuing discovery learning, which encouraged expository classes, a major focus of his research (MOREIRA, 2001).

In our conception, Ausubel reaches a fundamental point in the teaching/learning process, where the individual is the subject of their learning, which depends on their previous knowledge and on the interactivity with the environment, which provokes significant new knowledge. The same proposes that, in order for the apprentice to have meaningful learning, there must be three necessary conditions: the offer of new knowledge structured in a logical manner, the presence of previous knowledge in the individual's cognitive structure so that the bridge can be built. with the new knowledge, and, finally, the intention/purpose of apprehending/assimilating your knowledge with the one you want to achieve.

The individual's cognitive structure, for the author, is the organized content of ideas that, in terms of learning particular themes and subjects, refers to the organization of

content in that area that the individual wants to learn. In other words, the emphasis is placed on the acquisition, storage and coordination of ideas in the individual's brain. Based on this, the cognitive structure would be the set of cultural references that the subject has, since culture guides the individual's perception and cognition codes, favoring the acquisition, organization and anchoring of new knowledge.

In this perception, the cognitive structure of the individual for Ausubel (2003) is structured and organized, and new ideas are articulated according to the relationships that are established between them. Furthermore, it is in the individual's cognitive structure that new ideas and concepts gradually become fixed and organized, that is, learning.

According to his theory, the continuous incorporation of new ideas in the individual's cognitive structure provides learning due to the changes that occur in it. Learning can be mechanical or meaningful, where the main factor will be the relationship that the individual will make with the proposed new idea and previous knowledge already existing in their cognitive structure. In other words, if the new idea is significant for the individual, significant learning will occur, otherwise, it will be mechanical (MOREIRA, 2001).

Thus, when introducing to an indigenous student the concept of speed, for example, it will only be meaningful to them if somehow there is a clear relationship between the "Maraca Race", very common in indigenous communities' games, as the runner who arrives first covered the distance in less time, that is, had a greater speed. Thus, the new idea is related in a non-arbitrary way to the ideas that already exist in the individual's cognitive structure. Precisely because it is not arbitrary and substantive, there is a clear and coherent relationship between the new idea and previous knowledge, resulting in meaningful learning.

In addition to not being arbitrary, for learning to occur, and for it to be meaningful, it also must be substantive. Being substantive, the student will know how to explain the apprehended content in their own words and different ways that express the same meaning of the content. (ARAGÃO, 1976).

For instance, when the Basic Education student learns significantly that the concept of displacement and distance covered are different, that is, that displacement is a vector physical quantity, as it is characterized by intensity, direction and meaning, which mathematically would be the difference of final and initial position of the object. The distance covered, on the other hand, is a scalar physical quantity, which is characterized by an intensity, which

mathematically would be the sum of all the distances covered. In view of this, learning was also significant due to its substantivity, considering that the student grasped the meaning and concepts of what was taught, in such a way that he is able to express himself variably when explaining what was learned.

For Ausubel (2003), the main objective of academic teaching revolves around ideas being learned in a meaningful way; which allows the student to use the new concept learned in an original way, that is, unique, regardless of the environment in which this new content was first learned.

However, one cannot talk about meaningful learning without commenting on mechanical learning – opposite extremes, and unfortunately, the latter is very present in indigenous schools. In this case, the new ideas are not logically and clearly related to prior knowledge in the student's cognitive structure, they are simply memorized and reproduced, circumstances in which they are stored arbitrarily, which does not guarantee flexibility in their use, nor longevity.

As a consequence, substantial learning does not occur, therefore, the individual is not able to express the new content in a language different from the one in which this material was first presented.

In fact, the student does not learn the meaning of the new material, but only memorizes the sequence of words that defines it, decoding it. Therefore, he will be unable to use this knowledge in a context other than the one in which it was first presented. In the example given above – displacement and traveled distance – the individual will not be able to make the relationship between them, or even with the fact that displacement is a vector quantity and traveled distance and a scalar quantity.

#### A. Substantial Factors to Pedagogical Facilitation

The substantial factors to pedagogical facilitation, as the name implies, promote the action of learning and are related to the selection of the most relevant themes worked on with students. Thus, it is important to select the basic ideas so as not to overload the student with unnecessary information, making it difficult to acquire an adequate cognitive structure (MOREIRA, et al., 2001).

Ausubel (2003) believes that concepts should be presented to students preferably in a broader format, in other words, from the most general to the most specific ideas, as learning by subordination is easier for the individual than by superordination. Therefore, when concepts are worked on, they can be linked in a subordinate way – when learning takes place through subordination, the anchor

concepts necessary to provide meaningful learning are called “subsumers”.

In this sense, when the teacher selects more general ideas/concepts about a particular subject, these will serve as an anchor for future learning. Otherwise, if the choice is for more unique ideas/concepts, it will probably not be significant for the student, as they would be lacking prior knowledge in the student's cognitive structure, as they are associated with more inclusive concepts.

For Ausubel (2003), the programmatic principles for sequencing teaching content are progressive differentiation and integrative reconciliation. Progressive differentiation is characterized by learning by subordination, in which the most global and inclusive ideas must be presented to the individual in advance of the most specific ones, fostering the necessary conditions for anchoring new ideas and their subsequent differentiation. Integrative reconciliation, on the other hand, portrays the relationship between ideas, pointing out similarities and differences, in an attempt to circumvent imaginary or apparent divergences in the idea. That is, as concepts become singular and, simultaneously, establishing relationships that generate meaning, meaningful learning occurs. As defined by Faria (1989), integrative reconciliation basically consists of the explicit delineation of the relationships between ideas, of pointing out relevant similarities and differences, and of reconciling real and apparent inconsistencies.

However, we must be careful, when we present new ideas to those that already exist in the student's cognitive structure: clarify any differences between the already established ideas and those that are being learned, so that the student does not take the junction one with the other or the confuse the concept of both. Highlight any contradictions and similarities between the concepts that are being learned and those that are already known; analyze the new idea within the limited set of concepts related to a discipline, so that any contradiction disappears.

#### B. Previous Organizers

After the selection, sequencing and preparation of the most relevant contents in order to ensure clarity and stability of the ideas in the individual's cognitive structure, it is proposed the arrangement of previous organizers. According to Ausubel (2003), previous organizers are introductory materials designed to facilitate the learning of specific topics or sets of ideas that are consistently related to each other.

The previous organizers are intended to reveal in the student's cognitive structure mainstay ideas, in order to stimulate meaningful learning. Consequently, the objective of the previous organizers is to strengthen the formation of

non-arbitrary and substantive relationships with new concepts and ideas that will anchor in the student's cognitive structure, through the explanation of these ideas.

Hence, Moreira (2004) states that the advantage of the previous organizer is to allow the student to take advantage of the characteristics of a subsumer, that is: to identify the relevant content in the cognitive structure and explain the relevance of this content for learning the new material; give an overview of the material at a higher level of abstraction, stressing important relationships, and; provide inclusive organizational elements that take into account more efficiently and enhance the specific content of the new material.

### III. INTERCULTURALITY IN NATURE SCIENCE TEACHING

Firstly, we need to make it clear that the concept of interculturality defended in this study proposes the mutual recognition of all cultures, without hierarchization and superiority of knowledge. From this perspective, we were able to observe and understand the worldview of indigenous peoples, particularly their conceptions regarding the phenomena of the Natural Sciences.

Acknowledging interculturality as a pedagogical and methodological perspective allows us to recognize and value other cultural systems, outweighing hierarchy, in a context of complementarity which enables the construction of a dialogue. This, on the other hand, allows the sharing of knowledge, beyond all the false opposition between the modern and the traditional, written and oral culture, rationality and the affective dimension. These false oppositions pervade human relationships and learning (NARBY, 2000, 2005).

The concept of culture we adopt is essentially semiotic, as we believe culture as the accumulated totality of cultural patterns, that is to say, of "organized systems of significant symbols" (GEERTZ, 1989) on the basis of which individuals organize and guide the purposes of their actions.

It is a fact that we still find in indigenous school education the ideological vision of the colonizers in the Teaching of Natural Sciences, we believe that is heavily due to the textbooks that are sent to indigenous schools, as they pass on contents with rather a western worldview in order to reduce the them to mere mnemonic information, not recognizing local knowledge and their culture as important assets in the process of meaningful learning, hence harming the teach-learning process, since recognizing the other's culture as significant is what allows groups to talk to each other.

Thinking about Natural Sciences teaching from an intercultural perspective, brings the possibility of analysis that allows the decolonization of knowledge and, consequently, the imaginary that sustains it. Taking interculturality as a perspective enables the recognition and appreciation of other cultural systems, in addition to any hierarchy to foster dialogue.

This approach brings out the proposition of interculturality with the decolonization of power and knowledge. It is, therefore, the cultural and historical foundation in the production of an alternative teaching material which incorporates their cultural diversity and contextualized with their indigenous reality, thus respecting the richness of diversity as significant in the student's learning process.

Reflecting on the response of local knowledge relationship, which is identified by some as inferior to global knowledge, leads us to study the history of power relations between dominant cultures and dominated cultures.

The axis of this reflection allows me to question the historical separation of nature and culture in the teaching of Science, put into practice by the Eurocentric vision situated in the rationality of positivism, on which the normal science defended by the ruling class was built. I understand that normal science is the state of a science in which its research and results are predictable, that is, it is not concerned with creating novelties, but with specializing in what is already established by the current paradigm. The intention of the experiences is not to institute novelties, in fact, "The result is already known in advance, the fascination is in how to reach it" (KHUN, 2009, p. 60).

There are several challenges to teach Science for an indigenous community; which are, to understand their culture and their particularities, to talk to the community and most importantly, to listen to them - not merely talk about them or for them. (LINS, 2019) corroborates with this assumption when he defends that an individual should talk to one another, without letting their own conceptions about science prejudice the so-called common sense knowledge by normal science, this is perhaps the greatest paradigm.

Furthermore, current Education theorists have been endeavoring to involve interculturality in the Natural Sciences teach-learning process. In Brazil, the situation of coexistence of different cultures has always existed and has always been part of our reality, however, in an oppressive way, the dominant ideology has always sought to devalue the cultures dominated throughout the colonial and post-colonial period.

It is important to mention that intercultural teaching provides interaction with other people and provides an understanding of the meanings attributed to their actions. These actions may cause discomfort with other people's behavior due to the fact that logic determines the cultural context, differently from the typical logic of our cultural standards. In order to understand another person's behavior, you need to comprehend the logic of the organization, and also, meaningful symbols developed by their group.

Whilst, comprehending the logic of different cultural patterns allows us to understand, by contrast the peculiarities of the logic of our own cultural patterns and the relativity of the meanings we attribute to our acts. In this way, by reflecting on our actions from the perspective of other cultural patterns, we can discover other meanings that our own actions can take and, with that, discover different ways to guide them.

When referring to Indigenous Education, D'Ambrósio (2001, p.76) points out that education must use contextualized resources and instruments, as "contextualization is essential for any education program for native and marginal populations". Furthermore, he shows that "it is possible to avoid cultural conflicts that result from the introduction of white mathematics in indigenous education" (Loc. Cit.). By analogy, I believe that the teaching of Science can be approached considering its cultural context, so that the problems found in Science textbooks bring an adequate treatment of formulating and solving problems of physical phenomena found in the working school community, that is, referring to the climate, agriculture, fishing, what applies to the daily life of the community.

[...] everyday life is impregnated with the knowledge and practices of culture. At all times, individuals are comparing, classifying, quantifying, measuring, explaining, generalizing, inferring and, in some way, evaluating, using the material and intellectual instruments that are characteristic of their culture (Idem, 2002, p. 22).

The Mathematics defended in this study is based on the needs and/or concrete situations of the community itself. In this case, I sought to encourage the permanence of indigenous culture through the teaching of Mathematics proposed by Ethnomathematics, as follows:

[...] the mathematics practiced by cultural groups, such as urban and rural communities, groups of workers, professional classes, children of a certain age group, indigenous societies, and many other groups that identify themselves by objectives and traditions common to the group. (Idem, 2001, p. 9).

Agreeing with the author, I believe that both Science and Mathematics must be linked to real and natural phenomena; and a great example is in indigenous school education. The common sense of the indigenous people, for example, elders, fathers, mothers and chiefs are inexhaustible sources of scientific knowledge.

Consequently, trying to understand and often accept new cultures is not an easy relationship in our daily lives. History reveals to us that many of such relationships between different peoples and social groups have resulted in holy wars, genocides, processes of colonization and domination. According to Geertz (1984, p.54), "understanding the culture of a people exposes its normality without reducing its particularity", thus bringing, according to history, deeply conflicting and dramatic relationships.

According to Messeder (2018, p.10), "culture is a symbolic plot that organizes and guides the collective senses of being in the world, a cognitive and perceptual map translated into codes of behavior, of human beings' relationships with nature and among themselves". Culture as a language that can only be understood in its own context and logic of conception, enunciation and practice.

Therefore, understanding such processes of intercultural relations becomes the condition to understand not only the logics that lead to mutual destruction or subjection, but, above all, to discover the creative and dialogical possibilities of relations between different groups and cultural contexts, making, thus, the differentiated and adequate intercultural teaching material for certain realities.

In the conception of D'Ambrósio (2002), intercultural relations must be understood in a planetary dimension in which the mass media would facilitate the transport of this cultural plurality. Thereby,

[...] the relationships between individuals from the same culture (intracultural) and, above all, the relationships between individuals from different cultures (intercultural) represent the creative potential of the species. Just as biodiversity represents the path to the emergence of new species, cultural diversity represents humanity's creative potential (p. 28).

For Fleuri (2009), intercultural relationships are not relationships whose meanings are configured from singular, individual perspectives, nor are they consolidated in a short time. The formation of cultural patterns and the educational processes inherent to it are configured in the paradoxical intertwining of many perspectives that, for this very reason, constitute themselves dynamically and conflictually. And although each act has effects that



contribute to the configuration and transformation of cultural patterns, these only constitute long-term historical processes.

Therefore, the intercultural perspective implies a complex understanding of education that seeks - beyond pedagogical strategies and even immediate interpersonal relationships - to understand and promote, slowly and progressively, the formation of relational and collective contexts for the elaboration of meanings that guide life of people from collaborative principles.

Studying a people, a community, or just a group of rural workers, is entering the intended daily life, it is talking, listening, understanding the process, understanding the origins, never losing individuality, but taking into account the generalization of activities, analyzing each word, realizing in small details the scientific background that exists, remembering that, "even so, these descriptions and interpretations will always be from the point of view of a scientific interpretation" (SILVA, 2003).

In this way, to achieve the proposed objectives, I believe that the ethnographic methodology best suits my purpose, since the study of intercultural relations can only develop from interpersonal links in their historical facticity. For a survey with this character,

[...] it is not the event which interests the ethnographer, the raw social discourse in which he did not participate in the construction; rather, it is the meaning of the speaking event - speech acts, of some small parts of the informant's discourse - that can lead to an understanding of reality (Ibidem, p. 4)

In this sense, the relationship between people is a relationship between projects, proposals, and meanings. And the relationship between cultures, which occurs in the encounter between people from different cultures, calls into question all the symbolic apparatus from which each subject is guided. That is what, in my view, the intercultural relationship consists of. Subjects, people from different cultures who attribute different meanings to their actions, when interacting, they question not only the meaning of their action or their speech, but they call into question their entire cultural framework that allows them to give meaning to each of their actions, choices, words and feelings (FLEURY, 1996).

#### IV. IMPLICATIONS OF AUSUBEL THEORY AND INTERCULTURALITY

The compatibility of David Ausubel's learning theory with interculturality brings us extremely positive pedagogical and methodological implications, causing significant knowledge to indigenous students, as the teacher manages

to get closer to the student through interactivity with their background knowledge and the environment in which he is inserted, that is, his culture, his community also making the relationship with the concepts addressed in the classroom and beyond.

Ausubel, when proposing in his theory the necessary conditions for a meaningful learning, we observe that it provides an interdependence of the cultural concepts in which the student is inserted. For, in new concepts presentation, knowledge must be presented in a logical and structured way, associated with the cultural conceptions to which the individual is inserted. Likewise, prior knowledge so that the individual can "bridge" with new knowledge and, finally, the intention to apprehend their intercultural knowledge with the one they intend to achieve.

Another important factor is that in the activities proposed by teachers of Nature Sciences in the classroom and beyond, is the way in which this new structured concept must be presented to the student, that is, from a more general and broad to a more specific way. In other words, an approach associated with their cultural and social context will allow a better assimilation of the new concept to their previous knowledge, providing opportunities for meaningful learning by the student.

Thus, the challenge of the indigenous teacher to teach Nature Sciences in an intercultural way is to understand that their culture and particularities linked to the common sense of the respective ethnicity can dialogue with normal science. Therefore, their cultural knowledge is essential and must be valued at all stages of teaching, since the Natural Sciences is also founded as part of social and cultural traditions. And in our view, the ratification of the cultural context will favor a presentation of the content in a more global and dialogic way towards a more scientific one, favoring the anchoring of the new knowledge provided.

#### V. CONCLUSION

This work aimed to verify the possibility of an intercultural dialogue in the teaching of Natural Sciences guided by David Ausubel's theory of meaningful learning, aimed at indigenous students. It is worth confirming that the trajectory of our work was guided by Ausubelian cognitivism, parallel to the concept of interculturality. In this sense, the guiding concepts of meaningful learning were worked on along with the conceptual pillars of interculturality, valuing indigenous knowledge throughout the course.

The study convinced us of the great didactic-conceptual advantage of using ethnophysical knowledge to represent and model the main concepts of Physics, that is, of the Natural Sciences. This is due in large part to the capacity of the existing dialogue between the indigenous culture and the natural phenomena studied in Natural Sciences. We believe that the local conceptions, the teachers' pedagogical practices and the understanding of the process were fundamental for the significant response from the indigenous students.

Thus, the relationship between the teaching of Natural Sciences and, consequently, the intercultural and ethnographic context, thus enabling community dialogue, which intrinsically brings their prior knowledge, that is, more general, serving as a bridge to more specific knowledge, that is, scientific. Recognizing, therefore, the importance of culture in the construction and enhancement of local knowledge or an ethnic group.

In this way, we believe in the possibility of intercultural dialogue in the construction of the teaching of Nature Sciences that is responded positively. It is noteworthy that the participation of indigenous teachers and the community proved to be unique in the search for similarities and differences between the ideas that are represented in indigenous culture and scientific knowledge itself.

Therefore, the relationship between Natural Sciences teaching must have in its epistemological basis, an intercultural and ethnographic context, hence enabling community dialogue, which intrinsically brings their prior knowledge, serving as a bridge to more specific- or in other terms, more scientific- knowledge. Recognizing, therefore, the importance of culture in the construction and enhancement of local knowledge or an ethnic group.

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# Thermoelectric Effects on MoSi<sub>2</sub> with Finite Element Analysis using COMSOL

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**Keywords—** Thermoelectric effect, peltier effect, COMSOL simulation, thermoelectric cooler thermoelectric generator.

**Abstract—** Realization of the thermoelectric effects within finite element analysis (FEA) by means of the COMSOL-Multiphysics platform is offered. It lets thermoelectric calculations among temperature dependent material traits on random geometries. Further, the calculations can be pooled with structural analysis plus convection can also be taken in report. Thermoelectric cooler employs Peltier effect for dissipating heat in an electronic casing structure. It shows exceptional rewards over conservative cooling skill via quiet process, extended life span, and effortless integration. Nevertheless, Joule heating results in the accumulation of internal heat thereby exposes thermoelectric cooler towards the risk of thermo-mechanical breakdown all through continuous operations in pragmatic thermal surroundings. In this paper, a 3D module of thermoelectric material MoSi<sub>2</sub> is designed on the way to examine the thermoelectric effect of the material taking into consideration the temperature reliant TE material traits. The transient behavior is also observed. The results can be openly used intended for consistent design considerations and optimized thermoelectric devices in engineering.

## I. INTRODUCTION

The thermoelectric effects within finite element analysis (FEA) can be realized by means of the COMSOL-Multiphysics platform. It lets thermoelectric calculations among temperature dependent material traits on random geometries [1]. The field equations in thermoelectric coupled intended for temperature as well as electric potential under steady state calculations are described as

$$-\vec{\nabla} \cdot ((\sigma \alpha^2 T + \lambda) \vec{\nabla} T) - \vec{\nabla} \cdot (\sigma \alpha T \vec{\nabla} V) = \sigma ((\vec{\nabla} V)^2 + \alpha \vec{\nabla} T \vec{\nabla} V) \quad (1)$$

and

$$\vec{\nabla} \cdot (\sigma \alpha \vec{\nabla} T) + \vec{\nabla} \cdot (\sigma \vec{\nabla} V) = 0 \quad (2)$$

where the material traits  $\alpha$  indicate the seebeck-

coefficient,  $\sigma$  indicates the electric conductivity and  $\lambda$  indicates the thermal conductivity. Generally the material traits rely on the temperature moreover may perhaps be anisotropic. At this juncture simply isotropic substance traits are worn. For anisotropic resources, the appropriate matrices are taken in consideration. The transient magnetic fields are also not taken in consideration. The projected equations are as a consequence to the coupled equations in [2] or the text referred within [3].

## II. GEOMETRICAL MODEL

COMSOL Multi-physics allows the execution of ordinary random partial differential equations (PDEs) intended for the field variable  $\mathbf{u}$  over a one to 3D section  $\Omega$ . Two PDE modes are worn: The “Coefficient-Form” as well as the



“General Form”.

$$c_a \frac{\partial^2 u}{\partial t^2} + d_a \frac{\partial u}{\partial t} + (-c\nabla u - \alpha u + \gamma) + \beta \cdot \nabla u + au = f \tag{3}$$

The thermoelectric field equations at this instant are altered into the “coefficient form” as follows. In the midst, the vector value of the field variable is defined by

$$\vec{u} = \begin{pmatrix} T \\ V \end{pmatrix} \tag{4}$$

the coefficient c in (3) is

$$\begin{pmatrix} \lambda + \sigma\alpha^2 T & \sigma\alpha T \\ \sigma\alpha & \sigma \end{pmatrix} \tag{5}$$

Intended for transient calculations the capacitive influence need to be neglected. Generally it is satisfactory to mull over merely the thermal capacity (heat capacity C, density ρ). Then d in equation (3) is

$$d = \begin{pmatrix} \rho C \\ 0 \end{pmatrix} \tag{6}$$

The subsequent examples show outcomes of calculations for characteristic thermoelectric applications. The material traits for the calculations with temperature independent values are depicted in table 1. Here characteristic values for Molybdenum Silicide MoSi<sub>2</sub> were taken from [4] and Copper was taken from [2]. Temperature dependent material traits were interpolated by means of cubic splines (figure 1-3).

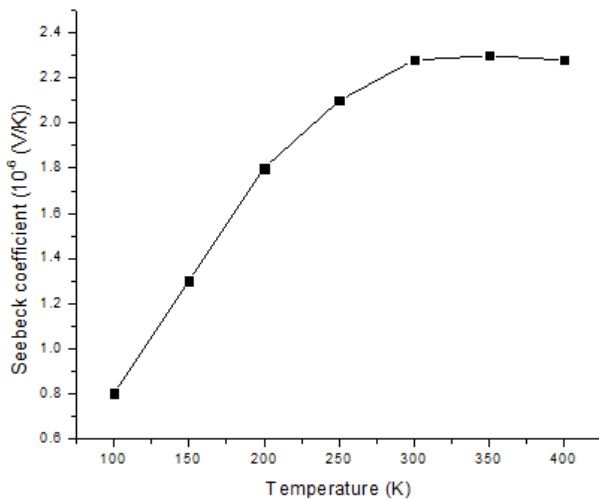


Fig.1: Temperature dependent Seebeck coefficient of MoSi2 and cubic spline interpolation.

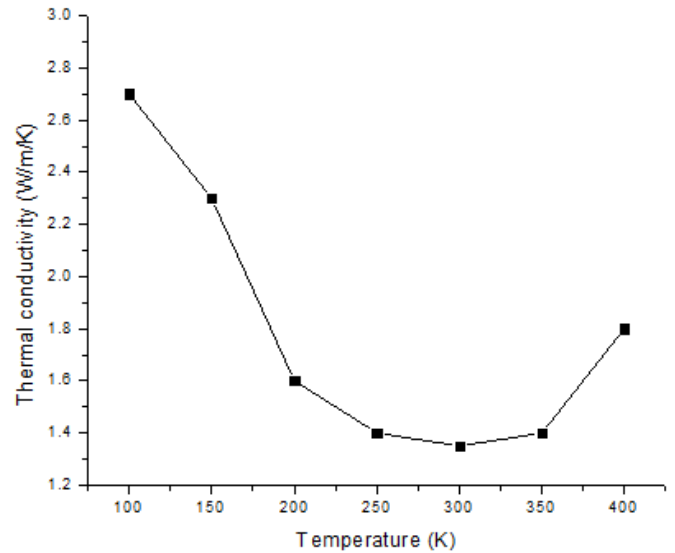


Fig.2: Temperature dependent thermal conductivity of MoSi2.

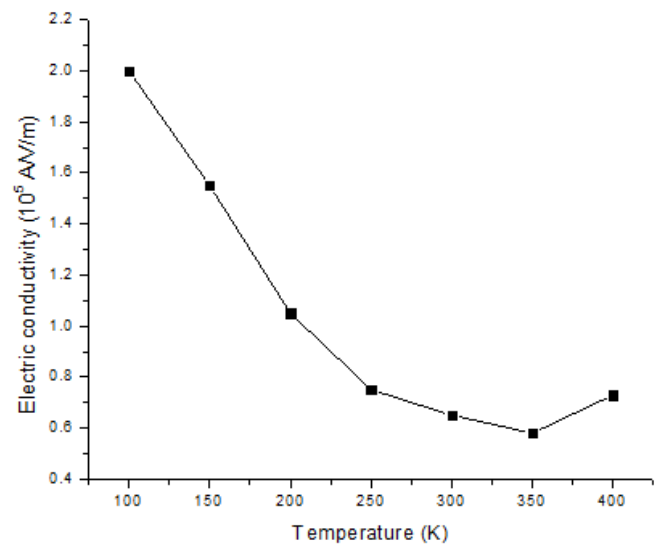


Fig.3: Temperature dependent electric conductivity of MoSi2.

Table.1 Numerical material properties. [4]

Material Properties	MoSi <sub>2</sub>
Density	6240 Kg / m <sup>3</sup>
Thermal Conductivity	66.2 W / (m.K)
Electric conductivity	3.28e <sup>6</sup> S/m
Seebeck Coefficient	3.9e <sup>-6</sup> V/K
Heat capacity at constant pressure	430 J / (kg.K)

Table 2: Temperature dependent material properties.

T (K)	$\alpha$ ( $10^{-6}$ V/K)	$\lambda$ (W/m/K)	$\sigma$ ( $10^5$ A/V/m)
100	80	2.7	2
150	130	2.3	1.55
200	180	1.6	1.05
250	210	1.4	0.75
300	228	1.35	0.65

350	230	1.4	0.58
400	228	1.8	0.73

### III. THERMOELECTRIC COOLER

The geometry of a straightforward thermoelectric cooler comprises of solo p-type semiconductor component with dimensions  $1 \times 1 \times 6 \text{ mm}^3$ . It is sandwiched by two copper electrodes of 0.1 mm in thickness (Figure 4).

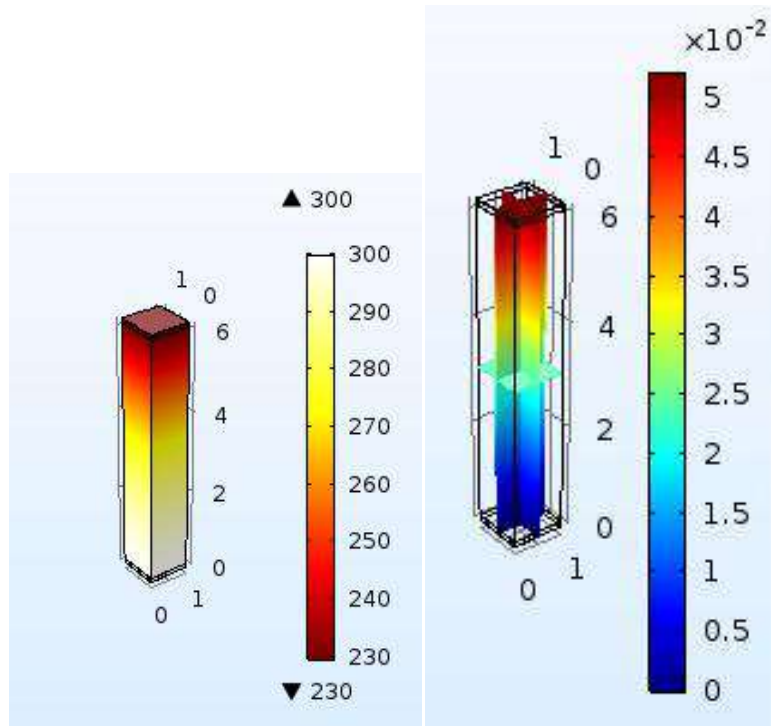


Fig.4: A p-type thermoelectric element.

The base is kept back at temperature 300 K along with 0V of voltage. At the top of the upper electrode, a current of 0.7A was applied. The resultant distribution of temperature is revealed in the middle. A temperature difference of nearly 70 K is achieved. Table 1 shows the (constant) material properties. Figure 4 shows the result of the calculation. In the center, the temperature distribution shows that the cold side temperature is at 230K. The associated voltage is shown right. To drive the current, a voltage of 50 mV is needed.

### IV. TRANSIENT OPERATION

Figure 5 shows the outcome of a time reliant computation. The chart reveals the transient cold side temperature with temperature dependent material parameters. The short current pulse leads to a momentary temperature plunge of

about 3K. Such super cooling effects are also described in [5].

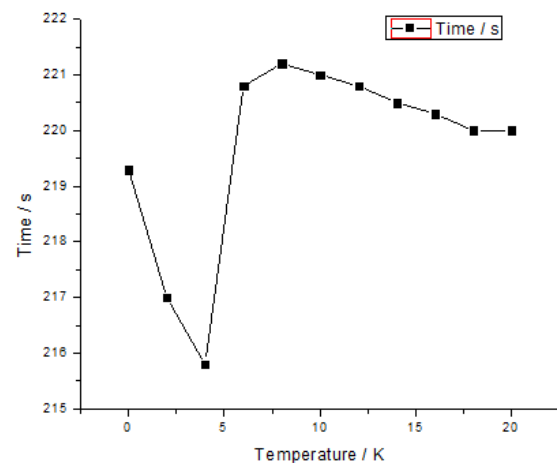


Fig.5: Transient calculation of Peltier super cooling.

A tiny current pulse leads to momentarily lesser temperatures at the cold end. In such transient computation, barely the thermal capacities as suggested by equation (6) in the midst of the heat capacities in addition to densities are represented in table 1.

## V. THERMOELECTRIC GENERATION

In order to simulate a thermoelectric generator, the earlier mentioned semiconductor component was worn yet again by means of the changeable material traits (figure 1 – 3). The top side of the higher electrode was adjusted to 373K, whereas the base of the lower electrode was adjusted to 273K along with 0V. Figure 6 displays the outcome of the current - voltage characteristics of the thermoelectric material and Figure 7 displays the outcome of the current power characteristics of the material.

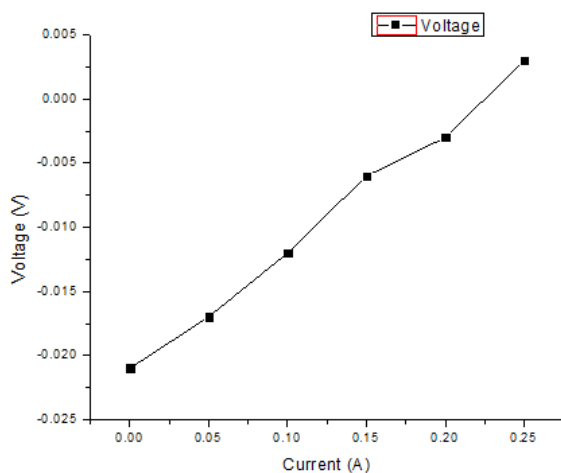


Fig.6: Current-voltage characteristics of the thermoelectric material

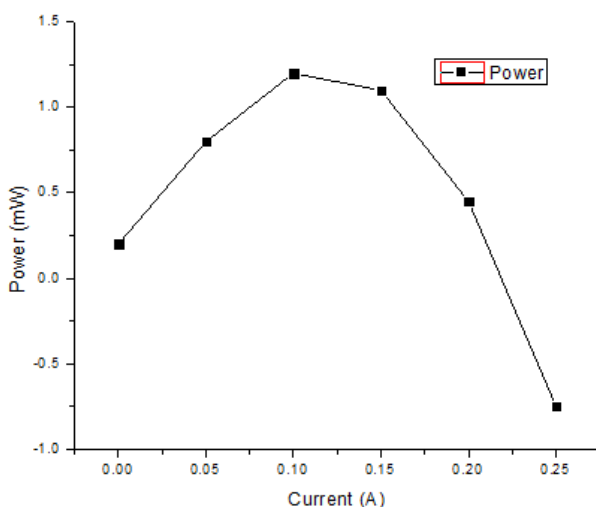


Fig.7: Current- -power characteristics of the thermoelectric material

In accordance to the properties, it was observed that the open circuit voltage of the component is computed to be about 21mV, whereas the short-circuit current is computed around 220mA. The highest power output is observed as 1.22mW.

## VI. SUMMARY

The accomplishment of the thermoelectric field equations using COMSOL multi physics 5.2 is projected. Thermoelectric computations may perhaps be finished for arbitrary geometries too. Anisotropy (not revealed here) as well as temperature reliance of the materials can also be incorporated. In addition, transient computations were made. It is probable in adding the structural analysis or convection effortlessly (not exposed here).

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## Municipalization of Environmental Licensing: An Analysis of The Identity Territory of Piemonte Norte do Itapicuru - Bahia

## Municipalização do Licenciamento Ambiental: Uma Análise do Território de Identidade do Piemonte Norte do Itapicuru - Bahia.

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**Keywords—** *environment, environmental  
management, municipal management,  
complementary law.*

**Abstract—** *Considering the responsibilities within the scope of environmental causes more precisely and in a local way, the study presents a discussion on the municipal environmental licensing process, regarding the Shared Environmental Management - GAC in the State of Bahia and the municipalities that make up the Northern Piemonte Identity Territory of Itapicuru. The research is a case study of a qualitative character applied in the municipal environment secretariats, with an exploratory character, in order to identify the quality of the environmental management used, as well as the main obstacles found in the licensing processes. Therefore, the GAC strengthened the public environmental management of the analyzed municipalities, with positive impacts for the proper treatment of their natural resources and physical environment, guiding its actions in administrative decentralization processes. In addition to creating the bases for the municipalities to form their Environmental Management System. Deficits in the continuity of actions developed by municipal managers were observed. This management decentralization process served to encourage and enable the population's participation in the environmental management of their municipality.*

**Resumo—** *Considerando as responsabilidades no âmbito das causas ambientais mais precisas e de maneira local, o estudo apresenta uma discussão sobre o processo de licenciamento ambiental municipal, quanto a Gestão Ambiental Compartilhada - GAC no Estado da Bahia e os municípios que integram o Território de Identidade Piemonte Norte do Itapicuru. A pesquisa é um estudo de caso de caráter qualitativo aplicado nas secretarias de meio ambientes municipais, com o caráter exploratório, a fim de identificar a qualidade da gestão ambiental empregada, bem como os principais entraves encontrados nos processos de licenciamentos. Diante disso, O GAC fortaleceu a gestão ambiental pública dos municípios analisados, com impactos positivos para o adequado tratamento de seus recursos naturais e meio ambiente físico, norteando suas ações em processos de descentralização administrativa. Além de criar as bases para que os municípios pudessem formar seu Sistema*



de Gestão Ambiental. Observou os déficits na continuidade das ações desenvolvidas por parte dos gestores municipais. Esse processo de descentralização da gestão serviu para incentivar e possibilitar a participação da população na gestão ambiental de seu município.

**Palavras-chave**— meio ambiente, gestão ambiental compartilhada, lei complementar.

## I. INTRODUÇÃO

O presente estudo traz uma discussão sobre o processo de licenciamento ambiental municipal, decorrente a análise dos Sistemas Municipais Ambientais e da Lei Complementar nº 140/2011, a qual fixa as normas para cooperação dos diversos níveis de governo para cumprimento das missões que dizem respeito à proteção do meio ambiente, à preservação de florestas fauna e a flora, e documentos e monumentos de valor histórico, artístico e cultural.

A instrumentação do licenciamento ambiental no Brasil proporciona a política ambiental nacional, como resultado um sistema de gestão descentralizado, obtendo a parceria entre a União, os Estados, o Distrito Federal e os Municípios pela Gestão Ambiental, abrangendo não só as questões ambientais, mas possibilitou que estados e municípios efetivassem a autonomia como gestores dos seus territórios. O pacto federativo corresponde a um esforço para alcançar a unidade a partir da diversidade, tratando-se de uma construção institucional complexa, cuja estabilidade depende de razoável equilíbrio entre as partes e o todo (DULCI, 2014).

O estado da Bahia, através da Resolução CEPRAM nº 3.925/09 do Conselho Estadual de Meio Ambiente, dispõe sobre o Programa Estadual de Gestão Ambiental Compartilhada com fins ao fortalecimento da gestão, mediante normas de cooperação entre os Sistemas Estadual e Municipal de Meio Ambiente, definindo as atividades de impacto ambiental local para fins do exercício da competência do licenciamento ambiental municipal, implementando a Política de Descentralização da Gestão Ambiental, através do Programa de Gestão Ambiental Compartilhada (GAC), para fortalecer a administração ambiental dos órgãos municipais de meio ambiente.

Mediante a este âmbito de descentralização, o poder público municipal deve planejar suas ações, alinhando aos da União e ao Estado, contemplando os princípios do desenvolvimento sustentável, incorporando a sociedade nas tomadas de decisão para uma gestão municipal compartilhada do meio ambiente. Assim, podemos identificar uma nova maneira de administrar.

O licenciamento ambiental consiste em processo institucionalizado e sua atribuição é exclusiva do Estado, através de instrumentos legitimados, que possam garantir o desenvolvimento humano, social e de proteção e

preservação ambiental, com critérios definidos segundo motivações políticas e econômicas e parâmetros oriundos do conhecimento científico LOUREIRO (2009b, p. 23). Para garantir todo esse processo, precisa de uma gestão ambiental eficiente afim de que a sociedade, a economia e o meio ambiente não sejam prejudicados, de forma onerosa, então em 1988 a Constituição Federal instituiu poderes comuns para a União, Estados e Municípios gerirem os recursos ambientais através de instrumentos tais como, o licenciamento ambiental.

A descentralização é vista como desafios da gestão ambiental, de acordo com Maria Augusta Bursztyjn (2006). Dentre eles, está a falta de sensibilização dos administradores públicos locais e da sociedade civil, em relação à relevância dos recursos naturais e o desenvolvimento dos municípios, tendo assim parcerias, obtendo êxito na execução das políticas públicas ambientais.

## II. REFERENCIAL TEÓRICO

O presente estudo traz a gestão ambiental municipal, partindo da sua definição aos desafios apresentados pelo processo, a discussão teórica tem continuidade com o tema governança ambiental, onde são apresentados três subtópicos: **Desenvolvimento da Gestão Ambiental; A Descentralização do Licenciamento Ambiental e Licenciamento Estadual e Municipal na Bahia.**

### 2.1 Desenvolvimento da Gestão Ambiental

A partir de 1969 com a institucionalização em legislação federal, com a criação do *National Environmental Policy Act* nos Estados Unidos, e depois de quase 50 anos, pode considerar que a Avaliação de Impacto Ambiental (AIA) reconhecida no mundo, como um instrumento fundamental para a gestão ambiental, tanto nacional e internacional, decididamente incorporada no direito ambiental (MORGAN, 2012).

O incentivo das Agências bilaterais e multilaterais no desenvolvimento no Brasil, trouxeram um papel importante para a propagação da AIA pelo mundo, entretanto demandavam estudos para a aprovação dos variados projetos e liberação de empréstimos (SÁNCHEZ, 2008). Em meados de 1990, o Banco Mundial promovia por meio de financiamentos, grandes projetos, a inclusão

da AIA no processo de implantação dos empreendimentos que através de suas atividades traziam impactos ambientais significativos em diversos países (MORGAN, 2012), incluindo o Brasil. Envolvimento este, provocado por pressões de ONGs em relação aos impactos causados a estes projetos financiados. Este movimento fez com que entidades multilaterais também inserissem a Avaliação de Impactos Ambientais nos processos (SÁNCHEZ, 2008).

No Brasil, institui-se como um de seus instrumentos, a avaliação dos impactos ambientais, na Política Nacional de Meio Ambiente (PNMA), no qual seus critérios básicos e diretrizes gerais de planejamento e implementação foram trazidos pela Resolução Conama nº 01/1986, elencando as atividades passíveis de elaboração de Estudo de Impacto Ambiental (EIA) e respectivo Relatório de Impacto Ambiental (RIMA) para aquisição de licença ambiental. Em 1988, tornou-se constitucional a sua exigência pelo Poder Público para a instalação de empreendimentos e atividades causadoras de significativo impacto sobre o meio ambiente (Artigo 225) (BRASIL, 1988).

Mesmo antes da legalização do instrumento em nível nacional, já havia agências públicas de proteção ambiental nos estados de Minas Gerais, São Paulo e Rio de Janeiro. Em nível municipal, a cidade de Porto Alegre/RS foi pioneira, inaugurando sua agência em 1976. Contudo, as iniciativas dos municípios eram somente reflexos do desejo das autoridades locais (NEVES, 2016).

Assim, o licenciamento ambiental também foi instituído como instrumento da PNMA para se alcançar os objetivos por ela propostos. A Resolução Conama nº 237 de dezembro de 1997 apresenta o seu conceito como (CONAMA, 1997):

*Procedimento administrativo pelo qual o órgão ambiental competente licencia a localização, instalação, ampliação e a operação de empreendimentos e atividades utilizadoras de recursos ambientais, consideradas efetiva ou potencialmente poluidoras ou daquelas que, sob qualquer forma, possam causar degradação ambiental.*

Nesta mesma resolução, elenca três licenças a serem expedidas (CONAMA, 1997):

*I - Licença Prévia (LP) - concedida na fase preliminar do planejamento do empreendimento ou atividade aprovando sua localização e concepção, atestando a viabilidade ambiental estabelecendo os*

*requisitos básicos e condicionantes a serem atendidos nas próximas fases de sua implementação;*

*II - Licença de Instalação (LI) - autoriza a instalação do empreendimento ou atividade de acordo com as especificações constantes dos planos, programas e projetos aprovados, incluindo as medidas de controle ambiental e demais condicionantes, da qual constituem motivo determinante;*

*III - Licença de Operação (LO) - autoriza a operação da atividade ou empreendimento, após a verificação do efetivo cumprimento do que consta das licenças anteriores, com as medidas de controle ambiental e condicionantes determinados para a operação.*

A Resolução Conama nº 237/1997 preconiza os procedimentos simplificados para atividades com pequeno potencial de causar impacto ambiental; assim, o órgão ambiental competente define os procedimentos a serem seguidos para a obtenção da licença, havendo a possibilidade da entrega de estudos ambientais mais simplificados (CONAMA, 1997).

Os instrumentos tratados acima, no âmbito brasileiro, estão ligados, a classificação dos efeitos dos empreendimentos e/ou atividades com significativo potencial de causar impacto sobre os recursos naturais e a qualidade do meio ambiente, servindo como auxílio para a emissão de licenças ambientais (SÁNCHEZ, 2008). Caso a aplicabilidade da AIA e do licenciamento ambiental não ocorresse, possivelmente este último ficasse restrito a um simples registro de intervenções ambientais. Logo, podemos considerar que a AIA se torna um instrumento de avaliação antecipada dos danos ambientais (MMA, 2009).

Assim, no procedimento de licenciamento ambiental, além da Avaliação de Impacto Ambiental pode ser complementada por estudos de complexidade maior como o Estudo e Impacto Ambiental; quanto por estudos de menor complexidade: Roteiro de Caracterização do Empreendimento; – RCE; Plano de Controle Ambiental – PCA; Relatório Ambiental Preliminar – RAP; Plano de Educação Ambiental- PEA, Plano de Recuperação de Áreas Degradadas – PRAD, entre outros. A Figura 1 exibe a interligação entre a Avaliação de Impacto Ambiental e o Licenciamento Ambiental no território brasileiro.

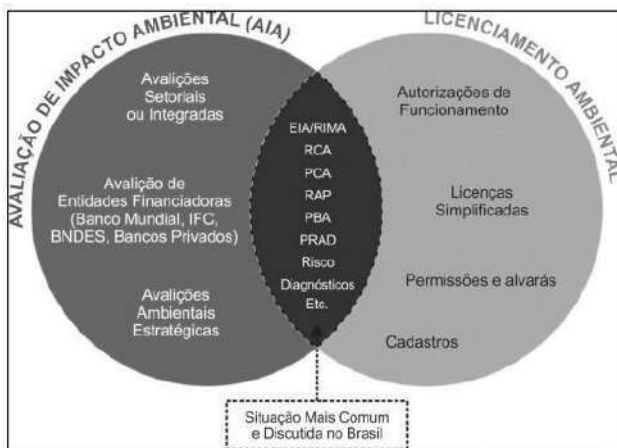


Fig.1: Aplicação da AIA no licenciamento ambiental brasileiro

Fonte: Fonseca (2012) apud Rocha (2014, p. 22)

O processo de licenciamento ambiental provocou discussões quanto aos agentes envolvidos, porque existia uma competência concorrente entre os entes federativos na defesa do meio ambiente. Isto fazia com que um ente invocasse a sua competência para licenciar no lugar de outro (FERREIRA, 2010) e esta concorrência existia pela falta de um instrumento legal que especificasse tais competências.

Com a promulgação da Lei Complementar nº 140/2011, pode-se atribuir a realização do licenciamento ambiental, distinguir quais atividades podem ser licenciadas pelo governo federal, estadual e municipal, reafirmando o que está prescrito na PNMA, no que diz respeito à promoção das ações em manter o equilíbrio ecológico, controlando as atividades potencial ou efetivamente poluidoras (BRASIL, 1981).

Compete o licenciamento de empreendimentos e/ou atividades em âmbito federal (BRASIL, 2011):

- a) localizados ou desenvolvidos conjuntamente no Brasil e em país limítrofe;
- b) localizados ou desenvolvidos no mar territorial, na plataforma continental ou na zona econômica exclusiva;
- c) localizados ou desenvolvidos em terras indígenas;
- d) localizados ou desenvolvidos em unidades de conservação instituídas pela União, exceto em Áreas de Proteção Ambiental (APAs);
- e) localizados ou desenvolvidos em 2 (dois) ou mais Estados;
- f) de caráter militar (...)
- g) destinados a pesquisar, lavrar, produzir, beneficiar,

transportar, armazenar e dispor material radioativo, em qualquer estágio, ou que utilizem energia nuclear em qualquer de suas formas e aplicações, mediante parecer da Comissão Nacional de Energia Nuclear (Cnen)

h) (...)

No âmbito estadual, o licenciamento ambiental de atividades utilizadoras de recursos ambientais com efetiva ou potencialmente poluidoras, respeitando a competência da União e dos municípios; bem como “o licenciamento ambiental de atividades ou empreendimentos localizados ou desenvolvidos em unidades de conservação instituídas pelo estado, exceto em Áreas de Proteção Ambiental (APAs)” (BRASIL, 2011).

No âmbito municipal, institui-se a realização do licenciamento ambiental de atividades “que causem ou possam causar impacto ambiental de âmbito local, conforme tipologia definida pelos respectivos Conselhos Estaduais de Meio Ambiente” e “localizados em unidades de conservação instituídas pelo município, exceto em Áreas de Proteção Ambiental (APAs)” (BRASIL, 2011).

Em situações em que o ente federativo não esteja apto em realizar o procedimento administrativo este poderá delegar sua atribuição a outro ente, uma vez que o mesmo não venha ter órgão ambiental capacitado, como por exemplo, possuir técnicos próprios competentes e em número suficiente com a demanda (BRASIL, 2011).

Conforme foi apresentado, a descentralização da gestão ambiental tem sido um papel importante no que tange aos objetivos de desenvolvimento, prestação de serviços públicos e na busca conservação ambiental, fazendo dessa temática uma melhor discussão sobre as políticas ambientais (PANYA et al., 2017).

## 2.2 A Descentralização do Licenciamento Ambiental

O desenvolvimento e implementação de políticas no que diz respeito à descentralização de recursos e responsabilidades para níveis subordinados de organização governamental, as políticas públicas ambientais, impactou em mais de 60 países, tornando um importante movimento na política ambiental (RIBOT, 2003; LANE; MCDONALD; MORRISON, 2004), possibilitando o surgimento de estratégias específicas de gestão, com soluções singulares para serem implementadas localmente (CORTNER; MOOTE, 1999; COCKS, 2003).

Podendo ser utilizada para diversas, a descentralização possui finalidades políticas, econômicas ou sociais, mediante quais motivações os líderes políticos seguirão (RONDINELLI, 1990). O mesmo autor, em 1981, demonstrou em três distintas classificações existentes relacionadas à transferência de poderes:

desconcentração, delegação e a descentralização. De acordo com referido autor, na desconcentração os órgãos locais permanecem subordinados ao governo central, com pouca participação no processo de tomada de decisão, além da transferência de recursos e atividades decisórias, e a falta de controle social sobre os agentes públicos; na delegação “envolve a transferência ou criação de instituições para planejar e programar decisões relacionadas a atividades específicas” (RONDINELLI, 1981).

A descentralização acontece quando um ente central transfere, baseado na lei, ‘poderes’ para instituições em níveis inferiores político-administrativos e territorial. Apesar de variadas razões, esta prática justifica como forma de crescer a efetividade e a equidade das atividades de desenvolvimento (RIBOT, 2003). Logo, torna-se necessário melhorar as relações de maneira vertical e horizontal com os diversos atores e suas responsabilidades concorrentes na governança ambiental (COCKS, 2003).

Aos que defendem a descentralização, relatam a mesma melhora a responsabilidade e a capacidade de resposta do governo, aumenta a participação do cidadão; reduz abusos de poder; melhora a estabilidade política; além de aumentar a competição política. Aos contrários relatam que esta ação prejudica o fornecimento de serviços públicos, diminuindo sua qualidade (FAGUET, 2014). Entretanto os relatos das experiências de descentralização demonstram a transferência de competências, mas levam consigo, recursos e poder, causando uma segregação do processo político (DECARLO, 2006).

A discussão sobre a descentralização, de acordo com a autora, para alguns pesquisadores a descentralização resulta em uma desregulamento dos serviços públicos, com recursos limitados, ficando os poderes restritos a elites locais. Logo, para outros, esta prática aproxima os cidadãos do processo decisório, além de aumentar a eficiência do Estado (DE CARLO, 2006).

Com a promulgação da PNMA, em 1981, o processo de descentralização das políticas públicas ambientais no Brasil, tendo sua visibilidade nos anos de 1990, no qual as competências em matéria ambiental foram distribuídas entre os entes federativos, fazendo a pasta do meio ambiente um bem comum; Com a Constituição Federal, em 1988, na qual os municípios foram classificados à categoria de ente federado, podendo ser tratado de maneira igual aos governos federal e estadual. Entretanto, mesmo com a promulgação da Constituição Federal, discorrendo sobre matérias de competência municipal, este processo de descentralização não é notado; Contudo, a quantidade de órgãos ambientais municipais tem aumentado ao longo dos anos (AZEVEDO;

PASQUIS; BURSZTYN, 2007; NEVES, 2016).

Os entes municipais podem exercer poder legislativo e material em relação ao meio ambiente, sendo a responsabilidade material conjunta com o governo estadual e federal, possibilitando também, o desenvolvimento do poder de polícia, a favor da proteção ambiental. Além do que, pode elaborar sua própria legislação de acordo com seus interesses, sendo livres para estabelecer suas prioridades e particularidades ambientais, em total sintonia com as normas e padrões federais e estaduais (BRASIL, 1981; NEVES, 2016).

Esta responsabilidade conjunta entre a União, estados e municípios é citada no artigo 23 da Constituição Federal, no inciso VI, descrevendo que as três esferas devem “proteger o meio ambiente e combater a poluição em qualquer de suas formas” (BRASIL, 1988).

No que tange ao licenciamento ambiental municipal, a Lei Complementar nº 140/2011, compete o licenciamento de atividades ou empreendimentos que causem ou possam causar impacto ambiental no âmbito de sua jurisdição.

Os municípios que demonstram interesse em licenciar celebram convênios com os Estados após comprovar o atendimento de requisitos básicos, em possuir órgão ambiental com gestores capacitados e conselho deliberativo de meio ambiente (NASCIMENTO; FONSECA, 2016), ficando isto legalmente especificado no artigo 5º da Lei Complementar nº 140/2011 (citada anteriormente como reguladora de competências do licenciamento ambiental) (BRASIL, 2011).

### 2.3 Licenciamento Estadual e Municipal na Bahia

Na esfera ambiental o estado da Bahia, possui o Conselho Estadual de Proteção Ambiental (Cepam), instituído pela Lei n.º 3.613 de 4 de outubro de 1973, no dia atuais denomina-se Conselho Estadual de Meio Ambiente, mantendo a mesma sigla, sendo subsidio do Sistema Nacional do Meio Ambiente (Sisnama) : o Conselho Nacional do Meio Ambiente (Conama), criado pela Lei 6.938, de 1981 (OLIVEIRA, 2007, p. 1).

Em continuação, podemos afirmar que a CEPRAM normatizou a implementação da descentralização da gestão ambiental, através da Resolução 3.925 de 30 de janeiro de 2009, sobre o Programa Estadual de Gestão Ambiental Compartilhada, conhecido como GAC, para o fortalecimento da gestão ambiental no estado:

*Dispõe sobre o Programa Estadual de Gestão Ambiental Compartilhada com fins ao fortalecimento da gestão ambiental, mediante normas de cooperação entre os Sistemas Estadual e Municipal de Meio Ambiente, define*



as atividades de impacto ambiental local para fins do exercício da competência do licenciamento ambiental municipal e dá outras providências (BAHIA, 2009).

Neste decreto discorre as orientações relacionadas à implementação da gestão compartilhada entre os órgãos ambientais estaduais e municipais. O decreto elenca as regulamentações da gestão ambiental compartilhada; quais ações para a estruturação do sistema municipal de meio ambiente; ressalvas sobre as atividades de impacto ambiental local e outros assuntos pertinentes ao desenvolvimento da gestão ambiental.

Podemos destacar que além dos marcos regulatórios, acima citados, a descentralização da gestão ambiental do Estado baseou-se em outros textos oficiais tais como:

- *A Constituição do estado da Bahia, através do seu art. 59, inciso VII, destacando que cabe aos municípios garantir a proteção do patrimônio ambiental e, em seu art. 213, § 4.o, com a criação através de lei municipal, atribuição do estado, o poder de delegar competências aos conselhos e órgãos de defesa do meio ambiente, (Bahia, 1989);*
- *A Política Nacional do Meio Ambiente, Lei Federal n.o 6.938, de 31 de agosto de 1981, em seu art. 6.o, estabelece, que a partir da criação do SISNAMA é outorgada a responsabilidade perante os órgãos e entidades para a melhoria da qualidade ambiental (Brasil, 1981);*
- *A Resolução Conama n.o 237/1997, em seu art. 6.o, dispõe sobre as normas de atuação dos municípios com competência para o licenciamento ambiental de empreendimentos e atividades de impacto ambiental local e dos que lhe forem delegadas pelo estado, por instrumento legal ou convênio (Conama, 1997);*
- *A Lei Estadual n.o 10.431, de 20 de dezembro de 2006, em seu art. 146, §1.o, dispõe sobre os órgãos e entidades que integram o Sistema Estadual do Meio Ambiente (Sisema), nos termos da Lei Estadual n.o 11.050, licenciamento ambiental e política de descentralização da gestão ambiental, com o objetivo de promover, integrar e implementar a gestão, a conservação, a preservação e a defesa do meio ambiente, no âmbito da política de desenvolvimento do estado (Bahia, 2006).*
- *A Lei Estadual n.o 10.431, de 20 de dezembro de 2006, em seu art. 159, prevê aos órgãos locais a execução dos procedimentos de licenciamento ambiental e fiscalização dos empreendimentos e atividades efetivas ou potencialmente degradadoras do meio ambiente que sejam de sua competência originária, conforme disposições legais e*

*constitucionais, bem como das atividades delegadas pelo estado (Bahia, 2006).*

- *O Decreto Estadual n.o 11.235, de 10 de outubro de 2008, em seu art. 176, dispõe que aos órgãos locais do Sisema cabe exercer a fiscalização e o licenciamento ambiental dos empreendimentos e atividades considerados como de impacto local, bem como dos que lhes forem delegados pelo estado (Bahia, 2008).*

No estado da Bahia, para obter o licenciamento municipal, delegação da competência para licenciar e fiscalizar as atividades relacionadas ao meio ambiente, desde que atendido o disposto na legislação, devem: possuir órgão ambiental capacitado; possuir Conselho Municipal de Meio Ambiente; dotar o órgão ambiental com equipamentos e meios necessários para o exercício de suas funções; e organizar e manter um Sistema Municipal de Informação sobre o Meio Ambiente (CEPRAM, 2013). Assim, o município deve manifestar-se quanto às classes de atividades e empreendimentos que quer licenciar, dentro do rol de atividades que a Resolução CEPRAM n° 4.327/13 entende como sendo de impacto local.

A realidade da descentralização está distante da maioria dos municípios brasileiros e, de acordo com Azevedo, Pasquis e Bursztyn (2007), isso ocorre, "sobretudo em estados onde a preocupação ambiental é vista como entrave ao desenvolvimento econômico".

As capacidades municipais de responder às suas agendas são altamente desiguais, sendo estas extremamente diversas e heterogêneas, estando os municípios maiores e economicamente mais dinâmicos, avançados (NEVES, 2016), uma vez que vulnerabilidades nas áreas financeiras, administrativas e institucionais são vistas como entraves à descentralização das políticas ambientais como, por exemplo, a falta de interesse e condições para a qualificação de técnicos e a falta de estrutura para fiscalizações (SCARDUA; BURSZTYN, 2003; AZEVEDO; PASQUIS; BURSZTYN, 2007).

Considerando a extensão territorial do Estado, surge o Programa Estadual de Gestão Ambiental Compartilhada (GAC), para atender à descentralização da gestão pública do meio ambiente e tem como principal objetivo apoiar os municípios baianos, individualmente ou por meio de consórcios territoriais de desenvolvimento sustentável, para adequação de suas estruturas municipais de meio ambiente tendo em vista Resolução do CEPRAM n° 4.327/2013 e suas revogações. E para atender a esse sistema descentralizado, apresenta-se o Consórcio Público como uma ferramenta cuja proposta prevê o

acompanhamento dos municípios consorciados para adequação da legislação ambiental dos municípios e suporte técnico as secretarias municipais de meio ambiente principalmente nas áreas de licenciamento e fiscalização ambiental (GRAÇA SOUTO, 2007). Em estreita relação aos desafios postos acima está à necessidade de se conhecer melhor os ativos e os passivos ambientais nos territórios baianos.

Para exercer o papel de gestor do meio ambiente, os Municípios devem estar organizados. O Poder Público municipal deve conscientizar-se em programar o Sistema Municipal do Meio Ambiente, em ser “considerado um conjunto de estrutura organizacional, diretrizes normativas e operacionais, implementação de ações gerenciais, relações institucionais e interação com a comunidade” (FREITAS, 2010). Logo, a estruturação do sistema de gestão ambiental municipal necessita de uma base institucional, a qual irá conduzir um conjunto de normas locais, uma estrutura administrativa adequada para sua realidade local, e essencialmente, com a participação popular (FREITAS, 2010). Assim, os órgãos instituídos serão capazes de gerar iniciativas e as convertendo em políticas do poder público local, sendo eles:

**Conselho Municipal do Meio Ambiente:** Órgão superior do sistema, instância colegiada podendo assumir caráter consultivo, deliberativo, normativo e/ou fiscalizador, conforme necessidades. É o responsável pela aprovação e pelo acompanhamento da implementação da política municipal de meio ambiente. Deve se reunir com periodicidade regular. Sua constituição poderá ser paritária, considerando igualdade numérica entre os integrantes do governo e da sociedade civil, envolvendo a maior quantidade possível de suas entidades representativas. Os integrantes, em geral, têm mandato de, no mínimo, dois anos.

**Órgão Executivo Municipal do Meio Ambiente:** Podendo ser: secretaria, diretoria, departamento ou seção. O município tem autonomia para definir as competências desse órgão, o que deve ocorrer respeitando-se a disposição de cada local, envolvendo a coordenação e a execução das políticas de meio ambiente, assim como a realização – ou delegação a terceiros – das atividades de fiscalização, licenciamento, monitoramento da qualidade ambiental, produção de informações e educação ambiental.

**Fundo Municipal do Meio Ambiente (FMMA):** órgão responsável pela captação e de gerenciamento de recursos financeiros determinados para a área de meio ambiente. Esses recursos podem ser originados de multas e de atividades relativas à gestão ambiental em âmbito municipal. Pode também captar de outras fontes: estaduais, nacionais, internacionais ou da iniciativa

privada. A existência do Fundo garante que os recursos sejam direcionados para as ações ambientais sem a necessidade de entrar no orçamento municipal. Assim, possui maior autonomia e não está sujeito a contingenciamentos ou a devolução no fim do ano fiscal.

**Orgânica Municipal:** Estimada como a lei máxima do município, esse aparato legal, deve dispor sobre a estrutura, o funcionamento e as atribuições dos poderes Executivo e Legislativo. Essa lei contém os princípios norteadores das matérias de interesse local em termos de saúde, saneamento, transporte, educação, uso e ocupação do solo urbano, parcelamento do território, entre outros temas de interesse municipal e que possuem importantes interfaces com o meio ambiente. A Lei Orgânica deve disciplinar o essencial. Os municípios que optarem por tratar do meio ambiente nesse formato deverão incluir neste código apenas os princípios e os objetivos da Política Municipal do Meio Ambiente (PMMA).

**Plano Diretor:** Sua função é orientar a atuação do poder público e da iniciativa privada na construção dos espaços urbano e rural, como também na oferta dos serviços públicos essenciais, visando assegurar melhores condições de vida para a população. Prevista pela Lei federal nº 10.257/2001, que instituiu o Estatuto da Cidade (EC), atribuindo ao município a possibilidade de formular e implementar a sua política de desenvolvimento urbano. Como instrumento básico da política de desenvolvimento e de expansão urbana, o Plano Diretor é exigido para cidades com mais de vinte mil habitantes, devendo ser aprovado pela Câmara Municipal.

**Código Ambiental:** As regulamentações ambientais municipais poderão compor um código próprio. Devendo disciplinar a política ambiental municipal com diretrizes e formas de aplicação, medidas administrativas cabíveis na área ambiental municipal.

**Recursos humanos:** De acordo com o Ministério do Meio Ambiente (2017), compreende-se a pasta ambiental ser uma área que se relaciona com a maioria das estruturas da Prefeitura. Logo, o/a gestora que irá administrar o Órgão Municipal do Meio Ambiente tenha uma visão macro da realidade municipal e seja capaz de dialogar com outros parceiros na Prefeitura, além de abrir-se ao convívio com a comunidade. De perfil aliado a capacidade técnica com habilidade política, sabendo explorar do corpo técnico e de especialistas, expertise, afim de oferecer em termos de soluções técnicas. Na organização da equipe técnica, os profissionais deverão ser escolhidos de acordo com as características e demandas de cada município que conheçam com mais profundidade os problemas gerados ao meio ambiente.

### III. METODOLOGIA

A pesquisa é um estudo de caso de caráter qualitativo aplicado nas secretarias de meio ambientes municipais dos municípios pertencentes ao Território de Identidade Piemonte Norte do Itapicuru, criado através da Lei 13.214/2014 no âmbito do Governo da Bahia, é um dos vinte e sete territórios de identidade, composto pelos municípios de Andorinha, Antônio Gonçalves, Campo Formoso, Caldeirão Grande, Filadélfia, Jaguarari, Pindobaçu, Ponto Novo e Senhor do Bonfim com o caráter exploratório, a fim de identificar a qualidade da gestão ambiental empregada, combinado com uma gestão integrada com a Secretaria de Meio Ambiente Estadual, bem como os principais entraves encontrados nos processos de licenciamentos.

A perspectiva é discutir sobre as condições que dominam, e sobre como pessoas, grupos ou coisas, funcionam no momento presente, utilizando a comparação e o contraste. O modelo de pesquisa descritiva documental visa compara costumes e usos, diferenças e tendências (BARUFFI, 2001).

O projeto teve como base a descentralização das atividades licenciáveis, melhoria da qualidade dos serviços prestados, uma possível melhoria ambiental, e o cumprimento da legislação. A busca dos dados utilizados foi através de pesquisas bibliográficas a respeito do tema, bem como análise documental nas secretarias municipais de meio ambiente. Foram selecionadas as legislações federais, estaduais, e Códigos Municipais que regem o licenciamento ambiental em cada município.

Logo, o enfoque se dá na mudança, no desenvolvimento dos indivíduos, de grupo, de práticas e de ideias e instituições, remontando às fontes de informação primária, documentais originais ou de primeira mão. As principais técnicas utilizadas nesse tipo de pesquisa são: coleta de dados históricos ou coleta de documentos; a crítica histórica (interna e externa); e a síntese.

Por sua vez, a pesquisa descritiva, que se apresenta em: analisar, registrar, descrever, interpretar e correlacionar fatos e/ou fenômenos. Essa pesquisa não busca manipular as variáveis, mas apropriar-se dos dados como são apresentados na natureza, descobrindo, de forma precisa, a frequência com que o fenômeno acontece, suas características e natureza, e a ligação que este pode possuir com outros fenômenos distintos.

As informações obtidas sobre a situação atual dos municípios quanto ao nível de licenciamento municipal foram obtidas junto aos sites eletrônicos da Secretaria Estadual

de Meio Ambiente.

### IV. RESULTADOS E DISCUSSÕES

Considerando a busca de compartilhar as responsabilidades nos âmbitos ambientais, mais precisas e de maneira local quanto a Gestão Ambiental Compartilhada entre o Estado da Bahia e os municípios que integram o Piemonte Norte do Itapicuru, sendo um desafio para todos os municípios consorciados, que passaram a ser responsáveis pelo licenciamento ambiental de impacto local e que possuem limitações em suas estruturas para desenvolver com eficiência estas atividades. Os municípios se estruturaram quanto à edição de lei ambiental, criação do conselho de meio ambiente e criação do fundo municipal de meio ambiente, fatores essenciais para a gestão ambiental municipal. Somados a estes fatores está a necessidade de dispor de equipe técnica qualificada para atuar no licenciamento e fiscalização ambiental. Neste ponto reside a fragilidade da maioria dos municípios baianos. Para fortalecer a gestão ambiental na Bahia é preciso manter o incentivo e estimular os municípios. Assim, é de extrema importância para a continuidade da gestão ambiental nos municípios consorciados, mantendo de maneira autônoma, técnicos para gestão ambiental nos municípios ou gerindo convênios que permitam este apoio.

A exigência dos requisitos necessários para adquirir tal competência deve ser mais rigorosa, em conjunto, ter o acompanhamento desses municípios após a adesão, devendo ser avaliada a cada quatro anos, devido à mudança de gestão municipal, e o último anseja o primeiro de cada gestão, analisando, assim, o princípio da continuidade das ações. No contexto dos processos de Licenciamento Ambiental, todos os municípios apresentam-se “capazes” a licenciar suas atividades, enquadradas a nível 3. Aqueles municípios, que aderiram ao convênio de consórcio, abrangem automaticamente o nível

máximo de competência municipal.

Quanto aos procedimentos organizacionais, todos os municípios apresentam: 1. requerimento ambiental, documento pelo qual o requerente realiza sua solicitação para regularização ambiental; check-list: lista de documentação para formação de processo e sistema de protocolo manualmente. Essa padronização é válida, devido aos interesses pessoais ou partidários.

Quadro 1: Comparação situacional dos municípios em relação ao GAC.

MUNICÍPIO	SITUAÇÃO	NÍVEL DE COMPETENCIA	CÓDIGO DE MEIO AMBIENTE	FUNDO DE MEIO AMBIENTE	CONSELHO DE MEIO AMBIENTE	CORPO TÉCNICO	DATA DE PUBLICAÇÃO
						Efetivos	
ANDORINHA	CAPAZ	3	SIM	SIM	SIM	Comissionado	23/05/2014
						01 eng. Ambiental*	
ANTÔNIO GONÇALVES	CAPAZ		SIM	SIM	SIM	Comissionado	20/01/2021
						Bióloga* – cedida de outro setor	
ALDEIRÃO GRANDE	CAPAZ	3	SIM	SIM	SIM	Comissionado	16/05/2019
						Terceiriza	
CAMPO FORMOSO	CAPAZ	3	SIM	SIM	SIM	Comissionado	12/04/2011
						01 eng. Ambiental*	
FILADEFIA	CAPAZ	3	SIM	SIM	SIM	Comissionado	09/08/2013
JAGUARARI	CAPAZ	3	SIM	SIM	SIM	Comissionado	27/06/2014
PINDOBAÇU	CAPAZ	3	SIM	SIM	SIM	Comissionado	28/04/2014
PONTO NOVO		3	SIM	SIM	SIM	Comissionado	28/04/2014
ENHOR DO BONFIM	CAPAZ	3	SIM	SIM	SIM	Comissionado	12/07/2013
						01 eng. Ambiental*	

\*concurado/efetivos

A cooperação entre os entes federativos durante o processo de licenciamento ambiental pode ser entendida de acordo com Trennepohl (2011), relata que um empreendimento e/ou atividade encontrar-se em processo de licenciamento, em um órgão ambiental, não afasta o poder de polícia dos demais, podendo exercer a fiscalização promovendo a apuração da infração da atividade. Durante o convênio de cooperação técnica, implementado pela Secretária Estadual de Meio ambiente, durante os anos de 2014 a 2016, foi oferecido assistência técnica na análise dos processos de licenciamento, estrutura física: computador, impressora, gps, transporte, combustível, afim de início a gestão ambiental nos municípios em estudo. Todos os municípios estudados aderiram ao Programa GAC, ainda demonstram insegurança nas ações provenientes do processo de Licenciamento Ambiental, desde a estrutura física, por causa, principalmente, de mudanças em seu quadro de pessoal, o que causa descontinuidade dos

procedimentos e ações.

Percebe-se que a transferência dos municípios à competência de ente federativo responsável pela gestão ambiental compartilhada, a partir da Constituição de 1988, atribuindo mais obrigações e competências, entretanto, apresentam dificuldades na capacidade institucional, administrativa e financeira para cumprimento legal.

Dentre as atividades e/ou empreendimentos, mais licenciáveis pelos municípios, estabelecidos pela Resolução CEPRAM nº 4.327, de 31 de outubro de 2013, anexo único podemos destacar, conforme tabela abaixo.



Tabela 2: Relação de atividades em comum nos municípios

<b>Divisão B: Mineração</b>
Grupo B3: Minerais Utilizados na Construção Civil, Ornamentos e Outros
Grupo B4: Minerais Utilizados na Indústria
<b>Divisão E: Serviços</b>
Grupo E1: Produção, Compressão, Estocagem e Distribuição de Gás Natural e GLP
Grupo E2: Geração, Transmissão e Distribuição de Energia
Grupo E3: Estocagem e Distribuição de Produtos
Grupo E4: Serviços de Abastecimento de Água
Grupo E5: Serviços de esgotamento sanitário coleta, transporte, tratamento e disposição de esgotos domésticos (inclusive interceptores e emissários)
<b>Grupo E9: Telefonia Celular</b>
<b>Grupo E10: Serviços Funerários</b>
<b>Grupo G2: Empreendimentos Urbanísticos</b>

Além, dos itens listados acima, existe aquelas atividades/empreendimentos de impactos locais, que não aparecem no anexo. Os quais podem ser inseridos na lei ambiental municipal, sendo mais restritivo que as outras esferas públicas, sendo elas: lavajatos, padarias e pizzarias que utilizem lenha, oficinas, entre outras atividades, que possam causar possível degradação ao meio.

A falta de comunicação sobre as concessões de licenças e medidas atribuídas aos empreendimentos, sendo um problema identificado quanto ao compartilhamento de ações entre os setores/secretarias dos entes municipais. Ora, se para abertura de um empreendimento na cidade, necessita de um alvará, concedido pelo órgão, geralmente, setor de obras/tributos, nada mais que equilibrado, uma gestão participativa entre os envolvidos. Nesse caso, a averiguação do local para instalação, deve-se possuir uma avaliação prévia do setor ambiental, a fim de evitar problemas futuros e administrar o parcelamento e uso e ocupação do solo. Nos municípios estudados, ainda não existe uma padronização e comunicação entre os setores, no que tange a equalizar os efeitos.

O Fundo de Meio Ambiente, em sua maioria não é executado em sua plenitude, independente e sem intervenção dos gestores municipais. Muitas vezes, não

são utilizados exclusivamente para o meio ambiente.

Em relação aos Conselhos Municipais de Defesa do Meio Ambiente, suas criações se deram antes da Lei referente ao licenciamento ambiental municipal, órgão consultivo e deliberativo; Existe paridade no Conselho, ou seja, metade de seus representantes é representando pelo Poder Público e metade faz parte da sociedade civil.

As leis ambientais, em sua maioria precisam ser atualizadas, de acordo com a realidade local de cada município. Aquelas que não, possui situações regulamentadas por lei própria, utilizam a lei Estadual e ou Federal como forma de aparo legal. Foram observados e comparadas entre o que acontece no cotidiano e o que preconiza as diretrizes legais de meio ambiente, bem como dificuldades operacionais de cada secretaria, estrutura física e quadro técnico

## V. CONSIDERAÇÕES FINAIS

A atuação dos órgãos municipais é determinante e imprescindível para as identificações de problemas locais e para a redução de empreendimentos não licenciados, que por consequência funcionam em desacordo com as diretrizes, bem como também os municípios e seus órgãos de gestão municipal atuam melhor na prevenção e redução de danos através do processo de licenciamento ambiental, sendo assim fundamental no desenvolvimento sustentável da região.

Por fim, é fundamental que a partir de agora os municípios sejam vistos como não somente órgãos simples, mas também como membros participativos na gestão integrada e na manutenção adequada e equilibrada do meio ambiente.

O presente estudo aborda a gestão pública municipal relacionada à gestão ambiental compartilhada, analisando quais os procedimentos executados pelas prefeituras e suas dificuldades. Logo, verificou-se que a gestão ambiental é um importante tópico da gestão pública municipal, entretanto, muitos gestores ainda não dão importância à temática ambiental, seja por desinformação, falta de corpo técnico ou falta de recursos. Para uma boa administração dos recursos ambientais, é importante que a prefeitura implante um Sistema Municipal de Meio Ambiente para organizando as legislações básicas que se aplicam ao meio ambiente e, por fim, possua um corpo técnico dedicado e especializado com as questões ambientais recorrentes em seu município. Dessa forma, com uma boa gestão dos recursos ambientais, os municípios evitam a ocorrência de danos ao meio ambiente e a obtenção de multas ambientais, além disso, em muitos casos, passam a ser aptos a pleitear recursos federais e estaduais direcionados à área

ambiental.

Políticas públicas quando realizadas de maneira adequada e satisfatória, garantem o bem-estar das comunidades, contribuindo assim, para o empoderamento e fortalecimento das pessoas. As potencialidades econômicas locais são amplas, e a gestão ambiental municipal como ferramenta para o alcance e manutenção do desenvolvimento sustentável, torna-se mais evidente e devem ser colocada em prática.

A atuação dos órgãos municipais é determinante para as identificações de problemas locais e redução de empreendimentos não licenciados que por consequência operam em desacordo com a nova lei, bem como também os municípios e seus órgãos de gestão municipal atuam melhor na prevenção e redução de danos através do processo de licenciamento ambiental, sendo assim fundamental no desenvolvimento sustentável da região.

Concluindo, é fundamental que a partir de agora os municípios sejam vistos com não somente órgãos simples, mas também como membros participativos na gestão integrada e na manutenção adequada e equilibrada do meio ambiente.

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# Talent retention practices by the view of the Administration university students at Universidade Federal Fluminense (UFF) in Macaé/RJ

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**Keywords— Talent Retention, People  
Management, Students, Administration.**

*Abstract – The marketing uncertainties have caused in numerous changes in the people management area. Understanding such moment, the present work, searched investigate issues about talent retention, objecting to describe the perception of the administration students in terms of talent retention currently adopted by companies. The formulated hypotheses were: H1) The factors considered as more valuable by students are not related to financial rewards; H2) The practices of talent retention adopted by companies influence the choice of the students that remain in them. H3) The students realizes that the companies don't invest in talent retention, because is not their priority. The nature of the study is descriptive-explorative with quantitative approach. The data were obtained by primary and secondary sources, raised by field research and bibliography research, respectively. The population investigated was constituted by 364 matriculated students in 2019/2, in the Administration course of the Universidade Federal Fluminense (UFF), in the city of Macaé/RJ. The research results show that the most valued tools by the university students are related to the training and development programs. With the study limitations stand out the size of the sample, presented in limited and reduced number to the university students of the above course.*

## I. INTRODUCTION

To define people management Gil (2007, p.17) affirm being: “the management function that views the cooperation of people that act in organizations to reach both organizational and individuals' goals”. The current competitive market demands, led by globalization, caused changes in people management in the last years, this creates the need of adapting currents marketing standards (Limongi, 2002) to marketing demands. Proof of this is that until not long ago, were spoken in Industrials Relations, in a bureaucratic view, current since the end of the Industrial Revolution found in the peak of the 50's.

In many organizations the term Human Resources Administration is still heavily used, inside a more dynamic vision that was outstand until the 90's. There are organizations that adopted the name People Administration, in an approach that tends to customize and view intellectual capacities. And, finally, the tendency that is verified today is Administration with the People, which means conduct the organization closely with the inside collaborators and partners that understands better their business and future.

As talent retention, this has been revealed to be a challenge to the Human Resources department, a strategic



problem, in which the managers assume a fundamental role that is encouraged by what the company offer. The organizational ambient to retain the talents is formed by initiatives like development of valorization ways of professionals and inspirational political Programs; hygiene; work security and life quality; together with a leadership that attends not just the company expectation, but as well as being sensitive with subordinates needs. This is the way that affirm that the base of talent retention refers to affiliation perception that the worker has in relation to what he believes that the organization does to keep them working, in a way that the expectations and individual's needs be attended (TANSLEY, 2018).

Under this perspective we searched doing a more detailed investigation about the theme, based in future managers, in order to find answers to the following question: How students realize the talent retention practices currently adopted by companies? The final research goal was describing the perception of students in terms of talent retention practices currently adopted by companies. From the definition of research problem and goal, three hypotheses were formulated, to know:

- H1.** The factors considered as more valuable by students aren't related to financial rewards;
- H2.** The talent retention practices adopted by companies influences in students' choices that remain in them and
- H3.** The students realizes that the companies don't invest in talent retention, because is not a priority for them.

The work is justified by his practical implication, due to, in face of the organization current moment, where the companies reduced significantly the staff board, theoretically keeping just more strategic and essential workers for the business continuity. Therefore, different organizational practices and processes are affected, may resulting, moreover, in reduction and even politics suppression and talent retention practices, where it can affect negatively the organizational mood, the productivity, the motion and staff satisfaction.

## II. LITERATURE REVISION

### 2.1 People management by a current optic

The organization act in a global and multicultural environment of work strength in constant changes and stiff competition. Madeira (2018) affirm that constantly monitoring the environment and adopt proactive attitudes in front of changes, reviewing scenarios and reformulating strategies, starts being a demand to organizations in front of a turbulent environment in which they are inserted, where it demands more agile and flexible people (LEGGE, 2005).

However, the challenge to be considered by organizations is the competitive maintenance against such context. For this, people management starts occupying strategy drawings and implementation that views contribute to competitive advantage maintenance and reach, in a way that considers the organization goals, as well as the people that in them works. For Limongi (2002), if the organization reach their goals in the best way possible, it needs to know how to canalize the people effort so that they achieve their individuals' goals and both parts wins.

People management is a very sensitive area to the dominant mentality in organizations. Rabaglio (2001) affirm that the people management covers numerous activities fully related together, to know: staff recruitment, position description, training and development, performance evaluation, and others. The author even claims that, people management is a management function that views promoting the cooperation of people who works in an organization, to reach the individuals and organizational goals. In other words: those who shall not be visualized as organization resources, but actually as partners that supplies knowledge, abilities and expertise, contributing and proportionating rational decisions, that provides meaning, and towards to the global goals. (LEGGE, 2005)

In relation to the people management goals, Lacombe (2011) believes that these should contribute to the organizational efficiency through the following ways: 1. help the organization to reach their owns goals and accomplish their mission; 2. proportionate competitiveness; 3. proportionate to the organization well trained and motivated people; 4. increase the self-actualization and people satisfaction in work; 7. keep ethical policies and behaviors socially responsible; and 8. build the best company and the best team.

Ulrich (2018) assures that the specific goal of people management is offering support to the organization so that it reaches bigger goals. To this end, is indispensable that the responsible for the people management know well the business, add well trained and motivated people to the organization, providing for them the possibility to prepare and develop capacities, as well as recognizing and compensating accordingly with the results.

What stands out with the concepts and goals pointed out, is that the context of people management is represented by an intimate correlation of organizations and people. The relationship between them is based in a solution that everyone wins. Besides that, it is perceived that manage people and humans' competencies represents today a strategic question to the companies and not a

mechanistic activity anymore, as well as being a centralized and bureaucratic process to be a flexible ambient, decentralized, searching the qualification not only of the organization, but the people in there working, in order to obtain partnership capable to generate positive and competitive results. However, the challenge still is to find and retain such talents.

## 2.2 Definition and talent retention

For Ulrich (1999, p. 20), “the successful companies will be the more experienced in the process to attract, develop and retain individuals with abilities, perspective and experience enough to conduct a global business”. For the author, such process constitutes one of the challenges to the HR area, besides defending the organization capacity, it must be always competitive. Therefore, the talent management starts covering the identification practices (selection and recruitment) and the talents retention practices, such as: compensation, life quality, development, career planning and leadership role, aspects that gain more and more importance in HR administration.

One of the development difficulties of the theme talents retention it is in the definition itself. Although the term is present in the society since ancient times, and the dictionaries established definitions, the use by people and organizations is made in different ways, which causes uncertainties about the application (SOUZA, 2018). The establishment of one definition to organizational language use, becomes important to strengthen the policies and practices to Talent Management and, although is not recommended to establish a restrictive definition for the word, that can difficult the characterization, the existence of a wider and vague definitions also doesn't collaborate in the application (TANSLEY, 2018). Under this aspect is that Santos (2018), understand the term talent as ambiguous. In some moments, refers to an attitude or personal ability, and sometimes to the talented performance of an individual, a behavior that goes beyond the common in attending any desirable criterium. In Mucha (2004) view, the talent is one of the strengths that boost the success in business, although the definition is fluid, influenced by organizational strategy and by ambient contingency where it is found.

Santos (2018), defines talent as people that have great mental ability, that are mentally prepared for innovation need and organizational changes. Everlim (2018), understand being talented workers those with potential above the average, based in their aptitude, perform their activities very well. Besides, they are willing and apt to progress. In Santos (2018) view, is a combination of an abilities

set, competence and experiences needed to the work accomplishment. Finally, Ulrich (2018), affirm that talent is the same of competence, *versus* compromise *versus* contribution. Talented employees need to have abilities, wills and goals, besides being capable, committed and contributive.

Is evident that the term talent has different concepts, not being possible to find one standard definition to be adopted. Despite not being possible a single term definition, it is perceived in general, that talents are not genius or people with special gifts, but just average people, with the same majority mental capacities, but with something else, that is intangible, for example: the perception of what really should be done and the responsible sense. Therefore, to determinate the flow and imprecision of talent concept, it is possible infer that there is no sense in searching a single term definition. That way, can be said that only one definition of talent has sense, inside of a specific dominium or in a use context, for example, that given by organization particularity in where is performed the management.

## 2.3 Human resources practices in talent retention

One of the biggest challenges current faced by organization is the employee retention, especially the most qualified ones. The work strength is more flexible, less faithful, having a considerable work activity search with better perspectives. In terms of definition, Ulrich (1999), believes that the retention is about a way of catching the essentials collaborator to the organizational performance. Santos (2018) understands that people retention is the result of a mutual satisfaction between the employee and his employer.

When we speak about talent retention, we have the alignment between the personal and professional needs to the company strategic goals, causing that the collaborator views the role that fits in organizational context, involving him in the company evolution. Such finding alerts to the fact that the company that neglect this reality in Human Resources policies will put in risk their own future in the market. In this regard, Souza (2018) believes that, the company that wishes to survive in the current market need to be capable to identify, develop and retain talents, since such practices are closely related to economic aspects, as far as searching retaining the professionals whose results are satisfactory to the organization.

As of the clarified considerations, notices that the work market characteristics direct impact what the companies should do to keep the more talented professionals in functional board, through talents retention practices, with the goal to keep the competitiveness or even the survival.

To retain talents, it can be found different incentives that influences the retention, grouped in five categories, they are: financial rewards; career development opportunities; functional content; social environment and balance between professional and family life. When having a careful look about the collaborator with the creation of a talents retention program, the companies search the potentiation of a space that the same works as a team, in fact, and more motivates. That way, the response that the company has with the implementation of this program are better organizational results, cost-cutting, less rotativity, knowledge retainment, more qualified collaborators and, consequently, better organizational results (MADEIRA, 2018).

### III. METHODOLOGY

#### 3.1 Research type

The present study was of exploratory-descriptive with a quantitative approach. According to Barros and Lehfeld (2003), the descriptive research has as main goal describe something. Vegara (2014) complement that this kind of research exposes the characteristics of certain population or phenomenon. Therefore, this study is classified in this way, because it aimed to describe the students' perception as talents retention practices adopted by company in that area.

The exploratory research has as goal, assist the researcher to comprehend better the problem situation faced by him. This kind of research is used when is necessary to define the problem with higher accuracy, identify action possibilities or obtain additional data before developing an approach, is about an investigation period in which the researcher seek to obtain the factors understanding that exercise influence in a situation that constitute the research object.

The quantitative approach, also in Veregara (214) view, is characterized by the use of quantification, as much in collecting information modalities, as in its treatment beyond statistics technics. For Gil (2002), the quantitative research makes use of quantification, as much in collecting as in information treatment, utilizing statistics technics, aiming results that avoid possible analyses and interpretation distortions, making possible a bigger security margin. As above, the quantitative approach has as differential the intention to guarantee the performed work precision, conducting to a result with less distortions chances.

#### 3.2 Population and sample

The research population can be understood as a group of people whom pretends to generalize the results and has common characteristics (VERGARA, 2014). The investigated population in this study was constituted by university students of UFF Admiration course, localized in the city of Macaé/RJ, constituted by 364 students with active enrollment in the first semester of 2019, according to the Institution Secretariat. It was opted to delimit the population only to the students mentioned, due to time limitation and available budget to perform the field research. Therefore, such cutout presented to be the most viable and convenient.

About the sample, is considered as a small part of the elements that composes the population. In the present study, were not stablished probabilistic criteriums to the sample obtainment, it was a free participation, charactering as non-probabilistic sample by accessibility, once it was selected the elements in which had access in the research moment (VERGARA, 2014).

#### 3.3 Research instrument and data colecting procedures

The data were obtained as of collecting primary and secondary sources. According to Santos (2002), the secondary data are statistics obtained not for a current study, but for another purpose, while the primary data are specially generated by a researcher for a certain study. The secondary data were collected by bibliography raisin about pertinent subject to "talents retention". The main used documents to compose the theoretical referential were articles, theses, dissertations, books and sites related to the study theme.

To collect primary data, it was used the field research with UFF students, during the period of April 27 to September 15 2019. The primary data collecting instrument used was questionnaire, exclusively developed for this research, having as a base the theoretical referential, composed by 20 questions, structured in five sections: in **Sections I and II**: it was performed the respondents profile raisin (gender and age), current situation in the work market and data related to the current company (acting area, company work time, company size and branches); in **Section III and IV**: it was searched to analyze what the university students understood as talent concept and if there was an alignment with the presented concepts in theoretical referential, as well as organization advantages that search retain those professionals. This perception about talent conception become important bearing in mind the term ambiguity and definition flow. Besides that, a verification was performed to verify if the company they worked adopted a "talent retention" Policy

and which retention practices were effectively used. In this stage, it was performed three questions in box selection style, limited to three selections and four more multiple choice questions; finally, in **Section V** it was searched to comprehend the students' perception about practices adopted by companies, in the sense of finding if these exercise influence in permanence decision, as well as which practices are more valued by them and the satisfaction level.

Yet the **Section V** was composed by three questions in linear scale style, two of multiple choice and two in selection box style. Previously, was performed a pre-test with twenty-five students, to identify eventual gaps. The questionnaire was perfected according to the pre-test performed together to 30 individuals, between February and March 2019, and not having nothing else to add was applied. It was used the "Google Forms" tool to create the questionnaire and a link was sent by e-mail to the university students.

Aiming the biggest respondent number, it was also opted to distribute a questionnaire in class. It was sent 364

questionnaires, however obtained 113 responses return, in other words: 31% of the sent questionnaires.

### 3.4 Analysis of the obtained data and discussion

Initially, we sought to raise the respondent's profile and the current situation on the work market. Only those who said they work or have worked in the last twelve months, have qualified for the next question section. In this stage, it has identified that the most is female (52,2%), what shows the gender equality, equally indicated by Censo da Educação Superior, performed by Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (INEP), in September 2018. According to Censo, the enrolment proportion in Administration courses in 2017 was 54,9% female against 45,1% male.

Regarding to age, 67,3% is in the 21- and 30-years age range, which point out to a young profile among the university students. Only 16,8% are 30 years old or more.

Table 1 Gender and age group from students

1. Gender	N	%	2. Age Group	N	%
Male	54	47,8	Till 20	18	15,9
Female	59	52,2	21 and 30	76	67,3
			31 and 40	15	13,3
			41 and 50	3	2,7
			51 or more	1	0,9
<b>TOTAL</b>	<b>113</b>	<b>100%</b>		<b>113</b>	<b>100%</b>

Source: research data

About the current work market situation, 81,4% are working or worked in the last twelve months. The positive response to this question qualifies the respondent to follow to the next sections, that had as goal, to raise the profile of

the companies and identify the university students' perceptions about talent retention. However, 18,6% of the students does not applies for not attended the criterion.

Table 2 – Current status job market

Do you work or worked in the last 12 months?	N	%
No	21	18,6
Yes	92	81,4
<b>TOTAL</b>	<b>113</b>	<b>100%</b>

Source: research data

In terms of company profile raising, about the activity size and branch, as well as information related to the university students as acting area and work time, it has 46,7% acting

mainly in Administrative area and are less than one years in the company (48,9%)



Table 3 – Performance and work time in the current or last company worked

<b>4. Performance area</b>	<b>N</b>	<b>%</b>	<b>5. Work time</b>	<b>N</b>	<b>%</b>
Administrative	43	46,7	Till 1 year	45	48,9
Financial or Accounting	7	7,6	2 to 5 years	36	39,1
Marketing or Sales	5	5,4	6 to 9 years	6	6,5
Operational	19	20,7	10 to 13 years	1	1,1
Humans Resources	9	9,8	14 years or more	4	4,3
Others	9	9,8			
<b>TOTAL</b>	<b>92</b>	<b>100%</b>		<b>92</b>	<b>100%</b>

Source: research data

The finding that the most students is less time in company maybe can be justified by economic moment experiment in Macaé city. According to CAGED, since 2015, hasn't been generated job vacancies and the recovering is occurring very slowly. There are reallocation difficulties in the work market, as well as the lack of opportunities for first work experience.

According to released data by CAGED in Portal do Ministério do Trabalho e Emprego (MTE), that registers

employee's admissions and discharge under the regime of Consolidação das Leis do Trabalho (CLT), in the period between 2015 to 2018 the number of discharges exceeded admissions. Taking April as a base, only 2019 the admissions exceeded discharges, with the creation of 597 new work posts, according to Table 4.

Table 4 – Job evolution in the city of Macaé/RJ

<b>Annual job evolution of based on April</b>					
<b>Year</b>	2015	2016	2017	2018	2019
<b>Vacancies</b>	-75	-14861	-10835	-4981	597

Source: Extracted from publishments of CAGED on MTE site and adapted by the author

Regarding to the companies' size and branch, 47,7% are a large size, being 43,5% centering in Support activities to oil and natural gas extraction branch.

Table 5 – Size and branch of the company activities

<b>6 Company size</b>	<b>N</b>	<b>%</b>	<b>7 Company Branch</b>	<b>N</b>	<b>%</b>
Till 19 employees	20	21,7	Support activities to oil and natural gas extraction	40	43,5
Between 20 and 99 employees	16	17,4	Wholesale and retail trade	3	3,3
Between 100 and 499 employees	13	14,1	Logistic and Transport support	4	4,3
500 or more employees	43	46,7	Services	16	17,4

	Civil construction	2	2,2
	Public administration	10	10,9
	Others	17	18,5
<b>TOTAL</b>		<b>92</b>	<b>100%</b>

**Source: research data**

The criterion adopted for the classification of companies according to size, obeyed to the same used in publishing of 2015 of Anuario do Trabalho nos Pequenos Negócios, resulted by SEBRAE - Serviço Brasileiro de Apoio às Micro e Pequenas Empresas – in partnership with DIEESE – Departamento Intersindical de Estatística e Estudos Socioeconomicos. In the refereed edition was considered, to the industrial sector, the occupied people number: Microbusiness: up to 19 people; Small Business: from 20 to 99 people; Medium Business: from 100 to 499 people; Big Company: 500 people or more.

The third section had as goal to analyse what talent concept presented in the theoretical referential had more alignment with the understanding of university students, also analyzing the advantages felted by companies that retain talents. Besides that, we sought identifying if the company adopted a retention policy, knew the talents and which were the advantages of retain them. For this, were presented six concepts, with the possibility of selecting until three options. The concept that presented more frequency (30,7%) was the Handfield and Axelrod (2002), in other words, the university students considers that talents possess abilities, embracing gifts, knowledge, experience, intelligence, discernment, attitude, character and innate impulses, besides the capacity to learn. Inside of such concept, talents can have innate characteristics, however are normal people with applying what they know and search skills and acquiring and expanding knowledge, as well as abilities.

*Table 6 – What is talent*

<b>8. In your opinion, what makes a professional be considered a talent?</b>	<b>N</b>	<b>%</b>
Have hard acquisition abilities and strategic importance for competitiveness, continuity or survival for certain companies	25	13,0
Have abilities, covering skills, knowledge, experiences, intelligence, discernment, attitude, character and innate impulses, besides the capacity to learn	59	30,7
Have great mental ability and is mentally prepared to innovation need	29	15,1

and organization changes

Have above average potential based in their talent, perform their activities very well and is willing and apt to progress	26	13,5
Combine abilities, competencies and experiences needed to the job accomplishment	35	18,2
Is gifted of something that everyone can have: perception of what really should be done and responsibility sense that obligate the accomplishment of a improving work	18	9,4
<b>TOTAL</b>	<b>192</b>	<b>100%</b>

**Source: research data**

When being questioned about the main company advantages that search retaining talent, were asked that up to three options were selected. It was noticed that the bests organizational results (29%), competitive differential (24,3%) and less rotation (13,3%) were the mainly advantages, in the students view.

*Table 7 – Company advantages that search talent retention*

<b>9. What company advantages that search talent retention</b>	<b>N</b>	<b>%</b>
Competitive differential	51	24,3
Continuity and survival	23	11,0
Organization mood improvement	21	10,0
Less rotation	28	13,3
Better organizational results	61	29,0
Knowledge retention	23	11,0
Others	3	1,4
<b>TOTAL</b>	<b>210</b>	<b>100%</b>

**Source: research data**

Besides that, for 57,6% of university students the company can identify their talents, however it does not adopt retention policy (60,9%).

Table 8 – The company identify talent and adopt a retention policy

10. The company can/could identify which are the talents?	N		%		11. The company adopt/used to adopt a talent retention policy?	N		%	
	Yes	53	57,6	Yes		2	31,9	5	
No	39	42,4	No	5	60,6	9			
			No, but plan develop	7	7,6				
<b>TOTAL</b>	<b>92</b>	<b>100</b>		<b>9</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>2</b>	<b>%</b>

Source: research data

In the 4 and 5 sections, we sought identifying retention practices effectively adopted in the company, as well as understand the student's perception about such practices, in the sense of finding if these exercise influence in permanence decision and which are the most valued by them. Therefore, only those who responded “yes” in question 11 qualified to follow in the research. In this case, of the 92 participants, only 29 were qualified to follow in the research, and of these, 93,1% said that the policy of talent retention was practiced. Besides that, 51,7% said that the company motivated the talent satisfaction, pointing out to an answer balance.

Table 9 – Practices of talent retention policy and talent monitoring

12. The Talent Retention policy is/used to be practiced?	N		%		14. The company perform/used to perform a monitoring of talent satisfaction?	N		%	
	Yes	27	93,1	Yes		15	51,7		
No	2	6,9	No	14	48,3				
<b>TOTAL</b>	<b>29</b>	<b>100</b>		<b>29</b>	<b>100</b>		<b>100</b>	<b>%</b>	

Source: research data

To identify which tool of talent retention, effectively, were adopted in the company, it was requested that the university students selected up to three options. The option

“Others” was included, so that we had the possibility to identify others tools that was not listed. The main tools identified was Training and Development Programs (26,1%) and Incentive Programs (Bonus, PLR, Action Distribution, etc) with 21,7%, that together reach almost 50% of occurrence in companies. A highlighted point is that LQW Programs (Life Quality in Work) show with less frequency, in other words, it is not in the mainly companies focus. In contrast, in accordance with what will be seen in answers to question 16, also is not the tool that the students value more occupying just the third place. Besides that, appeared two tools that were out of the presented options in question: Inside Recruitment and time flexibility throughout performance presentation above the average.

Table 10 – Tools effectively utilized by companies to retain talents

13. Wich tools the company effectively utilize/used to retain talents?	N	%
Incentive programs (Bonus, PLR, Actions Distribution, etc)	15	21,7
Life Quality in Work Programs	10	14,5
Training and Developments Programs	18	26,1
Salary and Position Plans	12	17,4
Benefits Plan	12	17,4
Others	2	2,9
<b>TOTAL</b>	<b>69</b>	<b>100%</b>

Source: research data

In a linear scale of 1 to 5, in which 1 means totally disagreeing and 5 totally agreeing, the following affirmation was presented: “the practices in “talent retention” adopted by companies that exercise/used to exercise influence in my choice to stay”. In that sense, 69% of the students totally agree or disagree with the affirmation, being 41,4% said just agreed. However, 13,7% totally disagree or agree. Still 17,2% show neutrality with the affirmation.

Table 11 – Talent retention practices and influences over the permanence choice

15. The talent retention practices adopted by companies exercise/used to exercise influence in my choice to stay	N	%
1	1	3,4
2	3	10,3

3	5	17,2
4	12	41,4
5	8	27,6
<b>TOTAL</b>	<b>29</b>	<b>100%</b>

Source: research data

About what practices adopted by the company the student value more, it was asked that until three options were selected. Most people showed that valued the Training and Development Programs (23,9%), followed by Salary and Positions Plans (22,4%) and Life Quality in Work (19,7%). A data that stands out is that the companies are righting in tools utilized to retain talents, viewing that Training and Development Programs is the practice with the most concurrency in companies, as well as the most valued by the university students. In contrast, Salary and Position Plans is the second tool more valued by students, but is in fourth place in companies' occurrence, tying with Benefit Plans.

Table 12 – Talent retention practices more valued

<b>16. From talent retention practices, which one do you value/used to value more?</b>	<b>N</b>	<b>%</b>
Incentive Programs (Bonus, PLR, Action Distribution, etc)	13	18,3
Training and Developments Programs	17	23,9
Life Quality in Work Programs	14	19,7
Salary and Position Plans	16	22,5
Benefits Plans	9	12,7
Others	2	2,8
<b>TOTAL</b>	<b>71</b>	<b>100%</b>

Source: research data

Besides that, 44,8% shown neutrality before the affirmation “The talents retention practices adopted by company are/were satisfactory”. Added to the neutral, that totally agree or disagree with the affirmation correspond to 62%. In this point, is evident that exist a demand to improvement in talents retention practices. This can be justified by the fact of not having a total alignment between what the company offers and what the university student value, as pointed out before.

Table 13 – Satisfaction related by talent retention practices

<b>17. The talent retention practices adopted by companies are/were satisfying</b>	<b>N</b>	<b>%</b>
1	1	3,4
2	4	13,8
3	13	44,8
4	8	27,6
5	3	10,3
<b>TOTAL</b>	<b>29</b>	<b>100%</b>

Source: research data

When asked about how long they pretended to keep working in the company, 48,3% of the university students said that they pretended to stay for up to three years, being 13,8% the percentual that pretends to stay for up to one years. Besides that, 27,6% does not pretend to leave the company.

Table 14 – Intention to stay in the company

<b>18. How long do you pretend to continue work at the current company?</b>	<b>N</b>	<b>%</b>
Till 1 year	4	13,8
2 to 3 years	10	34,5
4 to 5 years	1	3,4
6 years or more	1	3,4
Don't pretend to leave the company	8	27,6
Doesn't applies	5	17,2
<b>TOTAL</b>	<b>29</b>	<b>100%</b>

Source: research data

Regarding to which practices could be better in the company, only to 1,8% of the university students the practices are satisfactory. For 21,8% could be better in Incentive Programs (Bonus, PLR, Action Distribution, etc.), followed by Salary and Position Plan (20%) that was pointed in question number 16 as the second more valued tool by the students, but appears in fourth place in company occurrence. Benefits Plan, Training and Development Programs and Life Quality in Work were even with 18,2%.



Table 15 – Talent Retention practices that could be better

19. Wich practices adopted by the company could be better?	N	%
Incentive Programs (Bonus, PLR, Action Distribution, etc.)	12	21,8
Life Quality in Work Programs	10	18,2
Training and Developments Programs	10	18,2
Salary and Position Plan	11	20,0
Benefits Plan	10	18,2
None. The practices are/were satisfactory	1	1,8
Others	1	1,8
<b>TOTAL</b>	<b>55</b>	<b>100</b> %

Source: research data

Finally, 37,9% said totally disagreeing with the affirmation “The company does not invest in talents retention”, because is not/were not a priority. Adding those who totally disagree or disagree the percentual go up to 65,5%. Only 10,3% of the university students totally agree or agree with this affirmation.

Table 16 – Perception about the talent retention practices

20. The company does not invest in talent retention, because is not/were not a priority	N	%
1	11	37,9
2	8	27,6
3	7	24,1
4	1	3,4
5	2	6,9
<b>TOTAL</b>	<b>29</b>	<b>100</b> %

Source: research data

#### IV. CONCLUSION

Today, the relationship between the organization and the people who work in it, is based in a solution where everyone wins, therefore, to retain talents, the companies use tools like Training and Development Programs, Incentives Programs, Salaries and Positions Plan, LQW Programs, Benefit Plans, and others. In counterpart, when

attending the employees' needs, the company can obtain cost reduction, less rotativity, knowledge retainment, more qualified collaborators and, consequently, better organizational results.

The general goal of this study was proposed describe the perception of the Administration course students of a College Institution in the city of Macaé/RJ about the talents retention practices current adopted by companies. For this, it was performed a field research seeking to relate the empiric results to the analyzed literature in bibliography research. Three hypotheses were created to the study: H1. The factors considered as more valuable by students aren't related to financial rewards; H2. The talent retention practices adopted by companies influences in students' choices that remain in them; H3. The students realizes that the companies don't invest in talent retention, because is not a priority for them.

In the students' perception, better organizational results, competitive differential, and less rotativity, were pointed out as the main advantages in the company that search retain talent. In this sense, the research pointed out that the most companies can identify the talents, however, only 31,5% adopt a retention policy. In such companies, the main used tools are Training and Development Programs, close with Incentive Programs (Bonus, PLR, Action Distribution, etc), that together come almost to 50% occurency. In relation to the most valued tools by the university students, the majority pointed out the Training and Development Programs followed by Salary and Position Plan. Here it can be verified a convergence between what the company offers *versus* what the university students' value, viewing that the Training and Development Programs is the practice with the most occurency in companies, as well as the most valued by the university students. Such finding, confirm the first study hypotheses: the factors considered as more valuable by students aren't related to financial rewards.

Although the convergence previously indicated, the university students believes that the Incentive Programs (Bonus, PLR, Action Distribution, etc) and Salary and Position Plan, could be better. The majority agrees that the practices exercise influence in the choice to stay in the company, what confirm the second study hypotheses: The talent retention practices adopted by companies influences in students' choices that remain in them. Besides that, a big students' parcel pretends to stay in the company for up to three years, pointing out that there is intention to leave the organization in certain moment.

Finally, most of the university students disagree that invest in “talents retention” is not a company priority. Such fact refutes the third hypotheses: The students

realizes that the companies don't invest in talent retention, because is not a priority for them. In this way, it is considered that the general study goal was reached, once it was described all students' perception about talents retention adopted in companies. It is also believed, that the specific goals were reached, and the hypotheses properly tested.

As limitation of this study stands out the sample size, presented in small number and limited to UFF Administration course students. Besides that, it was not established probabilistic criteriums to obtain the sample, it was a free participation, characterized by an accessibility and convenience sample, not selected in a random way. Consequently, it is not possible to understand the results obtained to all colleges institutions or other organizations types. The results found are considered only for the population in question.

Another limitation to be pointed out is that a significant participants parcel (48,9%) has only 1 year of service, which can present perceptions still premature in relation to talents retention practices adopted in company. Highlighting that even with the presented limitations, it is understood that they did not prevented that the research goals were reached.

For future study purpose about the theme "talents retention", it is recommended studies that search pointing to how the companies can implement talents retention policies in a strategic way, and evaluate the results effectiveness.

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# The Pitaguary Ethnicity Sociobiodiversity and Sustainability Practices in Maracanaú, Ceará, Brazil

## Práticas de Sociobiodiversidade e Sustentabilidade da Etnia Pitaguary em Maracanaú, Ceará, Brasil

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CE.**

**Abstract—** *The aim of this paper is to identify the socio biodiversity practices that take place in the Pitaguary community and how these cultural practices reflects in the sustainability of their space. Socio biodiversity and sustainability are two concepts which belong to the life of indigenous people. They are fundamental to an ecological balanced environment and to the quality of life of human beings. The relationship established with nature combined with the traditional knowledge in the natural resources management to produce many items of the biodiversity make these people real natural universe specialists. The indigenous people possess an immeasurable cultural legacy in regard of the biodiversity and sustainability. The natural resources extraction and the harmonic relationship established with the nature elements are undoubtedly unique and it results in sustainability. It was carried out an ethnography study investigating the ancestral traditional practices of socio biodiversity and sustainability in the Pitaguary ethnicity known as “Santo Antônio do Pitaguary”. The community is located closest to the Santo Antônio dam in the Maracanaú city, Fortaleza metropolitan region in the Ceará State, Brazil. The method consisted of an exploratory-descriptive study with a qualitative approach and the use of interviews and direct observation as techniques. The results highlight that the ancestral culture and memory are present in the socio biodiversity practices of the Pitaguary community. Moreover, they reveal the importance of the traditional knowledge in the*



| biodiversity preservation for sustainability.

## Resumo

O escopo central dessa investigação é identificar quais as práticas da sociobiodiversidade e estão presentes na comunidade e como essas refletem culturalmente no alcance da sustentabilidade no/do espaço dos Pitaguarys. A Sociobiodiversidade e a sustentabilidade são dois conceitos que fazem parte intrinsecamente da vida dos povos indígenas e são indispensáveis para o ambiente ecologicamente equilibrado e para a qualidade de vida humana. A predominante relação com a natureza aliada ao conhecimento tradicional utilizado no manejo dos recursos naturais para a fabricação de diversos produtos da biodiversidade faz desses povos verdadeiros especialistas do universo natural. Os povos indígenas possuem um legado cultural imensurável a respeito da biodiversidade e, por conseguinte, da sustentabilidade. A maneira como eles extraem os recursos naturais e ao mesmo tempo se relacionam harmoniosamente com os elementos da natureza é sem dúvida algo singular e proporcionador da sustentabilidade. Foi realizado um estudo de cunho etnográfico sobre as práticas tradicionais ancestrais de sociobiodiversidade e sustentabilidade da/na etnia Pitaguary conhecida como “Santo Antônio do Pitaguary”, localizada próxima à barragem de Santo Antônio, no Município de Maracanaú, Região Metropolitana de Fortaleza, Estado do Ceará, Brasil. Trata-se de um estudo exploratório-descritivo de abordagem qualitativa com técnicas de coleta de entrevistas e observação direta. Os resultados mostram que a cultura e a memória ancestrais dessa etnia estão muito presentes no acontecimento da sociobiodiversidade, bem como evidenciam a importância de seus conhecimentos tradicionais na preservação da biodiversidade para a sustentabilidade.

**Palavras-chave:** Sociobiodiversidade, Sustentabilidade, Povos Indígenas, Pitaguary, Maracanaú-CE

## I. INTRODUÇÃO

O convívio harmônico entre humanidade e meio ambiente tem sido cada vez mais ameaçado pela ganância. O homem ao longo dos anos vem poluindo os solos, ar e as águas, desmatando florestas e matas, exterminando animais e vegetais, desequilibrando o planeta. Esses são apenas alguns dos efeitos dessa sociedade moderna que em nome do “desenvolvimento econômico” se apropria dos recursos naturais irresponsavelmente sem mensurar as consequências dessas ações para a biodiversidade e para as futuras gerações.

Em vista dessa situação, observa-se um esforço de muitas organizações ambientalistas em difundir com maior ênfase a ideia de sustentabilidade através das mídias e das campanhas de conscientização ambiental. Entretanto, percebe-se que tais ações ainda não são suficientes para mudar esse cenário de caos ambiental. A complexidade do problema exige uma reflexão mais profunda sobre a sustentabilidade em um processo de educação e reeducação socioambiental.

Na tentativa de resgatar na cultura ancestral o apego à natureza, diversos movimentos e grupos ativistas têm levantado a bandeira de reconstrução da nossa identidade legitimamente brasileira de conservação da nossa fauna e flora. Nesse contexto, destacam-se os povos indígenas, pois podem falar com propriedade sobre o que significa a cultura ancestral de apego a natureza.

Nesse sentido, a justificativa para essa pesquisa se deu pela importância em compreender a sociobiodiversidade e a sustentabilidade dentro de uma comunidade indígena a

partir de suas práticas, costumes, saberes e conhecimentos tradicionais para demonstrar como a cultura e a memória ancestral indígena estão presentes nessas práticas, bem como evidenciar a importância dos seus conhecimentos tradicionais na preservação da natureza.

Dessa maneira, este artigo apresenta resultados preliminares de um estudo em andamento a respeito da sociobiodiversidade e da sustentabilidade na comunidade Pitaguary, onde buscou-se identificar as práticas e a práxis da sociobiodiversidade e da sustentabilidade na comunidade indígena conhecida como “Santo Antônio do Pitaguary”, localizada próxima à barragem de Santo Antônio, no Município de Maracanaú-CE.

A comunidade de Santo Antônio do Pitaguary é uma das comunidades da etnia Pitaguary, as outras estão localizadas no Horto, no Olho d'Água, ambas em Maracanaú (CE), e na Munguba, localizada no município de Pacatuba (CE). Entretanto, a comunidade de Santo Antônio encontra-se em evidência pois além de ser a que possui maior exuberância em recursos naturais, também é o local de intensas lutas pela demarcação das terras indígenas Pitaguary<sup>1</sup>.

Atualmente a comunidade sobrevive principalmente da agricultura, da caça, da pesca, da criação de animais e do artesanato. Nesse sentido, a problemática para esse estudo envolveu conhecer melhor quais as práticas da sociobiodiversidade são desenvolvidas pela comunidade indígena Santo Antônio do Pitaguary, bem como discutir a importância dessas práticas na sustentabilidade local e identificar se os costumes e conhecimentos tradicionais

envolvidos nessas práticas ainda permanecem preservados e quais foram modificados.

Além disso, pretende-se analisar a práxis envolvida nas atividades da comunidade, para isso, levou-se em consideração a práxis como a ação transformadora do homem sobre o mundo, onde essa ação pode ser entendida como uma atividade prática amparada na reflexão<sup>2</sup>.

Pautado nessas definições de práxis, busca-se compreender como a comunidade Pitaguary reflete sobre suas práticas objetivando identificar as transformações sentidas e produzidas não só externamente mas interiormente.

O artigo foi subdividido nas seguintes partes: esta introdução, a metodologia utilizada, uma breve conceituação dos povos tradicionais, a discussão e análise dos resultados, as conclusões e os referenciais bibliográficos utilizados.

## II. METODOLOGIA

O estudo elegeu como procedimento técnico a pesquisa etnográfica com a abordagem qualitativa essencialmente descritiva, onde se buscará conhecer a história da comunidade, quais os rituais de cuidado do espaço onde estão inseridos, como é o cotidiano dos moradores e qual a influência do entorno.

A pesquisa etnográfica “visa compreender, na sua cotidianidade, os processos do dia-a-dia em suas diversas modalidades. Trata-se de um mergulho no microssocial, olhando com uma lente de aumento”<sup>3</sup>. Nesse sentido, busca-se adentrar o universo da comunidade indígena Pitaguary não somente pela observação, mas na própria imersão no campo pesquisado. Os processos mentais de um ser humano é complexo e diverso, por isso “devemos nos aproximar da realidade sociocultural do outro com nossos processos mentais comuns para entender seu produto sociocultural sempre diverso do nosso”<sup>4</sup>.

Na opinião do mesmo autor “umas das recomendações básicas para o etnógrafo no trabalho de campo é compreender o “outro” numa relação de constantes transformações cíclicas “do estranho em familiar” e do familiar em estranho”<sup>4</sup>. Para isso, “ao menos no que o consciente permite, é necessário que durante os momentos de estranhamento nas leituras do “outro”, esforcemo-nos em eliminar ao máximo nossas bagagens disciplinares e pré-conceitos”<sup>4</sup>.

Dessa forma, pretende-se realizar não apenas uma simples coleta de dados mas a “produção de dados” pelo convívio e estabelecimento de relações, cruzando olhares e ultrapassando estranhamentos de modo a transcrever a realidade da maneira mais fiel possível.

Com relação à natureza das fontes, a pesquisa se caracteriza como sendo de campo onde “o objeto/fonte é abordado em seu meio ambiente próprio. A coleta de dados é feita nas condições naturais em que os fenômenos ocorrem, sendo assim diretamente observados sem intervenção e manuseio por parte do pesquisador”<sup>3</sup>.

As técnicas de coleta de dados são a observação, as entrevistas abertas e semiestruturadas, com o intuito de melhor compreender a partir das falas dos entrevistados a relação da comunidade com suas práticas, o estudo documental, o instrumento do caderno de nota para registrar os sentimentos e a motivação dos atores no momento de execução de suas atividades e as fotos para o registro daquilo que se chama de “momentos extremamente ricos em que a imagem se fixa no tempo, uma fração do real, mostrando que um fato é único”<sup>5</sup>. O embasamento teórico do estudo foi realizado com a pesquisa bibliográfica, “a partir do registro disponível, decorrente de pesquisas anteriores, em documentos impressos, como livros, artigos, teses e etc. Utiliza-se de dados ou de categorias teóricas já trabalhadas por outros pesquisadores e devidamente registrados”<sup>3</sup>.

## III. POVOS TRADICIONAIS, SOCIOBIODIVERSIDADE E SUSTENTABILIDADE

O conhecimento tradicional diz respeito aos saberes e práticas de um povo acumulados e transmitidos de geração em geração. Tais conhecimentos possuem estreita relação com a biodiversidade e por essa razão foram definidos como o conhecimento que os povos tradicionais possuem sobre a diversidade biológica e suas propriedades, refletidos na cultura e nas práticas de cada povo<sup>6</sup>. O mesmo autor afirma que considera legítimo o direito de propriedade intelectual desses povos, tendo em vista que compõem uma coleção de invenções da mente e do espírito comunitário, repassados e aprimorados no decorrer do tempo. Como exemplos de populações tradicionais: os indígenas, os caboclos ribeirinhos, os quilombolas e os pescadores artesanais, onde a ocupação do espaço, a utilização dos recursos naturais e a produção agrícola são a base do trabalho familiar e voltadas para a subsistência<sup>6</sup>.

Uma outra definição diz que o conhecimento tradicional representa um “conjunto de saberes e saber-fazer a respeito do mundo natural, sobrenatural, transmitido oralmente de geração em geração”<sup>7</sup>. Isso por que nas sociedades tradicionais, especialmente as indígenas, o mundo natural, sobrenatural e social se inter-relacionam<sup>7</sup>.

Nesse contexto, merecem destaque o Decreto nº 6.040, de 7 de fevereiro de 2007, que instituiu a Política Nacional

de Desenvolvimento Sustentável dos Povos e Comunidades Tradicionais e reconhece os povos e comunidades tradicionais como grupos culturalmente diferenciados e a Convenção da Diversidade Biológica (CDB), assinada em 1992 na cidade do Rio de Janeiro durante a Conferência das Nações Unidas sobre Meio Ambiente. A CDB desempenhou um importante papel ao reconhecer a estreita e tradicional dependência de recursos biológicos de muitas comunidades locais e populações indígenas com estilos de vida tradicionais.

Esse reconhecimento encontra amparo no entendimento de que a diversidade biológica não se restringe ao meio natural, ela também adentra o âmbito cultural e social, tendo em vista que a biodiversidade faz parte de diversas maneiras da vida social e cultural das comunidades tradicionais e também da sociedade moderna. Em muitos casos os saberes surgem da evolução simultânea da sociedade e seus ambientes naturais<sup>7</sup>. “É a cultura enquanto conhecimento que permite às populações tradicionais entendê-la, representá-la mentalmente, manuseá-la, além de retirar espécies, colocar outras e enriquecendo assim a própria sociobiodiversidade ou etnobiodiversidade”<sup>8</sup>.

Esses povos possuem um profundo conhecimento sobre a natureza e seu ciclo adquirido pela considerável convivência com ela, como também conhecem bem os espaços físicos onde produzem economicamente e se organizam socialmente<sup>9</sup>. É essa notória conexão que os povos tradicionais têm com a biodiversidade que damos o nome de sociobiodiversidade. Esta, diz respeito ao modo como as diferentes culturas se relacionam com a biodiversidade<sup>10</sup>.

A sociobiodiversidade ressalta a convivência harmônica entre homem e natureza, onde o modo próprio de viver e produzir de cada comunidade tradicional não prejudica o meio ambiente.

A partir do estudo da sociobiodiversidade é possível compreender como as comunidades tradicionais se relacionam com a natureza, os benefícios dessa relação para ambos e entender como os conhecimentos sobre a biodiversidade vão sendo repassados de geração em geração através da oralidade; os mais velhos ensinando aos mais jovens como viver na natureza, como manipular seus recursos, como extraí-los, usá-los e conservá-los.

As experiências e saberes compartilhados ao longo do tempo fizeram desses povos tradicionais possuidores de uma incalculável bagagem cultural de cuidado com o meio ambiente. Ao direcionarmos nosso olhar para intensa e extensa degradação da natureza resultante da exploração desmedida dos recursos naturais, é possível entender mais claramente a importância deles na preservação da

biodiversidade e na sustentabilidade. Os povos tradicionais ao tempo em que se utilizam dos recursos naturais também os preservam, contribuindo para a manutenção de um meio ambiente ecologicamente equilibrado. Por isso, dar visibilidade ao conhecimento tradicional, ao mesmo tempo em que evidencia a importância dos povos tradicionais, contribui para a inclusão de coletividades excluídas historicamente, desafiando antigas concepções, herança de um Brasil colônia<sup>11</sup>.

Nesse contexto, merece destaque os povos indígenas, detentores de um vasto e profundo conhecimento sobre a biodiversidade, adquirido pela convivência diária com os elementos naturais e consolidado por meio da relação de dependência com a natureza. Diante da importância do conhecimento dos povos indígenas sobre a biodiversidade, assegurar os direitos desses povos é assegurar a sustentabilidade, pois eles protegem o espaço natural onde residem e preservam sua biodiversidade mesmo diante de todas as intimidações sofridas contra seu modo de viver<sup>12</sup>.

Em face da atual exploração dos recursos naturais para saciar o apetite consumista da nossa sociedade em detrimento da biodiversidade, será possível notar o quanto a cultura indígena tem sido expressiva para a sustentabilidade. Sobre tal questão, ao longo do tempo a sociedade foi adotando um modelo de vida resultante de uma “concepção” de que os recursos naturais são inesgotáveis. Desse modo, o mesmo autor alerta que é imperativa uma mudança cultural, dentro do conceito de sustentabilidade, pois dela depende a sobrevivência humana<sup>13</sup>.

#### IV. RESULTADOS E DISCUSSÕES

Tupi, Guarani, Tupinambá, Tapuia, Xavante, Kamayurá, Yonamani, Kadiweu, Txukarramãe Kaingang, Krahô, Kalapalo, Yawalapiti. São nomes que pisaram e pulsam no chão dessa terra chamada Brasil, formando suas raízes, troncos, galhos e folhas. Os indígenas que os colonizadores encontraram no litoral do Brasil, eram oriundos principalmente das tribos de tronco tupi e já viviam aqui alguns séculos antes. Estima-se que a população indígena do território brasileiro à época da chegada dos europeus, variava de dois a oito milhões de índios, dentre mil etnias diferentes<sup>14,15,7</sup>.

Quando os portugueses chegaram às terras do Brasil acharam o modo de viver dos nativos muito diferente daquilo que estavam acostumados. Em razão do olhar eurocêntrico, adotaram uma postura de superioridade em relação a eles. Por causa dessa postura, sentiam-se no direito de impor sua cultura aos nativos de qualquer

maneira, nem que para isso fosse necessário subjugar-los ou até matá-los<sup>16</sup>.

A discrepância entre a quantidade de índios do período colonial e da atualidade chega a assustar. É lamentável e ao mesmo tempo muito doloroso dizer, que a ocupação histórica do Brasil foi marcada pelo sangue do índio. A disseminação de epidemias, apropriação de territórios e submetimento genocida e etnocida das populações originais, alimentou até a década de 70 a crença no desaparecimento irresistível desses povos<sup>7</sup>.

Mesmo diante de todas as atrocidades sofridas eles não foram extintos. Apesar de representar apenas 0,2% da população brasileira, os aproximadamente 300 mil índios, constitui uma imensa sociobiodiversidade. São 206 povos indígenas com cerca de 180 línguas e sociedades diferenciadas, vivendo em milhares de aldeias espalhadas de norte a sul do país<sup>7</sup>.

Apesar de serem considerados extintos na segunda metade do século XIX pelas autoridades cearenses, os índios intensificaram sua luta pelo reconhecimento étnico cultural nas mais diversas localidades do estado do Ceará<sup>17</sup>.

Na cultura indígena, os rios, as árvores, os animais e a terra são parte da sua identidade ancestral. A natureza faz parte de sua família e por isso eles não se percebem sem ela. Assim como o viver na natureza e retirar dela o necessário para o seu sustento é algo natural, preservá-la também é algo que ocorre de maneira natural, espontânea, pois está interiorizada e exteriorizada na cultura, na memória e na relação de interdependência. Uma característica marcante dessa cultura é o respeito aos ciclos naturais e à capacidade de recuperação da biodiversidade. Trata-se de uma cultura que valoriza a sustentabilidade mais do que a exploração econômica, pois enxerga a natureza através de uma simbologia ancestral. Para o índio, o sistema de manejo dos recursos naturais se baseia em um complexo conjunto de símbolos, mitos e conhecimentos empíricos<sup>7</sup>.

Diferentemente, para o colonizador a única coisa que o movia ao olhar para a exuberante biodiversidade brasileira era a ânsia por encontrar riqueza, que se intensificou a partir do momento em que percebeu a vastidão territorial e o potencial natural da terra recém-descoberta. Aos poucos, a linguagem nativa foi sendo substituída pelo idioma do colonizador, suas práticas religiosas e culturais foram sendo difundidas violentamente. Os “índios”, como foram chamados, passaram de livres para escravos, de caçadores para caça. O encontro com os portugueses “mudou total e radicalmente seu destino, foi a introdução no seu mundo de um protagonista novo, o europeu. Embora minúsculo, o

grupelho recém-chegado de além-mar era superagressivo e capaz de atuar destrutivamente de múltiplas formas”<sup>15</sup>.

A chegada do europeu representou uma nova formação no plano étnico-cultural, um novo povo formava-se da língua e costumes dos índios, negros, e europeus. Era o povo brasileiro que nascia da mistura dessas matrizes à medida que elas se desfaziam<sup>15</sup>. Ao longo da história, os colonizadores buscaram de diversas formas aculturar os povos indígenas, e não só eles, mas também os afrodescendentes.

Apesar de todo o esforço dos colonizadores, esses povos resistiram bravamente para manter viva sua cultura e transmiti-la para seus descendentes, pois apesar da toda a violência sofrida, cultural e física, e do genocídio, “a memória e os traços identitários étnico-culturais desses povos nativos ainda podem ser encontrados nos mais diversos rincões deste país por meio do patrimônio histórico-cultural”<sup>18</sup>.

Mesmo considerando o índio um “ser inferior” culturalmente, seus saberes e sua cultura não foram totalmente desprezados pelos europeus, na verdade tornaram-se essenciais para o colonizador português que frente ao desconhecido, utilizou diversas técnicas, costumes e conhecimentos da cultura indígena para sobreviver nas matas e florestas do Brasil<sup>7</sup>. Desses preciosos conhecimentos podemos citar, por exemplo, na alimentação, que naquela época baseava-se no plantio de diversas culturas: o milho, a mandioca, a abóbora, o feijão, o amendoim, a batata-doce etc. Nas coletas de frutas nativas: o maracujá, a pitanga, a goiaba, a banana, o caju. Além da caça e pesca. Há ainda a adoção de técnicas de plantio indígenas (roça consorciada, itinerante, com base na queimada, tipo “slash-and-burn”), de artefatos como as peneiras, os pilões, o ralo, o tipiti e outros implementos que fazem parte da cultura rústica brasileira<sup>7</sup>.

É incontestável o legado cultural indígena e é inquestionável sua riqueza. A enorme quantidade de elementos herdados da cultura indígena está enraizada nesse Brasil de norte a sul, com “[...] as técnicas de fabrico e uso de canoas, da jangada, de tapagem, redes e armadilhas de pesca, de cobertura de casas rurais com material vegetal, o uso da rede para dormir etc.”<sup>7</sup>.

O índio tem genialidade e espírito criativo, não se pode usurpar sua contribuição cultural e social, pelo contrário, é indispensável reconhecer de forma mais efetiva sua participação cultural e social na história desse país.

Tudo que o índio queria era simplesmente continuar sendo “um ser livre” na sua terra, mas a opressão do colonizador foi tão grande que muitos povos indígenas adentraram o Brasil ocupando novas terras. Um dos grandes responsáveis pela ocupação indígena no Brasil



foram os aldeamentos jesuítas que mais tarde foram transformados em vilas pombalinas, conhecidas como as vilas dos índios no Brasil<sup>19</sup>.

Na capitania do Ceará grande, os aldeamentos jesuítas transformados em vilas pombalinas foram Aldeia da Caucaia, Aldeia da Parangaba, Aldeia da Paupina, Aldeia da Paiacu e Ibiapaba que se transformaram respectivamente em Vila de Soure, Vila Nova, Vila de Arroches, Vila de Mecejana, Vila de Monte-Mor e Vila Viçosa Real<sup>19</sup>. Darci Ribeiro acreditava que a passagem da aldeia para vila não introduziu as populações indígenas na sociedade, longe disso, percebeu-se que o índio passou a viver ao lado das cidades que se formavam ao redor dos aldeamentos sem mesclar-se a elas<sup>20</sup>.

Atualmente muitas comunidades indígenas vivem em zonas rurais periféricas aos grandes centros urbanos sobrevivendo da caça, da pesca da colheita de frutas, do artesanato, da agricultura e etc. Também é importante mencionar que muitos grupos indígenas estão localizados em zonas urbanas, onde vivem, em muitos aspectos, de modo similar ao do “não índio”, entretanto, preservando ainda inúmeras práticas, ritos e crenças ancestrais.

Apesar de diversas etnias indígenas viverem em áreas urbanizadas, sua cultura permanece viva, suas práticas com a natureza também e por essa razão uma das suas maiores reivindicações é pela posse da terra para praticar suas ritualidades e perpassar seus conhecimentos aos seus descendentes.

Os povos indígenas foram vítima do colonizador opressor no passado, e no presente continuam sendo vítima da indiferença da sociedade civil e do poder público que demonstram pouco interesse em desenvolver políticas públicas mais eficazes que valorizem a cultura indígena que tanto contribuiu na formação desse país, garantindo a posse de suas terras e proporcionando condições dignas de vida para a população.

É notória ainda a dificuldade em reconhecer a importância da cultura indígena na formação social e cultural do nosso país. Reconhecer não somente a contribuição histórica, mas também a atual, pois esses povos ainda residem, resistem e mantêm vivas suas tradições, sua cultura e suas práticas. Um exemplo disso é a comunidade indígena Santo Antônio do Pitaguary, localizada no município de Maracanaú, na localidade conhecida por Santo Antônio.

Os Pitaguary residem ao pé da serra entre Maracanaú e Pacatuba<sup>1</sup>; sobrevivendo principalmente da caça, pesca e do plantio de milho, feijão, mandioca, jerimum e outras culturas. Além disso, são detentores de um amplo conhecimento sobre ervas e plantas medicinais. Também

são peritos na fabricação de “colares, pulseiras e brincos feitos com penas, sementes, coco e palha”<sup>1</sup>.

Os artesanatos são produzidos com a matéria-prima extraídas na própria localidade, além de lindas peças de cerâmica pintadas a mão, onde o barro é extraído na própria aldeia e a tinta é produzida pelos próprios índios a partir de sementes e plantas nativas. Chama atenção também os bordados produzidos pelas mulheres da aldeia (o fuxico e o crochê), as roupas confeccionadas com a fibra do tucum e as bolsas e cestos feitos de palha, além dos adornos usados nas festividades feitos de fibras vegetais e penas de aves criadas na comunidade. Esses são apenas alguns exemplos das práticas desenvolvidas na comunidade Pitaguary.

A comunidade e o açude receberam o nome de “Santo Antônio” por causa de uma história contada pelos mais antigos a respeito de uma imagem de Santo Antônio que aparecia no “buraquinho”, localizado próximo ao açude<sup>21</sup>. Ainda conforme a história, a autora relata que, quando a imagem era retirada e colocada na capela, construída especialmente para ela, sempre voltava misteriosamente para o buraquinho. O fato chamou a atenção de muitos e o lugar de tornou sagrado sendo visitado pelos devotos do santo<sup>21</sup>.

Descendentes dos Potiguaras, as terras atualmente habitadas pelos índios Pitaguary já eram habitadas por seus antepassados. Formada por um povo gentil o hospitaleiro, a comunidade reside nessas terras há muitos anos, mas somente no ano de 2000 teve suas terras delimitadas conforme o Relatório da Fundação nacional do índio de 03 de julho de 2000, o que representou uma grande conquista para esse povo<sup>22</sup>.

Um das ações que contribui para a demarcação das terras indígenas dos Pitaguary, foi o reconhecimento e o apoio do poder público de Maracanaú, por meio da promulgação da sua lei orgânica, em 10 de abril de 1990, onde declarou-se o absoluto respeito ao povo indígena e seus descendentes, e a moção de apoio ao Povo Pitaguary publicada, em 1993, pela Câmara Municipal de Maracanaú<sup>22</sup>.

Para o índio a terra é um lugar sagrado onde conserva suas memórias, sentimentos, símbolos e tradições. Nela, eles refletem não só sobre os seres vivos e não vivos que compõem os espaços, mas também os elementos imaginários e seus significados. A mangueira, por exemplo, considerada sagrada, símbolo da mãe natureza, é uma memória viva na cultura Pitaguary. O toré, dança sagrada, representa a união do povo, sendo uma das manifestações mais importantes<sup>21</sup>.

Os seres encantados também entram no universo imaginário Pitaguary, como a caipora protetora da mata,

diz a lenda que ela só dava permissão para caçar àqueles que deixassem um punhado de fumo para ela<sup>21</sup>.

É a partir dessas e de outras narrativas que segundo a autora Pinheiro “se torna possível para os membros Pitaguary cristalizar a ideia já presente no imaginário de simbiose entre o mundo humano e o mundo natural. Essa simbiose é que permite colocar para e a partir do índio a função de “salvador” da floresta, dos rios, dos solos, enfim da terra”<sup>21</sup>.

A terra para o índio é um cenário mágico, repleto de encantos, que traz para a alma o sentimento de pertencimento e de autoconhecimento. É o lugar onde o índio planta, colhe, cria, sofre, luta, enfrenta batalhas e guarda suas memórias como o seu tesouro mais precioso. E são essas memórias a fonte que brota as narrativas que se espalham através do tempo, dos espaços repletos de significados, das atividades de caça, pesca e agricultura, das histórias de infância, dos guerreiros, caçadores, pajés, curandeiros, das lendas de caipora<sup>21</sup>.

Além de terra, da cultura, das memórias, da natureza, o índio precisa de saúde, de educação, segurança, trabalho, respeito, direitos. O índio precisa de políticas públicas que os alcance, considere suas singularidades e proporcionem qualidade de vida para essa população.

## V. CONCLUSÕES

Nessa pesquisa, pretendeu-se discutir como a cultura indígena permanece viva por meio das danças, símbolos, ritos, memórias, festas, manifestações artísticas e práticas. A amostragem inicial desse estudo indica que a comunidade Pitaguary guarda um rico patrimônio cultural sobre a biodiversidade, transformando-a em ações que geram trabalho renda e sustentabilidade.

Por isso esse estudo buscou reafirmar a importância dos povos indígenas principalmente no que diz respeito a uso dos recursos naturais e trazer uma reflexão sobre o que podemos aprender com eles, com seus saberes, costumes e práticas para a preservação da biodiversidade e sustentabilidade.

Defronte a descontrolada exploração dos recursos naturais, a sustentabilidade se mostra um caminho para se construir culturalmente uma consciência socioambiental de respeito ao meio ambiente, entretanto, esse caminho possui muitos desafios. Mas o que se mostra um desafio para a “sociedade moderna”, para os povos indígenas é parte de sua identidade cultural, o que nos leva a refletir sobre a importância deles para a preservação da biodiversidade e para o incentivo à sustentabilidade.

A Constituição Federal, lei máxima de nosso país, em seu artigo 231, trata a respeito do reconhecimento da

cultura indígena quando declara que “São reconhecidos aos índios sua organização social, costumes, línguas, crenças e tradições, e os direitos originários sobre as terras que tradicionalmente ocupam, competindo à União demarcá-las, proteger e fazer respeitar todos os seus bens”<sup>23</sup>. Sendo assim, cabe ao estado e ao povo brasileiro buscar proteger e valorizar a cultura dos povos indígenas.

Diante do exposto, é inegável como a cultura e a memória ancestral indígena estão presentes nas práticas da sociobiodiversidade e como eles refletem a sustentabilidade. Considerando a importância de seus conhecimentos tradicionais na preservação da biodiversidade, valorizar a cultura indígena e dar visibilidade às suas práticas de preservação da natureza, consiste em uma estratégia de conscientização ambiental.

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# Improving the Voltage Stability of the Nigeria 44- Bus 330KV Power Transmission Network using ANN Based Adaptive STATCOM Device

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**Keywords**— ANN, Eigenvalue, Modal,  
participating factor, STATCOM, Voltage  
Stability.

**Abstract**— This paper is targeted on the improvement of the Nigeria 330kV 44Bus network voltage stability using ANN based adaptive STATCOM. The three-phase version of the test network was modelled in MATLAB-SIMULINK for simulations. Using the data obtained from the Transmission Company of Nigeria (TCN), Oshogbo and simulation data; ANN based adaptive STATCOM was developed, trained and deployed to the Test network for compensation of the weak section of the network. Results and analysis of simulations shows that the test network is unstable as the modal analysis revealed the presence of eigenvalue with a negative real part. Yola bus was discovered to be the most vulnerable bus with the highest participating factor and a voltage profile (of 0.83pu) less than acceptable lower limit of 0.95pu. The connection of ANN based adaptive STATCOM improved the stability of the network by enhancing the voltage profile of the network's weakest bus by 22.9%. It was concluded that ANN based adaptive STATCOM was effective in improving the stability of the Nigeria three phase transmission grid network.

## I. INTRODUCTION

The Nigerian 330kV transmission network is characterized by poor generation, poor infrastructure, aged equipment, inadequate transmission capacity and poor maintenance culture. The above inadequacies together with other usual power system contingencies (change in loads, switching actions, loss of generation faults etc) have continued to impact negatively on the stability and security of the power networks. The implications of sustained poor system security and instabilities on the power network is that the power network becomes prone to frequent and long outages, loss of loads, cascaded outages and eventual voltage collapse. Long and frequent outages, or worse still blackouts, have adverse effects on both system equipment

and users. Inadequate power supply impacts negatively on socio-economic development of the users. On the other hand, frequent power interruptions can lead to failure of some system equipment, thereby increasing cost of operation of the system (Aneke & et al, (2021), Aneke & Ngang(2021), Ezekiel & Engla (2019))

Power system stability is the capacity of a power system to maintain an operating equilibrium condition after experiencing a physical disturbance (relative to an initial operating condition) such that the system integrity is preserved by keeping most system variables bounded (Kundur, 2004). The above definition suggests that for a power system to remain stable, it should have the ability to adjust and function successfully after undergoing small



and severe disturbances such that system variables like voltage magnitude and angle, current, active and reactive power losses etc remain within the limit of their acceptable values. On the other hand, an unstable system is unable to adjust and function successfully in the event of physical disturbances. Such systems are characterized by a sustained rise in system parameters mentioned above. The consequence of sustained increase in system parameters is cascaded blackouts and eventual system collapse. With the help of stability analysis of power system, it is possible to determine the limits within which the system can operate and the necessary control actions that can be taken to expand the stability boundaries of the network such that normal operating conditions of the system is restored even in the face of high magnitude disturbances (Iyidobi, 2018). In power systems, normal operating conditions demand that all buses remain at approximately the same voltage level and within an acceptable range of 0.95 pu and 1.05 pu. Under normal operation, a system should maintain steady voltage at all buses. Flexible Alternative Current Technology systems (FACTS) devices are power electronics-based power system compensators that are strong, flexible and fast switching. They have been successfully applied in voltage stability enhancement of multi-power system. Static Synchronous Compensator (STATCOM) has been identified as one of the most effective member of the FACTS device family as far as enhancing voltage profile and voltage stability of stressed transmission networks are concerned. STATCOM enhances voltage profile of network buses by providing adequate reactive power support at weak buses. In this thesis, STATCOM shall be used as the compensating device for enhancing voltage stability of the Nigerian 330KV 44bus transmission network. To enhance real time performance of the STATCOM, a properly trained Neural Network model shall be connected to the STATCOM to make its compensation effect adaptive to changes in the network operating conditions.

## II. LITERATURE REVIEW

### VOLTAGE STABILITY

The power system's ability to sustain continuous voltages at the entire system buses following a subjection to disturbance/contingency from a specified original operating state is referred to as voltage stability. Instability that may arise occurs in the form of a progressive fall or rise of voltages of some buses. Possible outcome of voltage instability is loss of load in an area, or tripping of transmission lines and other elements by their protective systems leading to cascading outages. Loss of synchronism

of some generators for example, may result from these outages.

Progressive drop in bus voltages can also be linked / associated with rotor going out of step i.e (rotor angle stability). For instance, at midpoints of a power network around to an electrical centre, the synchronism loss of machines which approach 180 degrees causes a sharp drop in voltage at these points. (Smith, J.D, 2002).

The function of protective systems is to enable voltages return to convenient levels, and also to split two machine groups; the former however depends on the state of the system after the separation.

The major factor that contributes to the instability of voltage is voltage reduction that occurs due to reactive and active power flowing across an inductive reactance linked to the transmission system. It also limits the power transmissibility possessed by a given transmission network. In the same way, when certain generators reach their armature winding or field time –overlap capacity limit, the power transfer ability in turn, becomes limited. Load is the main driving force for instability of voltage. The power consumed by the load when a perturbation or disturbance occurs is restored through the activities of some components such as the regulators of the distributive voltage, thermostats, motors, and tap-changing transformers.

Voltage minimization is further ascribable to increase in the stress of the high voltage (HV) network stress caused by restored loads. Another scenario that triggers instability of voltage occurs when loading dynamic attempts to reverse the power consumed above the capacity of the connected generation and the transmission network, hence a condition with a prolonged reactive power imbalance results (Smith, J. D (2002); Taylor C.W. (1994); Gao B. *et al.* (1996)).

Voltage stability is a term used to describe the capability of a power system to sustain after a perturbation or during steady state, constant voltages in the power system (Kundur, 1994; Kundur, 2004). This is analogous to the capability of the transmission and generation system to keep up with the dynamics of the load (Cutsem, 1998). Considering the system mechanism, voltage stability can either be a disturbance which is large or small. This means that the voltage stability phenomenon can either be short-lived or long term. The focus of the research work on this paper is long term voltage stability

From Kundur's definition of voltage instability, it can be deduced that lack of voltage stability is voltage instability and it is a consequence of unsteady unacceptable voltages.

The second definition is that “Voltage instability comes to play when there is an attempt by the load dynamics to reverse consumption of power above the required capacity of the combined generation and transmission system.” (Cutsem, 1998)

The above definition highlights the major reason for voltage instability; that is, load dynamics which seek to return operation beyond the grid’s capacities. However, this definition does not directly proffer measures for the evaluation of the stability of voltage in the system. Nevertheless, this definition is more unambiguous than the first one: in a case where minimized voltages can possibly be caused by instability of the rotor angle, it then follows that there is also a need to establish whether instability of the rotor angle is a causal effect of voltage instability or vice versa.

These two definitions will be used in this paper since they address different aspects and therefore do not contradict each other.

Kundur’s definition shall here-in be referred to as the voltage stability definition which is symptom based. In the same way, Van Cutsem’s and Vournas’ definition is tagged a voltage stability cause-based definition.

Recalling the definition of a power system’s stability in the introductory section; Stability of a power system entails the capability of an electrical power system which operates under specified initial conditions to return this system to its equilibrium state after the power system’s subjection to physical perturbation. This happens with most variables of the system being bounded so as to maintain the integrity of that power system. In other words, the integrity of such power system is conserved. In practical sense, the system’s integrity is said to be conserved when the power system is entirely intact without loads or generators tripping, apart from those that are either tripped intentionally or those ones that are isolated as a result of faulty elements as a means of safeguarding the operation of the remaining sections of the system.

The power system is to a great degree, a non-linear system whose operational environment, generator outputs, loads, and major functional parameters change constantly. More so, in the presence of a disturbance, the system’s stability is dependent on some factors, such as: initial operating conditions, and nature of the system’s motion around an equilibrium position. The different operating forces which exist in this system are instantaneously equal to one complete cycle or above a cycle in the equilibrium set.

The power system is usually bombarded with various amounts of disturbances, ranging from small to large. Load variation disturbances are considered as small disturbances, although the system has to be made in such

fashion that it can easily adjust to these varying conditions so as to function properly. In addition to that, it is imperative that the system must be designed to be able to overcome large disturbances with more serious consequences, some of which include large generation loss and short circuiting of a transmission line. One of the features of large disturbance is that as a result of faulty components being isolated, structural changes may occur.

The nature of a physical disturbance of a power system at equilibrium set determines whether or not the system may be stable or unstable. It then goes without saying that it is impossible and a waste of resources to model a power system that will be stable for all contingencies. Usually, the contingency design is chosen based on how high the probability of its occurrence is. Evaluation of the stability of large disturbance involves nonlinear effects that render the linearization of equation inapplicable.

The power system’s response to perturbation may be attributed to the equipment in use. For example, the isolation of a critical component by a protective relay due to its faultiness will result to a power flow variation, change in the machine’s rotor speeds and variation in the network bus voltages; the voltage regulators of the transmission system and the generator will both be actuated by voltage variation; also, speed variations of generators will activate prime mover governors. Variations of frequency as well as voltage affect the loads of the system also to different degrees which is a function of their features. Other protective devices may react to changes in variables of the system and may thereby cause the equipment of the circuit breaker to skip, which in turn weakens the given system and consequently can result to instability of the system.

However, it is observed that systems frequently experience little magnitude of power/voltage fluctuations of small magnitude. Therefore, to assess the stability of a system when a specific disturbance is induced, it is right to assume that the actual operating condition of the steady-state is in its original state.

#### **Static Synchronous Compensator (STATCOM)**

This device is the shunt element in the UPFC. It has found wide application in FACTS, and its main purpose is to support the working potential difference of the bus to which it is electrically installed and maintain stability of the dc-link capacitor voltage.

This device is designed with a matching transformer with parallel connection orientation to the transmission line, an inherent commutated switching power converter and a DC link as shown below.

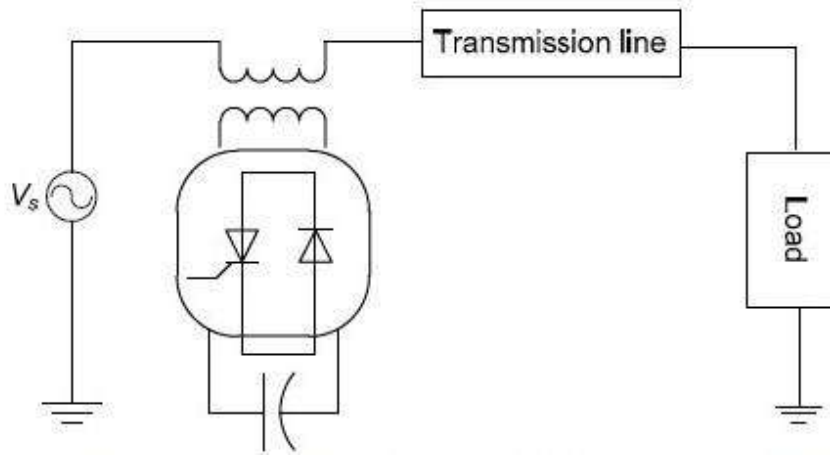


Fig.1: A STATCOM controlled two-bus network; Source: (Shakarami and Kazemi, 2010)

A DC input supplied to the circuit is converted to AC at the output. This controls the real power and as well the reactive power developed in the network. It also provides reactive power and controls active power flow, thereby enhancing the PTC of congested grid(Shakarami and Kazemi, 2010). In steady state analysis, the substitution of active power between the STATCOM and the transmission system can be neglected. Hence reactive only circulates between them (Zhang *et al.*, 2004).

STATCOMs generally, do not need many reactive components in order to inject reactive power (either capacitive or inductive) to high voltage transmission network, unlike SVCs. One colossal advantage of this device is that it requires smaller area and higher reactive power output at a low voltage transmission line since it

acts an independent current source. More so, considering the dynamic stability, STATCOM affords a better suppressing behaviour than SVC since it can exchange active power with system transiently.

**Artificial Neural Network**

Artificial neural network (ANN) is a generic nomenclature for a set of computing systems that closely operates like a human brain. When the interconnected units or nodes (artificial neurons) of the ANN are determined, each input signal is weighted, summed together, and transferred to an activation function which is used to represent the neurons in the biological brain. At the nodes, signal strength is either increased or decreased. Usually, neurons are divided into different layers, and these layers may transform differently on their inputs as shown in figure 2.

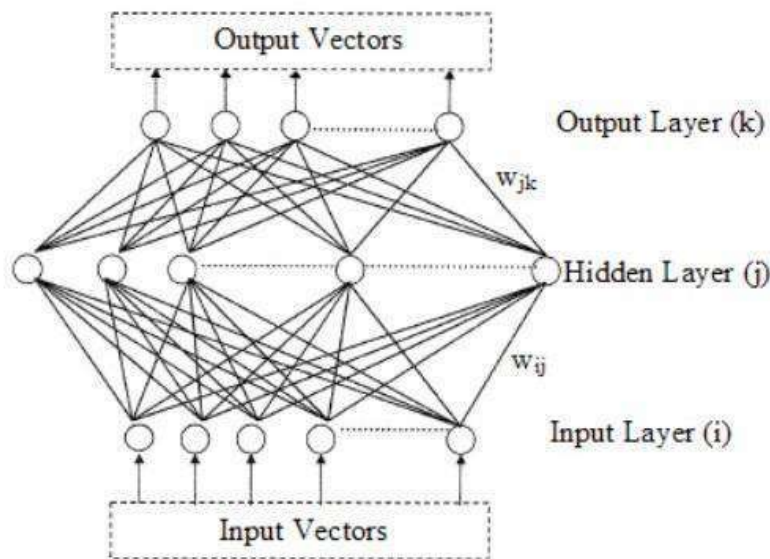


Fig.2: Typical ANN architecture model; Source: (Abu-Siada *et al.*,2010)

Each connected neurons transmit a signal like synapses to other neurons when the output signal exceeds the threshold limit of the neuron; and by considering several examples, the connected systems learn to perform tasks without being explicitly programmed to follow certain protocols or specific task routines. This unusual trend can be seen in the technology which recognizes image; where the ANN trains itself to recognize images explicitly labeled “human face”. However, the system can use the results obtained to identify the human face in other images. They do these without prior knowledge of human beings. This occurs because the system has automatically generated identifying features from the examples that they have learned.

O. Borazjani, M. Roosta, K. Isapour, and A. R. Rajabi (2015) proposed a fast technique to monitor and improve power system stability. They used an ANN-based method. In their work, they trained three layers feed-forward ANN along with back-propagation to give an optimum rescheduling of reactive power control variables needed to maintain voltage stability in the continuous utilization of the power system network; and, excitation generators, switchable VAR compensators, and OLTC transformers are used as reactive power control variables.

They make use of LP technique to determine the training data by solving various system conditions and implemented this method on a modified IEEE 30-bus test system. The results obtained indicate that at a high level of precision and speed, the ANN approach can enhance voltage stability in the power systems from a minimum range to a maximum range of load changes. A. Abu-Siada, S. Islam, and E.A. Mohamed (2010) proposed an improved technique for the on-line prediction of OLTC transformer configuration, and they also analyzed the maximum power

to the load center. In their work, IEEE Six-bus power system was employed to evaluate the method, and the numerical results obtained indicate that the function of the OLTC transformer imposes a colossal effect on the highest limit of the power transfer as well as the stability margin.

### III. METHODOLOGY

#### STATCOM SIMULINK MODEL

The basic building block of the STATCOM is a Voltage Source Converter (VSC) and the device is shunt connected to the test network through a coupling inductance. The coupling inductance can be a transformer or a reactor if the device is designed for direct connection to the bus bars voltage level. In this paper, the coupling inductance is a transformer. The STATCOM was modeled as an AC-voltage source to enable the magnitude, the phase angle and the frequency of the output voltage to be controllable.

To achieve this objective, a new model work space is created in Power System tool box (PSAT) Simulink environment. From PSAT library, the required component blocks (including transformer, voltage source converter, capacitor etc) are imported into the newly created work space. Each of the blocks is configured to reflect their ratings. At the end of the configuration, they are then linked together to form the STATCOM model.

Simulation is performed on the developed model to ensure that the model will perform as expected when connected to the test network. Simulating the STATCOM model is essentially to correct the error (s) that might pop up during the main simulation. Finally the model is saved to file for later use. The developed STATCOM MODEL is as shown below in figure 3 below.

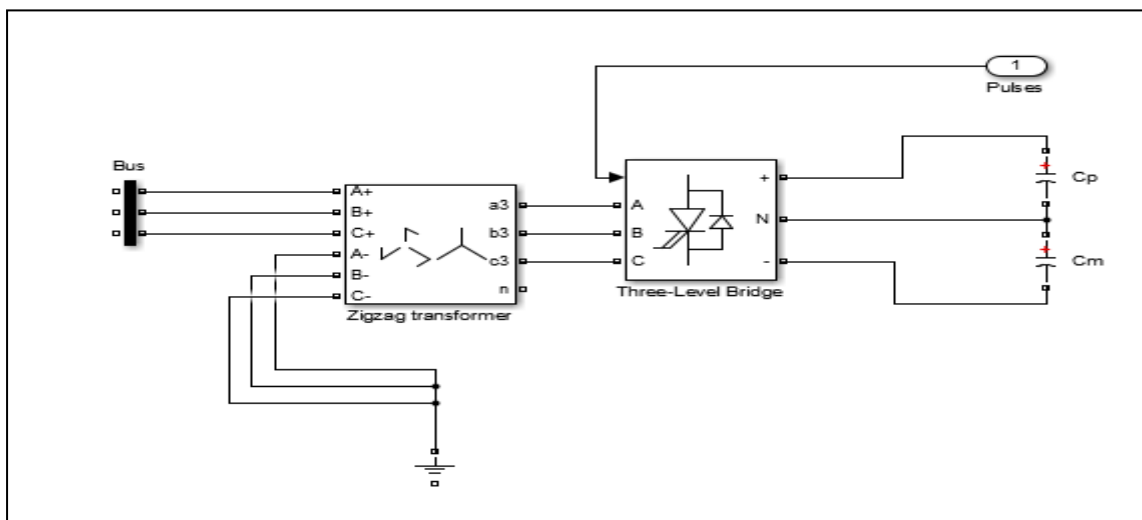


Fig.3: STATCOM simulink model



**STATCOM CONTROL STRATEGY**

The STATCOM is modeled as a voltage source inverter (VSI). Here the VSI converts direct current input voltage from the capacitor to AC output voltage supplied to the network bus. The output voltage supplied to the network bus helps to compensate active and reactive power demand at the bus where STATCOM is connected. Fig.4 shows the basic structure of ANN controlled STATCOM. The bus voltage and angle can be adjusted by controlling the injected real and reactive power at the AC network bus.

The expression for this injected real and reactive power at AC network bus as deduced by Ahmadi and Alinezhad (2009) is adapted for this modeling and is given below:

$$V_{dc} = \frac{-R(Q^2 + P^2)}{CV^2 \times V_{dc}} - \frac{V_{dc}}{CV} + \frac{P}{CV_{dc}} \quad (1)$$

The injected power at the AC network bus can be represented as:

$$P = V^2G - KV_{dc} VG \cos(\theta - \alpha) - KV_{dc} VB \sin(\theta - \alpha) \quad (2)$$

$$Q = V^2B - KV_{dc} V B \cos(\theta - \alpha) - KV_{dc} V G \sin(\theta - \alpha) \quad (3)$$

Where  $K = \sqrt{\frac{3}{8m}}$

- P= AC bus real power
- Q= AC bus reactive power
- V= Magnitude bus voltage
- V<sub>dc</sub> =Capacitor voltage
- G= Conductance of the system
- θ= Voltage angle
- α= Firing angle of GTO
- B= Susceptance of the system
- K= Constant

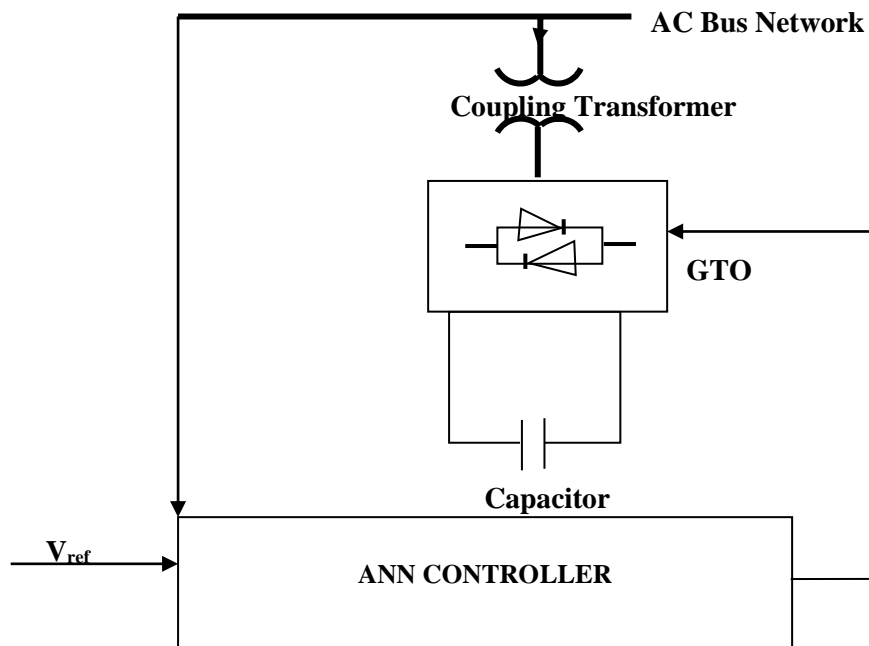


Fig. 4: Structure of ANN Controlled STATCOM

From equations 1 and 2 it can be seen that the injected real power (P) and the reactive power (Q) at the AC network bus are functions of the firing angle ‘α’. This implies that to adjust the injected active and reactive power (P&Q) and hence the AC voltage; the firing angle of the thyristor in the STATCOM need to be adjusted. The control strategy is

therefore to use a trained ANN controller that can sense the AC voltage and compare it with the reference voltage and then adjust the voltage closer to the reference value. By doing this, the voltage stability of the network is enhanced and voltage collapse in the network mitigated.

**DEVELOPMENT OF ARTIFICIAL NEURAL NETWORK (ANN) ADAPTIVE CONTROLLER FOR THE STATCOM**

By varying the value of the firing angles/pulses of the STATCOM bridges, STATCOM can enhance or reduce voltage profile of buses depending on the nature of compensation needed at the buses. In event of low voltage profiles at buses, STATCOM is able to enhance the voltage level but during over voltages, STATCOM is also able to reduce voltage level at the affected buses. The adaptive capacity, intelligence or control action required by STATCOM to adjust the firing angles/pulses of its bridges so as to respond adequately to the challenges of the network is provided in this work by an ANN adaptive controller. To effectively make the STATCOM compensation adaptive to the changes in the network, the ANN adaptive controller is rigorously trained with bus voltages from load flow and compensating firing angles/pulses from STATCOM.

To obtain the training data for the neural network, the three phase test network will be simulated under different working conditions to obtain optimum voltage profile values as well as ones below the minimum accepted value of 0.95 at the weakest bus with no STATCOM connected.

STATCOM was then connected to the three phase test network. The firing pulses/angles of the STATCOM is then adjusted so as to keep the voltage profile of the weakest bus within acceptable range of 0.95pu to 1.0pu. The voltage values obtained in the first simulation (without STATCOM) and their corresponding firing angles/pulses in the second simulation (with STATCOM) form the input and target training data respectively.

To develop the neural network for making the STATCOM adaptive, the ANN fitting application environment is opened in Matlab. From the ANN fitting application environment, the ANN is created with three inputs ( $V_a$ ,  $V_b$ ,  $V_c$ ) and 48 outputs representing the firing pulses. After creating the network, the input and target data already preloaded in the Matlab workspace is used to train the network. The training of the adaptive ANN was done offline.

After a successful training using Levenberg-Marquardt algorithm, the trained network is then deployed into a Simulink model and its code generated. The developed simulink model and its network architecture are as shown in figure 5 and 6 respectively below. It is this Simulink model of the trained ANN that is connected to the STATCOM to make it adaptive.

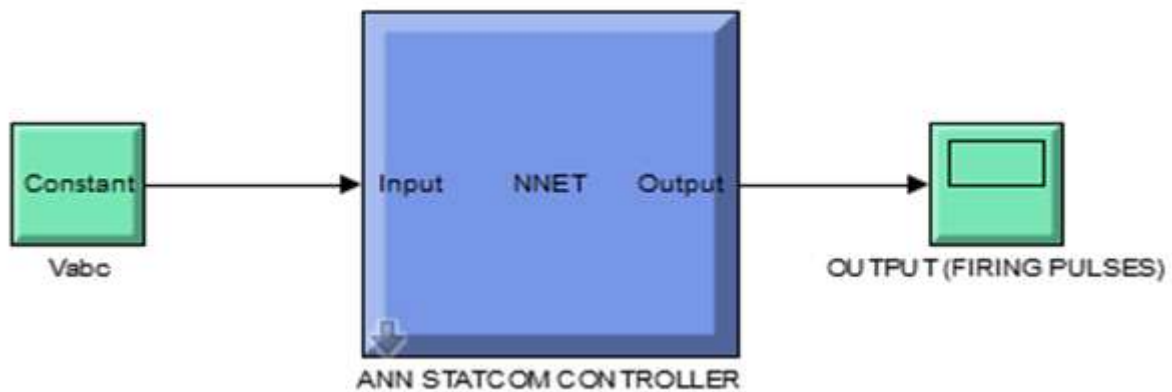


Fig.5: Simulink model of ANN BASED ADAPTIVE STATCOM

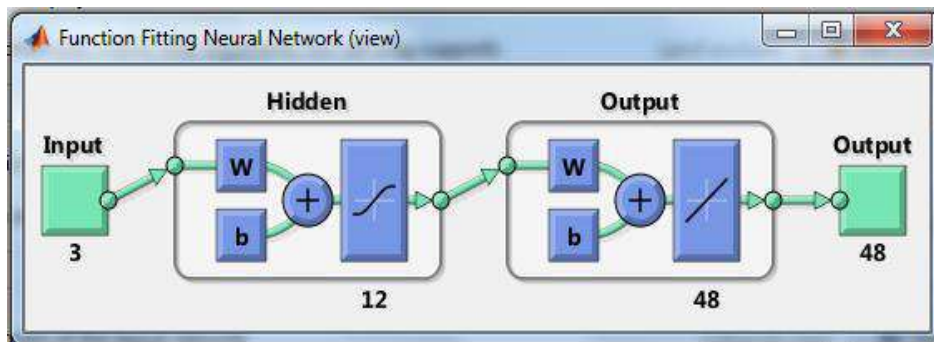


Fig.6: Architecture of the ANN BASED ADAPTIVE STATCOM

There is need to develop the three phase version of the PSAT simulink model of the test network as it will be cumbersome to handle this large number of buses in three phase network without this reduced version. This became necessary because of the need to perform real-time simulation on the test network which the PSAT simulink model can't perform.

To overcome this uphill task, the test network was divided into three sections: one section is the section which contains the weakest bus (Yola) and the other two sections were modeled into two equivalent networks as shown below in figure 7.

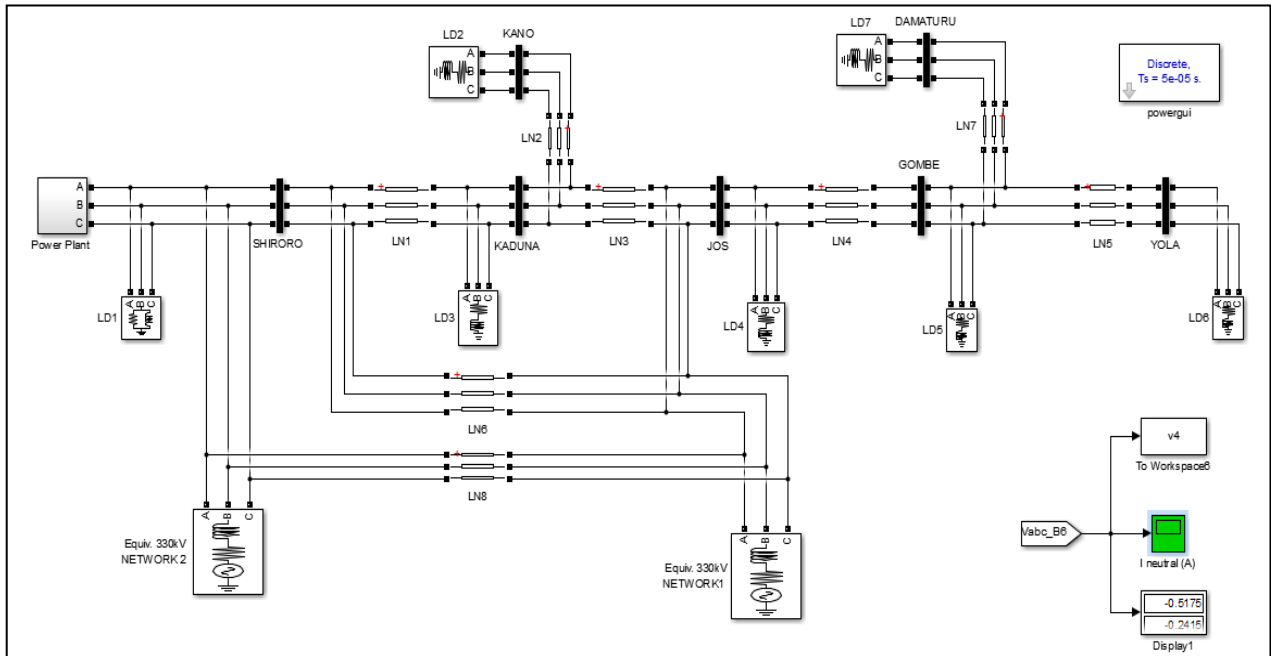


Fig.7: Reduced Version of the three Phase Simulink Model of the Nigerian 330kV Transmission Network.

#### IV. RESULTS AND DISCUSSIONS

##### Determination of the Stability of the Test Network Using Modal Analysis

From the plot of the system's eigenvalue in figure 8, it can be seen clearly that without STATCOM the system had an eigenvalue with a negative real path for the base case. This implies that at normal condition, the system is unstable.

There is therefore need to connect a compensating device so as to enhance the stability of the network and thereby preventing the network from moving to collapse point. This is achieved by moving any negative real part of the eigenvalue to the positive part.

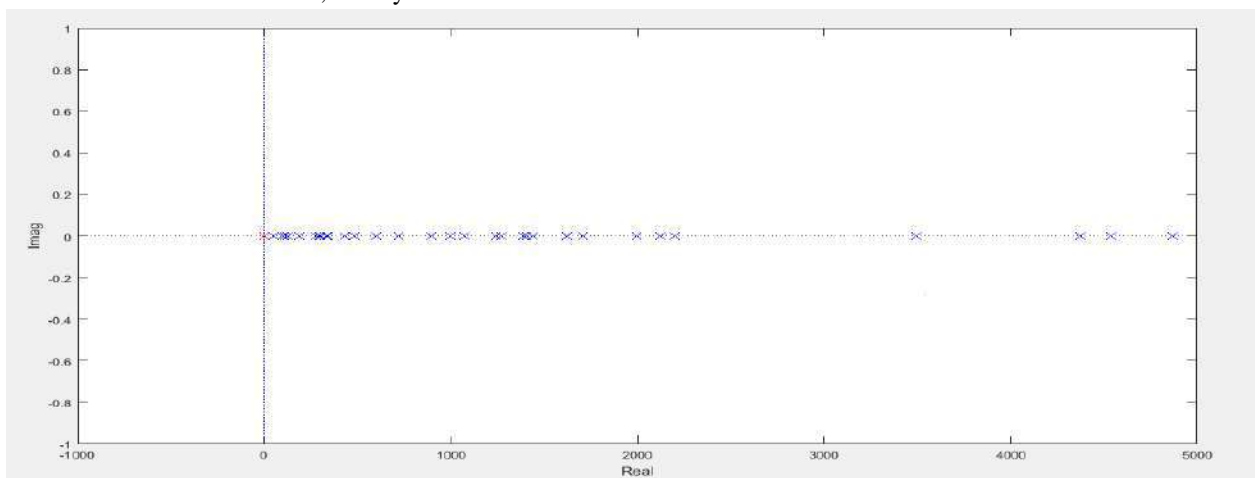


Fig.8: Plot of real and imaginary part the system eigenvalue for normal working condition.

**Determination of the weakest bus (es) of the test network using the participating factors**

Appendix 2 shows the respective participating factors for the identified critical modes of the base case presented in appendix 1. From appendix 2, it can be seen that for the highest participating factor values was 0.309011 corresponding to Yola bus. Since Yola has the highest participating factor, Yola bus is adjudged the weakest bus. This implies that the activities at Yola Bus contribute most to the networks instability. The above result indicates that compensation on the network shall be implemented on the Yola bus. The adaptive STATCOM will therefore be installed at Yola bus for effective compensation in the entire network.

**Evaluation of the performance of the adaptive STATCOM**

The performance of the adaptive STATCOM compensator and its controller shall be done by comparing the voltage profile of the weakest bus (Yola) without compensation with the voltage profile with adaptive compensation. In the earlier section, Yola bus was spotted as the weakest bus. Voltage stability of the network will be restored if compensation on Yola bus brings its voltage profile to a value within the acceptable stability limit of 0.95pu to 1.05pu. The three phase network of the test system is simulated without any form of compensation. The result obtained after this simulation is shown in figure 9. The adaptive STATCOM is then connected to the three phase test network and simulation carried out. The result of this simulation is shown in figure 11. The network connection corresponding to result of figure 11 (test network with STATCOM) is shown in figure 10.

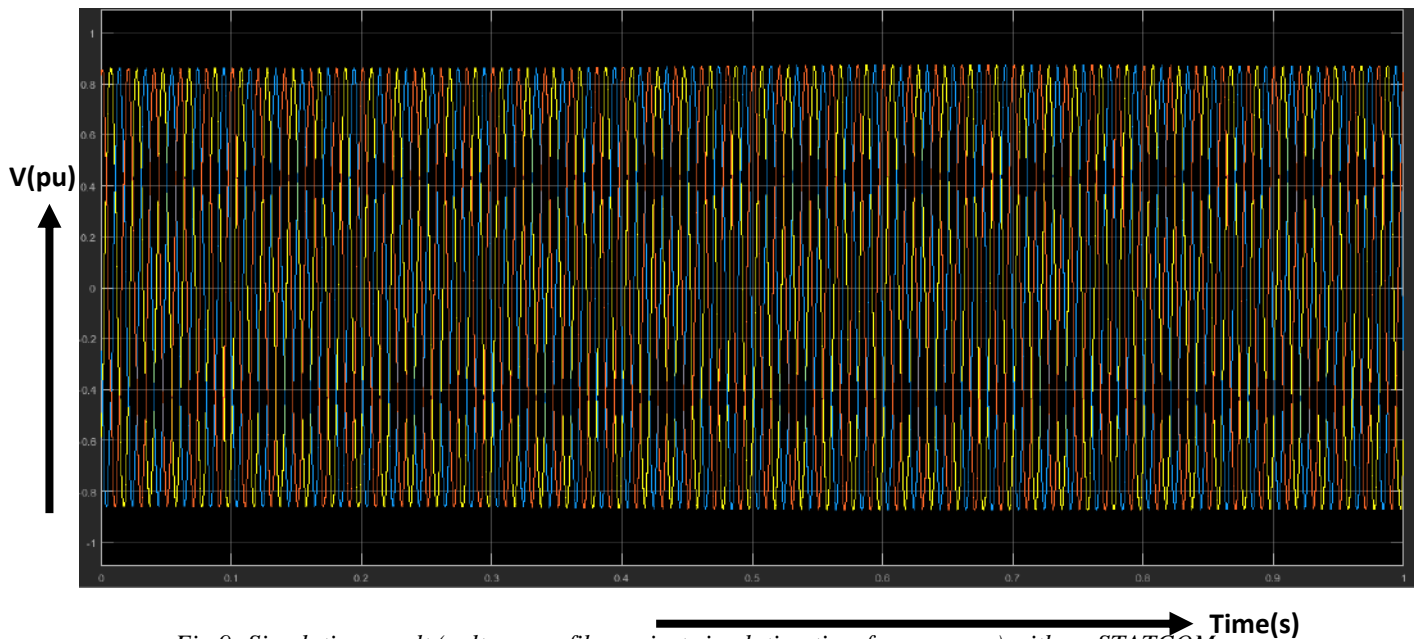


Fig.9: Simulation result (voltage profile against simulation time for case one) with no STATCOM

From figure 9, it can be seen that the voltage profile of the weakest bus (Yola) is 0.83pu. This value is clearly below the minimum acceptable value of 0.95pu. There is therefore need for compensation at the weakest bus to bring the system back to stability. STATCOM controlled

by ANN was connected across the Yola bus and the closest generator at Shiroro bus as shown in figure 10. The result of simulation carried out on figure 10 connection is shown in figure 11.



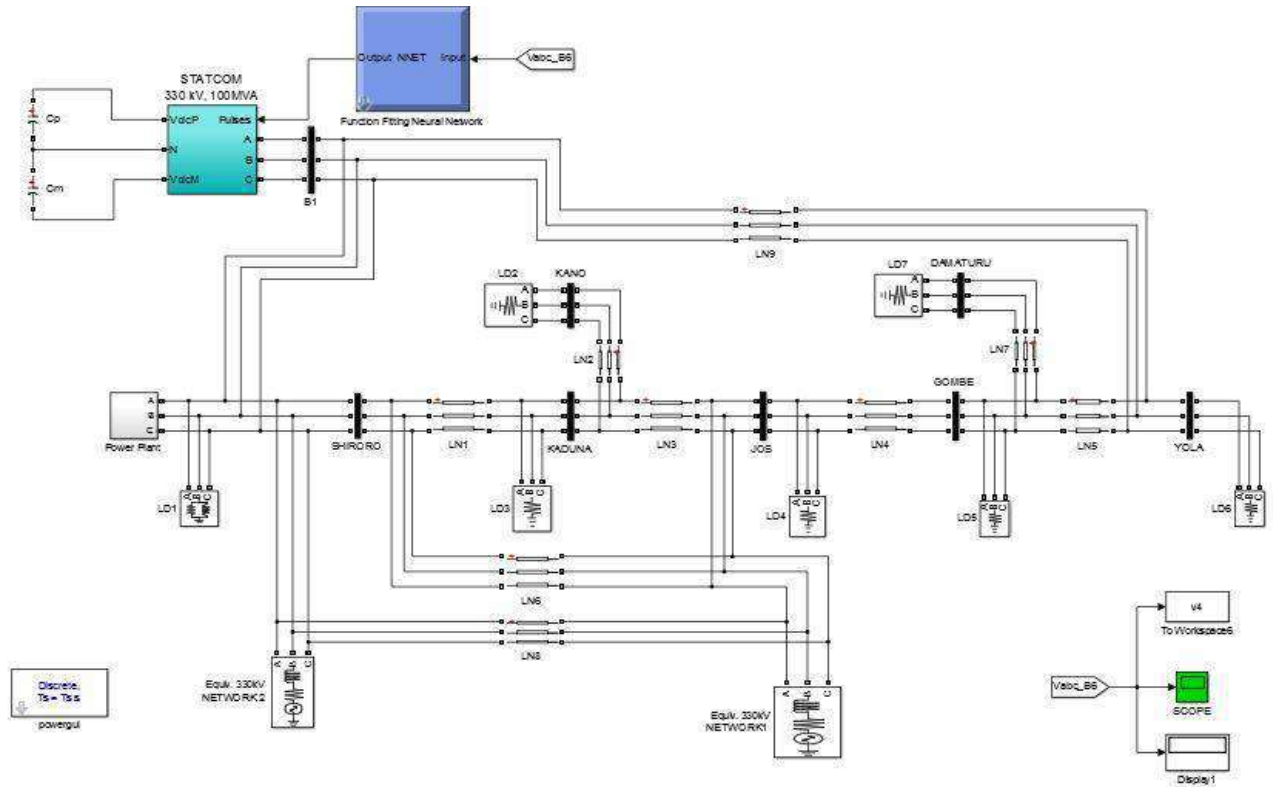


Fig.10: Three Phase Simulink Model of the Nigerian 330kV Transmission Network with ANN Based Adaptive STATCOM connected.

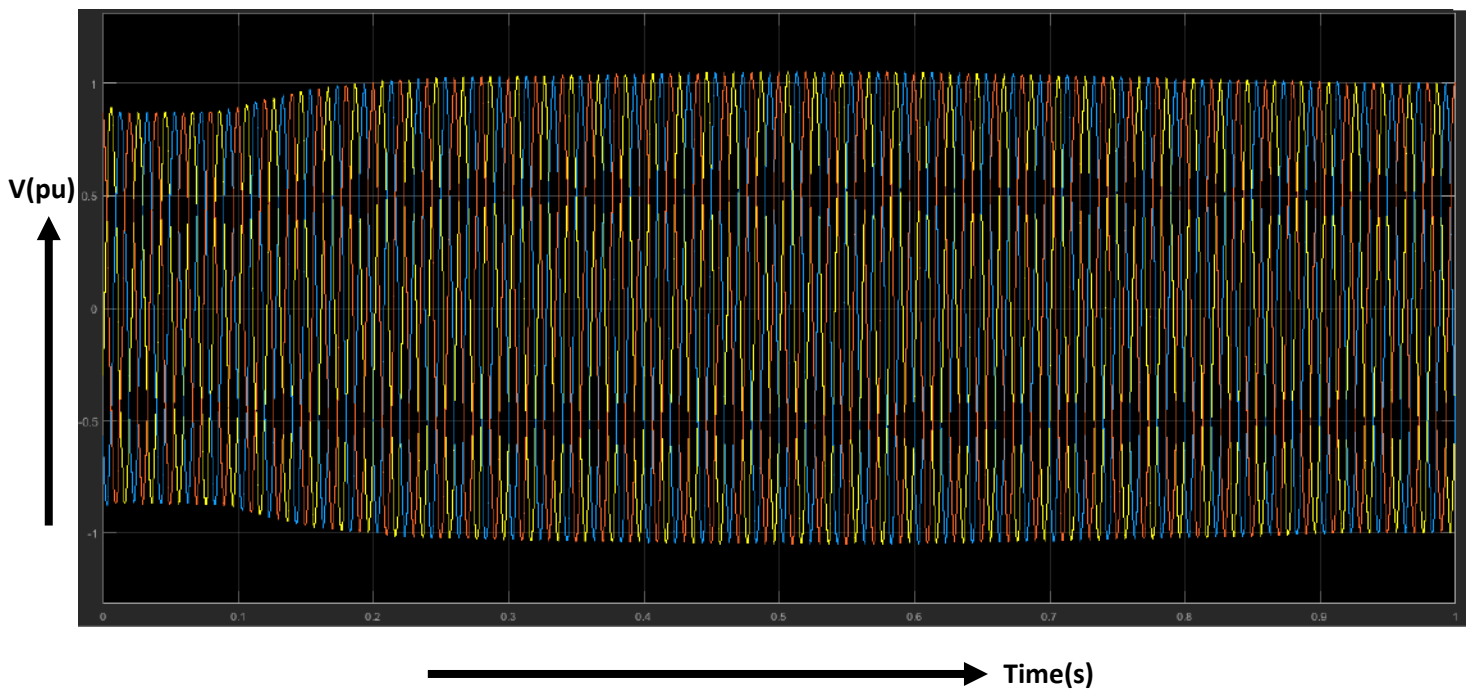


Fig.11: Simulation result (voltage profile against simulation time for case one) with Adaptive STATCOM connected.

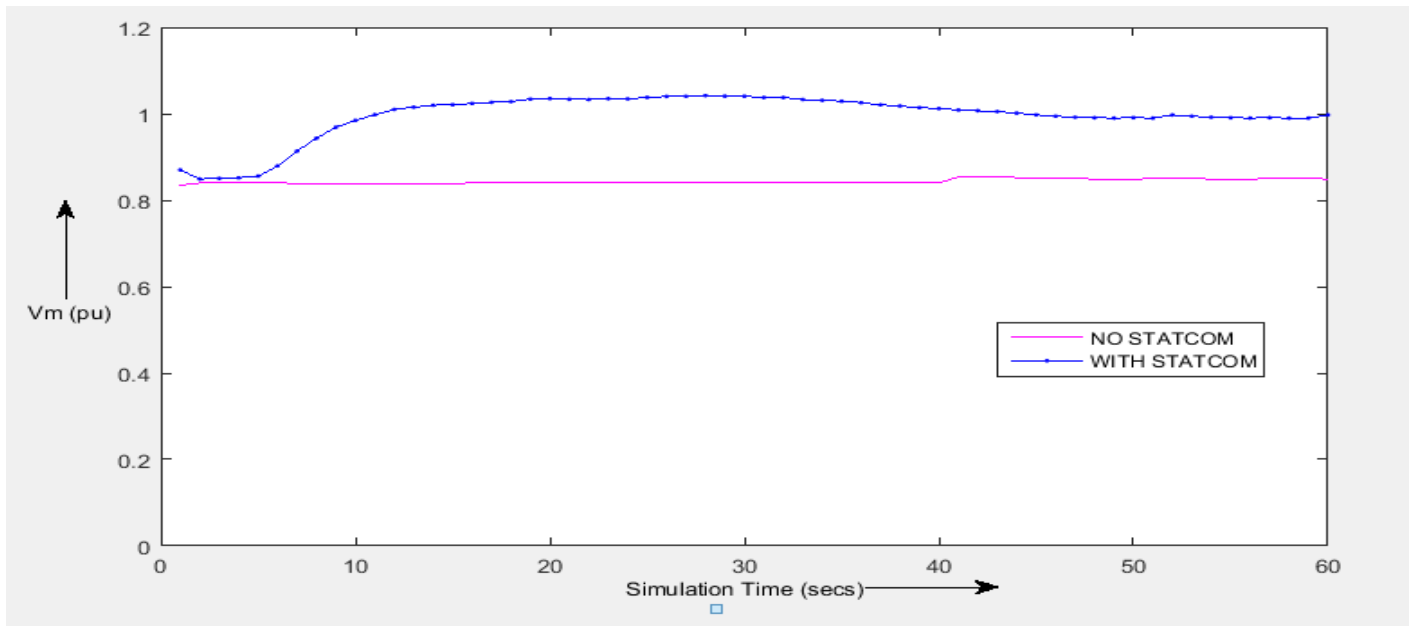


Fig.12: Simulation result (voltage profile against simulation time for case one) both when Adaptive STATCOM is connected and when not connected.

From figure 11, it can be seen that after 0.2 seconds, the voltage profile of bus Yola stabilized at 1.02pu. This value is within the acceptable range of 0.95 to 1.05pu voltage profile. This shows that for case one (no contingency), the ANN based adaptive STATCOM was able to bring the system to stability when connected.

As can be seen from figure 12, the peak voltage level without the adaptive STATCOM remained at approximately 0.83pu all through the simulation but when the adaptive STATCOM was incorporated, the peak voltage started rising and finally settled round 1.02pu. The incorporation of the ANN based adaptive STATCOM was able to increase the voltage profile of the weakest bus from 0.83pu to 1.02pu. This increase represents a 22.9% improvement.

## V. CONCLUSION

The test network was found to be unstable as the modal analysis revealed the presence of eigenvalue with a negative real part. Yola bus was discovered to be the most vulnerable bus with the highest participating factor and a voltage profile (of 0.83pu) less than acceptable lower limit of 0.95pu. ANN based adaptive STATCOM improved the stability of the network by enhancing the voltage profile of the network weakest bus by 22.9%.

It can be concluded that ANN based adaptive STATCOM was effective in improving the stability of the Nigerian three phase transmission grid network.

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# Sinusoidal Water Wave Dispersion Equation Formulated Using the Total Velocity Potential Equation

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**Keywords**— *total velocity potential, sinusoidal water wave.*

**Abstract**— *In this study, the dispersion equation was formulated with the same procedure as the linear wave theory dispersion equation formulation procedure, but in this study, the total velocity potential was used. The dispersion equation obtained has the same form as the linear wave theory dispersion equation. There is a difference in its coefficients which causes the obtained wavelength to be half of the wavelength dispersion equation of the linear wave theory.*

## I. INTRODUCTION

The solution to the Laplace equation with the variable separation method is in the form of a superposition of two functions, namely *cosine*, and *sine* (Dean, 1991). In Dean (1991), the formulation of the linear wave theory dispersion equation is done by using a single component, namely the *cosine* only. In this study, the velocity potential equation was carried out at the characteristic point where the value of the *cosine* function is the same as the value of the *sine* function. Therefore, the total velocity potential is in the form of *cosine*. The function obtained at this characteristic point will apply to the *cosine* and *sine*.

The formulation of the dispersion equation was carried out with the same procedure as the formulation of the linear wave theory dispersion equation, which is to formulate the water level equation using the Bernoulli (Milne-Thomson, 1960), carried out on the water surface. Then, with the water level equation obtained, the equation was formulated dispersion using linearized Kinematic Free Surface Boundary Condition.

Considering that the same velocity potential was used and carried out with the same procedure, a dispersion equation with the same shape but a different coefficient was obtained. The dispersion equation was analyzed using the

wavenumber conservation equation. It was found that the dispersion equation obtained was not a function of water depth.

In deep water, wave steepness was calculated using the maximum wave height from Wiegel (1949,1964). Wave steepness was compared with the critical wave steepness of Michell (1893) and Toffoli et al (2010).

The dispersion equation in shallow water is formulated using the wave number and the energy conservation equation. With those equations, equations for the change in wave height and wavenumber due to water depth change were formulated. Even though it does not aim to develop a shoaling model, it produces a simple shoaling equation.

## II. GENERAL SOLUTION OF LAPLACE'S EQUATION

The Laplace's equation (Milne-Thomson, 1960) on a two-dimensional axis system, namely  $(x, z)$  in the following form,

$$\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial z^2} = 0 \dots (1)$$

$\phi = \phi(x, z, t)$  is the velocity potential,  $x$  is the horizontal axis located on the still water surface;  $z$  is the vertical axis;  $t$  is time. The properties of the velocity potential (Milne-Thomson (1960)) are as follows,



$$\frac{\partial \phi}{\partial x} = -u$$

$$\frac{\partial \phi}{\partial z} = -w$$

$u$  is the velocity of the water particles in the  $-x$  horizontal direction. Meanwhile,  $w$  is the velocity of the particles in the  $-z$  vertical direction.

The solution (1) is analytically carried out using a well-known method, namely the Variable Separation Method, where the solution is considered to be a multiplication of three functions (Bland, 1961), namely,

$$\phi(x, z, t) = X(x) Z(z) T(t) \dots (2)$$

$X(x)$  is a function  $x$  only,  $Z(z)$  is a function  $z$  only and  $T(t)$  is a function  $t$  only, which gives the general solution

$$\phi(x, z, t) = (A \cos kx + B \sin kx) (C e^{kz} + D e^{-kz}) \sin(\sigma t) \dots (3)$$

This equation is a total general solution of Laplace's equation, which consists of two components, namely the  $\cos kx$  and the  $\sin kx$  components.

### 2.1. Analysis of the Constants in the Solution of the Laplace Equation

In (3), there are several constants, namely  $A$ ,  $B$ ,  $C$ , and  $D$ , which need to be formulated. These constants can be obtained by working on boundary conditions, where the Laplace equation is known as a boundary value problem where the specific solution was obtained by working on boundary conditions.

Working on the kinematic bottom boundary condition on the flat bottom, as done by Dean (1991), was used to formulate the constants. The kinematic bottom boundary conditions on the flat bottom are:

$$w_{-h} = 0 \dots (4)$$

Using (3), the velocity of the water particles in the  $-z$  vertical direction is

$$w = -\frac{\partial \phi}{\partial z} = -k(A \cos kx + B \sin kx) (C e^{kz} - D e^{-kz}) \sin(\sigma t)$$

Then

$$w_{-h} = -k(A \cos kx + B \sin kx) (C e^{-kh} - D e^{kh}) \sin(\sigma t)$$

Substitution to (4),

$$-k(A \cos kx + B \sin kx) (C e^{-kh} - D e^{kh}) \sin(\sigma t) = 0$$

This condition can be occurred in

$$C e^{-kh} - D e^{kh} = 0$$

Where,

$$C = D e^{2kh} \dots (5)$$

Substituting this equation into (3) will get the equation,

$$\phi(x, z, t) = 2D e^{kh} (A \cos kx + B \sin kx) \cosh k(h+z) \sin(\sigma t) \dots (6)$$

To get the constants  $A$  and  $B$ , it was done that on a wave as a whole there is only one single characteristic, where  $A = B$ ,

$$\phi(x, z, t) = 2A D e^{kh} (\cos kx + \sin kx) \cosh k(h+z) \sin(\sigma t)$$

Defined  $G = 2A D e^{kh}$ ,

$$\phi(x, z, t) = G (\cos kx + \sin kx) \cosh k(h+z) \sin(\sigma t) \dots (7)$$

Proving that there is only one wave characteristic. Then, an analysis was carried out on  $G$  through the velocity equation, for example, the vertical velocity  $w$ .

$$w(x, z, t) = -Gk (\cos kx + \sin kx) \sinh k(h+z) \sin(\sigma t)$$

The particle velocity  $w$  has units ( $m/sec$ ) while the wavenumber  $k$  has units ( $m^{-1}$ ). Then, the unit of  $G$  is ( $m \cdot m/sec$ ), indicating that  $G$  is the rate of transfer of wave energy, which must be a single value, implying that  $A = B$ .

The formulation can be done with other procedures, namely (6) done at the characteristic point where  $\cos kx = \sin kx$ , then (6) becomes,

$$\phi(x, z, t) = 2D e^{kh} (A + B) \cos kx \cosh k(h+z) \sin \sigma t \dots (8)$$

For the *cosine* component. As for the *sine* component,

$$\phi(x, z, t) = 2D e^{kh} (A + B) \sin kx \cosh k(h+z) \sin \sigma t \dots (9)$$

Both in (9) and (10), can be defined:

$$G = 2D e^{kh} (A + B) \dots (10)$$

Then, (8) and (9) become:

$$\phi(x, z, t) = G \cos kx \cosh k(h+z) \sin(\sigma t) \dots (11)$$

$$\phi(x, z, t) = G \sin kx \cosh k(h+z) \sin(\sigma t) \dots (12)$$

This proves the singularity of the value of  $G$ . However, it also indicates that the analysis of wave dynamics using (11) or (12) uses  $G$  which is a combination of two energies.

### 2.2. The Wavenumber Conservation Equation

In solving the Laplace equation with the variable separation method, there is no flat bottom assumption. The flat bottom assumption is only in the formulation of the constant. Furthermore, if (7) is done on a sloping bottom,

there will be values of  $\frac{dh}{dx}$ ,  $\frac{dk}{dx}$ , and  $\frac{dG}{dx}$ . In the following section, an analysis of the  $\frac{dk}{dx}$  was done.

It has been mentioned that in solving the Laplace equation with the Variable Separation Method, it is assumed that the flow potential consists of 3 components, as presented in (2).

In this equation,  
 $X(x) = \cos kx$ , is a function of  $x$  only,  
 $Z(z) = \cosh k(h + z)$ , is a function of  $z$  only  
 $T(t) = \sin \sigma t$ , is a function of  $t$  only.

Given the nature of the function, it must be

$$\frac{\partial Z(z)}{\partial x} = 0$$

Given  $Z(z) = \cosh k(h + z)$ , then

$$\frac{\partial k(h+z)}{\partial x} = 0 \dots\dots(13)$$

$Az = \frac{A}{2}$ , where  $A$  is the wave amplitude

$$\frac{\partial k(h+\frac{A}{2})}{\partial x} = 0 \dots\dots(14)$$

$Az = 0$ ,

$$\frac{\partial kh}{\partial x} = 0 \dots\dots(15)$$

### III. FORMULATION OF THE DISPERSION EQUATION

The dispersion equation will be formulated using velocity potential (11) and on a flat bottom. The velocity of the particle in the  $x$  horizontal direction and the  $z$  vertical direction is,

$$u = -\frac{\partial \Phi}{\partial x} = Gk \sin kx \cosh k(h + z) \sin \sigma t \dots(16) w =$$

$$-\frac{\partial \Phi}{\partial z} = -Gk \cos kx \sinh k(h + z) \sin \sigma t \dots(17)$$

#### 1.1. Water Surface Equation $\eta(x, t)$

To get the dispersion equation, first, the water surface equation is formulated (Dean (1991)). The equation was formulated using the Bernoulli equation which is carried out on the surface, namely

$$-\frac{\partial \phi_\eta}{\partial t} + \frac{1}{2}(u_\eta^2 + w_\eta^2) + g\eta + \frac{p_\eta}{\rho} = C(t) \dots(18)$$

The  $\eta$  index shows that the relevant variable is applied to the surface of the wave,  $g$  is the acceleration due to gravity,  $p$  is the pressure acting on the fluid particles,  $\rho$  is the density of the fluid, and  $C(t)$  is a constant that can be used zero for the periodic function (Dean (1991)).

$p_\eta$  is the pressure on the surface, i.e., atmospheric pressure, by using atmospheric pressure as the reference pressure,  $p_\eta = 0$ . After entering the dynamic free surface boundary condition  $p_\eta = 0$ , (18) divided by  $g$

$$-\frac{\partial \phi_\eta}{g \partial t} + \frac{1}{2g}(u_\eta^2 + w_\eta^2) + \eta = 0 \dots\dots(19)$$

The 2<sup>nd</sup> term is kinetic energy, while the 3<sup>rd</sup> term is potential energy. At a small wave amplitude, the 2<sup>nd</sup> term will be much smaller than the 3<sup>rd</sup> term. Therefore, it can be ignored, the Bernoulli equation becomes,

$$-\frac{\partial \phi_\eta}{g \partial t} + \eta = 0$$

The obtained water level equation is:

$$\eta(x, t) = \frac{1}{g} \frac{\partial \phi_\eta}{\partial t}$$

Substituting the flow potential equation,

$$\eta(x, t) = \frac{G \sigma \cosh k(h+\eta)}{g} \cos kx \cos \sigma t \dots(20)$$

For a periodic function,  $\frac{G \sigma \cosh k(h+\eta)}{g}$  is a constant. Defined

$$A = \frac{G \sigma \cosh k(h + \eta)}{g}$$

However, it has been mentioned that the use of a single velocity potential (11), implies that  $G$  is the sum of the energies of the two waves, therefore the wave amplitude equation must be divided by 2,

$$A = \frac{G \sigma \cosh k(h+\eta)}{2g} \dots\dots(21)$$

$A$  is the wave amplitude. But,  $G$  can not be calculated using this equation.  $G$  must be calculated using

$$G = \frac{gA}{2 \sigma \cosh k(h + \eta)}$$

This will be discussed in the next paper.

The surface water level equation becomes

$$\eta(x, t) = A \cos kx \cos \sigma t \dots(22)$$

#### 3.2. Dispersion Equation

The dispersion equation is formulated using the Kinematic Free Surface Boundary Condition (KFSBC),

$$w_\eta = \frac{\partial \eta}{\partial t} + u_\eta \frac{\partial \eta}{\partial x} \dots\dots(23)$$

For long waves and small amplitudes,  $u_\eta$  and  $\frac{\partial \eta}{\partial x}$  are small numbers. Thus,  $u_\eta \frac{\partial \eta}{\partial x}$  becomes a very small and negligible number, and KFSBC become,

$$w_\eta = \frac{\partial \eta}{\partial t} \dots\dots(24)$$

Substituting (17) and (22) into (24) and the same terms on the left and right sides of the equation cancel each other out, the following equation is obtained

$$2\sigma^2 = gk \tanh k(h + \eta) \dots\dots(25)$$

In (25) there is a variable whose value needs to be known. From the beginning, the formulation was carried out with a single flow potential, namely (11), where the formulation was carried out at the characteristic point where  $\cos kx = \sin kx$ , on the time variable, also used the characteristic point where  $\cos \sigma t = \sin \sigma t$ . Thus, a characteristic point

that is complete is the point where  $\cos kx = \sin kx = = \frac{1}{2}\sqrt{2}$  and  $\cos \sigma t = \sin \sigma t = \frac{1}{2}\sqrt{2}$ .

The solution obtained at this point is valued for both  $\sin$  and  $\cos$ . At this point, the water level elevation of (22) is,

$$\eta = \frac{A}{2}$$

Then (25) becomes,

$$2\sigma^2 = gk \tanh k \left( h + \frac{A}{2} \right) \dots\dots(26)$$

Then, the wave number conservation equation (14) was reviewed.

$$\frac{d \tanh k \left( h + \frac{A}{2} \right)}{dx} = \frac{1}{\cosh^2 k \left( h + \frac{A}{2} \right)} \frac{dk \left( h + \frac{A}{2} \right)}{dx} = 0$$

It was found that

$$\tanh k \left( h + \frac{A}{2} \right) = c \dots\dots(27)$$

where  $c$  is a constant number.

Equation (26) must apply to both deep and shallow water.

In deep water

$$\tanh k \left( h + \frac{A}{2} \right) = 1 \dots\dots(28)$$

Then the constant  $c$  in (27) is 1. The dispersion equation becomes,

$$2\sigma^2 = gk \dots\dots\dots(29)$$

Therefore, the dispersion equation is only for deep water.

Equation (29) gives a wavelength  $L = \frac{2\pi}{k}$  half of the well-known linear wave theory wavelengths in the deepwater of the form

$$\sigma^2 = gk \dots\dots\dots(30)$$

In Table (1), the comparison between wavelengths of (29),  $L_{29}$ , and wavelengths of (30),  $L_{30}$ , where  $L_{29} = 0.5L_{30}$ . The wave steepness of each wavelength is calculated using the maximum wave height of Wiegel (1949,1964), namely

$$H_{0,max} = \frac{gT^2}{15.6^2} \dots\dots(31)$$

Table.1: Comparison of wavelengths (29) and (30)

T (sec)	L <sub>30</sub> (m)	L <sub>29</sub> (m)	$\frac{H_{0,max}}{L_{30}}$	$\frac{H_{0,max}}{L_{29}}$
6	56.207	28.104	0.026	0.052
7	76.504	38.252	0.026	0.052
8	99.924	49.962	0.026	0.052
9	126.466	63.233	0.026	0.052
10	156.131	78.066	0.026	0.052
11	188.919	94.459	0.026	0.052
12	224.829	112.414	0.026	0.052
13	263.861	131.931	0.026	0.052

14	306.017	153.008	0.026	0.052
15	351.295	175.647	0.026	0.052

Wave steepness  $\left(\frac{H}{L}\right)$  generated by the two dispersion equations in Table (1), is very small, much smaller than the critical wave steepness of Michell's criteria (1893),

$$\frac{H}{L} = 0.142 \dots\dots(32)$$

And criteria for Toffoli et al (2010)

$$\frac{H}{L} = 0.170 \dots\dots(33)$$

From this, although (29) produces a wavelength that is much smaller than (30), it still needs further development in order to achieve a wavelength that gives a critical wave steepness according to the criteria of Michell (1893) or Toffoli et al (2010).

In order to obtain a critical wave steepness following the Mitchell or Toffoli criteria, the left side (29) is multiplied by a coefficient  $\gamma$ ,

$$2\gamma\sigma^2 = gk \dots\dots(34)$$

$\gamma$  is a coefficient that is greater than 1. By trial and error, the value of  $\gamma = 2.75$  is obtained which produces a wavelength with a wave steepness corresponding to the critical wave steepness of Michell (1893), with the calculation results presented in Table (2).

Table.2: Wavelength and wave steepness at  $\gamma = 2.75$

T (sec)	L (m)	$\frac{H_{0,max}}{L}$
6	10.219	0.142
7	13.91	0.142
8	18.168	0.142
9	22.994	0.142
10	28.387	0.142
11	34.349	0.142
12	40.878	0.142
13	47.975	0.142
14	55.639	0.142
15	63.872	0.142

Meanwhile, if Toffoli et al criteria are used, it will obtain  $\gamma = 3.285$ .

However, (29) and (34), need more intensive analytical study, to fulfill the kinematic free surface boundary condition.

### 3.3. Dispersion equation in shallow water

To obtain the dispersion equation in shallow water, the wave number conservation equation is carried out. First, define the value of  $k_0 \left( h_0 + \frac{A_0}{2} \right)$  in deep water where  $\tanh kh_0 \left( h_0 + \frac{A_0}{2} \right) = 1$ ,  
 $k_0 \left( h_0 + \frac{A_0}{2} \right) = \theta \pi \dots \dots (35)$

where  $\tanh(\theta \pi) = 1$ . Index 0 indicates the variable in deep water. The value of  $\theta$  is a positive number whose value is greater than or equal to 1. SPM (1984) uses the value of  $\theta = 1$ . According to the law of conservation of wavenumbers (14),

$$k_h \left( h + \frac{A_h}{2} \right) = k_0 \left( h_0 + \frac{A_0}{2} \right) = \theta \pi$$

Then

$$k_h = \frac{\theta \pi}{\left( h + \frac{A_h}{2} \right)} \dots \dots (36)$$

The index  $h$  indicates the variable at the water depth  $h$ , smaller than  $h_0$ . In this equation, there are two unknowns, namely  $k_h$  and  $A_h$ . One more equation of the relation between  $k_h$  and  $A_h$  is needed. The available equation is the energy conservation equation. The wave energy at one wavelength (Dean (1991)) is as follows,

$$E = \frac{1}{8} \rho g H^2 L \dots \dots (37)$$

$g$  is the gravitational force, and  $\rho$  is the mass density of water. Assuming there is no loss of wave energy, then the relationship should be as follows,

$$H_h^2 L_h = H_0^2 L_0 \dots \dots (38)$$

where  $H_0$  and  $L_0$  are wave height and wavelength in deep water, while  $H_h$  and  $L_h$  are wave height and wavelength at shallower water depth  $h$ . Equation (38) can be expressed as the equation for the wave number  $k_h$ ,

$$k_h = \frac{2\pi H_h^2}{E_0} \dots \dots (39)$$

Where  $E_0 = H_0^2 L_0$ , substitution (39) to (36) assuming a sinusoidal wave where  $A_h = 0.5 H_h$ , the equation for  $H_h$  is obtained.

$$\frac{H_h^3}{4} + h H_h^2 - \frac{\theta E_0}{2} = 0 \dots \dots (40)$$

$H_h$  is calculated by (40), then  $k_h$  is calculated by (39).

For example, the calculation of wavelength in shallow water used waves with a wave period of 8 sec. deep water wave height  $H_0$  is calculated by (31), deep water wavelength  $L_0$  is calculated by (29) or by (34) with  $\gamma = 1$ . The calculation is done by using  $\theta = 1$ , and ignoring breaking, the calculation results are compared with the linear wave theory dispersion equation, namely,

$$\sigma^2 = g k \tanh kh \dots \dots (41)$$

The calculation results are presented in Fig (1) below.

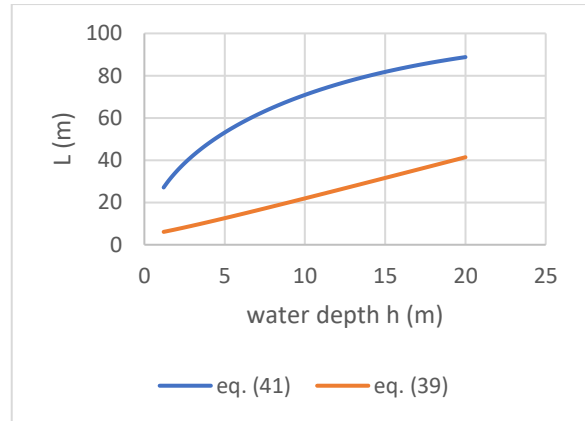


Fig.1: Wavelength of (41) and (39).

In Fig (2), the change in wave height to water depth (shoaling) is presented in the form of a nonlinear line. In the figure, the calculation is stopped when  $\frac{H}{h} = 0.80$  which is considered breaking. At that point, the wave height is  $H = 4.80$  m, the water depth is  $h = 5.99$  m, and the wavelength is  $L = 14.40$  m. From the breaking conditions, it was found that the shoaling that occurred was too large.

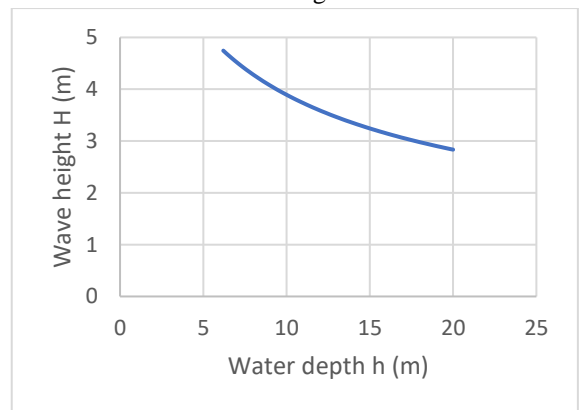


Fig.2: Shoaling on a wave period of 8 sec.

The magnitude of the resulting shoaling is because the wave energy is too large. After all, the wavelength  $L_0$  calculated by (29) is too long. When used (34) using  $\gamma = 3.285$  where the value of  $\gamma$  is the result of critical wave steepness adjustment with the criteria of Toffoli et al (2010), it is obtained that the deep-water wavelength  $L_0$  is shorter. Thus, the wave energy decrease, and the resulting shoaling is also not too large.

In Table (3), the results of the shoaling calculation are presented where  $L_0$  is calculated by (34) using  $\gamma = 3.285$ , and water depth coefficient  $\theta = 1$ . The wave height at  $\frac{H}{h} = 0.78$  was compared with the average breaker height of the five-breaker height index (BHI) from a number of previous studies conducted by Komar and Gaghan (1972), Larson, M. and Kraus, N.C. (1989),



Smith and Kraus (1990), Gourlay (1992), and Rattana Pitikon and Shibayama (2000).

Komar and Gaughan (1972)

$$\frac{H_b}{H_0} = 0.56 \left(\frac{H_0}{L_0}\right)^{-\frac{1}{5}} \dots\dots\dots(42)$$

Larson and Kraus (1989),

$$\frac{H_b}{H_0} = 0.53 \left(\frac{H_0}{L_0}\right)^{-0.24} \dots\dots\dots(43)$$

Smith and Kraus (1990),

$$\frac{H_b}{H_0} = (0.34 + 2.74m) \left(\frac{H_0}{L_0}\right)^{-0.30+0.88m} \dots\dots\dots(44)$$

Gourlay (1992),

$$\frac{H_b}{H_0} = 0.478 \left(\frac{H_0}{L_0}\right)^{-0.28} \dots\dots\dots(45)$$

Rattana Pitikon and Shibayama (2000) :

$$\frac{H_b}{H_0} = (10.02m^3 - 7.46m^2 + 1.32m + 0.55) \left(\frac{H_0}{L_0}\right)^{-\frac{1}{5}} \dots\dots\dots(46)$$

In these BHI equations,  $H_0$  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 the bottom slope and  $H_b$  is breaker height. In this study, bottom slope  $m = 0$  is used.

Breaker depth  $h_b$  in Table (3) is calculated by the breaker depth equation from SPM (1984), that is,

$$\frac{h_b}{H_b} = \frac{1}{b - \left(\frac{aH_b}{gT^2}\right)} \text{ or } h_b = \frac{H_b}{b - \left(\frac{aH_b}{gT^2}\right)} \dots\dots\dots(47)$$

$$a = 43.75(1 - e^{-19.0m})b = \frac{1.56}{1 + e^{-19.5m}}$$

Calculation with bottom slope  $m = 0$  obtained  $\frac{H_b}{h_b} = 0.78$ .

Therefore, Table (3) mentioned the value of  $\frac{H}{h} = \frac{H_b}{h_b} = 0.78$ . It is found that  $H$  is close to  $H_b$  and  $h$  is also close to  $h_b$ . This indicates that the shoaling of (39+40) can be improved by shortening the deep water wavelength and the wavelength  $L_0$  calculated by (29) is still too long.

**IV. CONCLUSION**

A review of the critical wave steepness in deep water results that the wavelengths obtained using the total velocity potential are better than the wavelengths formulated using a single velocity potential, likewise with the results of studies in shallow water. However, it still needs to be shortened again.

In short, it can be done in a simple way, by increasing the coefficients in the dispersion equation. However, it is necessary to investigate the origin of these coefficients analytically based on hydrodynamic equations, especially the kinematic free surface boundary condition and the Bernoulli equation.

Considering that the formulation of the dispersion equation in deep water in this study was carried out following the procedure for formulating a linear wave dispersion equation and producing a dispersion equation in the same form as the linear wave theory dispersion equation, the dispersion equation obtained can also be referred to as a linear wave dispersion equation.

To conclude, the analysis of wave dynamics using the velocity potential solution of the Laplace equation with the Variable Separation Method should use the total velocity potential.

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Table.3: Comparison of equations (39+40) with BHI.

T (sec)	Eq. (39+40)		BHI	
	$H_h$ (m)	$h$ (m)	$H_b$ (m)	$h_b$ (m)
6	1.805	2.314	1.721	2.207
7	2.457	3.149	2.343	3.003
8	3.209	4.114	3.06	3.923
9	4.061	5.206	3.873	4.965
10	5.014	6.427	4.781	6.129
11	6.067	7.777	5.785	7.417
12	7.22	9.256	6.885	8.826
13	8.473	10.863	8.08	10.359
14	9.827	12.598	9.371	12.014
15	11.281	14.462	10.757	13.791

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# Skills and Competencies for Resilience in Manufacturing Systems: A Systematic Literature Review

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**Keywords—** *resilience, resilience engineering, resilience in manufacturing systems, skills of a resilient system.*

**Abstract—** *The manufacturing industry operates in a constantly changing environment, whether internal or external. Revolutionary shifts in demand and technology are becoming more common. As a result, organizations must be prepared to absorb or mitigate the impact that these changes may have on their outcome, thereby becoming resilient. The aim of this study is to identify which skills and competencies manufacturing companies must develop to become resilient and resist these sudden changes. In order to achieve the proposed goal, this article conducts a systematic literature review. Two databases, Science Direct and SpringerLink, were searched, as well as articles published at the Resilience Engineering Symposium between 2015 and 2020, using the search term "resilience engineering in manufacturing." A total of 64 relevant articles were obtained. The analysis of the articles yielded 23 skills and competencies that companies use to be resilient, with organizational flexibility being the most mentioned skill. As a result, these skills were classified using the four theoretical skill profiles for a resilient system (monitor, anticipate, respond, and learn). There was practically a balance between the four skills mentioned by the authors in the articles, with a higher tendency for the ability to respond to variability, interruptions, disturbances, and opportunities presented in a manufacturing system.*

## I. INTRODUCTION

Organizations or manufacturing systems are currently embedded in environments that may undergo transformations. Changes can occur within or outside of the system, with varying degrees of impact and frequency. A minor impact can have a significant impact on an organization, and it must be prepared to deal with the consequences to avoid losses, errors, or failures <sup>[1]</sup>. Similarly, adverse, or unexpected external events can disrupt the system's normal operation, impairing the expected outcome. These events could include pandemics,

terrorist attacks, natural disasters, and economic downturns <sup>[2]</sup>.

Manufacturing systems are increasingly being forced to deal with the consequences of these unfavorable events on their processes. This is justified by the current historical period's frequent and rapid changes in technology and demand. As a result, organizations have looked for ways to adapt to these events to absorb or mitigate their negative impact <sup>[3]</sup>.

Because of the incorporation of organizations into this dynamic environment, people engaged in system activities

are frequently challenged to adapt in order to maintain productivity at acceptable levels of performance. However, if these activities are not properly monitored, they can jeopardize security or the company's own operations <sup>[4]</sup>.

This problem arises because managers are unaware of the information pertaining to the execution of these activities. As a result, an organization can become more resilient once all managers at all hierarchical levels have access to information on how activities are carried out, providing the necessary resources for people to adapt and make decisions in unexpected situations, thereby maintaining the safety flow of effective production <sup>[5]</sup>.

Resilience in manufacturing systems can be defined as their ability to withstand the effects of adverse events while retaining their structure. This concept also includes the ability to reorganize, reconfigure, restructure, and reinvent in response to a disruption <sup>[6]</sup>.

According to the above-mentioned concept, systems that move from failure to success, or from loss to gain, by combining aspects of robustness and agility <sup>[1]</sup>, acquiring skills to respond to events, monitoring their current state, predicting future threats or opportunities, and learning from their signs of weakness or through past experience, are considered resilient <sup>[7]</sup>. Traditional production systems are resistant to changes imposed on their initial state by internal or external factors. Resilient systems, on the other hand, lack this resistance, allowing them to respond to unexpected events more quickly and effectively <sup>[8]</sup>.

Resilience can best be understood through the four skills required for a system to be considered resilient, namely: responding to events, monitoring developing events, anticipating future threats or opportunities, and learning from past mistakes and successes. Therefore, Resilience Engineering (RE) is a discipline that composes the way these four skills can be established and managed <sup>[7]</sup>.

Resilience Engineering emerges as a response to the environment in which organizations operate, which is characterized by an increasing level of complexity and uncertainty, as well as a need to devise new strategies to deal with these uncertainties. To that end, it provides tools for proactive risk management as well as inherent knowledge of system complexity and variability <sup>[9]</sup>.

RE evolved from studies with different emphases, but with a common socio-technical approach that views humans and artefacts (physical and organizational) as equal agents in the system's performance. The proposed RE techniques were designed to map the interactions of agents in a complex system. One of these methods is the Functional Resonance Analysis Method (FRAM), which first saw use in aviation <sup>[10]</sup>. One of the most researched

lines currently proposes the use of FRAM to describe the differences between work-as-imagined and work-as-done <sup>[11]</sup>.

Therefore, the purpose of this article is to provide an answer to the following research question: What are the most used skills and competencies to promote resilience in manufacturing systems?

This article contains five sections, the first one is the introduction, the second section describes the methodology used, and the third section describes the results of the systematic literature review. The fourth section contains the analysis and discussion of the findings. Finally, the fifth section presents a summary of the main findings and recommendations for future research.

## II. METHODOLOGY

The methodology consists of a systematic review of the literature on the topic of manufacturing resilience, as well as an analysis of selected articles based on that review. These two steps are explained in detail below.

### 2.1 Application of Systematic Literature Review

The objective of conducting a literature review in research is often to allow the researcher to map and evaluate the existing intellectual content, which will then lead to a research question. Classical reviews have been criticized for including only authors from a certain area, chosen for inclusion based on the writer's implicit biases, and for a lack of critical appraisal. Systematic reviews, on the other hand, present a repeatable procedure and transparent scientific processes that aim to minimize or eliminate biases through an exhaustive literature review that allows the reviewers' decisions to be traced <sup>[12]</sup>.

The systematic literature review of this study consists of three steps: defining the parameters used in article selection, selecting databases to consult, and analyzing the articles that were chosen. The research done for this study was restricted to articles in the English language based on the keyword "resilience engineering in manufacturing." The research comprised articles published between 2015 and 2020, including articles from the event known as "Symposiums of Resilience Engineering".

Following the principles of a literature review <sup>[13]</sup>, the keyword used could appear in the title, abstract or scope of the articles. As previously stated by the authors, the term "resilience" cannot be used alone because this concept is investigated in various fields such as psychology, sociology, and economics, resulting in a high number of studies which do not represent the theme of the current study.



Books, theses, dissertations, and other event articles were not considered for analysis. Only articles dealing with the theme of resilience in manufacturing systems were considered.

The databases chosen for the survey of articles were Science Direct and SpringerLink, as they were used in previous studies of the same nature. The Science Direct database search resulted in ten magazines and journals: Journal of Cleaner Production, Procedia Manufacturing, Procedia CIRP, IFAC – Papers online, Construction and Building Materials, Procedia Engineering, Renewable and Sustainable Energy Reviews, Safety Science, Science of the Total Environment and Technological Forecasting and Social Change. 82 articles on the subject were obtained from these journals.

Articles from the Administration area were used as a filter in SpringerLink’s research, yielding a total of 159 publications on manufacturing resilience. There were 116 productions found in publications related to the Resilience Symposium in 2013, 2015, and 2017, the event takes place every two years. The 2019 proceedings were not available at the time of this research.

As a result, a total of 357 articles were obtained. When double publication is considered, this number falls to 345. The title and abstract were read, filtering these publications to 92 articles that could be submitted for analysis. The preliminary reading yielded 54 publications; however, 10 more articles were added as references in other articles, resulting in a total of 64 studies. Figure 1 depicts this procedure.

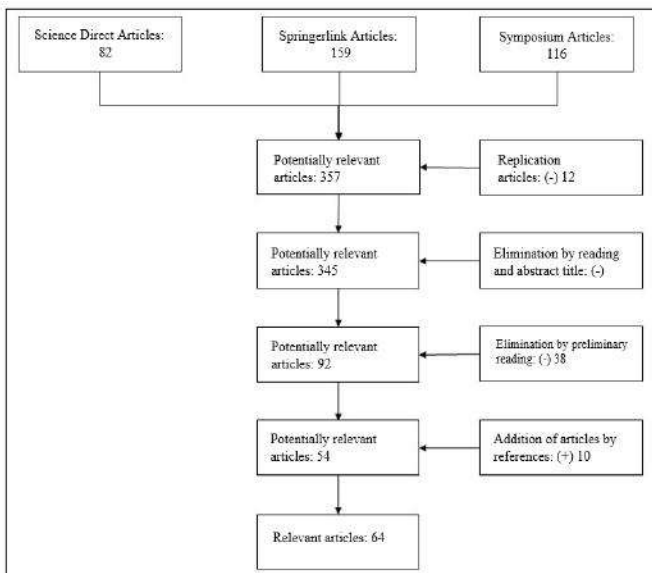


Fig. 1: Representation of the survey process

2.2 Analysis of Selected Articles

The above-mentioned aspects were analyzed in a subsequent stage. In addition, techniques for measuring or quantifying resilience in these systems are presented. Subsequently, these results are discussed with the aim of identifying the importance of resilience in systems and its difference among other concepts present in the literature. The articles were categorized into one of four categories developed by the authors of this study:

- 1 - Articles that present skills and practices for promoting resilience.
- 2 - Articles that present techniques and practices for defining and promoting resilience in organizations' suppliers.
- 3 - Articles that quantify the value of resilience, measuring it.
- 4 - Theoretical articles without presentation of practical work.

III. RESILIENCE APPROACHES

This chapter discusses the various approaches to resilience and how they are applied to manufacturing systems as well as processes that aid or support production.

3.1 General Conceptualization of Resilience

In material science, resilience is the ability of a material to absorb energy when it is deformed elastically, and release that energy upon unloading, allowing the recovery of that energy that has been accumulated. The property associated with this process is the modulus of resilience, which is the deformation energy per volume unit required to tension the material from an unloaded state to its resistance to flow. A uniaxial tensile test can then be used to calculate or measure the resilience of a given material [14].

In health and medicine, resilience is defined as the ability to maintain or recover mental health following adversity. According to the authors, the definition of resilience in this context varies from one area to the next, each conceptualized in its own way. They all, however, tend to converge on a central point, which is aimed at identifying how some people manage to overcome adversity without suffering negative physical and mental consequences [15].

The concept of resilience can be extended to organizational systems, specifically manufacturing systems, which is the focus of this study. The difference between analyzing an organizational system and analyzing an individual, piece of equipment, or material is that the

organizational system has many variables and interactions, each of which can have a negative or positive impact on it. The study of these interactions began in the Middle Ages when alchemists sought ways to convert materials into gold. Despite their failure, they discovered several properties of the materials and, most importantly, the significance of the interaction of the processes. As a result, resilience in a manufacturing system is the system's ability, given the various interactions that act on it and the interactions of its actors, to support changes in the environment and resize or restructure itself while ensuring the achievement of results <sup>[16]</sup>.

### 3.2 Definition of Resilience in Productive Systems

The articles examined in this study present different concepts on resilience. These concepts vary depending on the type and location of the resilience being studied. As a methodological constraint, the resilience studied is that of manufacturing or production systems.

When it comes to manufacturing systems, it is possible to conceptualize resilience as a quantitative measurement that combines both a system's robustness and its ability to quickly restore capacity following the occurrence of a disruptive event <sup>[17]</sup>. Some authors agree with this definition <sup>[18]</sup>, adding that resilience is a system's ability to withstand potentially high-impact interruptions, as defined by its ability to mitigate or absorb the impacts of interruptions while recovering quickly and returning to normal conditions. In addition, the use of redundancy and flexibility allows a system to resume operation following failures, component failures, and so on. This capability is critical in the design of engineering systems, operating systems, and life management systems in the face of disruptive and adverse events <sup>[19]</sup>.

In a more specific context, such as manufacturing and assembly systems, resilience is defined as the system's ability to deal with all types of changes. One property that contributes to resilience is robustness. It enables a system to function despite external and internal disturbances, which is an important property because it promotes an appropriate response to environmental turbulence <sup>[20]</sup>.

Another view tries to integrate some lean concepts as well. The authors define resilience as the ability to resist or quickly recover from unexpected interruptions. For this, the system or production line must be robust and capable of anticipating disruptive events, as well as having a control strategy in place to mitigate the impact if the event occurs. This concept considers unexpected events such as resource shortages and quality loss, both of which stem from the lean approach <sup>[21]</sup>.

Sanchis and Poler <sup>[22]</sup> propose a concept of resilience divided into three different perspectives. The first takes a

proactive approach, arguing that organizations must be prepared to anticipate and mitigate the negative effects of outages. The second represents a reactive perspective, which includes resilience, in which the company attempts to restore operations after disruptions occur. The third vision proposes a continuous vision, that of adaptive capacity, which can be defined as an organization's ability to adjust and adapt to a changing environment.

### 3.3 Resilience in Ergonomics and Safety Engineering

Resilience Engineering is a security approach or philosophy that focuses on the prevention, detection, and management of disturbances before, during, and after they occur, while also incorporating human factors. The authors propose a model that incorporates factors that promote a resilient environment, such as system complexity, worker age, worker commitment, preparation, and experience, among others <sup>[23]</sup>.

Shirali and Nematpour <sup>[24]</sup> and Gattola, et al. <sup>[25]</sup> agree with the previous authors that resilience includes the ability to anticipate and manage risks before they become serious threats to the operation, as well as the ability to survive a situation in which the operation has been compromised. RE strives to clarify how the organization creates security to determine when the model needs to be reviewed. In a similar vein, England <sup>[26]</sup> defines resilience as the amount of time required to regain equilibrium following adversity.

Other vision of resilience is the one focused specifically on workers and their well-being. According to the authors, RE is built on four pillars that take into account all levels of the organization: responsiveness, critical development monitoring, anticipating threats and opportunities, and learning from past experience. The RE seeks to correctly identify and value behaviors and resources that contribute to the responsiveness of systems. Thus, the authors propose monitoring the well-being of workers as an indicator of system performance, since healthy workers are associated with a healthy system, increasing adaptability and resilience to unexpected events <sup>[27]</sup>.

Pan, Su, and Zhou <sup>[28]</sup> argue that a resilient installation leads to a resilient community, particularly in security. The resilience of facilities is related to disaster management, as it is necessary not only to respond to disasters, but also to intentionally develop the capacity to absorb the effects of these disasters. This is a facility and its occupants' capability. The involvement of occupants is also important because when an adverse situation occurs, the group must respond as a whole. To promote engagement of the occupants, the authors created a disaster training alternative game.

### 3.4 Other Definitions and Applications of Resilience

Cybersecurity is defined as the ability of systems to be immune to threats, and cyber defense is defined as the ability of systems to successfully resist cyber incidents. Thus, resilience is defined as the "sum" of cybersecurity and cyber defense. In this case, it aims to preserve the continuity, reliability, and safety of activities <sup>[29]</sup>.

In addition, it is possible to apply the concept of resilience to product development, stating that resilience must ensure the availability of "post-surprise" options, assuming that surprises in the process are unavoidable. In his work, the author develops a holistic approach, integrating risk-based thinking with resilience, and applying it in product development, claiming that risk management and resilience are disciplines that complement one another <sup>[30]</sup>.

A different approach is the one that focus on safety indicators. According to the authors, resilience recognizes that security reviews that focus solely on negative events make it difficult to fully comprehend the process. Based on that, they define it in three dimensions: risk awareness, responsiveness, and support <sup>[31]</sup>.

Navaratne <sup>[32]</sup> extends the concept of resilience to the area of material selection, stating that the resilience of a system can be increased by the adoption of certain practices, methods, or the use of certain materials. In his work, the author tested various packages of noodles, a common emergency food. He stated that by locating suitable material, food security resilience could be improved, particularly in the event of a disaster.

### 3.5 Quantification and Measurement of Resilience

Resilience can be quantified and calculated. The authors, here, propose a model for calculating the value of resilience in manufacturing plants. The proposed model consists of seven steps: 1. Map the process flow; 2. Build the process capability block diagram; 3. Build the global network of reconstruction activities; 4. Define the damage scenario; 5. Calculate the initial loss of capacity; 6. Determine the capacity recovery function and 7. Determine economic loss. The model is used to determine the capacity recovery curve and economic loss for any predefined damage scenario caused by disruptive events that affect manufacturing facilities. This model generates an estimate of the value of the system's resilience <sup>[33]</sup>.

Furthermore, Pavlov and Zakharov <sup>[34]</sup> propose a method for quantifying supply chain resilience. The authors created an original model based on the concept of a hypergraph of production processes as well as the functioning of its differentiation. The proposed resilience

indicators are structurally functional and structurally technological.

Focusing on safety, a performance indicator model was developed that can represent early warning signs of system functional criticism. The authors chose to collect environmental data through games, experimenting with GREWI (Resilience-based Early Warning Indicator Method), a new method based on gamified data collection. This approach aims to encourage workers' engagement in workplace safety. In the end, it was possible to measure workplace resilience <sup>[31]</sup>.

Schattka, Puchkova, and McFarlane <sup>[35]</sup> developed a method for assessing a production system's performance in the face of process interruptions and determining the overall effective level of resilience. The authors used an Artificial Intelligence-based Operational Research technique to perform a stochastic simulation, generating an optimization method and a resilience score.

Kammouh, Gardoni and Cimellaro <sup>[36]</sup> introduced an approach to assess the time-based resilience of engineering systems through indicators. A Bayesian Network (BN) approach is employed to deal with the relationships between indicators, however, due to the dynamism of engineering systems, the temporal dimension is approached using the Dynamic Bayesian Network (DBN). DBN extends the classic BN by including a time dimension, allowing variables to interact at different stages of time. It can be used to track the evolution of a system's performance based on data collected in a previous step. This allows you to predict the state of resilience of a system through its initial condition. A DBN-based mathematical probabilistic framework is developed to model the resilience of dynamic engineering systems.

### 3.6 Techniques and Practices that promote Resilience

The use of redundancies and flexibility can improve a system's resilience. In industries and hospitals, for example, system redundancy is very common. It is a reserve element that enters the field if the primary one fails. One example is the use of backup generators in hospitals in the event of a power outage. The authors also claim that having parallel machines in a system makes it more resilient because, in the event of a failure, the backup machine replaces the one that is stopped. Flexibility, on the other hand, represents how easily a system can readjust when adversity occurs <sup>[18]</sup>.

Azadeh, Roudi, and Salehi <sup>[23]</sup> reinforce this idea by stating that flexibility, redundancy, and adaptability are variables that can be used to promote and measure resilience. The authors also emphasize that some customer-related variables, such as integrity, benevolence, capacity, and predictability, can be used for this purpose.

The authors assess the resilience of their suppliers by using additional cost and delivery time variables, concluding that adaptability is the most important variable in this regard.

Karl et al. [37] demonstrates ten practices identified in the literature for promoting resilience in their study: sustainability, agility, redundancy, flexibility, visibility, sharing of resources or information, robustness, sensitivity, risk management culture, adaptability, market position, risk control, public-private partnership, and supply chain network design.

Sharing information in an organization's supply chain promotes resilience by reducing uncertainty and risk. Li et al. [38], confirms this point by demonstrating through experiments that sharing information reduces the amount of backordering or reprogramming.

Another technique used to promote system resilience is found in the work of Ljasenko, Lohse, and Justham [39], who replaced fixed automation systems with mobile robots. The study sought to determine whether this change influenced the occurrence of urgent orders, the arrival times of fluctuating products, and variations in the production mix. The results revealed that the robots were more beneficial to the system.

Righi and Saurin [40] define a wide range of elements that interact dynamically to promote resilience. The authors demonstrate this by stating that making processes and results visible, as well as encouraging diversity of thought in decision making and understanding the difference between prescribed and actual work, are all actions aimed at promoting organizational resilience. Saurin et al. [41] declare that actions that promote resilience would result from the scenario-based training itself, because it was designed to directly dialogue with the four fundamental skills that a system must have to be resilient: responding, monitoring, learning, and anticipating

Training and guiding workers to improve working conditions is also considered a practice to generate resilience [24]. Ray-Sannerud, Leyshon and Vallevik [27] emphasize that healthy workers are associated with a healthy system. According to Patriarca et al. [31], using heuristic techniques in the manufacturing process can also help to increase resilience. Monitoring system configuration on a regular basis and encouraging cooperation among stakeholders in a supply chain are also ways to improve it [42], [20].

**IV. PRESENTATION AND DISCUSSION OF FINDINGS**

A review of the literature that supports the adopted methodology was presented in the previous chapter. The

results of the tabulation analysis, as described in the methodology, are then presented.

**4.1 Analysis of Skills and Competencies of a Resilient System**

As described in Chapter 2, the analyzed articles were classified into four categories. Figure 2 depicts their positions in relation to the total number of studies examined. It is possible to verify that most of the articles analyzed bring some practice or skill related to resilience.

In category 1, it is possible to verify that each author defines and applies the concepts of resilience in different ways. All concepts, however, have the same foundation, which is the ability of a system to mitigate or absorb the effect of a disruptive event and quickly recover to normal conditions. Some authors continue to categorize resilience into two categories: proactive resilience and reactive resilience. In some studies, continuous resilience is also defined as a third perspective, which is related to the adaptive capacity of a system [17], [22].

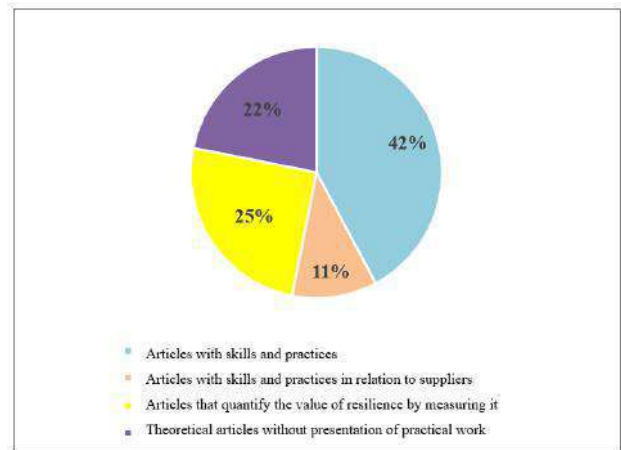


Fig. 2: Article's positions in relation to the total number of studies examined

Finally, all practices, skills, competences, and techniques that promote system resilience, particularly in manufacturing systems, were considered to determine which are the most studied in the literature or the most frequently used by organizations. This analysis identified a total of 23 skills and competencies. Table 1 presents all the skills, as well as the relative frequency of each one.



Table 1: Skills and competences identified in the articles

Skill/Competencies	Absolute frequency	Relative frequency
Flexibility	8	29.63%
Monitoring of impacts and risks	5	18.52%
Anticipation of impacts and risks	5	18.52%
Redundancy	5	18.52%
Adaptability	5	18.52%
Training	4	14.81%
Collaboration	4	14.81%
Diversity of thoughts	3	11.11%
Agility	3	11.11%
Robustness	3	11.11%
Visibility	2	7.41%
Sustainability	2	7.41%
Sharing information	2	7.41%
Market position	2	7.41%
Social responsibility	2	7.41%
Safety culture	2	7.41%
Physical infrastructure	1	3.70%
Sensitivity	1	3.70%
Decentralization	1	3.70%
Reengineering	1	3.70%
Trust between members	1	3.70%
Responsiveness	1	3.70%
Learning	1	3.70%

The analysis of Table 1 reveals that flexibility is the most studied and cited skill for promoting resilience in manufacturing systems. Flexibility can be defined as the ability of a system to restructure itself in response to the occurrence of a specific event, such as the manufacture of a new product. Extending this concept of flexibility to the supply chain, it is defined as a chain's ability to adjust in response to the needs of its partners and environmental conditions in the shortest amount of time possible [39], [37].

Following flexibility, four other skills are listed as the second most important for promoting a resilient system: risk anticipation and monitoring, redundancy, and adaptability. Adaptability is a similar concept to flexibility, but it is defined as the ability to assemble an adequate structure to adapt to new conditions and goals. As previously stated, the use of redundancy is defined as the use of backup equipment or systems that activate when the primary one fails. Finally, the culture of anticipating and monitoring risks stems from the safety and project sectors and is defined as the ability to anticipate events and monitor them over time [20], [26].

Training and collaboration skills are ranked third on the list. Training is the process of guiding employees on how to behave in disruptive situations so that they do not panic. If workers are well-organized, they will be able to successfully absorb or mitigate an adverse event. Collaboration encompasses not only interactions between employees, but also interactions between businesses and their customers, its suppliers, shareholders, and so on [24], [42].

Finally, the ability to agility and sturdiness are present in fourth place. Agility is defined as the ability to respond quickly to a disruptive event or, in the case of the supply chain, a change in offer and demand. Robustness, on the

other hand, is defined as a system's ability to withstand or absorb the impact of a negative event [37].

According to Wachs et al. (2015) [13], a system has four macro basic skills to be considered resilient: Monitor, Respond, Anticipate and Learn. As a result, you must constantly monitor for disruptions and threats. Anticipate future changes in the environment that could affect the system's ability to function. Respond to frequent disruptions and threats quickly and efficiently and learn from past mistakes and successes [43].

Figure 3 depicts the categorization of all 23 skills identified in Table 1 as belonging to one of the four macro skills of a resilient system. Based on the four previously mentioned criteria, each skill was rated only once. By analyzing the graph, it is possible to conclude that answering is the most studied macro skill, or most mentioned by the authors, followed by anticipating, monitoring, and learning.

Knowing what to do and how to respond to regular and irregular variability, interruptions, disturbances, and opportunities is referred to as the macro ability to respond. Responding also encompasses the assessment of the situation. The author also states that this ability can be divided into two strategies: proactive and reactive. Proactive refers to anticipating potentially destructive situations and defining the use of solutions, whereas reactive refers to generating, creating, inventing, or deriving solutions [43].

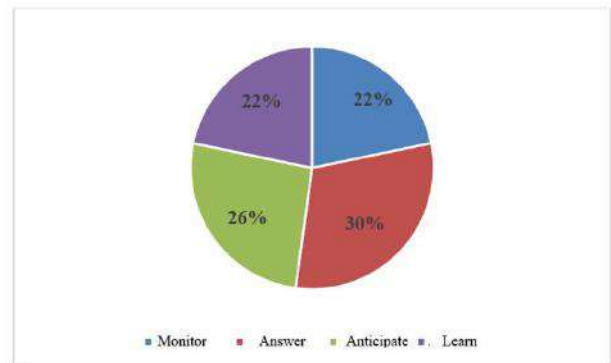


Fig. 3: Classification of skills according to macro skills

Anticipating means anticipating events, threats, and new opportunities for improvement in the future, such as potential changes, disruptions, pressures, and their consequences. Anticipating also entails giving yourself enough time to reflect on the project to identify and recognize potential issues [5].

Monitoring refers to knowing what to look for, or how to monitor what is or could become a threat in the near future that will require a response. Monitoring should

include both what happens in the environment and what happens within the system. Learning is also defined as a change in behavior as a result of an experience. Only by learning from past performance can future performance be improved. <sup>[43]</sup>

#### 4.2 Analysis of the Quantification and Measurement of Resilience

According to the articles reviewed, 25% of them proposed models, methods, or ways to quantify or measure the resilience of a system, supplier, or medium. A summary of the main methods used to assess resilience is provided below.

- a) The vulnerability and resilience of suppliers can be used to estimate their resilience <sup>[44]</sup>;
- b) Resilience can be calculated using a capacity loss and recovery function in conjunction with an economic loss function <sup>[33]</sup>;
- c) It is possible to estimate a resilience value by considering some of the skills discussed in the previous section <sup>[23]</sup>;
- d) A resilience value for the system was estimated using a hypergraph of production processes and their functioning and differentiation <sup>[34]</sup>;
- e) Use process safety indicators for complex socio-technical systems, to create an early warning of failures and system resilience <sup>[31]</sup>;
- f) Three metrics can be used to quantify resilience: performance loss, performance restore time, and total underperformance time <sup>[35]</sup>.

#### 4.3 Analysis of Supplier Resilience

Suppliers are an important part of a manufacturing system because a lack of supply for the organization can cause a variety of problems, so a supplier analysis is required. The analysis of the selected studies also brought criteria to define the resilience of suppliers, having their resilience measured or estimated based on integrity, benevolence, predictability, cost, and delivery time, as seen in some of the studies, for example.

Experiments by Li, Pedrielli, Lee, and Chew <sup>[38]</sup> demonstrated that sharing information with suppliers really helps to encourage supply chain resilience in terms of reducing backorder quantity and duration when destination inventory levels are specified.

In addition, Hosseini, and Khaled <sup>[44]</sup> identify eight contributors to supplier resilience in their work: surplus stock, location separation, contracting of support suppliers, robustness, reliability, forwarding, reorganization, and restoration. The set method was used to analyze and classify the data. The most important enablers of supplier

resilience were identified as robustness, reliability, and redirection.

Parkouhi and Ghadikolaei <sup>[45]</sup> add to the previous authors' findings by claiming that a supplier is more resilient if it ranks higher in terms of price variation, vulnerability, capacity limit, capability limit, visibility, raw material acquisition difficulties, and on-time delivery.

Chen, Hsieh, and Wee <sup>[46]</sup> define the following criteria for identifying resilient suppliers: Finance, Quality, Delivery, Relationship, Service, Technology and Product, Supply and Infrastructure Installation and Market Reputation, Assets and Infrastructure, Management and Organization, Corrective Action Effectiveness, Conflict Resolution and Problem Resolution Capabilities.

## V. CONCLUSION

Organizations are increasingly embedded in a context of constant change because of the dynamic nature of the environment. The study of resilience aids these organizations' adequacy and survival. Technology is becoming increasingly advanced, and as a result, demand, products, and services are rapidly changing. As a result, companies must be prepared to be always adaptable to the environment and to the market.

The definitions of resilience presented in this article, which vary depending on the system used, as well as the strategies for promoting them, enable this study to pave the way for understanding and maintaining resilience in these systems. Operators in these systems can also combine the various strategies presented in this article to tailor them to their organizations' needs.

The purpose of this article was to identify the skills and competencies needed for a system to be considered resilient. A systematic literature review enabled the identification of some concepts of resilience and how they are addressed in systems, particularly manufacturing systems.

The analysis of 64 articles resulting from research conducted in two databases and a Symposium revealed that resilience is conceptualized in various ways, but always with the same foundation. The results revealed that for a system to be resilient, it must be flexible above all. Other important competencies discovered in the analysis for promoting resilience in the manufacturing system are related to maintaining monitoring and anticipating impacts and threats, particularly from the external environment.

The use of redundancies has also been shown to be beneficial in terms of promoting resilience. When it comes to critical systems or components, redundancy should be used whenever possible. The results indicate that it is

possible to measure resilience quantitatively, and it is feasible to convert resilience into a number for possible comparison.

This article adds to the literature in the field, primarily for the study of resilience in manufacturing systems, by introducing the key concepts and skills required for its promotion. The study had the limitation of being based on two databases and a symposium. A scope expansion is suggested for future work, allowing more evidence to confirm the results obtained here.

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# Antônio Conselheiro and the Arraial De Canudos: A Socio-Anthropological Analysis

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**Keywords** — *Straws. Counselor. Communitas.  
Socioanthropological.*

**Abstract**— *The writing in question was built from the TCC - Course Conclusion Paper by one of the authors, entitled “The prophet and the politician: an analysis based on Antônio Conselheiro and Arraial de Canudos”. Therefore, we intend to use the fragments of the work in question to reorganize the analysis that proposed to put in dialogue the ideas of Antônio Conselheiro, the prophet, with the materiality of the praxis achieved with the Arraial de Belo Monte, Canudos. In relation to the latter, we think of the environment from the concept of communitas proposed by the English anthropologist Victor Turner (1969), contextualizing from Canudos, a “communitarian society” created in the Brazilian hinterland. With this perspective, we will reflect on Canudos as a place where it is possible to glimpse traces of a sertanejo prophetism. Thus, thinking about how that ‘main prophet’ was able, from his place of speech, to lead and seduce those people to faithfully follow their spiritual advice, defending his ideals of an anti-structure society, not refraining from even taking up arms to face the military forces of the Republic structure; we will consider, therefore, about the resistance of Canudos as a practical result of the socio-political-religious discourse of that prophet.*

## I. INTRODUCTION

This brief writing aims to reflect on the work developed by Antônio Conselheiro, as well as his political environment: the Arraial de Belo Monte, Canudos. Thus, we created strategies to think about the dialectical relationship between: prophecy and politics, having as existential locus the role of the religious leader. About this, we add to the prophetic plot, the aspect of politics as the

mundane element, expanding the ballast for the practice of what was suggested in the religious discourse.

Canudos is presented here as a communitas, which crystallized in the social relations between newly arrived neophytes from various parts of the sertão, effective sociopolitical actions that brought them back together, under the blessing of that prophet. In this regard, we show that the Counselor knew how to articulate, in a pragmatic way, his religious discourse with the socio-political

discourse and his power of speech enabled that *communitas* to effectively face its main demands. It is, therefore, an analysis of the Counselor's performance as a typical country "prophet" in a communitarian environment; aiming, in this way, to shed light on this discussion, considering that the strength of the speech of a religious leader in the political and social sphere is undeniable, whether or not he is revered as a prophet (TURNER, 1969).

The writing was constructed with the aim of bringing to the center of the debate a spark of what is meant by 'prophet' - from the point of view of a concept. To do so, it was necessary to search the descriptions in biblical-theological approaches, making slight connections with the socio-anthropological implications. The prophet Counselor appears in the text through his performance as a spiritual leader, he knew how to reconcile and articulate the religious and prophetic discourse with a sociopolitical discourse, shaping himself in the course of events, for an effectively more political stance than the religious one of the past, mobilizing actions and reactions in that public space that crystallized a true *communitas*.

It is also plausible to think, from the ontological point of view of a religious, that the prophet's speech may not be, essentially, social, in addition to being religious or prophetic. Therefore, it presents itself impregnated with aspects of its relationship with what is sacred to it and the implications arising from this. Thus, thinking about the relationship between the prophet and the politician, funneling the debate to the context of the Counselor, will undoubtedly provoke a broad reflection, problematizing and pondering the notion or concept of prophet. In this way, we intend, modestly, to contribute to the debate about the prophetic function in the structures of the studied societies.

## II. METHOD

The proposal for writing in course is a writing with a qualitative aspect, which seeks to contribute to the debate on the concepts of prophet and politics. In this regard, we seek the context experienced by Antônio Conselheiro, something that will undoubtedly provoke a reflection on the notion or concept of prophet. In this way, we intend to give rise, modestly, to the debate about how socio-anthropological research methods have sought to understand and explain the presence and prophetic function in the structures of studied societies, as well as the maintenance of existing 'powers'.

To understand the hermeneutic movement of the concept of prophet, we seek the understanding proposed by the Social Sciences in dialogue with the historicity, in

part, experienced by the authors of this work, mainly in the political experiences they had in their youth, commonly experienced in ecclesial formations and in the analysis of conjecture that existed in the 80's and 90's. In this regard, it is worth noting that, with this writing, we lend ourselves to the role of studying Canudos as a *communitas*, a category proposed by Turner (1969), thus finding the idea proposed, already predefined, by the prophet Counselor.

## III. RESULTS: ANTÔNIO COUNSELOR O PROFETA DO BELO MONTE

Antônio Conselheiro (1830-1897) was a leading religious leader in what became known as the Arraial de Canudos. The prophet of the Bahian sertão was on the front line of resistance in the massacre called by the media at the time: "Guerra de Canudos", which took place in Bahia between 1896 and 1897, fatally recorded in the book "Os Sertões" by Euclides da Cunha.

In order to think of Antônio Conselheiro as the prophet that he had become in the Arraial de Belo Monte, it will be necessary to look in his biographical history for elements that help to understand how the construction of his religious and prophetic profile took place. Therefore, it is, in fact, imperative to also look for what his influences were, what models he was inspired by and sought to follow. For this reason, in the course of this biographical narrative, even if briefly, we introject relevant facts and characters that, in some way, directly influenced Antônio Conselheiro. In this regard, we can highlight his contemporary religious, who were directly intertwined with its history: they are José Antônio de Maria Ibiapina (Father Ibiapina - 1806-1883) and Cícero Romão Batista (Father Cícero - 1844-1934). The mention of these characters aims basically to endorse the understanding, as we have said before, that the appearance of a prophet cannot be explained purely and simply or exclusively by superficial arguments, which seem to allude only to the epiphanic aspects.

In this regard, it is essential to also consider the social aspects imbricated in the formation of these religious individuals, evidently that the impacts of the faith defended by them and courageously demonstrated in the course of their social actions should not be overlooked. It is exactly the religious aspect that worried us, especially considering the fact that these are religious subjects who, in defense of the faith and a socio-religious ideal, did not shy away from leading highly significant actions, including affecting the condition of their own existences, but voluntarily succumbed believing in that collective dream and that proved to be possible.

#### IV. DISCUSSION: CANUDOS COMMUNITAS OR THE PROPHET CONSELHEIRO?

In 1893, the pilgrim prophet arrived in the parts of Bahia, at the crossroads characteristic of the northeastern hinterlands. The region is distanced by about 200 kilometers from the railway, only reached on foot or on donkeys. A village between five mountains and multiple trails along the caatinga. A very decayed place, which had once housed an old farm, then in ruins, on the banks of the Vaza-Barris River, called Canudos, referring to a plant that thrived on the riverbank. There he established himself, founding a new communitarian public space. Thus, the *communitas* were born outside the structural domain of the new Republic, often called the sacred village of Belo Monte, the Promised Land, *Canaã Sertaneja*' (CUNHA, 1992).

For Tunner (1969), *communitas* could be defined as "a relationship between concrete, historical, idiosyncratic individuals". For him, the human groups that could be defined as *communitas* would be those that "in a short time are transformed into structures, in which the free relations between individuals are converted into relations, governed by norms, between social people". Thus, we can highlight that Canudos materialized as a *communitas* for having/being "existential and spontaneous", or, as Tunner (*idem*) defined, "approximately what hippies would call happening today, and what William Blake called - "the fleeting moment that passes", or, later, "mutual forgiveness of the defects of each one"".

In light of the above, we can state that Canudos became the *communitas* of the outskirts of the Bahian hinterland, where it was possible to enable effective political actions in a contingent, albeit ephemeral, under the baton of a religious leader first, then a political agent whose power of speech was capable of fostering the necessary persuasion for its viability. In that socio-religious and political environment, all individual interests were supplanted by essentially collective interests, it is clearly possible to think there the existence of 'liminalities' in that councilorist '*communitas*'; and also to glimpse that those who were attracted there, effectively submitted to certain 'rites of passage' (TURNER, 1969), as we will try to demonstrate later on when the arrival of subjects who voluntarily adapted to that established scenario, but still under construction .

Another aspect of that Canudian prophetism is that the Counselor, despite acting as a prophet, did not foster the mystical characteristic or the magical aspect of this function; it is possible to visualize this, through his writings, that there was a subject with an undeniable intellectual capacity of persuasion or persuasion, due to the

skill of argumentation. He did not oppose, at the expense of his prophetic posture, that his minions would take up arms in defense of the Arraial and himself; and they did so without, however, losing their spiritual tranquility and religiosity, not even in the worst moments of that apocalyptic confrontation between 'good and evil', between us and them, as seen by both sides.

It is necessary to undertake a good socio-anthropological analysis in reading the writings left by the Counselor in his sermons, taking into account the circumstances and contexts in which they were recorded, the thoughts and feelings of that prophet; these writings were found in the sanctuary where he lived, shortly after the invasion of the camp of Canudos. The Centro de Estudos Baianos, of the Federal University of Bahia (CEB-UNEB) , published the *Breviário de Antônio Conselheiro* , in a volume with more than 800 pages; dividing into two parts: the first with excerpts from the Gospels; the second with historical-biblical episodes and summaries of sermons, with theological and doctrinal themes, such as the symbolism of the cross or the laws of divine worship. It was his practical and liturgical Sermonary. In the volume there is also an annotation entitled: "Notes on the Precepts of the Divine Law of Our Lord Jesus Christ for the Salvation of Men, by Pilgrim Antônio Vicente Mendes Maciel, in the village of Belo Monte, Province of Bahia, May 1895". Clear evidence that the Counselor did not claim other titles besides being a simple pilgrim.

As seen, Conselheiro did not call himself a prophet, but a pilgrim. In relation to this it is also known that many of his followers respected him as a prophet, and gave him other titles. To try to bring the Counselor a little closer to a prophetic profile, from the point of view of the concept, we could recall here some elements that, in a way, helped to foster this image projected on him. However, it is necessary at least to bring to light what would be the prophecies attributed to him, which could justify such fame.

It is known that, as a pilgrim of the sertões, he not only built works, but also wrote his sermons with relative aplomb and intellectuality, as can be seen; among his writings are found, what many authors understood to be his prophecies:

"In 1897 there will be a lot of pasture and little trail and one shepherd and one flock."

"In 1898 there will be many hats and few heads."

"In 1899 the waters will remain in blood (...) It will rain a great shower of stars and there will be the end of the world".

"In 1890 the lights will go out".

“Verily I say to you, when the nations fight with the nations, Brazil with Brazil (...), from the waves of the sea D. Sebastião will leave with all his army”.

“There will be four fires, the first three will be mine, the fourth I give to my good Jesus”. (NOGUEIRA, 1978).

However the prophecy that became most famous was the following, “(...) In 1896 had a thousand flocks run from the beach to the right; then the certão will become a beach and the beach will become a certão” (sic).

There are records of another writing attributed to the Counselor, entitled: “Storms that rise in the Heart of Mary on the occasion of the mystery of the Annunciation”; that it had been found in the same place as the previous ones, but that it took a different fate, passing from hand to hand to the writer Euclides da Cunha, a few months before his death.

In that Canudos *communitas*, Antônio Conselheiro clearly demonstrated his effectiveness as a prophet; skillfully mobilizing their spiritual discourse, in accordance with the needs of those listeners, showing their concerns in the field of spirituality of that people, but reconciling their preaching with the sociopolitical sphere, acting effectively in the face of the ills suffered by them. There, it was possible to see evidenced the figure of a subject who managed to acquire a certain prominence as political leadership, as a result of his oratory, his charismatic capacity and for knowing how to articulate religious and sociopolitical discourses with the reality in which he himself lived. This is certainly the reason why he managed to arrest those listeners, who became followers under his baton; keeping them away from hunger and drought, feeding them also by faith; and so all placed their full trust in that divine sertanejo spokesman.

## V. THE BELO MONTE ARRAIAL: CANUDOS COMMUNITAS

In the world socioeconomic context of the time, as is known, capitalism and the era of republicanism were expanding, beginning with the United States War of Independence in 1776 and the French Revolution of 1789. History points out that the economic and social capitalist system it continued to subject the forms of government that existed until then, starting with England and from Europe to the rest of the world; becoming the majority system until the first world war, when some countries opted for communism. In Brazil, at the end of the 19th century, specifically in Arraial de Belo Monte, Canudos, there was established a communitarian religious society, based on work and a self-sustainable economic activity and based on solidarity. This reality, as we have already

seen, quickly showed its practical effects in terms of food production, housing, and with that, mainly, it kept away, for a relatively long period, drought and hunger, which had always been the main fears of those backhanders.

Canudos, therefore, emerged as a communitarian environment, socially just, in theory, without classes and without inequalities; just like a real '*communitas*', where subjects interacted stripped of their former values, which is why they did not need to sustain the hierarchies of structures from outside; in that *communitas* there was no exacerbated concern between the public and the private, it belonged to everyone. Composed of individuals who separated themselves from the condition they experienced in the past, fleeing from their respective '*social dramas*' and temporarily undergoing a '*liminal*' process, as if an intermediary to be again added to a new social reality proposed there.

To the detriment of having '*merchants*' there, there are also records that private owners put houses for sale; however, there was a great mass that was supported equally, that was the essence and dynamics of Canudos; the fertile, communal and egalitarian side of Belo Monte made it a scenario where it would be possible, roughly speaking, to glimpse a socialist/communist aspect working literally and guaranteeing the subsistence of those sertanejos. There the Counselor preached the Kingdom of Heaven, but he called on those poor to unite in building a new world where it was possible to glimpse equality and justice in the here and now.

The socio-religious, political and economic character of that camp attracted crowds; there were rumors that that '*communitas*' reached the status of the second largest '*city*' in the state, if we consider the questionable post-conflict military reports as true, which indicated that there were about twenty-five thousand inhabitants there (to have one idea the capital of Bahia, Salvador then had 200,000 inhabitants); it is said that Canudos came to export part of its production of goats and skins, as well as having a certain organization to the point of having commercial relations with other locations (as an example there is the case of wood purchased in Juazeiro-BA for the works of the Temple). Belo Monte made it possible to integrate economic and social needs with religious needs, and vice versa; fully concretizing what for the countryman should never be dissociated: religion and life.

Thus grew that public space *communitas*, countless people and entire families flocked there, mainly the poorest of the Brazilian Northeast; residents of the region, farmers, Indians (kaimbé, Kiriri and Tuxá), as well as newly freed Afro-descendants. These human groups came from all over, leaving, as some claimed, certain regions of



Bahia and Sergipe almost uninhabited due to the exodus that had taken place.

In practice, the socio-political-economic regime of Canudos was relatively similar to the proposal of socialism, in terms of the production and distribution system; without state control, as if aiming to establish a communist society, or without classes of exploited and exploiters, justifying the clear opposition to the anti-capitalist vision defended by the Counselor and often publicly evidenced; for example, when he declared to reject the tax charges of the newly instituted republican regime; the scenario already foreshadowed the existence of two antagonistic forces about to confront each other, on the one hand the councilors ideology seeing the new regime as a demonic force; on the other side, the new Republic, which, in turn, also faced any idea or movement that seemed monarchist or anti-capitalist, as being equally demonic, retrograde and, therefore, contrary to the new positivist ideals of “order and progress” already on the pennant.

The socio-religious and political context of Canudos constitutes a scenario where it is easily possible to reflect on the close connection between faith and the socio-political circumstances experienced in that model of communitarian public space; an atmosphere where it can be seen that the religiosity of those counselors grew to the extent that they could not

## VI. THE REPUBLIC AND CANUDOS. THE CONFLICT BETWEEN STRUCTURE AND ANTISTRUCTURE.

The Counselor's preachings, or rather, his socio-religious and political discourse, were already impregnated and imbued with criticism of the society organized under the great property that exploited the poorest. It was common to hear of entire families selling what little they had to go in search of the Canudista socialist ideals. In a short time, the socio-religious and political discourse began to provoke irritation, not only to ecclesiastical authorities, but to the current system of government. That Belo Monte *communitas* began to demonstrate its dangers to the new imposed pattern of society; it generated all kinds of unrest, certainly that the Counselor's speeches, leadership posture and socio-political actions evidently boosted the forces against that *communitas* even more. The newly instituted republican political regime was seen by the Counselor as something demonic, for the reasons we have already listed; he saw the Republic interfering in the things of God, taking away the Emperor's divine right to rule in the guise of the infamous patronage. The Counselor uncompromisingly defended the right of the

Sovereigns as being divine and any regime contrary to this would be, for him, the personification of the evil itself.

Straws *communitas* imbued with clear liminalities generating multiple creative actions that crystallized and stratified a real liberation from the external structural contours, but at the same time demonstrated, in the eyes of others, postures considered absolutely dangerous from the point of view of maintaining the law and structural order, the purity potentiated inside the camp, was the inversely proportional danger outside it. The drama and the stage were staged there, and the climax of the socio-religious reality of Canudos *communitas* was already demonstrated, whose performance really upset the state structure, the anticlimax was under way, the conflict was inevitable.

In that Brazilian social context, a scenario of imminent war was being drawn up. In this case, two points of view were formed, shouting out antagonistic conjectures; on the side of the republican military, the worst of feelings regarding any idea of a return to monarchy, seen as a delay, an unacceptable setback; also with extreme words, feelings and actions, they projected on the figure of the Counselor, his followers and Canudos *communitas*, the retrograde, grotesque and even 'demonic' figure of the battered monarchy, to be annihilated at all costs. In a short time, the army was ordered to destroy that ephemeral *communitas*, already insubordinate to the State; justifications soon came, various preposterous arguments, all making efforts to point out in that religious leader, a demented and dangerous monarchic counterrevolutionary, who should be annihilated at all costs; this was the main justification used for that fratricidal war, started in 1896 and which lasted until the end of 1897.

## VII. CONCLUSION

Although the sources that allude to this theme are plentiful, the productions are still considered few. Those dealing with the importance and implications of socio-religious discourse with the political. It seems that the vast majority of the works focus only on the socio-political aspects of the episode; they don't care so much about the steeped socio-anthropological implications of religious nuances. It seems that many authors and researchers cannot escape the temptation to look at the sertanejo religious subject, through lenses riddled with prejudices and value judgments. Thus, failing to envision positively the social and political value of a religious subject.

The figure of the “sertanejo religious subject” is seen, therefore, in this work, exercising its 'prophetic' function with effective power of speech in the sociopolitical sphere, perhaps it is exactly for this reason that we have so little research bringing more coherent

approaches, which look for all possible versions of the saga of the Arraial de Canudos *communitas*, also known as the Tróia de taipa and the 'sacred village' (CUNHA, 1992).

Given the above, we emphasize that the importance of reflecting on the importance of a prophet and his socio-religious discourse in his social and political context reasonably demonstrated how much the power to speak of a religious subject, linked to his ability to mobilize a range of followers, with effective sociopolitical actions.

To clarify this finding, inevitably, efforts were needed to problematize this theme, making it a feasible task, especially because it was possible to think about the inescapable questions raised and raised, implicit and explicit in the textual body; for example, to what extent can the power of speech of a religious figure reconcile spiritual and sociopolitical discourse? And can his acting as a prophet promote effective sociopolitical actions, in an environment with communitarian characteristics? Judging by the example of prophet and *communitas* that we use, we can see that yes, the questions can be effectively materialized, obtaining plausible positive answers.

When sewing this theme, using the figure of Antônio Conselheiro as the prophet and Canudos as a socio-religious environment typifying the public space *communitas*, it was quite evident that the religious discourse and the leadership posture of that prophet, fully articulated the relationships structured there by subjects in state of liminalities and, even to the detriment of this, incontestable practical political actions were carried out in that communitarian camp; clearly demonstrated in the efforts for survival and, at the end, in the unquestionable resistance undertaken in the face of the armed conflict that took place there.

It was important to point out the religious subjects mentioned, with the Counselor in greater focus, as 'types' that minimally fulfilled the proposal of this research; for understanding the importance that these had in recent history, when they acted as true sertanejo prophets in their sociopolitical contexts. The work allowed us to think about the power of speech of a religious subject in his communitarian environment. Linked to this, we saw that this undertaking would not be possible without an environment model as an example. Therefore, the Arraial de Belo Monte, Canudos shown as a *communitas* was the ideal space that made it possible for us to foster reflection.

By analyzing it, we were able to see that a real dimension of public space was created there, *communitas* with major socio-religious and political events, where it was also possible to see crystallized the phenomenon of liminalities; that same space arrived individuals fleeing social structures, passing through ritual processes of

passage, being aggregated in communion, demonstrated in the final resistance of the conflict.

In addition to these points listed, the research also allowed to bring to this reflection, the discussion about what the prophet was with the Counselor model and portraying him as a type of sertanejo prophet of our recent history, enabling the extraction of possible socio-anthropological implications of this concept for more up-to-date reflection. In this way, the writing pointed out the importance of the necessary reflection, as it instigated us, with this, to debate about the perspectives that authors of the social sciences brought to light, pointing out the perspective of making future efforts to further problematize this concept; to perhaps even contribute, modestly, in 'repositioning' the place of the prophet in socio-anthropological approaches; with that, it can favor bigger and better reflections alluding to this theme.

Another interesting point achieved in this research was when we could see that, when dealing with the figure of a prophet, his power of speech and action in his social context, both the biblical-theological-Jewish-Christian and the socio-anthropological approach, in fact, point out that it is about

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# Study of the neutralization of cell multiplication, in vitro, with Botulinum Neurotoxin Type A

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**Keywords** — *Anti-cancer enzymes; Bacterial toxins; Botulinum toxin type A; Apoptosis.*

**Abstract**— *Non-melanoma skin cancer is the most frequently diagnosed cancer in humans. The process of cutaneous carcinogenesis is not fully understood. However, several studies have been carried out to better explain the mechanisms that lead to malignancy. Methods: We tested in vitro the neutralization of non-melanoma carcinoma cell replication with botulinum toxin. Results: There was no significance in cell inhibition. Conclusion: Although our results have not been promising, further research with botulinum toxin should be encouraged to provide additional data on its effects on skin lesions, as with current evidence it is possible to correctly plan clinical trials aimed at testing its action on the skin. non-melanoma skin cancer*

## I. INTRODUCTION

Despite the many advances in the diagnosis and treatment of cancer, tumor diseases are one of the main reasons for death worldwide. The side effects of chemotherapy and drug resistance of some types of cancer belong to the current major therapeutic problems. Therefore, the search for new anticancer substances and drugs is very important. (Henkel; Baldwin; Barbieri 2010)

Currently, ten major characteristics of cancer have been universally recognized, including unlimited multiplication, evasion from growth suppressors, promoting invasion and metastasis, resisting apoptosis, stimulating angiogenesis, maintaining proliferative signaling, elimination of cell energy limitation, evading immune destruction, genome instability and mutation, and tumor enhanced inflammation. (Hanahan; Weinberg, 2011)

There are key features in cancer formation that have been universally recognized, including unlimited multiplication, evasion of growth suppressants, promotion of invasion and metastasis, resistance to apoptosis, stimulation of angiogenesis, maintenance of proliferative signaling, elimination of cell energy limitation, evasion of immune destruction, genome instability, and tumor-enhanced mutation and inflammation (Hanahan; Weinberg, 2011).

Although there is already an understanding of most of the characteristics of cancer, the cellular and non-cellular components of the tumor niche help tumors acquire these characteristics. (Chen, et al. 2015)

Skin cancer can be classified into major subtypes: melanoma, basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and rare tumors. (Amaral ;Garbe , 2017).

Non-melanoma skin cancer (NMSC) represents one of the most common malignancies in humans, with basal cell carcinomas derived from keratinocytes (BCCs) and squamous cell carcinomas (SCCs) accounting for approximately 80% and 20% of NMSC cases, respectively. (Didona, et al 2018)

Although a high recurrence rate is observed, these cancers rarely metastasize and the results are promising with targeted therapies, however the development of resistance has been described. (NCCN,2018)

Botulinum neurotoxin Type A (BoNT/A) is one of the most potent toxins known (Pirazzini et al., 2017). It blocks neurotransmission via the specific cleavage of the synaptic protein SNAP-25 (synaptosomal-associated protein of 25 kDa). Atualmente, existem inúmeras indicações para o uso das neurotoxinas botulínicas (BoNT) tipos A e B na clínica médica. Their specific inhibitory action on

cholinergic synapses makes them desirable for the treatment of various hyperkinetic movement disorders as well as those caused by glandular hyperactivity. (Jankovic, 2017)

However, the literature is limited on the addition of BoNT/A to the culture of cancer cell lines. Some articles report that there is a delay in cell growth and mitotic activity of certain cancer cells and promote cell apoptosis (Matak.; Lacković, 2015)

Promising studies have been developed, such as those by Karsenty et al., (2019), which reported the inhibition of the growth of LNCaP and PC3 cells in vitro and in vivo (prostate cancer xenografts in mice) after the application of abobotulinum toxin, a in this regard they observed that TXB significantly reduced LNCaP cell proliferation as well as a dose-dependent increase in apoptosis, but did not affect PC-3. (Piamo; Ferrer 2020). Therefore, the search for TXB action in skin cancer cell lines is necessary, so that we can have a view of the in vitro activity on them.

### I.1 Objectives

The present study aims to investigate experimentally the neutralization of skin cancer cell growth using botulinum toxin. If this hypothesis is confirmed, thus establishing a model with the next objective of studying possible mechanisms involved in this neutralization.

### I.2 Method

#### Cell growth assay (MTT)

SCC-25(oral squamous cell carcinoma cell line) or HUVEC (noncancerous control cell line) (2.10<sup>4</sup>) cells were seeded in 96-well plates and cultured in 10% FBS medium for 48 h, in the presence of botulinum toxin. Cells were harvested, 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT, 0.5 mg/ml in normal media) was added, and the cells were incubated for 4 h; then, 100  $\mu$ l DMSO (Dimethyl Sulfoxide) were added, and the optical density of 570 $\lambda$  value was detected. round bracket (i.e., (3) reads as "equation 3").

## II. RESULTS

The results revealed that was not lethal to the cell lines.

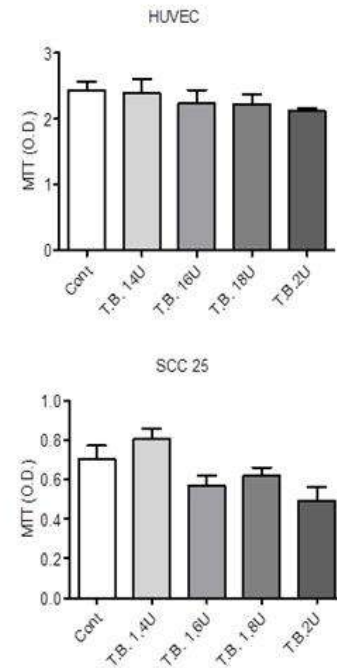


Fig. 1: Test results

## III. CONCLUSION

Although our results were not encouraging, the positive effect of BoNTs on different cancer cell lines and their direct effects on certain cancer tumors is encouraging. More studies are needed to verify these results and if verified to develop a methodology by which BoNT injections can be safely used for the treatment of certain human cancers.

Currently, there are vast indications for the use of botulinum neurotoxins BoNT/A in clinical medicine. Their specific inhibitory action on cholinergic synapses makes them desirable for the treatment of several hyperkinetic movement disorders as well as symptoms caused by glandular hyperactivity and bladder dysfunction (Jankovic, 2017)

The rationale for the use of BoNT/A is that, under conditions of increased muscle tone, the administration of the toxin alleviates pathological symptoms by blocking neuromuscular transmission. However, experimental evidence indicates that not all effects of BoNT/A can be explained by blocking the neuromuscular junction alone (Marchand-Pauvert et al., 2013).

There is no consensus on how other actions arise. Experimental studies of skin effects with botulinum neurotoxins, in vivo and in vitro, have identified a number of direct effects of BoNT/A on non-neuronal cells in the skin. In experimental use of BoNT / A demonstrates ability to protect skin flaps, reducing cutaneous lymphocyte



infiltration and improving acanthosis in KC-Tie2 and NL, (Kavlick et al. 2012) and decrease mast cell activity. (Park, 2013)

Anticancer properties of BoNT/A have been identified in three types of cancer cell lines, prostate, breast and colon. BoNT/A inhibits the growth of LNCaP human prostate cancer cells in vitro and in vivo, (Karsenty, et al. 2009) in addition to increasing the phosphorylated form of phospholipase A2. This would be the likely mechanism that explains how the toxin reduces cell growth and proliferation (Proietti, et al 2012), rats, the intraprostatic injection of BoNT / A altered cell dynamics inducing apoptosis, inhibiting proliferation and down-regulation of adrenergic receptors, which were associated to apoptosis and atrophic alteration. (Nishiyama 2009). In a comparative study, rats treated with BoNT/A showed reduced epithelial staining of Bcl-xL and consistently increased staining of Bax and caspase-3 when compared to saline-treated animals. (Scott, et al 2021).

How breast and colon cell lines have been shown to respond to BoNT/A

through changes in gene expression in RNA and protein levels, (Dreyfus, et al, 2021). Therefore, other types of cancer may become a potential target for BoNT's anti-cancer activity. Relevant evidence that BoNTs exhibit biological effects in many types of human cells, with a much broader effect based on individual cellular responses to the cholinergic impacts of BoNT/A. (Grando; Zachary, 2018).

Although our results have not been promising, further research with botulinum toxin should be encouraged to provide additional data on its effects on skin lesions, as with current evidence it is possible to correctly plan clinical trials designed with the aim of trying out its action in non-melanoma skin cancer.

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## **Productive backyards, solidarity economy and sustainable development in the community of Novas Vidas, Ceará, Brazil**

### **Quintais produtivos, economia solidária e desenvolvimento sustentável na comunidade de Novas Vidas, Ceará, Brasil**

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**Abstract**— This paper aims to identify the main characteristics indicative of advances in the solidarity economy via cooperation as an alternative for local sustainable development, namely: Novas Vidas community, located in Ocara, Ceará, Brazil. Indeed, economic difficulties in the context of capitalist society directly impact the strategies for strengthening cooperativism. It is possible to see the importance of the discussion of cooperativism in the perspective of strengthening local development and environmental sustainability. In this sense, for the production of this study,

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**Keywords— Sustainable development, Solidarity economy, New Life, Ocara-CE.**

*the methodological paths of qualitative research were followed, aiming to understand how farmers develop the Solidarity Economy through productive yards in the community with a view to sustainability. Regarding data collection techniques, on-site observation and non-directive interview were used. Regarding the analysis techniques, discourse analysis was applied. As a succinct conclusion, it became clear that the possibility of sustainable development depends on strategic actions or focal public policies.*

## I. INTRODUCTION

A crise econômica causada pelas políticas intervencionistas praticadas pelo Estado, no contexto da sociedade capitalista, vem gerando o fortalecimento de estratégias de reestruturação da economia, sob o enfoque de propostas alternativas, a partir da cooperação solidária (ALVES et al., 2017). A partir dessas concepções podemos perceber que a proposta de criação de empreendimentos sociais implantados em territórios marcados pela extensa desigualdade social pode constituir iniciativas assistenciais, que visam promover melhores condições de vida de pequenos grupos ou famílias de trabalhadores excluídos das políticas públicas e do atual regime do mercado. “De forma geral, a Economia Solidária não é uma alternativa somente para os pobres e excluídos, mas proporciona avanços em diversos domínios e contextos, e envolve de maneira responsável amplos segmentos da sociedade” (ALVES et al., 2017, p. 246).

De acordo com Silva e Silva (2008), a intervenção do Estado na perspectiva social, sob o enfoque da política social, surge no início do século XIX como resposta ao agravamento da crise econômica e social que afetou diversos países europeu, em que abriu espaço para expansão do capitalismo. Assim sendo, entre as perspectivas de desenvolvimento de alternativas possíveis, o Estado passou a se posicionar como principal mobilizador intervencionista, com enfoque em promover uma movimentação com o objetivo de combater as desigualdades que afetam a grande maioria da população. Assim, tal iniciativa solidária assume o papel de política pública que visa promover a geração de trabalho e renda, através da cooperação solidária, como forma de transformação das classes sociais menos favorecidas pelas políticas estatais.

A cooperação solidária destaca-se como potencial de autonomia social, com vistas a possibilidades de crescimento econômico e melhores condições de vida da população, através do desenvolvimento local (ALVES et al., 2017). A partir dessa análise, compreendemos, então, que a economia solidária pressupõe a representação de um modelo de gestão vinculado aos princípios que buscam a inclusão social dos indivíduos que buscam a recuperação

da dignidade humana, que se delinea com o processo de formação de espaços democráticos e de outras maneiras de socialização entre os indivíduos desassistidos pelas políticas públicas estatais. Como expresso por Barbosa, Crubelati e Macedo (2016, p.73).

Deste modo a educação popular nos permite refletir sobre as relações entre trabalho e educação que se perpetuam no ambiente do trabalho associado sob a ótica da economia solidária que busca pelas práticas formativas, para se contrapor ao viés capitalista rompendo com a lógica de exclusão que se perpetuava nos ambientes de trabalho e subordinação da vida cultural e material.

A partir daí observa-se que o cooperativismo tomou uma forma intensa de destaque como alternativa de mobilização de vários indivíduos que trabalham juntos em busca de determinado objetivo, tanto no sentido da coordenação, como na relação com trabalhadores, que organizam suas atividades em forma de rodízio.

Em outras palavras, a articulação do desenvolvimento econômico permeado com as práticas da economia solidária apresenta crescentes preocupações com as gerações futuras, sobretudo com o surgimento de cooperações que previnam o desemprego (BENINI et al., 2008). Nesse novo olhar para as questões do desenvolvimento econômico e social, a economia solidária, também possibilita a promoção do desenvolvimento sustentável, sendo apresentado como alternativas de produtividade de atividades culturais, econômicas e políticas sociais. (ALVES et al., 2017).

Partindo desse princípio, percebemos, então que a economia solidária parte da dimensão de reestruturação do processo de gestão democrática e de manifestações reivindicatórias que visam o fomento de políticas públicas em prol de soluções para os problemas enfrentados pelos trabalhadores, que acabam sendo atingidos de forma recorrente com a exploração do trabalho, e com a consequente degradação dos recursos naturais.



Contemplando esta perspectiva o objetivo central deste estudo é o de caracterizar os avanços da cooperação solidária, como alternativa de desenvolvimento local, na comunidade de Novas Vidas, no município de Ocara, Ceará.

Metodologicamente a referida pesquisa de abordagem qualitativa foi desenvolvida na comunidade Novas Vidas, onde buscamos compreender como os agricultores desenvolvem a Economia Solidária através dos quintais produtivos com vistas ao desenvolvimento sustentável. Para coleta de dados e informações, empregamos as técnicas da observação direta e a entrevista não diretiva. Como técnica de análise aplicou-se a interpretação de conteúdo e análise do discurso.

## II. ECONOMIA SOLIDÁRIA E DESENVOLVIMENTO LOCAL

Antes de falarmos de economia solidária precisamos compreender o contexto de surgimento dessa prática de atividade econômica. Na Europa do final do século XVIII, notadamente na Grã-Bretanha, verifica-se a difusão de diversas máquinas e ferramentas movidas a vapor. Essa inovação tecnológica impulsiona a nascente revolução industrial que serviria de esteio ao intenso desenvolvimento do modo de produção capitalista ao longo do século seguinte (SILVA; SILVA, 2008).

A transição de uma economia baseada primordialmente na exploração da terra para uma produção industrial traz como consequências o crescimento desordenado das cidades e o incremento das desigualdades sociais no cenário urbano. A inexistência de regulamentação do trabalho assalariado nas fábricas nascentes impõe aos trabalhadores urbanos jornadas de trabalho extenuantes, remunerações insuficientes e condições muito precárias de trabalho, de modo que, compromete até mesmo a sobrevivência das famílias.

Diante dessa situação, em resposta a esse cenário de desigualdade social que oprimia a classe operária, diversas ideias críticas ao modo de produção capitalista passam a florescer, a exemplo das ideias socialistas e anarquistas. Neste contexto surgem também propostas de autogestão dos trabalhadores baseadas no associativismo e cooperativismo. Propostas que, mais tarde, dariam origem ao conceito de “economia solidária”. A empresa solidária “nega a separação entre trabalho e posse dos meios de produção, que é reconhecida como a base do capitalismo”. Numa empresa deste tipo, o capital é detido por aqueles “que nela trabalham e apenas por eles” (SILVA; SILVA, 2008, p. 2).

De acordo com os autores citados anteriormente, as discussões históricas sobre as lutas sociais e a crescente insatisfação da população estimularam a classe trabalhadora a iniciar um movimento de mobilização em favor do combate ao capitalismo. A economia solidária surge, assim, como nítida resposta ao agravamento da crise do trabalho e a crescente insatisfação popular, ligados por todas as formas sociais, possibilitando a criação de uma nova estratégia do desenvolvimento local (SILVA; SILVA, 2008 E MELO, 2017).

No Brasil as práticas ligadas à economia solidária passam a chamar atenção a partir da década de 1990. Diversas cooperativas de produção, trabalho consumo e crédito surgem como resposta à exploração e exclusão no mundo do trabalho decorrente da crise econômica pela qual atravessava o país. A falência de algumas empresas levam seus trabalhadores a buscarem novas formas de organização e autogestão visando a manutenção de seus postos de trabalho. (TAUILE; RODRIGUES, 2004).

Foi o caso — inaugural —, no início dos anos 1990, dos trabalhadores da Makerli, empresa de razoável porte do ramo calçadista, em Franca/SP, que se organizaram sob a forma cooperativa para tentar salvá-la. Empresas desse tipo, e em todo o país, foram progressivamente se associando e surgiu, logo a seguir (1994), a Associação Nacional de Trabalhadores em Empresas de Autogestão (Anteag), que no início desta década já contabilizava o acompanhamento de um conjunto estimado em 150 empresas, sendo a grande maioria cooperativas e envolvendo cerca de 30 mil trabalhadores (TAUILE e RODRIGUES, 2004, p.38).

A partir daí, práticas de associativismo e cooperativismo ganham grande destaque nas novas propostas de desenvolvimento local. De acordo com Melo (2017), o desenvolvimento local surge como fator de produtividade que permeia o desenvolvimento econômico baseado em fatores de produtividade e capacidade de atuar em processos que amplie os interesses econômicos coletivos e capacidade de atuar em conflitos sociais. Entre essas perspectivas podemos ressaltar a criação de políticas públicas pelo Estado, apresentadas como novos projetos que buscam atuar em diferentes realidades locais.

Na visão de Melo (2017, p. 8) “tais iniciativas solidárias apresentam-se determinadas também pela preocupação social através da solidariedade, da cooperação com a emancipação social através da solidariedade, da cooperação e da associação entre os

trabalhadores vulneráveis socialmente ou excluídos [...]”. Assim sendo, podemos compreender que as forças produtivas locais são exercidas pelos membros da sociedade civil, que integram o grupo de pessoas em busca de melhores condições de sobrevivência econômica para suas famílias e de sustentabilidade ambiental.

Da mesma forma que o desenvolvimento local se configura como uma alternativa ao processo clássico de desenvolvimento econômico, também se estabeleceram as diretrizes para uma nova agenda de crescimento baseada na sustentabilidade ambiental, isto é, o desenvolvimento sustentável, em contraposição ao desenvolvimento atrelado e subordinado à racionalidade econômica da produção e acumulação de capital, que era medido e quantificado pelo aumento da produção e pela produtividade dos fatores econômicos. (MELO, 2017, p. 6).

Nessa mesma perspectiva, Barbosa, Crumbelati e Macedo (2016), ressaltam que a economia solidária vem tentando se solidificar como um projeto econômico que se diferencia do capitalismo, no sentido de relações entre os trabalhadores mediante práticas de autogestão baseada em princípios de solidariedade entre os cooperados, com ênfase na igualdade entre os homens. Assim sendo, o desenvolvimento do cooperativismo pressupõe melhores condições sociais e econômicas entre os envolvidos, nos quais acarretam ganhos locais e formação de relações comerciais com outros comércios. Para tanto, é inevitável ressaltar que a solidariedade desenvolvida requer o envolvimento das forças políticas locais que, na maioria das vezes, não valorizam os produtos locais, uma vez que essa forma de produção estratégias de negociações nos quais os preços dos produtos nem sempre são negociados de maneira justa, em função da concorrência dos produtos negociados tradicionalmente.

Assim se expressa Duarte et al. (2018, p. 8).

Não obstante, ao possuir um perfil competitivo nessas redes, necessita certificar sobre as condições de condicionamento, volume e embalagem, nas quais os preços nem sempre são ajustados com as compras personalizadas ou com o abastecimento acoplado a grupos associativos ou cooperativas de pequenos produtores.

Com base nisso, na atual situação do estágio do capitalismo contemporâneo, a cooperação solidária pode abrir caminhos para possibilidades de suscitar uma nova

concepção de trabalho na medida em que o sujeito é considerado “livre” para garantir a sua subsistência em que o desenvolvimento sustentável perpetua no trabalho do cooperado. (BARBOSA; CRUBELATI; MACEDO, 2016). Desse modo, compreendemos que o cooperativismo solidário busca uma nova configuração, com ênfase no desenvolvimento social mediante a prática de autogestão, para superar os desafios do atual cenário de exclusão que prevalece na conjuntura do mercado capitalista.

### III. COOPERATIVISMO NA AGRICULTURA FAMILIAR, ECONOMIA SOLIDÁRIA E SUSTENTABILIDADE

A agricultura familiar é um ramo do cooperativismo que vem crescendo significativamente nos últimos anos. De acordo com Silva e Ferreira (2019), os desafios enfrentados são muitos, no qual atinge diversas questões de mercado, tais como dificuldades no relacionamento com o mercado, inovações organizacionais, dificuldades nas questões de logísticas e comercialização local. A partir desse contexto é possível perceber que esse ramo da economia ainda se encontra em processo de construção, visto que, a economia solidária enfrenta o grande desafio de alcançar a visibilidade da agricultura familiar de competir com o agronegócio empresarial (SILVA, 2011).

Segundo Assis, Priore e Franceschini (2015), no meio rural a pobreza e a desigualdade social são os principais responsáveis pela fome e a exclusões sociais de pequenos grupos de produtores, em razão do fato das políticas públicas voltadas para o desenvolvimento rural privilegiam apenas, a produção em grande escala. Diante desse contexto, podemos compreender que esses pequenos produtores rurais produzem apenas para manter a subsistência das suas famílias.

Porém, é válido ressaltar que nos últimos anos as políticas sociais vêm tentando abrir espaços para dinamizar a ascensão desse tipo de empreendimento. Entre essas estratégias podemos ressaltar a viabilização dos pequenos produtores rurais a comercializarem seus produtos em iniciativas econômicas, como o Programa de Aquisição Alimentar- PAA, gerenciado pelo Ministério do Desenvolvimento Social- MDS, mediante a combinação com o Programa Nacional de Alimentação Escolar- PNAE, que possibilita a inserção dos pequenos produtores a fornecerem alimentos diversificados e orgânicos na alimentação das escolas públicas, estimulando a economia local e a valorização do trabalho humano.

De acordo com Santana e Lima (2018, p. 317-318),

O programa é gerenciado por um comitê de representantes do Ministério do

Desenvolvimento Social (MDS), do Ministério da Agricultura Pecuária e Abastecimento (MAPA), do Ministério do Desenvolvimento Agrário (MDA), do Ministério da Fazenda (MF) e do Ministério do Planejamento, Orçamento e Gestão (MPOG). Sua operacionalização é realizada pela Companhia Nacional de Abastecimento (Conab) e pelo próprio MDS, em parceria com os Municípios e Estados. Ademais, é implantado, principalmente, a partir das seguintes modalidades: Compra Direta da Agricultura Familiar; Formação de Estoque pela Agricultura Familiar; Compra da Agricultura Familiar para Doação Simultânea e Incentivo à Produção de Leite.

Aliado a todos esses aspectos, isso reforça o importante papel atribuído a qualquer produtor rural, principalmente as atividades de produção social, que também contribui para o desenvolvimento local e favorece para o abastecimento de alimentos para comércio do município, ou outras regiões.

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Assim, dentro desse contexto, é importante destacarmos o que diz a Lei 11.326, que trata sobre a Política Nacional da Agricultura Familiar e Empreendimentos Familiares Rurais, que em seu Art.4º apresenta os seguintes princípios:

- I - descentralização;
- II - sustentabilidade ambiental, social e econômica;
- III - equidade na aplicação das políticas, respeitando os aspectos de gênero, geração e etnia;
- IV - participação dos agricultores familiares na formulação e implementação da política nacional da agricultura familiar e empreendimentos familiares rurais.

Historicamente, os princípios de sustentabilidade passaram a ser um tema de intensa discussão, principalmente no nível da agenda das políticas

sociais. Segundo Jacob (1999, p. 39), "a área social é atualmente onde se explicitam os maiores desafios de respostas que possibilitem uma articulação dos diferentes interesses em jogo". Nessa direção, torna-se essencial a participação popular nos espaços que contemplem a organização das agendas governamentais, e conseqüentemente inserir os problemas socioambientais nas discussões contemporâneas do aumento da exploração dos recursos naturais do planeta. Na questão social, as práticas de sustentabilidade podem ser consideradas um projeto uma importante estratégia de combate dos contrastes das desigualdades sociais, como também melhorar as condições de vida dos indivíduos e a conservação ambiental (CARVALHO, 2019).

Sobre esses aspectos Barbosa, Crubelati e Macedo (2016, p. 76) ressaltam que,

A busca por experiência de trabalho associado é a tentativa de estabelecer práticas econômicas solidárias que primariam por uma sustentabilidade humana nos princípios da dignidade e transformação das realidades impostas trazendo o trabalho associado como alternativa para romper com essa lógica imposta.

Diante desse contexto, torna-se essencial difundir o conceito de sustentabilidade, em qualquer atividade produtiva que visa o crescimento econômico, assim como no âmbito da sociedade de maneira geral. Com isso, vale ressaltar que o quadro socioambiental surge como ideia de integrar forças positivas em prol da causa de qualificar o desenvolvimento na causa do universo do desenvolvimento sustentável.

Jacob (1999, p. 34) ratifica isso ao afirmar que;

O conceito de desenvolvimento sustentável surge como uma idéia força integradora para qualificar a necessidade de pensar uma outra forma de desenvolvimento. Seu fundamento provém da necessidade percebida de busca de um equilíbrio em relação às capacidades e às limitações existentes. O desenvolvimento e o bem estar humanos requerem um equilíbrio dinâmico entre população, capacidade do meio ambiente e vitalidade produtiva.

Com isso, pode-se concluir que o processo de construção da inclusão social, envolvendo a inserção da sustentabilidade, tem o poder de promover a democratização do processo produtivo, permitindo à participação popular, direta ou indiretamente no

encadeamento do desenvolvimento socioeconômico, representado por iniciativas de forças produtivas locais, como no caso da economia solidária.

#### IV. RESULTADOS E DISCUSSÃO

A pesquisa sobre a Economia Solidária foi desenvolvida na comunidade de assentamento, denominada Novas Vidas, localizada na cidade de Ocara, cuja base econômica é a agricultura de subsistência e a produção de castanha de caju. A referida comunidade está localizada entre serras e sertões da Macrorregião do Maciço de Baturité, a 85 quilômetros da capital do Estado do Ceará, Fortaleza (Figura 1).



Fig.1: Plantação de horta na comunidade Novas Vidas.

Fonte: Acervo dos autores (2021).

Desde o ano de 1997, a comunidade é associada ao ADAO (Associação do Desenvolvimento da Agricultura Orgânica), a partir desta, a comunidade dissemina seu trabalho de produtos orgânicos além da região do Maciço de Baturité. Segundo Van Bellen (2006) o desenvolvimento sustentável deve atender às necessidades das gerações presentes sem comprometer a possibilidade das gerações futuras atenderem às suas próprias necessidades. As frutas, legumes e verduras produzidas pela agricultura familiar da comunidade de Novas vidas são comercializados nas comunidades vizinhas, no centro de Ocara e para o Programa de Aquisição de Alimentos (PAA, 2020) e Programa Nacional de Alimentação Escolar (PNAE, 2021).

A quantidade de famílias que trabalham e produzem frutas, legumes e verduras para agricultura familiar, são apenas sete. O entrevistado, um dos maiores produtores da comunidade, Antônio Sabino, mas popularmente conhecido como Bitonho, alega que a maioria das famílias estão bem “desligadas” no que se refere à realização do trabalho dos quintais produtivos como subsistência. Alguns chefes de família estão aposentados, sem descendentes para continuar o trabalho, outras famílias produzem apenas para o consumo. As sete famílias que desenvolvem o trabalho da Economia Solidária nos

quintais produtivos tem como base o trabalho de subsistência. Bitonho fala com emoção o quanto é gratificante e prazeroso o trabalho na agricultura, segundo ele, a pessoa pode está com qualquer stress, ao chegar ao campo de plantações logo fica bem, esquece qualquer problema, é uma terapia prazerosa. Desse modo, “é gratificante ver seu trabalho disseminado em prol de uma educação alimentar saudável nas escolas onde os próprios filhos estudam”, fala o agricultor entrevistado apresentando os quites prontos para entrega, como podemos ver na Figura 2.



Fig.2: Quites do PAA prontos para enviar para as escolas municipais de Ocara.

Fonte: Acervo dos autores (2021).

A comunidade dispõe de recursos hídricos, três açudes que no período do verão fazem a irrigação das plantas, período em que mais produzem. No período do inverno é bem complicado, as plantas ficam queimadas, pois são plantadas livremente sem proteção de estufas, a terra fica com excesso de água causando uma produção bem inferior. Contudo, as famílias produzem frutas: goiaba, mamão, acerola, as quais são comercializadas frescas e outras são transformadas em pompas. Legumes: feijão, milho, quiabo, jerimum, abobrinha, tomate, pimentão, pimenta de cheiro. As verduras: coentro, cebolinha e alface. Já está sendo executado o projeto de produção de banana nos quintais produtivos com previsão para 2022, ser uma fruta associada no fornecimento no PAA e PNAE.

Vale ressaltar, que o entrevistado elencou que um dos membros da Economia Solidária além de fornecer produtos para o PAA, ainda é cadastrado no (PNAE) junto a uma cooperativa que fornece produtos da agricultura familiar para todo o Maciço de Baturité. Desse modo, a Base Nacional Comum Curricular (BNCC) apresenta em sua décima disposições gerais, “agir pessoal e coletivamente com autonomia, responsabilidade, flexibilidade, resiliência e determinação, tomando decisões com base em princípios éticos, democráticos, inclusivos, sustentáveis e solidários”. (BNCC, 2018, p. 9-10).



## V. CONSIDERAÇÕES FINAIS

Partindo de princípios sustentáveis, a presente escrita teve como problema/hipótese de pesquisa perceber que a economia solidária parte da dimensão de reestruturação do processo de gestão democrática e de manifestações reivindicatórias que visam o fomento de políticas públicas em prol de soluções para os problemas enfrentados pelos trabalhadores, que acabam sendo atingidos de forma recorrente com a exploração do trabalho, e com a consequente degradação dos recursos naturais.

Dessa forma, elencou como objetivo principal identificar as principais características indicadoras de avanços da economia solidária via cooperação como alternativa para o desenvolvimento sustentável local, na comunidade de Novas Vidas, município de Ocara, Estado do Ceará, Brasil.

Assim, foi possível perceber que uma das principais economias apresentadas no município de Ocara, é a agricultura de Subsistência, ou seja, uma atividade que traz como princípios a economia solidária, interligando e interagindo com os diversos setores da sociedade.

Corroborando na defesa de um planeta sustentável, devemos buscar políticas públicas que fortaleçam as famílias no desenvolvimento de suas ações na comercialização dos produtos orgânicos em larga escala, buscando ao mesmo tempo apoio de diferentes segmentos da sociedade para que de fato aconteça a preservação da educação ambiental, seguindo fatores determinantes para a sustentabilidade equilibrada do planeta.

Os valores de preservação do meio ambiente devem ser trabalhados primordialmente no chão da sala de aula, visto que a BNCC traz habilidades que devem ser desenvolvidas a partir da matriz curricular anual das escolas. Assim, os projetos desenvolvidos devem conter ações plausíveis sobre os impactos ambientais e a importância do consumo de frutas, legumes e verduras orgânicas e de produção dos quintais produtivos, garantindo a sustentabilidade e a melhoria da qualidade de vida da sociedade.

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# Design & Development of a Computer Controlled Tensile Strength Testing Machine for Testing of Strings & Fabrics

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**Keywords** — *Tensile Strength Testing, Elongation Mechanical Testing, Image Processing, Ultrasonic Distance Sensing.*

**Abstract**— *Tensile testing is a primary material science test in which a sample is tension-proof until it is failure. Test results are frequently used to select an application material, to verify quality and to forecast how the material reacts with other forces. The features assessed directly by a tensile test include maximum tensile strength, maximum length and a reduction of the area. From these measures the following characteristics can also be determined: Young modulus, the ratio of Poisson, yield strength and stress resistance. Testing machine is used for the development and maintenance of better information on known materials or the development of new materials. There are many test machines, but the most common of these is the one that tests tensions, compression and bending of the materials. For the test specimen to be tested, the engine must have the proper characteristics. Three major parameters exist: strength, speed, accuracy and precision. The test machine is mainly used in the creation of the stress line diagram. The computer algorithm may be applied to compute the yield strength, tensile force, youth module or total elongation once the diagram has been generated. The author has designed & fabricated a model for demonstration of the techniques employed using viper motor (DC motor) for force exertion, load cell & instrumentation amplifier of reading force, ultrasonic distance sensor for measurement of displacement. Simultaneously a tripod mounted webcam is employed to capture real time video & image processing & employed to compute displacement on the basis of motormovement.*

## I. INTRODUCTION

Mechanical testing is one of the most essential methods of material study which can assess how deformation and destruction may be resisted by external loads. The insecurity with which materials and advanced engineering constructions are measured mechanical properties might lead to a reduced operational safety. Therefore, contemporary high-performance test equipment and adequate measuring tools are necessary and important to equipment mechanical testing centers.

Tensile tests are a basic material science test since a sample is exposed to uniaxial tension. The test results are used extensively to pick a material for an application,

check the quality of the material and predict how it reacts to other forces. These include: final strength of the tensile, maximum elongation and reductions in the area. These measures can also identify the following properties: the young modulus, the relationship of Poisson, the yield strength and stress- resistance characteristics. Testing machines are utilized for the production or development and maintaining of better information on the materials known.

The electromechanical and hydraulic models are offered for two types of machinery. An electric motor, a gear reduction system, and a transducers move one, two or four screws are used to produce the electromechanical

machine A number of crosshead speeds may be varied by the speed of the engine. A closed loop system based on a microprocessor may be built to control the speed of the crosshead accurately. One or two drive pistons in a manually controlled machine are used by a hydraulic test engine to move the crosshead. In a closed-loop hydraulic servo system, the operator controls the handle valve to control the loading rate. In turn, an electronically controlled servo valve ensures that the needle valve is replaced with accurate control. The electromechanical machine is generally capable of a wide variety of test speeds and prolonged cross-head displacements, but it is an affordable option to produce big forces.

### 1.1 Objective of the Proposed Research Work

[1.] Design & Development of a automatic tensile strength or elongation testing system that combines the best of Vision Processing & Sensor/Signal Technologies.

[2.] Use of advanced image processing algorithms to measure elongation speed(s), & movement of timing strips to monitor displacement & thus elongation over time.

[3.] Use of advance sensing technologies to monitor real time tensile testing parameters using sensors such as force, temperature, load etc & image processing data such as snap point, elongation movement etc.

[4.] Use of computer processing & tabulation algorithms in conjunction with sensor technology to integrate tension/stress over time to form automated lifecycle, durability testing system.

[5.] Use of fuzzy logic & artificial intelligence algorithm for real time control of tension motor force in highly energy efficient and accurate method with minimal overshoot.

## II. LITERATURE REVIEW

**Aizhan Erulanova et. all** Tensile testing plays an important part in developing higher-source nodes, the reliability of which restricts the existence of mobile mechanical systems. Materials need to withstand minimal loads and preserve their integrity, shape and size, and high-quality voltage tests are essential. Mechanical testing is one of the most important material test methods for evaluating their ability to cope with external load deformation and destruction. Insecurities regarding the mechanical characteristics and function of materials, modern engineering systems, can reduce safety [1].

**Siti Nadia et. all** This paper explains the tensile behaviour of composites with various fiber volume

factions in jute- polypropylene fibers. Composite laminates made from weaving jute fiber were prepared using lamination by hand with the fiber volume percentage of 20-80% and polypropylene folds. The laminates were tensile tested in accordance with ASTM D3039. The experimental results showed that the fiber-to-resin material influences greatly the composite tensile characteristics. The tensile strength and Young's composite modules with the growing fiber volume fraction are rising [2].

**Włodzimierz Szewczyk et. all** For many practical applications of paper and paper materials, breaking energy is of great importance. It is performed in a one-way tensile test on paper by external forces before its fall. The paper analyses the impact on the energy consumed by paper moisture content during the tensile tests within the range of humidity balance achieved in the paper air conditioning system at a temperature of 23 °C. Two measurement methods have been proposed to forecast changes in energy breaking caused by changes in moisture content [3].

**Lenin Jimenez et. all** The aim of the project is to create and design a virtual instruments (VIS) system for the automation of tensile tests for material characterization within the Electromechanical Engineering Laboratories. The frame is built on a sturdy hardware architecture, excellent data accuracy is given and a virtual tool automatically defines the test curve and testing characteristics. [4].

**Bandit Suksawat et. all** The tensile test machine was constructed in order to detect true carbon steel stress and strain, and a specimen projection diameter was proposed to measure the area effectively. The main parts of tensile testing, top and bottom tensioning aggressors, a 1,000 kg load-cell tension force measuring cell, 0.5 µm LVDT sensor and average 1,280 0.700 pixel, 30 frames per second in depth, are a hydraulic cylinder and a hydraulic tensioning machine. [5].

**S Nabila et. all** Jute is a natural fiber with relatively low cost and high volume yield, which is environmentally friendly. The goal of this study was to assess the effects of polypropylene (PP) strengthened weight fractions of jute fibers in order to achieve optimal PP/jute composite properties. For pretreatment, jute fiber was alkalinized. The PP was rendered initially via the extrusion process, and the composites were produced with a hot press device for compilation into the lamina of the PP matrix and jute fiber [6].

**Weilai Yao et. all** The significance of concrete tensile strength affects the efficiency of structures such as hearing resistance and the load bearing capacity of



concrete cone failure anchors as a critical method of failure. The tensile stress is also a significant mechanical feature to be properly considered in building as a concrete compressive strength. For the evaluation of structures, particularly those that exist for years, there are the real value of in situ tensile and a concrete compression strength that have long been deteriorating in realistic service settings [7].

**M.S. Parmar et. all** An instrument to measure the smoothness of finished fabrics has been designed and developed. The pendulum theory is the basis of the instrument. A roller less wheel, moving along the arc-shaped platform is part of the weight (string hang). As a sample holder the platform serves. When the weight is pushed, the platform swings back and forth. Owing to fabric friction, the amplitude of the swing decreases. Inverse proportion to the rust or rugging of the cloth is the amplitude [8].

**Yi Zhou et. all** Modern body armour used for ballistic defence consists of several layers of tissue and other types of cloth and helps to absorb and dissipate projectile kinetic energy to end high velocity projectiles. This mechanism is generally recognized as interplaying many factors that affect the effect of the yarn pull-out by the inherent textile structure (the interlacing of the warp and weft yarns) [9].

**Naoki Hayakawa et. all** A micro scale tensile fatigue test device has been designed by Authors to test specimens made from bulk materials. The micro-manipulator is attached to the probe and enables precise initial placement and tensile stress application. The present study covers the process and conclusions of traction tests on specimens constructed from magnesium alloy ground grain AZ31 and tensile fatigue tests. [10].

**S.R. MISHRA et. all** Accurate measurement of diverse geosynthetic characteristics is necessary for proper quality control and design procedures. A considerable parameter of all mechanical properties needed to be designed is the tensile strength of geosynthetics. At present, during geosynthetic tensile testing, test techniques in laboratories are incapable of measuring local stresses. These stressed materials have a substantial impact on their geosynthetic performance, due to production flaws, seaming, puncture and tearing of the textile [11].

**Daudi S. Simbeye et. all** The universal testing machine's measuring and control system was used in data collection and processing and closed-loop control of the actuators was carried out. This is a complete automated test platform for measuring devices and control technology. The Electronic Universal Test Control System was

developed and implemented based on studying relevant technology and specifications. The system determines the mechanical properties of materials such as tensile and elongation, strength, distortion and displacement, and assumes good performance [12].

**Serkan Nohut et. all** The spun bond nonwoven materials of polypropylene (PP) are particularly essential for the health, furniture and household industries. Subjects with high tensile strength are needed in these industrial applications. Digital image analysis (DIA) in the textile industry is widely used in the determination of fabric property and online controls. The literature well establishes the measurement of textile weight by means of digital image processing.

However, limited knowledge on tensile strength prediction and break elongation can be given with digital image analysis (DIA) [13].

**Piotr Przybysz et. all** Paper is a versatile product utilized in daily life and in various industries and businesses. The manufacture and use of global paper goods is expanding gradually at 400 million tonnes. Paper goods also comprise environmentally-friendly components from fibrous crops, mainly wood and recycled streams, such as pulp, as part of their usefulness and relatively low prices. [14].

**Mohammed Naveed et. all** Over the last few years, demand for mechanical properties in aerospace, automobile, defenses, etc. of aluminium matrix composites (AMCs) has gradually increased. Thanks to its excellent wear resistance and manufacturing ease, Al6061 is very popular for all available aluminium alloys. The distribution of an acceptable combination of hard ceramic powder and aluminium fillers gradually leads to the use of new techniques to improve the durability and wear resistance of Al6061 [15].

### III. METHODOLOGY

#### 3.1 Proposed System Block Diagram

In this block diagram we can 220 volt ac supply goes to stepdown transformer then it converted in to 12 volt/5 amp supply then is goes to rectifier circuit for convert it to dc supply after this battery is connected for store energy in the form of dc voltage. After this voltage regulator circuit is used for regulate voltage. Regulated voltage supply is used for power up our main control unit and circuit. Load cell is connected to microcontroller and ultrasonic sensor is used for measure distance. Here we use PIC microcontroller for perfume operations. 16x2 LCD display is used for print the data. Relay driver circuit is used for drive relay

according to wanted direction of viper motor. USB to TTL converter is used for transmit data to our computer and laptop for analysis.

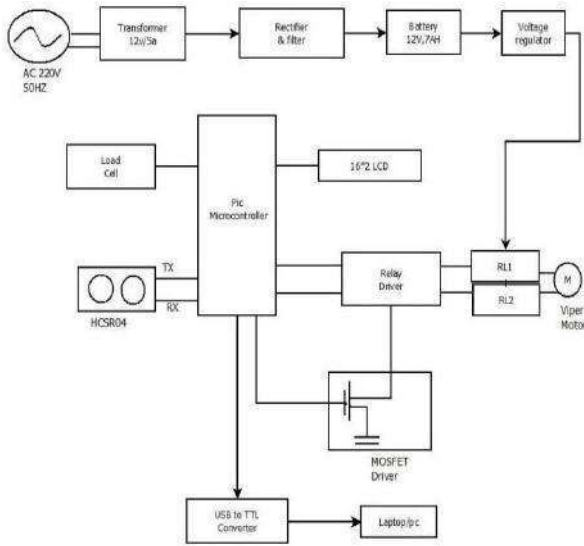


Fig.1: Block Diagram

### 3.2 Flow Chart of MATLAB Implementation

**Implementation** The above flow chart is the our MATLAB implementation code flow chart in this flow chart we can see 1<sup>st</sup> our code is start then clear screen, RAM and all opened files. Then initialize all the variables. Then initialize variable Pos [270 140 100 200]. Then display menu functions that is previewline video stream, define ROI, Test real time marker detection, start test and quit. Then get input from user. Then switch to Y, here five cases are available these are, case 1 is real time video preview, case 2 is call define region of interest, case 3 is call test real time marker detection, case 4 call start test case 5 is quit.

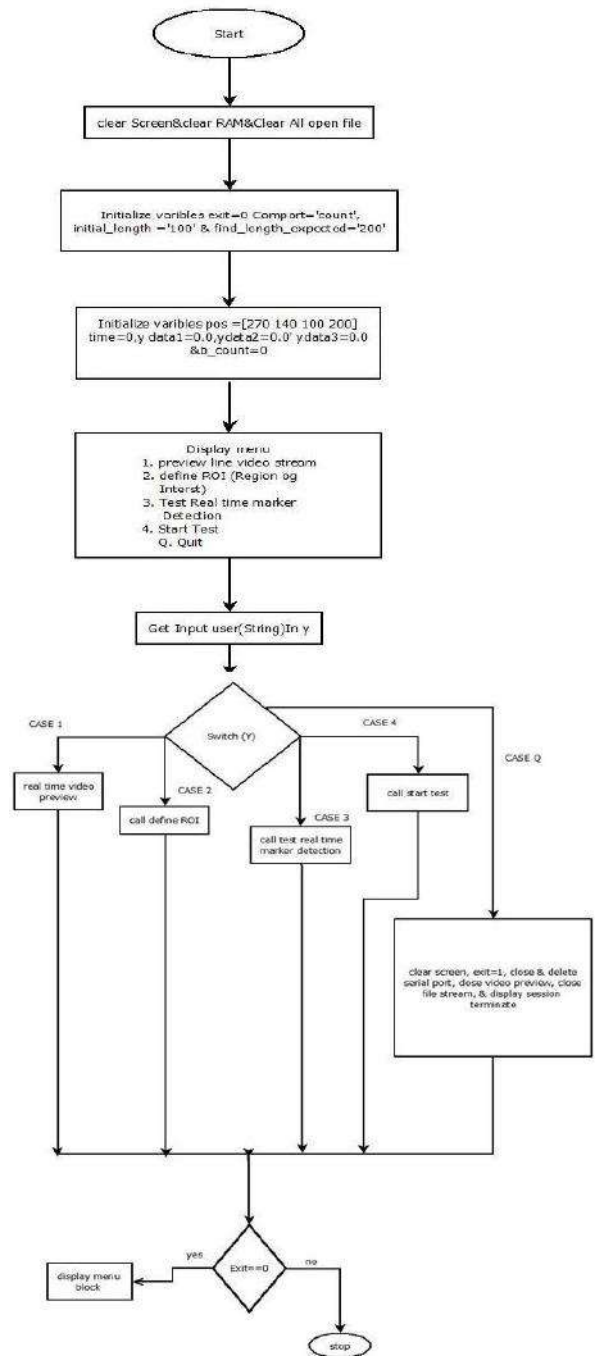


Fig.2: Flow Chart of MATLAB

### 3.3 Real Time Video Preview Module Flow Chart

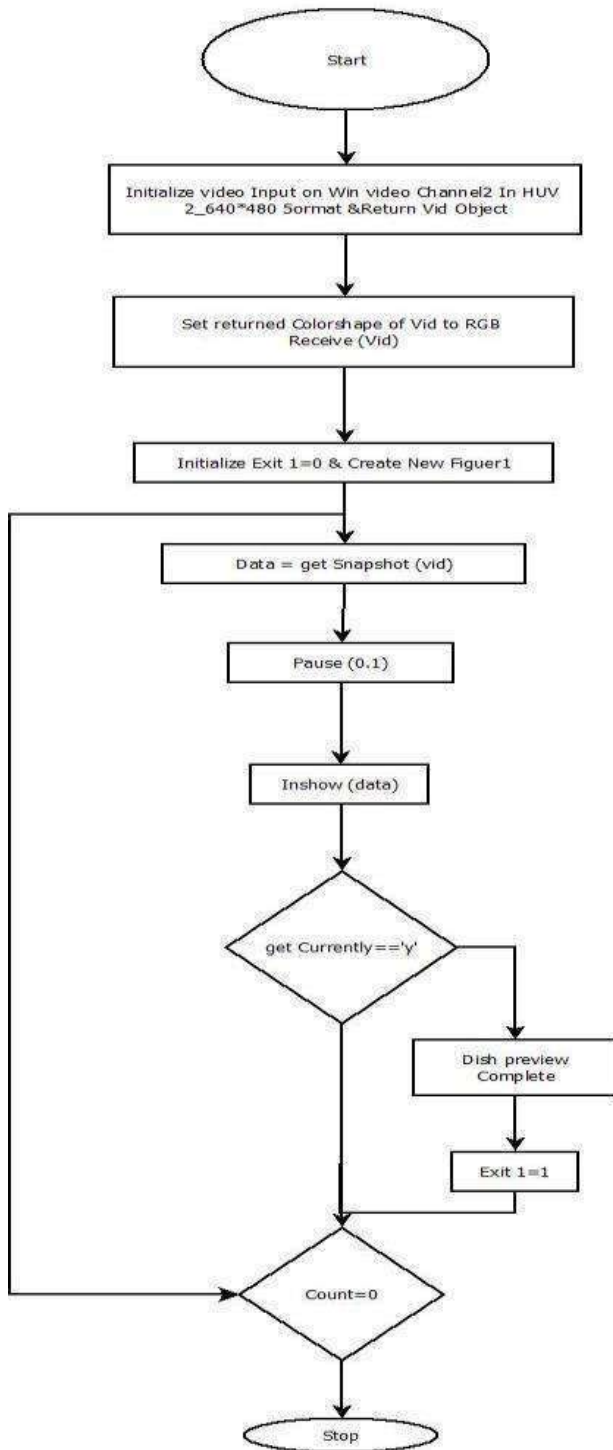


Fig.3: Real Time Video Preview Module

The above figure is the flow chart of real time video preview module program. In this flow chart we can see 1<sup>st</sup> module code is start then initialize video input on win video channel2 in HUV2 on 640X480 format. Then set color shape of vid to RGB. Then initialize exit1=0 & create new figure. Then get snapshot then pause video. Then some condition will be apply that is if current key

== 'Y' then dish preview complete and exit1 =1, then if count = 0 then algorithm will be stop if count not equal to zero then algorithm goes to data = get snapshot(vid).

## IV. RESULTS

### 4.1 Proposed Hardware Design



Fig.4: Hardware Image

### 4.2 Jumper Wire Results

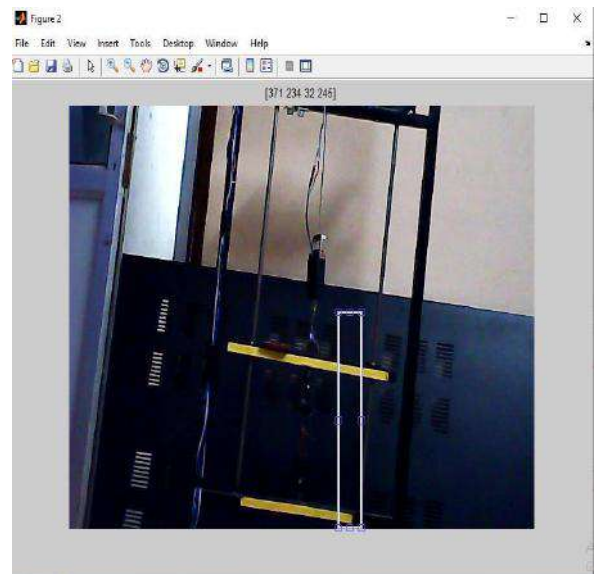


Fig.5: ROI

In this window we can see the Region of interest because our selected option is 2<sup>nd</sup>. Here region of interest is [371 234 32 245]. Region of interest is calculated by yellow colour of both bars.

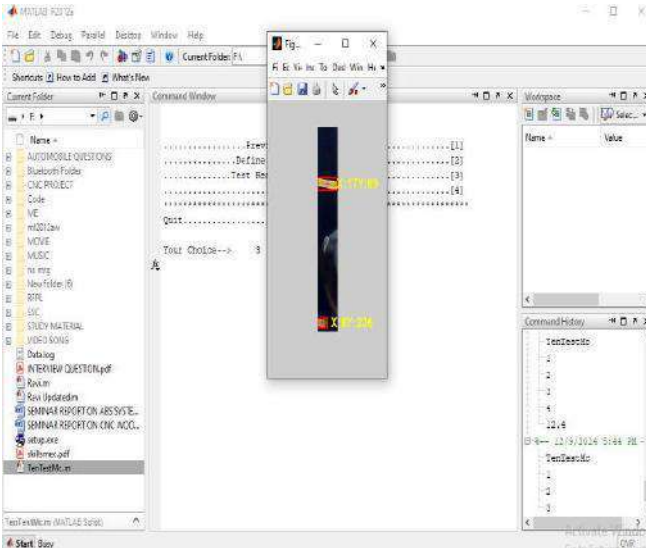


Fig.6: Marker Detection

In this window we can see real time marker detected centroid of yellow colour marked bar. That is for upper bar X:17Y:69 and for lower bar X:8Y:236.

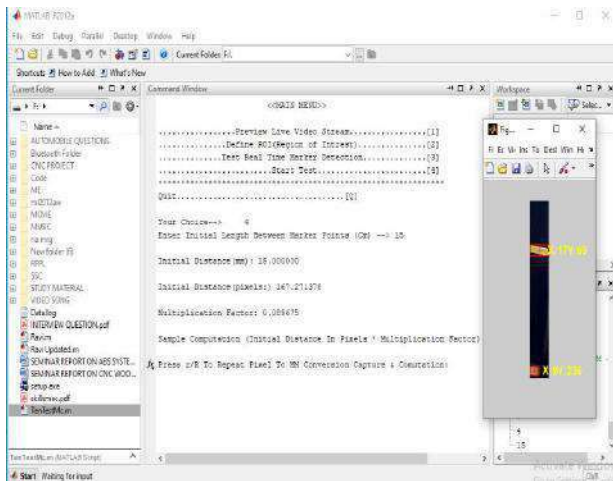


Fig.7: Test result values

In this window we can see the test results values that is given below:

Length Between Marker Points is 15 mm. Initial distance (Pixels) – 167.271378 Multiplication Factor is: 0.089675

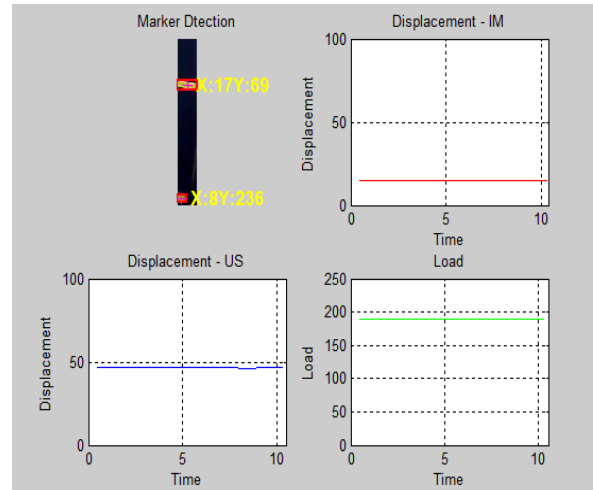


Fig.8: Graph Plots1 of jumper wire

In this figure we can see time and displacement graph and we can also see load and time graph with short range.

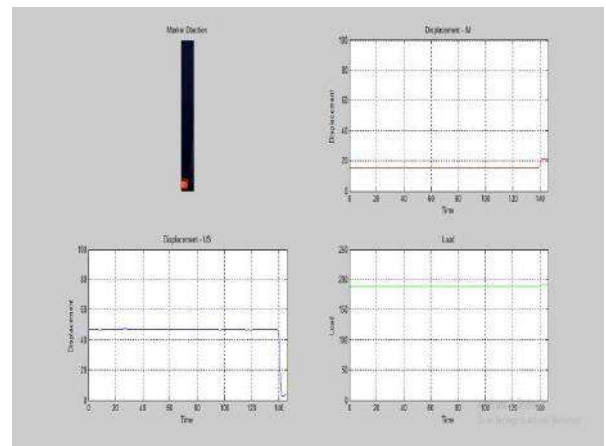


Fig.9: Graph Plots2 of jumper wire

In this window we can see graph plot between time and displacement and we can also see graph plot between load and time with wide range.

As above process we take outputs for three type of wires that's are jumper wire, plastic and soldering wire. Outputs of these 3 wires tabulate in below table.

Table: 1 Results Output

S. No	Wire Type	Initial distance	Initial distance pixels	Multiplication factor
1.	Jumper wire	15mm	167.271378	0.089675
2.	Plastic wire	15mm	168.255554	0.089150
3.	Soldering wire	15mm	159.437564	0.094081



## V. CONCLUSION

Tensile testing & measurement of elongation properties of materials is an important aspect of material testing. Accurate & reliable determination of these properties are crucial to infrastructure development & civil/mechanical engineering application, however these are highly time consuming & operator intensive. The proposed system has been developed to automatic the process of tensile testing as elongation testing by using computer assisted combination of image processing & sensor technology.

The proposed system uses combination of ultrasonic displacement sensor with image processing. Displacement order force is measured using image processing & ultrasonic sensor, both techniques are employed to improve the accuracy of measurement by using mathematical techniques of both displacement data such as weight averaging. As demonstrated by the result above the proposed system has been successfully implemented & tested. Both image processing & ultrasonic displacement show some curve pattern of displacement, also the depiction of material break under force is shown in load curve, thus proving the working of the designed system.

## VI. FUTURE SCOPE

The proposed computerized tensile strength or elongation testing machine has been successfully developed & demonstrated. However with the modernization & advancement of computer & sensor technologies, it is imperative to enhance or upgrade the developed system to meet the needs & challenges of the future. One of the most sought updated would be to incorporate artificial intelligence or machine learning to hybridize displacement data captured from both the technique to assimilate an accurate displacement curve. Also artificial intelligence & machine learning can be employed to detect break of material order test, & automatic determination of quality of material order test by of saving the captured data.

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# Sustainable Cultural Afro Brazilian Practices in the Melancias Quilombola Community in Ocara-Ceará- Brazil Práticas Culturais Sustentáveis Afro-brasileiras na Comunidade Quilombola de Melancias em Ocara-Ceará- Brasil

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**Keywords**— *Ocara-CE, Práticas culturais,  
Quilombo Melancias, Sustentabilidade*

**Abstract**— *This paper aims to present the cultural practices experienced in the Lagoa das Melancias Quilombola community, located in Ocara, Ceará, Brazil. The focus is to emphasize the cultural practices of the community residents considering the sustainability and the identity recognition as quilombolas remaining group. It is an exploratory study with a qualitative approach and the method chosen is the ethnography case study. The data collection consisted of direct observation, conversation circles, field/notes diary, on-line and face-to-face interviews, through electronic resources such as whatsapp and pictorial resources. The data analysis techniques were composed by the content interpretation and narrative speech. As a conclusion, it is possible to attest that the community residents' identity profile reflects their history and ancestral memory which can be found in nowadays cultural practices in the subsistence agriculture, in women's handcrafted practices, in the medicinal plants cultivated, in the capoeira circles and in the wearing of rastafari hair.*

**Resumo** - *Este artigo tem por escopo principal apresentar as práticas culturais vivenciadas na comunidade quilombola em Lagoa das Melancias, município de Ocara, Ceará, Brasil. Trata-se de uma pesquisa de natureza básica, do tipo exploratória*

*com abordagem qualitativa e método procedimental o estudo de caso etnográfico. Neste sentido, destacam-se as práticas culturais no que concerne à sustentabilidade e ao reconhecimento identitário como remanescentes quilombolas das pessoas que residem na comunidade de Lagoa das Melancias em Ocara-CE. Para a coleta e geração de dados empregou-se a observação direta, as rodas de conversas, o diário e as notas de campo, as entrevistas presencial e virtual, por meio do recurso eletrônico digital whatsapp e recursos imagéticos. No tocante as técnicas de análise dos dados/informações coletados/as empregou-se a interpretação de conteúdo e do discurso narrativo. Ao final, conclui-se que o perfil identitário das pessoas que residem na comunidade em epígrafe refletem a história e memória dos ancestrais presentes nas práticas culturais da agricultura de subsistência, nas práticas artesanais femininas, no cultivo das plantas medicinais, nas rodas de capoeiragem e no uso do cabelo rastafári.*

## I. INTRODUÇÃO

Ao desenvolver o referido estudo, pudemos reconhecer a nossa identidade cultural brasileira, compreendendo que, apesar dos fortes traços do colonizador em nossas terras, a predominância da cultura africana permanece fortalecida e visivelmente arraigada em nossas vidas, presentes no arcabouço da história brasileira, no que se refere aos diferentes olhares educacional, social e econômico.

Pretendemos conhecer as práticas culturais sustentáveis desenvolvidas por mulheres, jovens e idosos descendentes de povos quilombolas da comunidade denominada Lagoa das Melancias, BR 116, Km 82, Ocara<sup>1</sup>-Ceará-Brasil. Com isso, o objetivo deste estudo é conhecer e fortalecer as práticas culturais sustentáveis presentes na comunidade, seus processos cotidianos nas diversas modalidades com a aplicação de métodos e técnicas que estejam em sintonia com a abordagem qualitativa<sup>1</sup>.

A pesquisa permite-nos entender que a vinculação da comunidade com as práticas culturais é a base para a sustentabilidade dos remanescentes quilombolas, sendo de fundamental importância o desenvolvimento de ações educativas com a juventude para a preservação do meio ambiente sem causar degradações e evitar perda das manifestações culturais, visão peculiar às gerações mais jovens. Neste sentido, existe a necessidade de maior presença do poder público local e estadual visando realizar ações que valorizem as atividades socioculturais e conservem o ambiente natural, oferecendo condições de permanência dos comunitários em seu lócus.

Cabe ressaltar que as dificuldades não se tornaram empecilho para os moradores em garantir seus direitos, especialmente quando foram realizar o reconhecimento da comunidade quilombola pelo Ministério da Cultura, através do Departamento do Patrimônio Afro-brasileiro e Associação Fundação Cultural Palmares. Foi destacado o

fato de que a área é habitada por comunidade negra, descendentes de escravizados e que desempenham papel fundamental relacionado à cultura afro-brasileira, visto pelas práticas culturais realizadas na comunidade.

Atualmente o termo sustentabilidade pode ser definido como a capacidade do ser humano interagir com o mundo preservando o meio ambiente para não comprometer os recursos naturais das gerações futuras. Com o meio ambiente degradado, o ser humano abrevia o seu tempo de vida, a economia não se desenvolve, complicando o futuro da humanidade. Para preservar a natureza é necessário que se faça uma mediação entre o homem e natureza, antes o ser humano precisa do auto cuidado e respeito, como parte essencial do planeta que habita, transforma, mas que exige equilíbrio. Sendo de fundamental importância os cuidados de preservação com a mãe natureza para que de fato, a sustentabilidade venha fluir na humanidade. O desenvolvimento sustentável é o que deve atender às necessidades das gerações presentes sem comprometer a possibilidade das gerações futuras atenderem suas próprias necessidades<sup>2</sup>.

A inserção das práticas culturais sustentáveis de Melancias na sociedade local e circunvizinhança possibilitam que as pessoas valorizem nossa cultura, e possam desenvolver competências, habilidades, princípios, valores e atitudes relacionados à sustentabilidade. Portanto, surge a indagação: quais são essas práticas culturais e como estão sendo disseminadas na comunidade local para que seja de fato preservada a identidade dos remanescentes? O incentivo à comunidade para participar de doações de materiais recicláveis, aprender e desenvolver trabalhos artesanais, grupos artísticos, visando não somente à economia, mas como terapia ocupacional, evitando-se assim patologias futuras que são adquiridas por falta de trabalhos terapêuticos, favorecendo mais a qualidade de vida.

## II. METODOLOGIA

Este estudo visa fortalecer e valorizar as práticas culturais de uma comunidade de povos remanescentes,

1

Ocara pertence à microrregião do Maciço de Baturité, a 85 quilômetros da capital, Fortaleza. O topônimo "Ocara" vem do tupi-guarani e significa palco, terreiro, ou terraço de aldeia, ou taba.



motivando-a a disseminar a arte nas demais regiões do Maciço de Baturité, de modo a fomentar maior visibilidade e contemplação do fascinante trabalho vivenciado. Desse modo, a pesquisa qualitativa “recorre-se às técnicas de análise de conteúdo, do discurso e/ou das narrativas”<sup>3</sup>.

O processo metodológico é o estudo de caso etnográfico do tipo exploratório de natureza básica com abordagem qualitativa em uma comunidade quilombola, denominada Lagoa das Melancias, BR 116, Km 82, município de Ocara na Macrorregião do Maciço de Baturité, Ceará, Brasil. Para a coleta de dados foram empregadas técnicas da observação direta, grupo focal, roda de conversas, o instrumento do diário e das notas de campo e entrevistas semiestruturadas com jovens e idosos, moradores da referida comunidade.

Desse modo, “o pesquisador descreve o caos dos fatos observados, estabelece os fundamentos da análise, os critérios de comprovação para extrair interpretações generalizantes fidedignas”<sup>4</sup>.

Após tais procedimentos de coleta e geração de fontes foram empregadas as técnicas de análise de conteúdo e do discurso narrativo na perspectiva da crítica dialética levando em conta o contexto sócio-histórico, procedimentos pertinentes e adequados quando se trata de pesquisa de abordagem qualitativa<sup>3</sup>.

Vale ressaltar que durante o desenvolvimento da pesquisa, fomos surpreendidos pela pandemia causada pelo Coronavírus Zonótico (SAR-COV-2/COVID-19), assim, nos reinventamos para prosseguir. Foi necessário reestruturar as técnicas da pesquisa com apropriação da tecnologia, ferramenta indispensável nos últimos tempos para manter a conectividade humana na vida educacional, econômica e social. “As tecnologias digitais que estão ao nosso redor nos dias atuais enfatizam uma mudança de mentalidade”<sup>5</sup>.

Os graves riscos causados pela covid-19, ainda frequente em várias comunidades de Ocara com incidência de casos letais, a ausência de uma porcentagem significativa da população vacinada, e a consequente possibilidade de riscos de contaminação, levou-nos a outro caminho. A continuidade da pesquisa aconteceu pelo contato com a comunidade de Melancias através do uso da tecnologia por meio do whatsapp.

O percurso metodológico desenvolvido até o momento, com todos os achados da pesquisa está registrado e documentado em fotografias, registros escritos no diário e nas notas de campo, mensagens e vídeos arquivados no aparelho celular e notebook dos pesquisadores.

### III. RESULTADOS E DISCUSSÃO

A noção de território na sociedade moderna deve ser vista como resultado de uma história como construção da sociedade e civilidade, devendo ser estranhada e relativizada em qualquer contexto de outra matriz e perspectivas culturais, sejam elas indígenas, quilombolas, tradicionais<sup>6</sup>.

Similar aos indígenas, os africanos ao serem comercializados no Brasil, também resistem à cultura do colonizador, sofrem maus tratos, torturas, genocídios, sendo negociada a identidade original. A maioria dos escravizados consegue aprender a rezar, obedecer e trabalhar para os seus senhores<sup>7</sup>. Sendo esse novo aprendizado indispensável para a sobrevivência da cultura intrínseca incorporada à nova identidade

O povo brasileiro conduziu suas marcas históricas em um legado de negação pelo colonizador, mas em resistência incorporada pelos grupos étnicos raciais como escudo de luta, dor, mas de superação, em meio às turbulências, submissão e torturas vivenciadas ao longo da história. No entanto, nota-se que o africano no Brasil foi desapropriado de si, foi tratado como um ser qualquer, de forma desumana. Assim, esses povos reconstruíram depois de muito tempo suas características de ser cultural, através da convivência com outros povos africanos de diversas etnias e com indivíduos da velha Pindorama sob um regime de exploração escravagista<sup>8</sup>.

Podemos perceber que a partir da Lei Áurea de 1888, a terminologia quilombo fica invisível no cenário jurídico brasileiro, retornando um século depois, com a promulgação da Constituição de 1988. Desse modo, o conceito que se tinha de quilombo se resumia a terra de escravos fugidos e seus descendentes aliado às suas meras características morfológicas e à perpetuação de seus signos culturais e resquícios com base na ancestralidade quilombola.

De forma considerável, percebemos que os quilombolas têm como base de subsistência econômica o cultivo da terra, enfrentando dificuldade de acesso a programas de incentivo à agricultura familiar devido à falta do título da terra, que garante a posse das famílias. A Secretaria de Políticas de Promoção da Igualdade Racial (SEPPIR) executa ações que contribuem para garantia de direitos das organizações quilombolas. Nesse sentido, o perfil dos quilombolas é de agricultores, extrativistas ou pescadores artesanais, mas eles têm uma limitação de acesso a terra, por isso não conseguem ser inscritos na Declaração de Aptidão do Programa Nacional de Fortalecimento da Agricultura Familiar (Pronaf), que dá acesso às políticas públicas, o que asseguraria seus direitos e não seriam excluídos pelos órgãos governamentais<sup>9</sup>.

É salutar que estudos e debates acerca da cultura afro-brasileira tenha se destacado nos últimos anos, visto que a sociedade vem buscando o conhecimento na atualidade nas universidades, especialmente a partir do incentivo do governo Lula, onde as camadas populares ganharam vez e voz para ingressar nas universidades. Isso facilitou a compreensão da população menos favorecida. Notamos que na história brasileira os principais heróis não estavam nas enciclopédias, nem descritos nos livros didáticos, houve uma omissão de fatos históricos que estiveram distantes do conhecimento da sociedade. Por isso é racional ressaltar que é somente a partir da Lei nº 10.639, sancionada em 9 de janeiro de 2003, que estados e municípios se veem obrigados a incluir as temáticas do negro e do índio em suas agendas de debate<sup>10</sup>.

No que concerne à cultura do município de Ocara encontramos pelos vestígios que o local foi terreiro indígena, visível na própria denominação de um nome tupi Guarani, trazendo em sua essência os costumes e tradições dos nossos ancestrais. Faz parte também desta região, a comunidade de Melancias, habitada por povos remanescentes de quilombolas que vivenciam os valores, a cultura do artesanato, da agricultura de subsistência, do cultivo de plantas medicinais, da roda de capoeira vivenciada pelos jovens e do uso do cabelo rastafári peculiar nas práticas femininas. Essas práticas culturais, ainda hoje, na contemporaneidade, são resistência ao “modelo” de vida imposto na sociedade desde tempos coloniais.

Os habitantes da comunidade Lagoa das Melancias, localizada no município de Ocara-CE, registrada no livro do Cadastro Geral nº 013, Registro nº 1538, nº 154, nos termos do processo administrativo da Fundação Cultural Palmares nº 01420.003633/2010-71, se autodefinem como remanescentes de quilombo, conforme certidão e certificado reconhecidos e expedidos no dia 27 de outubro de 2011, pelo Ministério da Cultura, através do Departamento de Proteção ao Patrimônio Afro-brasileiro e Associação Fundação Cultural Palmares, representados respectivamente pelo Diretor Alexandro Anuniação dos Reis e pelo Presidente, Eloi Ferreira de Araújo<sup>11,12</sup>.

O certificado da terra quilombola demonstra a conquista de direitos adquiridos pelos remanescentes. Sendo uma comunidade limítrofe, desprovida de recursos, vivem economicamente da agricultura e das práticas culturais desenvolvidas como fonte de subsistência. Com rara assistência de políticas públicas na garantia da qualidade de vida, contudo, os remanescentes agradecem a conquista de possuir a terra para trabalhar, assegurando a moradia e a sobrevivência de seus familiares e da comunidade, mesmo tendo que buscar recursos

incessantemente, pois ainda sentem fortemente o fardo da exclusão presentes na falta de oportunidades e acesso aos direitos fundamentais como saúde, educação e lazer, direitos garantidos desde a Constituição Federal de 1988<sup>13</sup>.

Em uma das rodas de conversa informal com a comunidade de Melancias em fevereiro de 2020, o Sr. Antônio filho de pioneiro dos ancestrais da referida comunidade, relata que a escola municipal existente na localidade foi nucleada, as crianças, adolescentes e jovens precisam migrar para outras comunidades escolares vizinhas. Na comunidade não existe posto de saúde, ou seja, o Programa Saúde da Família (PSF) realiza atendimentos na casa do Sr. Antônio. Tais atendimentos deveriam acontecer uma vez por mês, porém na maioria dos casos ficam até três meses sem a presença da equipe da saúde na comunidade. Quanto à tecnologia, o sinal da internet não chega com frequência o que inviabiliza uma comunicação plausível com a comunidade. A associação dos moradores não tem uma sede própria, se organizam para os momentos de discussão também no alpendre da casa do Sr. Antônio, como mostra a fig. 1.



Fig. 1: Reunião no alpendre do Sr. Antônio

O relato de moradores da comunidade em relação à “agricultura de subsistência, no plantio de milho, feijão, jerimum, as hortaliças, sendo a renda complementada pelas habilidades do artesanato, da culinária e da comercialização dos produtos”, base econômica na garantia da subsistência das famílias no período do inverno (vide fig.2). Durante o verão a base da economia é a colheita da castanha e do caju, atividade que integra crianças, jovens e idosos. Relata Sr. Antônio que quando a safra é boa o dinheiro também aparece mais fácil melhorando um pouco a qualidade de vida dos comunitários<sup>14</sup>.



Fig. 2: Paisagem de Melancias no período de inverno

A estreita relação das pessoas com as plantas vem de uma herança milenar, desde os primórdios da humanidade, quando não se tinha vestígios da medicina científica. Herdamos muitas práticas da medicina dos povos indígenas e africanos que buscavam na natureza a cura do corpo e da alma através das plantas naturais. Com a aproximação das pessoas de diferentes culturas, das diversas regiões, muitas plantas também percorriam o país durante essas migrações e, seu usufruto sendo sempre utilizadas e disseminadas em inúmeros locais. “Os índios já possuíam habilidades tanto no reconhecimento de plantas quanto no modo de preparo de extratos, levando em consideração a ritualidade e o respeito por seus ancestrais”<sup>15</sup>.

Destarte, encontramos na comunidade quilombola de Lagoa das Melancias a cultura do uso das plantas medicinais de diferentes origens. No livro “As plantas curam”, pode-se comprovar que as plantas citadas na fig. 3 abaixo são medicinais<sup>16</sup>.

Nome popular das plantas medicinais	Nome científico das plantas medicinais	Origem das plantas citadas
Agrião	Nectandra nitidula	Ásia e Europa
Malvarisco	Plectanthus amboinicus (Lour.) Spreng	Ilha de Amboina Nova Guiné
Corama	Bryophyllum pinnatum	Ainda incerta, mas é cultivada na Amazônia
Boldo	Peumus boldus	Andes do Sul e Andes

	Mol.	Chilenos
Hortelã	Mentha piperita	Europa
Capim Santo	Cymbopogon citratus D.C Stapf	Índia
Canela do mato	Nectandra nitidula	Sri Lanka, sul da Índia
Cumarú	Dipteryx odorata	Brasil

Fig.3: Plantas medicinais

Os residentes na comunidade de Melancias veem a importância das plantas medicinais no preparo de chás para a cura de algumas infecções como dor de barriga, febre, tratamento de gripes e de outras patologias que podem ser “curadas” em casa, sem necessariamente ir ao posto de saúde para tomar medicamentos farmacêuticos. Além dos cuidados com as plantas medicinais, as pessoas entrevistadas juntamente com um grupo maior de mulheres desenvolvem o artesanato na comunidade. A artesã conta com satisfação o quanto é gratificante a realização do trabalho com artesanato<sup>17,18</sup>.



Fig.4: Tapete produzido pelo grupo de mulheres



Fig.5: Colcha produzida pelo grupo de mulheres

Nas fig.4 e 5 apresentamos algumas peças produzidas na referida comunidade, tapetes feitos com tiras de tecido, toalha de mesa feita de pedaços de tecidos cortados em pequenos diâmetros pontilhado em seu entorno ponto a ponto com agulha manual, depois puxa a linha e faz um franzido unindo toda a borda do tecido, formando uma



espécie de flor, conhecido como fuxico<sup>2</sup>, totalmente manual. Os tapetes são mais sofisticados, costurados na máquina de costura elétrica. No Brasil encontramos inúmeras atividades artesanais, de modo peculiar nas comunidades remanescentes, dentre as atividades comerciais, o artesanato tem destaque<sup>19</sup>.

A cultura da capoeira disseminada pelo professor Ernilton Oliveira que pratica a ginga com um grupo de crianças e jovens, busca incorporar a cultura dos ancestrais, e vivenciar a disciplina e o ritual. “A capoeira, dessa forma, é reconhecida como fenômeno cultural urbano, cuja história permeia o passado e o presente”<sup>20</sup>.



Fig.6: Roda de capoeira

A fig. 6 apresenta o grupo de capoeira organizado pelo professor Ernilton Oliveira em Melancias. Em conversa pelo whatsapp, o professor confessa que a capoeira é algo acima das palavras e das pessoas. Desde que conheceu a ginga se tornou parte da sua vida, da sua fé, algo bem espiritual. Além de ser sua profissão, a capoeira é também sua escola de vivência, pois tanto aprende com adultos quanto com crianças<sup>17</sup>.

As rasteiras da capoeira para o professor é um banho de humildade, as dores físicas são fortaleza e elevação espiritual que traz energia. As músicas feitas por outros capoeiristas são a alma desta filosofia de vida que o professor abraçou. Em suas palavras deseja muito Axé pra todos os amantes da arte, pois ela representa tudo na vida da comunidade, o gingado, o molejo, a dança e a musicalidade da arte corporal e o desenvolvimento psicológico dentro da arte<sup>21</sup>.

Atualmente, com o progresso da tecnologia percebemos a massificação e a globalização cada vez mais presente na sociedade através dos diferentes estilos, gostos, modo de ser e estar que tenta homogeneizar a cultura brasileira, não somente, pela cultura vivenciada pelos nossos ancestrais, mas também, pelo poder midiático do capitalismo que busca atrair as pessoas ao consumismo

2

Artesanato manufatureiro, feitos com pedaços de tecidos coloridos em formato de flor.

e, assim, vivenciar a moda imposta pelo poder que opera e domina a sociedade através do marketing. Em resistência ao poder dominante e opressor, surge o movimento Rastafári “como uma proposta de liberdade e igualdade para o povo negro”. É fruto da diáspora africana, com raízes milenares no continente africano e etíope, passando pela Jamaica com uma mescla das práticas de escravizados, discussões religiosas e do movimento panafricanista<sup>22</sup>.

Corroborando com essa prática cultural ancestral, encontramos na comunidade Melancias a cultura do cabelo rastafári, símbolo da cultura jamaicana, praticada no Brasil, especificamente, após a segunda guerra mundial, período em que os grupos e movimentos negros se tornam mais resistente e operante contra a classe dominante, preconceituosa e racista.



Fig. 7: Cabelo rastafári das mulheres de Melancias

Destarte, a partir dos anos 2.000 quando algumas jovens foram morar na capital de Fortaleza, aprenderam o manuseio da arte, reproduziram na comunidade e hoje é bem comum o uso entre jovens e mulheres, sendo essa atividade realizada também por alguns jovens do sexo masculino da produção de cabelos rastafári<sup>3</sup>. “A moda rastafári vai crescendo através de um estilo diferente caracterizado por um cabelo com nós ou torcido que pode ser ajeitado de formas diversas”<sup>23</sup>.

#### IV. CONCLUSÃO

As práticas culturais disseminadas pela comunidade de Melancias devem permanecer presentes na estrutura organizacional e na reprodução social da comunidade, propiciando o sentimento de pertença em todas as

3

Diz-se de, ou movimento místico, político e cultural dos negros da Jamaica e das Antilhas anglófonas. (A música, reggae é manifestação desse [...]). Na comunidade de Melancias o rastafári é uma manifestação cultural realizada nos cabelos, no uso de tranças ou nós coloridos.



gerações, de modo a seguir a cultura dos remanescentes de quilombolas. Mesmo na atualidade, é importante não perder a essência da identidade, da formação da etnia. A vivência cultural na comunidade de Melancias se assemelha à de outros quilombos de origem africanos, com a agricultura de subsistência, os costumes peculiares cotidianos, a roda de capoeira, o costume do cabelo em forma de tranças, o uso de medicamentos naturais, os trabalhos artesanais, como a confecção dos tapetes de retalhos e em forma de fuxico, bem coloridos. São traços fortemente visíveis da descendência africana, características de comunidade que se organiza para a sustentabilidade.

Contudo, nesta amostragem concluímos que os grupos de mulheres, idosos e jovens buscam fortalecer as práticas culturais a partir dos recursos naturais da comunidade quilombola de Melancias, disseminando os costumes afrodescendentes para o reconhecimento sustentável da comunidade, em vistas a valorização da identidade e diversidade cultural afro-brasileira nas diferentes gerações, através da sustentabilidade econômica e social promovendo melhoria da qualidade de vida e o desenvolvimento local. Almejam parcerias de cooperativas e políticas públicas que fortaleçam a sustentabilidade e possam mobilizar de forma a produzir impactos com recursos de forma contínua para desenvolver o trabalho em uma região com poucos investimentos e escassez de marketing.

Após a observação direta do objeto de investigação, rodas de conversas, debates com a comunidade de Melancias, segue-se com a divulgação do trabalho escrito como incentivo à população no que concerne o desempenho do trabalho dos grupos, destacando sempre a importância da garantia das práticas culturais sustentáveis visando perpetuar a história e memória ancestrais da comunidade estudada.

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# Youth Speeches Mediated on the Web Radio About Digital Games and Mental Health

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**Keywords—** *Mental health. Technology. Teenager. Health education.*

**Abstract—** *Digital Information and Communication Technologies enable dialogues with youth about mental health and the overuse of digital games available in cyberspace. Thus, this study sought to understand the knowledge and sayings of youth about the use of digital games on the Internet and how their excess affects their mental health. We opted for a qualitative approach, exploratory-descriptive type, carried out in the cyberspace of The Web Radio AJIR, contemplating the communication content of the Program In Tune With Health - S@S in connection with the youth of public schools in the state of Ceará, Brazil. The participants were 85 young schoolchildren. The main knowledge and sayings of youths form, addictions in digital games, time limit on social networks, consequences of the abusive use of digital games, games and influences for violence, excessive games and elevation of anxiety and mental disorders, leading to depression and guidance to help people dependent on the use of social networks. Thus, the dialogues produced on the radio web were promoters of education for health care with school youths on the prevention of violence, digital dependence and what are the practices considered appropriate for the use of video games on the Internet.*

## I. INTRODUCTION

In recent decades, technological advances, especially in digital communications, have brought demands to the field of mental health for the excessive use of digital games that have become important leisure activities of youth. This prompted the health professionals to look at the mental health of this population in order to evaluate and develop care practices focusing on the prevention and promotion of youth health in the use of these devices attached to the Internet.

In this way, the National Household Sample Survey (PNAD, in Portuguese), carried out in 2015, teenagers between the ages of 15 to 17 and 18 to 19 years old constitute the group of people who most access the network with percentages equivalent to 82.0% and 82.9%, respectively<sup>1</sup>.

In the survey on the use of the internet by children and teenagers by TIC KIDS ONLINE carried out in Brazil in 2018, by Cetic.br/NIC.br7, which interviewed children and teenagers between 9 and 17 years old, covering the

universe of 2,964 families, demonstrated that 86% were connected to the Internet, which corresponds to 24.3 million users, with regional and socioeconomic variations<sup>2</sup>.

Therefore, cyberspaces on the internet are part of the daily lives of teenagers and young people in our country who configure the world wide web with their modes of languages, aesthetics and self-art, embroidering this place where millions of people exchange information, develop their labors and create their social bonds of human coexistence.

However, the internet started to be inhabited by the entertainment industry, in particular, the production of video games that discovered an important niche in the market, which is the attraction of children and teenagers for animation, action and adventure games available online for worldwide access. These games, still, were made available on the network as a technological novelty and what was a joke or distraction, became an increasingly active, attractive and desired entertainment mode for children and young people who assumed the command and control of the games, for mechanisms of action, interaction and direct influence through persuasion techniques<sup>3</sup>.

Otherwise, this is because some games are programmed, computationally, through several stages with progressive levels of complexity, always challenging the player without him realizing that he is in a "trap" of beginning, attempt, loss and restart. This cycle focuses the psychic attention of children and teenagers on not finishing playing and, continuously, maintaining their social relationships of entertainment with these devices that capture their desires and their wishes, leaving them 24 hours focused on cyberspaces on the Internet that offer online games<sup>3</sup>.

It is worth mentioning that from the beginning, in the creation of the first interactive electronic game by students of the Massachusetts Institute of Technology in the United States in 1962, the script of the confrontation and the feeling of satisfaction appeared when managing to control the threat presented in the game's content, demonstrating the superiority of heroes flying to the galaxy and fighting the forces of evil in science fiction, which was the terminology used in the classification of games for a long time<sup>3</sup>.

It is also noteworthy that in 1974 the first video game device, the "Atari console" for the Pong game, a two-person tennis game or arcade game, was launched. Since then, electronic technologies have been improved and worked as objects of consumption that the middle and upper classes youth had as their primary consumers, with gifts dreamed of acquiring by their family members.

Nevertheless, the consoles for Nintendo's Game Boy games and Sony's Play Station, appearing in the third generation of video games, with classic button controls, which allowed greater mobility for players to develop better handling skills with access devices to the visual content of the games<sup>3</sup>.

In 1990, 3D games appeared and at the beginning of the 21st century, industries in the field launched game content design that impresses through sharp graphics that project social reality on the virtual screen of games with a high specialization of computer programming. Therefore, games have become increasingly competitive, channeling the collective fear of killing unknown monsters and creating a new youth culture for video game players, permeated by the pleasure and challenge of always winning<sup>3</sup>.

This culture was boosted with access to the Internet by youths who gained access to online games also in this cyberspace, with the possibility of transposing expanded virtual realities in which players will be able to build a "double" of themselves as protagonists of the narratives in virtual programmed reality in the online game.

Thus, the creative designs of electronic games are contextualized by the confrontations and challenges of wars, struggles and terror, as compensatory strategies for players' responses in training their reactions to everyday stress, aiming to learn how to control cortisol and channel the fear and then win the game and, at the same time, beat the enemy<sup>4</sup>.

However, in contemporary many games with violent narratives, social networks are also available on the Internet that are accessed by video and webcam applications with online transmission between groups and adolescent colleagues<sup>3</sup>.

Therefore, World Health Organization concerned about the potential illnesses arising from the use of video games and even their excessive use, used criteria from the version of the International Classification of Diseases (ICD-119) to define games as gaming disorder #6 C 51.0 (online) and #6 C 51.1 (offline) and # Q E 22 for hazardous gaming, as harmful to the health of youths, which can cause coma, choking, pneumonia, poisoning and other accidents<sup>5</sup>.

In this way, health education goes far beyond the daily needs of protection, nutrition, hygiene and disease prevention only, it requires care about the excessive use of online games, problematizing the recreational use and problematic use of digital games and video games by youth.

In this sense, the content of the educational programming broadcast on Web Rádio AJIR, which is an



online dialogical communication channel for the production of web health care with school and university youths, which was sought through the "Program in Tune with Health", dialogue about the excessive use of digital games on the Internet.

It is noteworthy that the term, webcare refers to the devices of knowledge and power produced by the discursive practices of communication and health education in self-care, made possible by experiments with digital technological tools, as new ways of caring and teaching young people<sup>6</sup>.

It is worth noting that the web radio is an online channel designed, computationally, as Digital Technologies of Communication and Education (TDIC), which enables pedagogical strategies for nurses to promote education for the web care and the prevention, promotion and rehabilitation of human health<sup>7</sup>.

Thus, this research was carried out in the virtual environment of the web radio, as content of the "Program in Tune with Health", addressing "Mental Health and Digital Games" and aimed to understand the knowledge and sayings of youths about the use of digital games on the Internet and how excessive use affects your mental health. Yet, the following questions stand out: what are the speeches of school youths about mental health related to the excessive use of the Internet and Digital Games? And what is this audience's knowledge of health problems arising from the excessive use of social networks?

## II. METHODS

Qualitative research, exploratory-descriptive, carried out in the cyberspace of Web Radio AJIR, covering the communication content of the Program In Tune With Health in connection with public elementary, high school and professional schools in Sobral - Ceará.

The Program In Tune with Health took place in October 2019 with the agenda Mental Health and Digital Games, with school youths in the cities: Fortaleza, Juazeiro do Norte, Ubajara, São Benedito and Sobral. The interviewee was a psychologist who problematized dialogues on this topic with the youth.

The web radio is a digital communication channel articulated between the Youth Association of Irajá with the Laboratory of Collective Practices in Health and certified by the Pro-Rector of Extension of the State University of Ceará, registered with the Council for Teaching, Research and Extension of this University.

This channel counts 13 years of experiences of communication practices and digital education with the youths who access the Internet and produce their arts of

life as genealogical devices of know-power that "manufacture" their subjective synchronized by the daily archived discourses of social life.

Interactive discursive mediations were made possible by viewing the audiovisual content available on "Web Tv", which hosts the YouTube channel: <http://www.uece.ajir.com.br> and has repercussions for communication on the social networks of web radio. The content of the annual thematic program has the participation of youths, teachers, coordinators and principals of the school territories registered in the Program In Tune with Health. In the mediation of synchronous programs, the following are invited: researchers on sexualities, gender relations, teenage pregnancies, culture of peace, HIV and AIDS, sexually transmitted infections, violence, gender, bullying, Mental Health and Digital Games, among others.

It is noteworthy that the programming of the digital channel is diversified, featuring interactive content with youth in schools on topics related to health education<sup>6</sup>. (TORRES, 2015). In the studio, at the university and in school territories, the strategies were facilitated by the research coordinator of the project, research fellows and extension of the undergraduate course in Nursing and the Postgraduate Program in Clinical Care in Nursing and Health at the State University of Ceará and at reception of the communication of the programs, teachers of basic education that compose the team of pedagogical coordination and mediation in the school territory.

We chose terminology, young people/youth and youth(s), considering the experiences, places of speech, affective-social ties, group relationships and youth subjectivities produced in the cultural conviviality<sup>8</sup>.

Thus, the participants were 85 young schoolchildren, 45 from the first year of high school aged between 15 and 16 years old and 40 from the eighth year of elementary school, aged between 13 and 14 years old from three public schools of Sobral in Ceará. Data collection was carried out on the web radio, Facebook and WhatsApp message board, with systematization of the "Questions-Discourses (QD)" that constitute discursive substrates of youth productions about self-care in interactions on the web radio<sup>6,7</sup>. (TORRES et al., 2015, 2018,2019, 2020, 2021). The analysis of the data was carried out by the composition of the question-speeches, as discursive practices that produce knowledge and powers engendered in the social life of youths<sup>9</sup>.

However, the QPs were systematized in thematic categories: web radio: pedagogical devices that produce speeches with Youths on Mental Health, Internet and

Digital Games: speeches about excessive uses in social networks.

In effect, the research was approved by the Research Ethics Committee of the State University of Ceará, as opinion n°: 3,478,945, integrating a broad study entitled: "Use of web radio in training and health care: experimenting with communication strategies and health education with youths".

### III. RESULTS

The young people's knowledge about mental health care using the internet to access digital games brought narratives in the mediations in the Program in Tune with Health on the online channel Web Radio AJIR-UECE, privileged locus of communication-discussion based on the dialogue with this public promoting nursing educational web care in schools school territories.

Thus, for the production of the interactive dialogues of the young schoolchildren with the guest-debater on the online web radio channel through the link: [www.uece.ajir.com](http://www.uece.ajir.com), they were encouraged to send questions/comments through communication software and the WhatsApp application, allowing a rapprochement between health professionals and students in a learning relationship, rapprochement with the language and culture of the youth audience.

The program started by problematizing the theme through the anchor question, which had the function of triggering the communication of the topic under debate as an extension of the communication in the social networks of the web radio. Then, the dialogue with the interviewee began, a psychologist who explored the vocabulary universe of youths, problematizing the consequences of digital games, their risks when using in excess in mental health, symptoms and treatment in the behavioral alert that resembled the "Game disorder".

After that, it was possible to characterize and explore Category 01 - Use of web radio as a pedagogical strategy with Youths on Mental Health and access to online digital games, internet and Digital Games.

In this sense, the participants expressed their doubts regarding mental health and the excessive use of digital games on the Internet, with emphasis on addictions, time on social networks, consequences of excessive use of games, excitement to violence, psychological suffering and illness of the victims expressed in the speech-questions:

Can "addiction to digital games" affect school performance? How can this happen? (Youngster 01, WhatsApp).

"How many hours on average can we spend on social media?" (Youngster 02, WhatsApp).

How can you manage your playing and studying time and fulfill your responsibilities? (Young 04, WhatsApp).

What are the consequences of the abuse of digital games? (Young 08, WhatsApp).

How to get rid of a game addiction in a person? (Young 09, WhatsApp).

Why do Games influence the mind? (Young 12, WhatsApp).

Do digital games engage in harmful actions like violence? (Youngster 14, WhatsApp).

Can the games that young people play often cause addiction or even become violent? (Young 20, WhatsApp).

What is the psychologist's opinion about the abusive use of games, as a way to "escape" from personal and social problems? (Youngster 27, WhatsApp).

Can digital games also help with mental health? (Young 23, WhatsApp).

Why do digital games generate anxiety problems in young people? (Young 36, Facebook).

Gambling addiction can lead to a variety of illnesses, but is there any that leads to taking certain unexpected actions like guns and suicides? (Young 44, WhatsApp).

Can antisociality cause addiction? And how to help a teenager who is addicted to social media? (Young 55, WhatsApp).

If I stop playing for two days can my anxiety increase? (Young 71, WhatsApp).

It was noted that the participants brought questions that demonstrated their interest in learning about digital games and mental health, with addictions, time on social networks, overuse, heightened anxiety and depressive states being central to them, and how to be helped when one has dependence on social networks.

These concerns of youths also arose when referring to navigation in the digital territory of the Internet, with excessive presence on social networks, as a way of interactions with their posts, dialogues with friends, among others, which is explored below.

Thematic Category 02 - Youth *Dialogues on Excessive Use of Social Networks and Repercussions on Human Health*

In this category, "Question-Anchor (QA)" was the trigger of the problems with the youths, which was related to the theme and has another way of exploring the dialogues as this is launched at the beginning of the program for everyone to respond and at the end is

problematized by the guest. Thus, she reported to know: What health problems can occur due to excessive use of social networks?

However, of the 85 participants, 21 of them answered the QA in the *Whatsapp* groups and the mobilizers passed it on to the program's production team. These Speech Questions (SQ) have been systematized below:

*Loss of sense of time when young people begin to compare their lives with the lives of others (Young 14, WhatsApp).*

*Hearing loss, impairs vision, sedentary lifestyle, insomnia and becomes antisocial (Youth 27, Facebook).*

*Increased loneliness and depression, insomnia, pain, impairs vision (Youth 32).*

*Depression, addiction and sedentary lifestyle (Young 40, WhatsApp).*

*Impaired vision and hearing (Young 58, Facebook).*

*Vision problems, psychological problems, depression, etc. (Young 28, WhatsApp).*

*Insomnia, headaches, physical inactivity, leading to the situation of Antisociality (Young 62, WhatsApp).*

*Increased loneliness, depression, insomnia, pain and impaired vision (Young 76).*

*Loss of sense of time, dependence (Youth 81, WhatsApp).*

*Loss of sense of time, causing depressive problems, due to the comparison of his life with that of others, social isolation, abstinence from always posting photos, among others (Young 83, WhatsApp).*

The SQs demonstrated provocations about prevention and forms of treatment to combat the addiction to the excessive use of the Internet in accessing digital games, which were mediated by the guest, alerting young people on how to avoid addictions to playing on the Internet.

Therefore, the strategies problematized by the guest were to observe her and her friends' behavior, for social isolation, excessive absences in commitments, unusual silence, among others. The need to develop preventive actions was concentrated in a week dedicated to the theme to carry out dialogues and promote open and participatory communication among youth, thus valuing their speech acts.

#### IV. DISCUSSION

Digital technology in the daily life of human beings has brought new social and behavioral problems because its early, excessive and prolonged use in Internet cyberspaces, cell phones, social networks and video games, online and

offline, will produce alerts about the accountability of all, especially professionals who take care of the health of adolescents and young people.

The survey TIC KIDS ONLINE – Brazil (2018), carried out by Cetic.br/NIC.br7 in a representative sample of 2964 families with interviews with Brazilian children and adolescents between 9 and 17 years old, showed that 86% are connected to the Internet, which corresponds to 24.3 million users, with regional and socioeconomic variations<sup>10</sup>.

In Europe, about 94% of adolescents have access to the network in their own homes and use it for more than 20 hours a week (RIAL et al., 2014). As portions of these Internet users remain connected for a period that varies between 1 hour and 2 hours daily. Nevertheless, there is a percentage of them that exceed this connection time, remaining on the network for more than 3 hours (SECADES, et al., 2014). This was found in the “internet addiction” survey in 70.6% of adolescents, showing a higher percentage in girls (77.5%) than in boys (64.5%)<sup>11</sup>.

Thus, from the speech-questions prepared by the participants during the transmission of the Program in Tune with Health, on the web radio channel it was possible to perceive curiosities about the risks that the excessive use of digital games on the Internet and its repercussions on mental health. Also, it was observed that the use of the web radio in the educational and communicative process turned the discussions into curiosities and exchanges of knowledge between youths plugged into the online channel.

In digital technology area, social networks related to the activity of playing video games refer to the greater popularization on the internet and, consequently, the proliferation of online spaces with the use of video games. Still, there are many blogs, websites, forums, YouTube channels and other platforms, designed to promote discussions between experienced gamers with digital newbies.

In fact, by facilitating access to the Internet and online games, one can play and have another life, outside of reality, a virtual life, within game spaces, establishing confrontations and challenges of wars, struggles and terror that become strategies for to provoke player response movements and thus, to train their reactions to the stress of the circumstances, with the objective of learning to control the cortisol and to channel the fear and then, to win the game and, at the same time, to beat the enemy<sup>4</sup>.

However, in Brazil, since 2005, there was already a virtual games production, as if they were sports activities with the possibility of playing in a network, between teams of teenagers and young people. The winners earned

rewards in cash prizes by participating in national and world championships, making the online gaming market booming in the cyberspace of the Internet, in addition to encouraging the player to undertake to generate financial income for themselves and their family<sup>12</sup>.

In this way, the player who is immersed in digital games culture is not only modulated as if he were inserted in an external reality and independent of himself, but both are reciprocal source of modulations with each other, as practical actions related to playing video games are established<sup>13</sup>.

The youth's question-speeches on "Mental Health, Internet and Digital Games" pointed out violence as a complex social problem with many factors involved. Among them are video games that "naturalize" violence as a learning model in living with other peers, increasing impulsiveness and aggression towards the weakest. Though, aggression and the practice of violence, such as emotions and behaviors in the real, family and social context, are expressed in the ways of playing on the Internet, giving way and encouraging players to create their targets and eliminate them<sup>14,3</sup>.

However, not every player is potentially aggressive and violent because for him to follow the specific system of rules, different from our reality, defined by gameplay<sup>15</sup>, is also to draw parallels with social rules, seeking to understand that violence can be practiced in the fictional gaming environment and not in a social coexistence environment.

In this sense, although video games do not directly generate violence, where their content is not directly transposed to reality, youths can produce different discourses of opposition to the practices of excessive use that generate violent behaviors, but, if they observe themselves and when necessary, seek help professional.

Some young people also asked about addiction to digital games and school performance. The early and long-term use of online games, social networks or various applications with films and videos on the Internet can cause difficulties in socializing and connecting with other people and school difficulties<sup>17</sup>.

In the second category of the study, "Youth dialogues about the excessive use of social networks", the young students mentioned several negative points such as: loss of sense of time, hearing loss, impaired vision, sedentary lifestyle, insomnia, antisociality, anxiety, depression between others.

Thus, early, constant, increasing, and prolonged exposure, in terms of hours per day, the use of violent games can be extremely harmful in developing

adolescents, when the limits and rules for use are not clearly established in the routine and in the family context.

According to Rossi<sup>16</sup>, at the same time that technology facilitates our lives, it generates extreme pressure, in terms of immediacy, with the speed of information, it also causes problems of stress and high anxiety.

In this context, dependence on the media causes mental problems, increased anxiety, violence, cyberbullying, sleep and eating disorders, physical inactivity, hearing problems due to the use of headphones, visuals, postures and repetitive strain injuries (RSI). And they also involve sexualities, such as greater vulnerability to grooming and sexting, including pornography, easier access to pedophilia networks and online sexual exploitation, access to drug use, self-harm and suicides with "jokes" or "challenges" can cause coma due to cerebral anoxia or death<sup>17</sup>.

Associated with these problems, addiction to games can be associated with other comorbidities, such as mental and behavioral disorders, most often with mood disorders (depression and bipolarity), impulse control disorders, anxiety disorders (mainly social anxiety), disorders attention deficit and hyperactivity disorder (ADHD) and autism spectrum disorders (ASD) (mild degrees) and obesity and physical inactivity, among others<sup>3</sup>.

There are some circumstances that serve as warning signs to differentiate recreational use versus problematic use of digital games and video games by youths, paying attention to warning signs, time of using screens or games, greater than 2-3 hours/day for teenagers aged 11-18, frequent episodes of playing more than 4-5 hours/day or "spending the night" playing video games, habitual and progressive isolation in the room to play alone or with friends in groups, drop in performance, failure, dropout, cyberbullying practices, among others<sup>3</sup>.

As stated above, on the channel the web radio made it possible to guide healthy lifestyle habits, physical activity, sports, food, immunization and coexistence with understanding human diversity, as well as stimulating the potential development of all young people to nourish themselves with art, culture and health.

## V. CONCLUSION

Youths produce their subjectivities in the movement in which society also produces their ethical and moral values, thus enabling the actions of educational health care using digital technologies on the Internet, such as the web radio, it will be able to minimize the risks and empower them for the web take care of themselves and others.

However, youths are captured by the consumer market of digital games made available on social networks on the



Internet, they are subjected to health vulnerabilities when there is excessive use and loss control of social rules, still, promoting computerization and communication with interactive dialogues with specialized professionals will be able to avoid damages and risks to the individual and collective health of this public.

Thus, the interaction of school youth in mediations on the web radio, demonstrated that dialogical communication is pedagogical in the production of the web with care in mental and collective health with the youth population.

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# Panorama of the use of Intangible Assets and Innovation in Brazilian Fashion Companies

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**Keywords**— *Intellectual Property, Fashion, Innovation, Industrial Design, Systematic Review.*

**Abstract**— *This article analyzes the panorama of fashion design innovation in Brazil and how orthodox Intellectual Property institutes are used to protect these innovations. A systematic review of fashion law was also carried out to conclude whether existing protection is sufficient or specific regulation is needed. Examples of patent, utility models and industrial design were analyzed in a critical manner in order to conclude if the protection of fashion designs can be carried out through such institutes. Finally, a detailed analysis of the results of a national publicly held company in the field was carried out to assess the relevance of using intellectual property institutes to protect their own designs. It is concluded that patents, industrial designs and utility models are underused, leaving the possibility of protection solely through copyright.*

## I. INTRODUCTION

This article aims to analyze the protection and use of Innovation in fashion designs in Brazil and how it can be strategically interesting for the fashion industry. The identification of two antagonistic currents in fashion: fast fashion, which brings news to the market aggressively, bi-weekly, with cheaper materials and in a way that is predatory to the environment (PETERS; LI; LENZEN, 2021), and slow fashion, more concerned with quality, sustainability and durability (YOON; LEE; CHOO, 2020), bring the need to qualitatively analyze the innovation of fashion designs as instruments of innovation that can be protected.

Defining innovation is not a trivial task, there are more than 60 definitions of the term (ALBU, 2017) considers Joseph Schumpeter, as the “prophet” of innovation and he conceptualizes it as “*employing different resources in a different manner, in doing new things with them*” (SCHUMPETER, 1997, p. 78). The concept has evolved since then, but it’s clearly originated in the aforementioned Author’s works. Today, in short, it can be said that innovation is (but isn’t limited to) the practical implementation of an idea with effective use, in a manner which brings re-

sults to the improvement of a process, product, organization or marketing strategy.

Although it is a broad concept, innovation is considered an essential factor for market competitiveness, as well pointed out by Ionela-Andreea (2019) and Jin; Cedrola (2018).

Jin and Cedrola (2018) quote Schumpeter, objectively consolidating that, for the Author, there are five types of innovation: of a product, of a production process, the creation of a new market, acquiring a new source of supply or raw material, and restructuring of an organization. Such views on types of innovation are also adopted by the Oslo manual, which brings internationally standardized methodologies that allow measuring innovation (OECD/EUROSTAT, 2018).

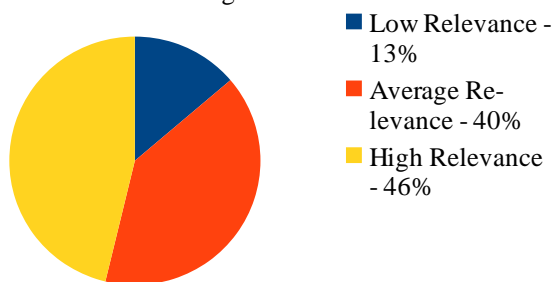
In Brazil, the Oslo manual is used to guide the data collection of PINTEC (IBGE, 2017), which is the National Innovation Survey, demonstrates that, in the Garment Manufacturing sector, from 2015 to 2017, there was a total of 14,365 companies in Brazil with more than 10 employees hired in this field, among which 4,969 implemented

some type of product and/or process innovation, meaning that 35.59% of companies in the sector sought to innovate in some way.

Also according to PINTEC (IBGE, 2017), of the companies in the Garment manufacturing sector that invested in innovation, 2,297 of them reported that innovation was a highly important factor to stay in business, 1,988 of these companies considered innovation as something of average importance and 684 considered innovation as something irrelevant for their business. In the same period, R\$91,300,000.00 (ninety-one million, three hundred thousand reais) were invested in research and development in the area, which demonstrates that it is a sector of considerable economic relevance and that has reasonable levels of innovation.

The following graphic consolidates the data presented above:

Importance of innovation to secure market share in the garment manufacturing sector



As innovation is largely subject to protection through intellectual property institutes, an analysis of the possibility of Design protection through existing intellectual property legal institutes is convenient.

It's not intended to use an Intellectual Property as an instrument for the fulfillment of Innovation. Excellent study by Sweet and Eterovic Maggio (2015), reveals that only countries with Economic Complexity Indices (ECI) and above-average *per capita* income have a positive relationship with robust Intellectual Property Regulation.

Although Brazil is in the 49th position in the ECI ranking, according to the atlas of economic complexity that ranks countries and product complexity (HARVARD COLLEGE, 2021), it is only in the 101st position of the *per capita* income ranking (THE WORLD BANK GROUP, 2020), so that legislation aimed at Intellectual property does not heavily influence the result of innovation or may even be counterproductive according to the aforementioned study.

There is no intention to criticize the conclusions of that study. In fact, it turns out that countries with low ECI rates and *per capita* income do not benefit from Intellectual Property Regulations as much as earlier countries on these

scales, but what would be the alternative? Not regulating Intellectual Property? The question is rhetorical. Of course, it is convenient and appropriate for countries to provide robust protections for intangible assets, which even attract foreign investments, as well put by the Intellectual Property Index of the United States of America Chamber of Commerce (PUGATCH; TORSTENSSON; CHU, 2017).

Furthermore, developing countries aim to actually develop themselves, and it is necessary to prepare for a more mature market with extensive use and respect for Intellectual Property institutes.

Thus, industries that innovate may have an interest in protecting Intellectual Property arising from these innovations to curb the undue copying of assets that, if innovative, are often expensive to implement, as demonstrated by PINTEC's data exposed above.

This analysis has also exemplified existing and used protection modalities, such as trademark registrations, industrial designs, patents and what the litigation involving the fashion industry is about, the meaning of the scope of Innovation in Fashion Designs in Brazil.

Observing the fashion industry through conventional methods of industrial property protection such as patents can be considered "*myopic and does not help to advance the global fashion industry to the next level*" (JIN and CEDROLA, 2018, p 25), but, although the functionality of the garments is not so accentuated, the design and symbolism of what they wear are important factors (idem).

Thus, given that there are protections beyond the functionality of fashion designs, a preliminary legal analysis will be necessary before entering the analysis of the protection of innovation in this field, considering that the current structure of the current legal regime is, even if partly, suitable for protection of fashion products and can be measured through it.

## II. METHODOLOGY

We stem from the theoretical framework brought by Schumpeter to analyze the reports and data found on innovation. The research consisted of exploratory research (SILVA; MENEZES, 2001) with bibliographic analysis, and a systematic review of the literature on the legal landscape. A considerable theoretical basis for analyzing the issue was found and qualitative documentary analysis (IDEM) of patent filings that aim to protect designs with functionalities, as well as Industrial Designs at INPI, were also carried out.

A qualitative documentary analysis of the results of publicly traded companies listed on Bovespa in the fashion

industry was also be carried out to conclude whether the panorama of use and protection of innovation in fashion designs in Brazil, given that these companies are required by law to make their balance sheets available to the public and such information proved invaluable for this study.

These qualitative analyzes will be subjective and open to discussion about their interpretation. Our main goal is to provide insight into the point of view for the matter, so that the interpretations set out below will not translate into a final point of view in the matter, much less the only possible interpretation.

Benjumea (2015, p. 887) adequately considers that “*qualitative research is interested in the subjectivity of an experience*” (free translation), which is a view that we share and cherish.

### III. SYSTEMATIC REVIEW AND LEGAL PANORAMA DISCUSSION

A comprehensive research was carried out, and although many articles about Intellectual Property protection of fashion designs were found (QUINELATO, 2019, PITA; LEAL, 2018 and FAKHOURI; MOREIRA, 2018) many of them approach the question through the eyes of the autonomy of fashion law as a new field of law, often advocating for new regulation (QUINELATO, 2019, OSMAN, 2017, ARROSI, 2021, and ZORATTO; EFING, 2021).

The conclusion drawn from the articles found on the subject is clearly that Brazilian protection for fashion is low, as it does not specifically protect fashion in its nuances and particularities. The literature indicates the existence of specific protection on the completeness of fashion design in different legal systems, such as the specific protection rules of the European Union, as well as national legislation in France and Italy. Outside the European Union, there are specific protections in the Kingdom United Kingdom and Japan (HEDRICK, 2008 and MARTIN, 2019).

On the other hand, it's possible to conclude that it is not necessary to introduce a new branch of law, complex regulations or specific legislation. As Martin (2019, p. 470) points out, the French and Italian protections on fashion are based only on "copyright" and that such protection is not only sufficient, as it is considered the strongest legislation in the world on the matter, indicating that the teleological interpretation of legislation would be sufficient to achieve such protection. There, fashion is not considered utilitarian, but "wearable art", which confers protection by copyright, which lasts one's entire life plus fifty years after

the person is deceased (in Brazil, the protection is extended to 70 years after the death of the author).

Martin (op. Cit.) does not distinguish between Copyright and *Droit d'auteur*. An interesting monograph deals in depth with this theme, which is beyond the scope of this work (ALGARVE, 2010), but this reference is deserved.

In Brazil, the Intellectual Property Law Doctrine understands that there is resistance to the use of clothing protection through Copyright because of the way article 8, VII, of the LDA (Copyright Law) was written, which provides for "*the industrial or commercial use of the ideas contained in the works*" impervious to protection by copyright.

It can be seen from the literature about this subject, that, in principle, fashion designs themselves, could not be protected through patents, as the shape itself cannot be protected though this industrial property institute, considering that the patent does not lend itself to this purpose. Though plastic form and merely aesthetic characteristics ordinarily cannot be protected through patenting, patents can effectively be used to protect specific elements of certain garments.

It is also possible to conclude that, despite the Industrial Design being able to protect prints and some aspects of clothing, there would not be the possibility of protection by the necessary form of preexisting garments.

Such conclusions seem to be appropriate with the concept of Industrial Designs, including the distinctions masterfully highlighted by Denis Borges Barbosa (2020, p. 18), which consolidates all the distinctions between the institutes discussed so far:

*Thus, if the creation is technical, it'll be the case of patenting an invention or an industrial model. If the creation is purely aesthetic, without application to an industrial product, it may be protected through Copyright; if it's a work of applied art, with the qualification of being able to serve as a type of industrial manufacture, we are in the domain of industrial design. (free translation)*

The need for specific legislation to protect fashion is not an exclusive claim of Brazilian authors. Martin (2019, p. 470) informs that the lack of cohesive legislation on the subject has led to an increase in lawsuits involving Fashion Law in the United States, which could lead to a change in government policies focused on the subject.

The same Author mentions an article where she demonstrates that some universities, as early as 2013, already taught "Fashion Law" as a legal specialty, such as



the following institutions: Cardozo Law School, New York Law School, Loyola Law School, Brooklyn Law School and the Fashion Institute of Technology, SUNY – State University of New York (PASQUARELLI, 2013).

After this systematic analysis, it is possible to say that, in fact, there is no specific protection for “fashion design” in a unitary, non-dissociated form in Brazil. This, however, does not necessarily lead to the conclusion that Intellectual Property is absolutely incapable of protecting fashion designs through preexisting legal institutes when claimed within their specific fields.

However, we recognize that considerable effort and a sophisticated understanding of the law is needed to protect each feature within its particular sphere, which further highlights the importance of the proper use of existing institutes (patents, industrial designs, style records in the national library, trade dress, trademarks three-dimensional marks, among others) as instruments for protecting the designs.

The fact that, for example, the Industrial Design cannot protect plastic forms or prints considered to belong to the state of the art does not mean that the Industrial Design is inapplicable to clothing in general, and it is possible to find some designs of elements that make up the clothing properly registered as Industrial Designs within the database of INPI, although this number is not considerable.

Although it is not possible to protect industrially reproducible designs through Copyright, the protection of handmade products or products that have artistic characteristics (provided they are not purely artistic) is possible through this institute.

By the way, Kilmar (2014) considers the cumulative protection under different Intellectual Property institutes possible in Brazil. This hypothesis was rejected by Barbosa (BARBOSA, 2019) and the partial cumulative protection system is proposed by Souza; Peralta (2021), for whom protection through Industrial Design and Copyright can be combined, as long as the production isn't purely artistic, which, to our understanding, is the most adequate conclusion, respecting the solid contrary position of Barbosa (2019).

So far we demonstrated that some aspects can be protected through patents and, in fact, there are numerous patents on elements contained in clothes, deposits made precisely by companies that make shoes, pants, shirts, *et cetera*.

Therefore, the currently existing intellectual property is sufficient to protect a large part of the elements used in fashion designs, as long as there is an interest in the protection and safeguarding of rights by those who conceived

the design, even if it is not properly aimed at protecting the overall fashion design in itself.

Both to illustrate the protection through existing intellectual property institutes and to quantify whether this protection is being used by designers, a documentary research will be carried out on fashion items that have been deposited with the INPI (the National Institute of Intellectual Property, which is the PTO).

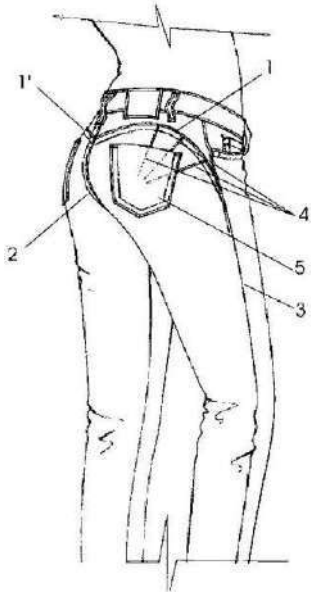
Bear in mind that according to the concept of innovation brought by Schumpeter (1997), mere invention does not always bring effective innovation, as, while not implemented, “*they are irrelevant from an economic point of view*”.

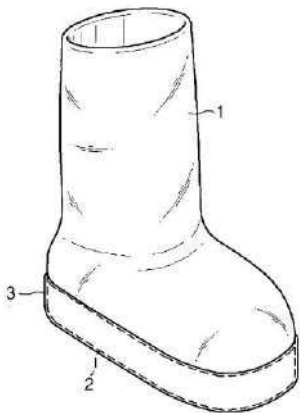
The difference between those who use intellectual property institutes and those who don't use them is simply the interest in holding exclusivity over the intangible assets resulted from the innovation. However, it is clear that more innovative companies tend to protect their creations through intellectual property.

For example, Nike has more than 830 Industrial Design processes in Brazil, according to a consultation carried out on the INPI website, many using the unionist priority criterion, with the filing being made primarily in the United States of America.

#### IV. DOCUMENTARY ANALYSIS

Documentary research on the subject reveals the existence of patents granted on clothing, as long as the clothing has a utilitarian characteristic for its design to be patentable, as is the case of the examples in Tables 01 and 02 below:

<p><i>Table 01 –Example of protection of design elements through a Utility Model</i></p>

<p>“Improvement in Women's Gluteal Shaper Clothing” - Utility Model No. MU8802978-6U2.</p>
<p>Utility model patent 'IMPROVEMENT IN WOMEN'S CLOTHING BUTTON MODELING', consisting of a modeling system in clothing, which eliminates the uncomfortable system of straight seams, simplifying it to a system with arched seams, which provide greater comfort, better design and better practical result in use. (DERBAS, 2008)</p>


<p><i>Table 02 –Example of protection of design elements through a patent</i></p>

<p>"SHOES SIMILAR TO PADDED SHORT SHOES" Patent no. PI0618001-9A2</p>

Footwear similar to padded short socks, where the present invention refers to functional footwear with a new concept, which adapt, by themselves, to the shape of a foot and promote a feeling of softness when walking with them; the footwear includes: an upper foot attachment section for covering and securing an upper portion of a foot, and a foot support section attaching to the upper foot attachment section for supporting a lower portion of the foot; the foot support section includes an elastic pad having a soft elastic body which can be deformed according to the shape of the foot; the shoes have a simple structure and can provide a feeling of walking barefoot on a spongy quilt, or on a thin fabric similar to a soft mat, to provide complete comfort to the wearer while walking. (MÜLLER; MÜLLER, 2006)

The example displayed in table 02 above is an invention patented through a Utility Model, as it is merely incremental on something that already exists (jeans), as it has practical utility, in the sense of providing more comfort and attributes its own aesthetic characteristic, as shown in the report descriptive of the invention.

The footwear shown in table 02, being innovative, in the sense of constituting something different that was never conceived before, it's a patent of an invention, denoting that despite containing a necessary shape to cover the feet, the invention was considered sufficiently new to be granted, precisely one of the requirements set out in art. 8 of the LPI – The Industrial Property Law (BRAZIL, 1996).

Its also possible to see industrial designs for protecting the visual elements of clothing, such as the configuration applied to a Nike shirt (Table 03):

<p><i>Table 03 – Examples of protection of design elements through Industrial Design</i></p>

<p>Administrative Process No.: BR302014002714-0F (MURPHY, 2014)</p>

From the above record, it is possible to infer that garments can be protected by Industrial Designs. It is note-

worthy, however, that the Registration of Industrial Designs in Brazil does not depend on the analysis of the merits of the application, only on the mere compliance with the formal requirements of the deposit, according to art. 111, sole paragraph of the LPI (BRAZIL, 9.279/96), according to which INPI will only issue an opinion on the merits if requested by the interested party.

From the presentation and "Release" of Results for the first quarter of 2021 of Hering S/A (CIA. HERING, 2021), it can be seen that there is reference to the use of open innovation, digital transformation, customer data and vision, omnichannel trading and innovation. In the "release" of quarterly results, the stimulation of the innovation environment through a "systems architecture" is expressly mentioned. These data are well described in the financial statements (CIA. HERING, 2021b, p. 53), where there is a description of what are considered "intangible assets":

The Company has trademarks and patents and software recognized as intangible assets. The value of trademarks and patents refers to the registration of the Company's trademarks with the competent national and international entities, which are amortized according to the validity period of the registrations. The software value refers to software acquired from third parties and generated internally, which is amortized over the lifespan defined in the appraisal report. All have defined useful lives and are measured at cost, less accumulated amortization and accumulated impairment losses

Notice that the terms "trademarks and patents" are treated without distinction, denoting a low concern for the meaning of these assets. It is also seen that in the description of intangible assets, industrial designs or copyrights are not even mentioned, revealing that data on these expenses are non-existent or strategic (and, therefore, deliberately not highlighted).

Throughout the demonstration, two partnerships with the artists "Verena Smit" and "Rita Wainer" are mentioned, in honor of the "Women's month". Although it is not possible to infer whether they were accounted for as intangible assets, according to the company itself, the collections and marketing strategies associated with these artists brought visibility to the brand and/or caused a social impact.

Royalties' revenues are not detailed, so it is impossible to define whether they result from the licensing of brands

arising only from franchising instruments or whether other elements make up this revenue.

It is evident from reading the statement that Hering S/A invests in innovation through the designs of its collections, even pointing out that the "new basics" collection brought 17% of *new customers* and that the international women's day campaign brought 24% of new customers. However, it is very clear that there is no concern with the protection of these collections by the conventional methods provided for in legislation to protect Intellectual Property.

## V. CONCLUSION

This paper sought to bring the panorama of innovation protection in fashion designs in Brazil and whether legislation and intellectual property institutes are sufficient for its protection. A literature review on the legal protection of fashion was carried out, as well as an exemplary qualitative documentary analysis in order to demonstrate whether the existing legal institutes are sufficient.

The consensus in the literature is that there is low protection due to the absence of specific legislation for the legal protection of these assets, given the lack of clarity and little use of the applicable legal institutes, respecting the conclusions that the protections provided by the orthodox intellectual property institutes do not are sufficient (ZORATTO; EFING, 2021 and GIACCHETA; SANTOS, 2018).

Despite such findings, it is concluded that there is some protection of fashion designs through preexisting intellectual property institutes, although their effective use depends on solid distinguishing ability over the applicable intellectual property institutes, since some types of protections by them sometimes overlap and sometimes exclude each other due to the way the legislation was conceived, especially with regard to Copyright and Industrial Design legislation, considering that in some cases the protections are cumulative, in others, mutually exclusive.

We've seen that countries such as France and Italy have orthodox protections, but their applications have a much greater scope due to the interpretation given by law enforcers, providing for a broader protection to fashion designs, which means that specific legislation only for fashion designs is probably unnecessary, being enough a clear distinction of the concept of what is considered to be protected by Industrial Design or by the Copyright Law or even if the juxtaposition of such rights is acceptable.

However, it appears that, even with this protective framework for intellectual property in the country, none of the biggest garment retailers use the existing institutes of industrial property, concluding that the current panorama

is insufficient or irrelevant for the industry, with the exception of those that invest heavily in innovation, like Nike.

We, therefore, conclude that the institutes are of negligible importance to the point of not even being highlighted in the income statements of these companies.

Analysing INPI's database and the balance sheets of some of the largest publicly traded companies in the fashion industry listed on BOVESPA (B3), such as Hering, C&A (C&A MODAS S.A., 2021) and Renner (LOJAS RENNER S.A., 2021), it's impossible to identify relevant data referring to Royalties paid or received in detriment of the use of Industrial Designs, specifically, although "copyright pieces" (contracted or in partnership with stylists, designers or artists) are considerably used.

The companies' innovation in their respective income statements was limited by the adoption of digital channels, use of technologies to reduce environmental impact, adoption of more environmentally responsible materials, improvement of sales channels and management of social networks, but no evidence was found about the development of Industrial Designs, patents or utility models for the protection of fashion designs for the three companies analyzed.

On the other hand, there was a perception of profit through the sale of products with added value because they were associated with artists or flashy visual elements, denoting that the use of copyright is the only legal resource possible to be used by industries to protect their own product innovations.

It is estimated that this result occurs because such companies use "fast fashion" collections and there is no interest in the long-term protection of assets that are so ephemeral, since the collections are changed very quickly and collections can be launched for each commemorative date, however, further deepening is needed to reach a conclusion about the reason behind such phenomenon.

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# Cultivar x environment interaction on green ear yield in corn inoculated with *Azospirillum brasilense*, at low latitude

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**Keywords**— *biological nitrogen fixation, phenotypic stability, Zea mays.*

**Abstract** — *The cultivation of green corn has been increasingly important for small farmers, due to its economic and social importance, derived from consumption in natura in the form of green ears. Thus, the present work was carried out to study the behavior of corn cultivars, in the presence and absence of the bacterium *Azospirillum brasilense*, under different nitrogen doses, aiming at the productivity of green ears in cultivation under low latitude. Two trials were installed, one in the agricultural year 2019/20 and the other in the agricultural year 2020/21, in the central region of the State of Tocantins. The experimental design used in each assay was randomized blocks, with three replications. The treatments were arranged in subdivided plots, where treatments involving seed inoculation with the bacterium were allocated in the plots *Azospirillum* (C Az) and without inoculation of seeds (S Az), in the subplots five doses of nitrogen (00, 30, 60, 90 and 120 kg ha<sup>-1</sup> N) and in the subplots eight maize cultivars. For each process (C Az and S Az), an adaptability and stability study were carried out using the Eberhart & Russell (1966) and environmental stratification by the method of Lin (1982), where the combination of each dose of N, in each assay and in each process (C Az e S Az) represented a distinct environment. There was a differential response of the cultivars between the processes with and without seed inoculation. Seed inoculation resulted in a higher increase in the productivity of green ears. The cultivar BRS-3046 and AG-1051 adapted to the environments.*

## I. INTRODUCTION

The corn (*Zea mays* L) has aroused great economic interest due to its nutritional properties, being used in human food, mainly in natura like green corn (roasted, baked, porridge, pamonha, bled and other), which has

driven social, economic, and cultural development in small and medium-sized properties [1].

To obtain a high productivity of corn, nitrogen fertilization is indispensable, since nitrogen is the mineral nutrient required in greater quantity by the crop, because it

acts on root growth and vegetative development, directly participating in the biosynthesis of proteins and chlorophylls, which reflects in productivity gains [2].

However, due to the high cost of this intake, combined with the environmental risk arising from its use, there is a need to incorporate technologies for rationalization and awareness in the use of nitrogen fertilizers [3]. In this sense, one of the alternatives would be the use of diazotrophic bacteria capable of making atmospheric N available to the corn plant, enabling crop growth and increased grain yield [4], as well as a reduction in the use of nitrogen fertilizers and the final cost of crop implantation [1].

Second Moreira et al. [5], diazotrophic bacteria can contribute to plant growth through nitrogen supply, phosphate solubilization and increased nitrate reductase activity [6]. In addition, these bacteria may result in changes in the morphology of the root system, in the number of radículas and diameter of the roots, probably due to the production of growth-promoting substances: auxins, gibberelins and cytokinins [7].

Increases in grain yield in corn crop when inoculated with *Azospirillum brasilense* have been observed in several studies involving maize [8]. To produce green corn, Araújo et al. [9], when studying the effect of inoculation with *Azospirillum brasilense*, associated with nitrogen fertilization, there was a significant increase in the number and mass of commercial ears with the inoculation of *A. brasilense*, treatment without inoculation, and that the combination of inoculation with *A. brasilense* and nitrogen increases by more than 30% the production of green corn cobs.

In a series of environments represented by years, locations, sowing times, different forms of management, fertilization and others, cultivar interaction x environment (C x A) that influences the performance of cultivars, hindering the selection process of those with superior characteristics. Aiming to mitigate the effect of this interaction, the identification and use of genotypes with wide adaptability and stability [10] and the identification of similar environments, which makes the improvement program more agile and reduces costs [11], have been tools used.

In this sense, the identification of green corn cultivars with adaptability and specific stability to different environments, combined with the use of new technologies, such as nitrogen-fixing bacteria, could result in increases in current productivity indices, as well as promote a rationalization in the use of nitrogen fertilizers.

However, after the economic, social importance and they're in natura consumption in the form of green ears,

there are few studies involving the green corn crop, for this purpose, aiming at the identification of cultivars, associated with the use of new technologies, such as nitrogen-fixing bacteria, in the presence of different nitrogen doses, under low latitude conditions, to which the present study is proposed.

## II. MATERIAL AND METHODS

The present study was carried out in the experimental area of the Federal University of Tocantins - UFT, campus of Palmas – TO (altitude of 230 m, latitude 10°12'54"S and longitude 48°20'02"W). Two tests were installed, the first season being in the agricultural year 2019/20, in sowing carried out on 12/04/2019, and the second season in the agricultural year 2020/21, in sowing carried out on 10/12/2020.

The soil of the experimental area, where the tests were carried out, according to the Brazilian Soil Classification System is considered as dystrophic Yellow Red Latosol. Soil samples collected at a depth of 0 to 20 cm showed, on average, the following characteristics: pH (CaCl<sub>2</sub>) 6,0; Clay 15,5%; Silte 5,9%; Sand 78,6%; M.O 11,63 g dm<sup>-3</sup>; P (Mehlich<sup>-1</sup>) 9,92 mg dm<sup>-3</sup>; K 0,2 cmol dm<sup>-3</sup>; Ca 1,90 cmol dm<sup>-3</sup>; Mg 1,12 cmol dm<sup>-3</sup>; S.B 3,22 cmol dm<sup>-3</sup>; CTC 5,02 cmol dm<sup>-3</sup>, e V 64,14%. It is emphasized that the two tests were performed in adjacent areas, in the same location.

Table 1 shows the average rainfall temperatures and precipitations recorded in the agricultural years 2019/2020 and 2020/2021 in the UFT experimental station [12].

Table 1. Average temperatures (°C) and rainfall (mm) in the conduction period of the tests in the 2019/2020 and 2020/2021 harvests in Palmas - TO.

Period	Crop 2019/2020		Crop 2020/2021	
	Temp. average (°C)	Precipitation (mm)	Temp. average (°C)	Precipitation (mm)
November	28.6 °C	198 mm	27.9 °C	52 mm
December	26.9 °C	298 mm	26.8 °C	258 mm
January	26.8 °C	308 mm	26.3 °C	349 mm
February	26.9 °C	342 mm	24.2 °C	485 mm
March	26.5 °C	420 mm	26.1 °C	511 mm
Average	27.0 °C	314 mm	26.4 °C	338 mm

Source: [12].

The experimental design used in each assay was randomized blocks, with three replications. The treatments were arranged in subdivided plots, where treatments with

seed inoculation were allocated in the plots with *Azospirillum* (C Az) and without inoculation of seeds (S Az), in the subplots five doses of nitrogen (00, 30, 60, 90 and 120 kg ha<sup>-1</sup> N) and in the subsubplots eight maize cultivars, three of which were simple hybrids (M-274, PR-27D28, AG 8088-PRO2), two double hybrids (BRS-2022, AG-1051), two triple hybrids (BRS-3046, BM-3061) and a variety of open pollination (Anhembí), all acquired in the local trade. The experimental plots consisted of four rows, with 3,0 m length, spaced by 1,0 m totaling an area of 12,0 m<sup>2</sup>.

The tillage was in conventional cultivation, without the need for cathes. At sowing, fertilization was performed in the groove with 70 kg ha<sup>-1</sup> from P<sub>2</sub>O<sub>5</sub>, and 48 kg ha<sup>-1</sup> from K<sub>2</sub>O potassium chloride.

Sowing was performed no-side in the groove, and the seeds were inoculated 30 minutes before planting with the bacterium *Azospirillum brasilense* (AbV5 and AbV6), being 100ml for each 25 kg as recommended by the manufacturer. Population density was 50,000 plants per hectare [13].

Weed control was performed using a post-emergent herbicide. It was not necessary to control pests and diseases. Cover fertilization was performed with ammonia sulfate (21% from N), in the doses (00, 30, 60, 90 and 120 kg ha<sup>-1</sup> N), between the lines of the plots, half of which

were applied to the V4 and half in V8 (four and eight true leaves, respectively) [14].

Based on the useful area of the plot (two central rows), green ears were collected as the grains were between the stages of milky grain (grain with about 80% moisture) and pasty grain [15]. Then the ears were scattered, and the weight of each parcel converted into kg ha<sup>-1</sup>.

After obtaining the productivity data of the green ears, statistical analyses were performed for each process, i.e., for the process with inoculation of the seeds with *Azospirillum* (C Az) and for the process without inoculation of seeds (S Az). Initially, individual variance analysis was performed and, later, joint analysis of the assays was performed, in which the smallest residual mean square did not differ by more than seven times the largest. Then, for each process, adaptability and stability analyses were performed according to Eberhart & Russel [16], as well as environmental stratification according to the method of grouping environments based on the Lin algorithm [17].

In statistical analysis, in each process, the combination of each dose of N (kg by ha<sup>-1</sup>) in each of the trials (sowing time), represented a distinct environment. Thus, for each process (C Az and S Az), ten environments were obtained from the combination of the five doses of N with the two assays, as shown in Table 2.

Table 2. Environments derived from the combination of two assays (sowing times) and five nitrogen doses in cover (kg by ha<sup>-1</sup>) in seed inoculation processes (C Az and S Az) for productivity of green ears in Palmas - TO.

Environment	Epoch 1	Dose N	Environment	Epoch 2	Dose N
1	04/12/2019	00	6	10/12/2020	00
2	04/12/2019	30	7	10/12/2020	30
3	04/12/2019	60	8	10/12/2020	60
4	04/12/2019	90	9	10/12/2020	90
5	04/12/2019	120	10	10/12/2020	120

Statistical analyses were performed using the statistical computer program Genes [18].

### III. RESULTS AND DISCUSSION

For the process without inoculation of seeds (S Az) the analysis of joint variance showed significant effect of environment, interaction Cultivars x Environments, and not significant effect for cultivars. On the other hand, for the process with inoculation of seeds (C Az) there was significant effect for cultivars, environments, and cultivars x environments (Table 3).

Table 3. Summary of the analysis of joint variance to produce green ears in two seed inoculation processes S Az and C Az, and in eight maize cultivars submitted to five levels of N in the agricultural years 2019/20 and 2020/21. Palmas - TO.

Source Variation	Degree of freedom	Square medium	
		S Az Epoch 1 and 2	C Az Epoch 1 and 2
Blocks/Environment	18 18	37066	97448





8 x 9	67.56	32.44	8 x 9	76.37	23.63
8 x 10	40.69	59.31	8 x 10	68.63	31.37
9 x 10	62.50	37.50	9 x 10	60.65	39.35

S Az: without inoculation of seeds; C Az: with inoculation of seeds, Environments: First Season (1, 00 kg ha<sup>-1</sup> N; 2, 30 kg ha<sup>-1</sup> N; 3, 60 kg ha<sup>-1</sup> N; 4, 90 kg ha<sup>-1</sup> N, and 5, 120 kg ha<sup>-1</sup> N); Second Season (6, 00 kg ha<sup>-1</sup> N; 7, 30 kg ha<sup>-1</sup> N; 8, 60 kg ha<sup>-1</sup> N; 9, 90 kg ha<sup>-1</sup> N, and 10, 120 kg ha<sup>-1</sup> N), agricultural years 2019/20 and 2020/21.

The environmental index, for the two processes (S Az and C Az) evaluated in the ten environments are presented in Table 5. Second method of Eberhart & Russel [16], favorable environment is one in which its average is higher than the general average of all environments studied, resulting in a positive index. On the other hand, unfavorable environment is one whose average is lower than the general average, thus being negative index.

In the agricultural year 2019/20, all environments (environments of 1 the 5) without *Azospirillum* (S Az) and with *Azospirillum* (C Az), classified as unfavorable. In the agricultural year 2020/21, all environments (environments 6 to 10), for the processes (S Az) and (C Az), were classified as favorable. Thus, within each process in each of the agricultural years, the doses of N used in coverage (30, 60, 90 and 120 kg from N by ha<sup>-1</sup>) were not able to cause changes in the classification of environments, so that their classification in favorable and unfavorable occurred mainly due to climatic fluctuations between agricultural years.

In the agricultural year 2020/21, the environments were classified as favorable due, mainly, to the occurrence of more regular rainfall in the grain filling phase (February 2021) (Table 1), when compared with the environments from the agricultural year 2019/20.

The occurrence of lower water availability during the grain filling phase promotes changes in metabolic routes [22], reducing the number of grains per m<sup>2</sup>, the number of ears per m<sup>2</sup> [23], length of internodes, the storage capacity of sugars in the stem, in addition to resulting in thinner stems, smaller plants and smaller leaf area, which can impair the development of plants [24].

In all environments (1 to 10), whether favorable or unfavorable, seed inoculation (C Az), promoted a greater gain in the productivity of green ears. This fact may have occurred due to diazotrophic bacteria contributing to plant growth, through the supply of nitrogen via symbiotic fixation [5] and to promote an increase in the availability of N from mineral fertilization to plants, through the

incorporation of inorganic nitrogen into complex molecules, resulting from the increase in nitrate reductase enzyme activity [6].

In addition, these bacteria may result in changes in the morphology of the root system, in the number of radículas and diameter of the roots, probably due to the production of growth-promoting substances (auxins, giberelinas and cytokinins) [25]. Thus, with the use of these bacteria, it would be possible to reduce the use of nitrogen fertilizers, reducing the cost of production and contamination of the environment resulting from the leaching of this element [1].

Chavarria & Melo [26], report that the use of micro-organisms (FBN) in agricultural practices has become increasing, as nitrogen fertilization is an important element in production costs, reduces environmental damage and reduces the greenhouse effect.

Increases in grain yield in corn crop when inoculated with *Azospirillum brasilense* have been observed in several studies [8].

Table 5. Environmental index (Ij) of ten environments, for productivity of green ears (kg ha<sup>-1</sup>), in processes without inoculation of seeds (S Az) and inoculating the seeds (C Az), according to the Eberhart & Russell [16] method, in the agricultural years 2019/20 and 2020/21, in Palmas – TO.

Environment	S Az		C Az	
	Average	Index (Ij)	Average	Index (Ij)
1	6,140	-2431	8,258	-748
2	6,565	-2006	7,218	-1788
3	7,532	-1039	7,592	-1414
4	6,906	-1926	7,241	-1765
5	8,094	-477	8,422	-584
6	8,966	395	9,274	268
7	9,947	1376	10,136	1130
8	10,152	1581	10,304	1298
9	10,354	1783	10,484	1478
10	11,050	2479	11,130	2124
General Average	8,571	---	9,006	---

Environments: Agricultural Year 2019/20, sowing on 04/12/2019: (Environment 1, 00 kg ha<sup>-1</sup> N; Environment 2, 30 kg ha<sup>-1</sup> N; Environment 3, 60 kg ha<sup>-1</sup> N; Environment 4, 90 kg ha<sup>-1</sup> N, and Environment 5, 120 kg ha<sup>-1</sup> N).

Agricultural Year 2020/21. Sowing on 10/12/2020: (Environment 6, 00 kg ha<sup>-1</sup> N; Environment 7, 30 kg ha<sup>-1</sup> N; Environment 8, 60 kg ha<sup>-1</sup> N; Environment 9, 90 kg ha<sup>-1</sup> N, and Environment 10, 120 kg ha<sup>-1</sup> N).

The averages and parameters of adaptability and stability of each cultivar, for each of the processes (S Az and C Az) for the productivity of green ears, by the Method of Eberhart & Russell [16], are represented in Table 6.

All cultivars showed significant regression deviations ( $S^2d \neq 0$ ), in both processes (S Az and C Az), indicating the non-predictability of behavior (instability), i.e., they present variations in the productivity of green ears depending on the environment.

The cultivars BRS-3046 and AG-1051, in the processes S Az and C Az, presented regression coefficient greater than the unit ( $\beta_1 > 1$ ) and average higher than the general average of the group, being considered adapted to favorable environments, that is, where the technological level employed is high.

AG 8088-PRO2 and BRS-2022, in both cases, they presented specific adaptation to unfavorable environments ( $\beta_1 < 1$ ), that is, with low investment in cultivation technology. In this environment, however, only the cultivar AG 8088-PRO2, in the process S Az, averaged higher than the general average and can be classified as well adapted.

The other cultivars presented different classifications when comparing the different inoculation processes (S Az and C Az), indicating their differential behavior when submitted to different seed inoculation processes. Thus, while PR-27D28 presented  $\beta_1 < 1$ , in the process S Az, and  $\beta_1 > 1$ , in the process C Az; BM-3061 presented  $\beta_1 > 1$ , in

the process S Az, and  $\beta_1 < 1$ , in the process C Az. On the other hand, M-274, presented  $\beta_1$  not differing from the

unit, in the process S Az, and  $\beta_1 < 1$ , in the process C Az and Anhembi presented  $\beta_1 < 1$ , in the process S Az, and  $\beta_1$  not differing from the unit, in the process C Az.

The Cultivars M-274, in the process S Az, and Anhembi, in the process C Az, presented regression coefficient equal to the unit ( $\beta_1 = 1$ ), that is, they were adapted to favorable and unfavorable environments. These M-274 average dwelled above the overall average. These cultivars are responsive to improving the environment, but require an adequate positioning, because if grown in unfavorable environments, where the technological level is low and face adverse climatic conditions, usually present reduction in productivity [27].

Revolti (2014) it was not possible to generalize the recommendation of the most appropriate form of inoculation since there is a genotype interaction x inoculation form. Therefore, it is necessary to develop cultivars, aiming at the production of green ears, through breeding programs aimed specifically at the processes S Az or C Az.

Already Quadros et al. [20], when evaluating the field agronomic performance of corn hybrids inoculated with *Azospirillum brasilense*, verified the effect of the interaction between hybrids and treatments on productivity, indicating that inoculation may be more efficient in certain hybrids. According to these authors, the benefit of inoculation, depending on the maize genotype, can be observed in different parts of the plant, such as the grains, shoots, or stems.

Table 6. Adaptability Parameters ( $\beta_1$ ) and stability ( $S^2d$ ), for productivity of green ears (kg ha<sup>-1</sup>), in eight maize cultivars, according to the method of Eberhart & Russell [16], in agricultural years 2019/20 and 2020/21, in Palmas – TO.

Cultivate	S Az			C Az		
	Average	$\beta_1$	$s^2 d$	Average	$\beta_1$	$s^2 d$
BRS-3046	8,926	1.16**	472407**	9,716	1.33**	287478**
Anhembi	8,431	0.85**	166164**	8,316	1.00ns	431036**
M-274	8,637	1.00ns	228198**	8,890	0.70**	384264**
PR-27D28	8,147	0.79**	116181**	8,568	1.19**	236571**
BRS-2022	8,382	0.91*	293953**	8,814	0.88*	135527**
BM-3061	8,425	1.19**	281028**	9,457	0.79**	332616**
AG-1051	9,000	1.14**	266382**	9,360	1.34**	420721**

AG 8088-PRO2	8,621	0.95*	100670**	8.928	0.78**	683710**
General Average	8,571			9,006		

$\beta_1$  = Regression coefficient; S<sup>2</sup>d= regression deviations; \*\*, \*, ns= significant to 1%, 5% and not significant respectively by the test t.

The results of the clusters of the environments, according to the method of Lin [17] (Table 7), for the process C Az, revealed the formation of a single group composed of environments 7 (sowing 10/12/20, 30 kg ha<sup>-1</sup> N) and 9 (sowing 10/12/20, 90 kg ha<sup>-1</sup> N). In this case, aiming at the optimization of human and financial resources in breeding programs, it would be possible to conduct only the test with the lowest nitrogen fertilization, that is, from 30 kg from N ha<sup>-1</sup>.

On the other hand, in the absence of *Azospirillum brasilense* (S Az), no group with similar environment was formed (Table 7). Therefore, it can be inferred that the doses of N used (00, 30, 60, 90 and 120 kg ha<sup>-1</sup> N) and climatic factors (precipitation and temperature), arising from different agricultural years, promoted significant changes in the environments. In this way, for this feature S Az, it is recommended to conduct a larger number of trials represented by the combination of years with different doses of N in coverage.

Table 7. Grouping of the ten evaluation environments for green ear productivity (kg ha<sup>-1</sup>), by the method of Lin [17], in agricultural years 2019/20 and 2020/21, in Palmas – TO.

S Az		C Az	
Group	Environments	Group	Environments
I	---	I	7; 9

Environments: Rehearsal First Season (Environment 1, 00 kg ha<sup>-1</sup> N; Environments 2, 30 kg ha<sup>-1</sup> N; Environments 3, 60 kg ha<sup>-1</sup> N; Environments 4, 90 kg ha<sup>-1</sup> N, and Environments 5, 120 kg ha<sup>-1</sup> N), in 04/12/2019.

Rehearsal Second Season (Environment 6, 00 kg ha<sup>-1</sup> N; Environment 7, 30 kg ha<sup>-1</sup> N; Environments 8, 60 kg ha<sup>-1</sup> N; Environments 9, 90 kg ha<sup>-1</sup> N, and Environment 10, 120 kg ha<sup>-1</sup> N, in 10/12/2020.

#### IV. CONCLUSION

There was differential response of cultivars between processes with and without seed inoculation.

Seed inoculation resulted in a higher increase in the productivity of green ears.

BRS-3046 and AG-1051 presented broad adaptation to the environments.

Due to the differential behavior of cultivars, in the presence and absence of *Azospirillum brasilense*, there is a need to conduct specific improvement programs for each process.

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# Productivity Analysis in Recyclable Materials Sorting Operation - A Case Study at Recifavela Cooperative

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**Keywords— Waste Pickers Cooperative, Wastage, Recyclable Materials, Productivity, Added Value.**

**Abstract—** *The reduction of waste in manufacturing processes and the productivity gain have been researched by several authors as economic competitive advantages for companies. More recently, environmental and social concerns have also been included in these studies. In this broad context, which additionally involves economic, environmental and social aspects, are the cooperatives of waste pickers (CMRs), which need to be placed on the same level where companies with productive and competitive profiles are located. Thus, the research presented in this article seeks to contribute to the advancement of this debate, considering the existence of gaps in the literature that address productivity studies in the production activities of recyclable materials sorting cooperatives. Therefore, the objectives of this study are directed to the questions that involve productivity (kg/cooperated) in the operation of screening materials, measuring the waste that occurs and which proposals for improvements can be implemented to increase productivity. This research is limited to a cooperative of collectors that adopts the sorting belt in its process. The methodology adopted is a case study, of applied nature (generating knowledge with practical application), quantitative and with exploratory data analysis. The results show that there are losses of production/waste of time of the (co-operated) operators, which could be reversed in aggregated value and, consequently, in increased productivity of the cooperative's business system in the sorting operation.*

## I. INTRODUCTION

One of the main current concerns of society is the environmental issue, precisely because it is a prerogative of great importance to populations in terms of quality of life. Thus, international organizations have sought to develop symposia, seminars and global meetings that involve discussions on environmental issues (Silva, Monteiro, & Leite, 2018). In Brazil, the approval of the National Solid Waste Policy (PNRS) in 2010 represented a milestone by obliging several productive sectors to implement reverse logistics programs, a demarcation in response to one of the country's main environmental

challenges, with direct effects on the quality of life in cities (CEMPRE, 2019). At one end are consumers with the responsibility to properly package the solid waste generated. In the other, manufacturers who are unaware of the destination given by the customers to the products at the end of their useful life. Among these two extremes are the cooperatives of waste pickers, who are responsible for allocating post-consumer materials for recycling. In this context, PNRS brings a great innovation by recognizing waste picker cooperatives as key agents in the recycling chain and as potential suppliers of companies to enable reverse flows of recyclable materials (Demajorovic,

Caires, Gonçalves, & Silva, 2014). The picking of materials and the sorting of these materials for recycling are important phases for the management of municipal solid waste (de Souza, Camarotto, & Fontes, 2019)

The formation of cooperatives is a practical result of certain individuals who were marginalized, mostly homeless, who realized that by joining together they would achieve a greater amount of products to be marketed, increasing the value raised (Magni, & Günther, 2014). The recognition of recyclable material collectors by the Ministry of Labor in 2002 as a profession was an important contribution to the organization of waste picker cooperatives in Brazil. The collector is defined as someone who collects, classifies and sells recyclable materials (Besen, & Fracalanza, 2016).

The recycling cooperatives, being constituted companies, face barriers to placing their products. The participation in the recycling chain is hampered for various external and internal reasons, among them are (i) the low remuneration of the services provided, (ii) the lack of structure necessary to trade directly with the recycling industry, (iii) the quality of the materials arriving at the sorting cooperatives, (iv) low-scale production, (v) deficiencies in process management and training of cooperators 25% of waste pickers in Brazil are illiterate (Besen, & Fracalanza, 2016), (vi) inadequate organization of production resources, among others. These deficiencies have a direct impact on the low productivity of cooperatives and, consequently, on lower financial gains for co-operatives. An example of increased productivity can be illustrated in the case of the Vira-Lata Cooperative, which evolved from 0.19 tons of materials collected by cooperated in 1999 to 16.7 tons per cooperated in 2008. This significant increase in productivity is due to the purchase of new equipment, improvement of the quality of materials collected and partnerships with public and private authorities (Demajorovic et al., 2014).

Magni and Günther (2004) state that the great difficulty encountered by waste picker cooperatives, from the point of view of their management, is the conciliation between their eminently entrepreneurial economic activity and the principles of self-management. It is important to note that waste picker cooperatives are seeking efforts to achieve more efficient management for their service provision (Dias, 2016). A positive experience in this sense is evidenced by Batista, Gong, Pereira, Jia, & Bittar (2018), that mention investments of Tetra Pak Brazil in programs to increase productivity, supported by improvements in the management of cooperatives. As an example, through a group of Tetra Pak consultants, it is possible to diagnose and identify opportunities for improvement, such as layout changes, third-round production deployment, workforce

training programs, among others. Cooperatives, which were initially set up to promote the social inclusion of the homeless must evolve to an efficient and productive level of organization, so that, on the way to achieving higher productivity there is a demand to maximize production and sales results using less resources. This path necessarily involves improvement actions in order to reduce waste in the process of sorting recyclable materials from waste pickers' cooperatives. orientation by the principles and tools of lean manufacturing corroborate the improvements in productivity to be achieved, consequently, the companies that adopt these practices seek to reduce waste and activities that do not add value in manufacturing processes. (Jabbour, Jabbour, Govindan, Teixeira, & Freitas, 2013, Roosen, & Pons, 2013, Rohani, & Zahraee, 2015).

In the specific case of cooperatives, the focus is to identify which operations in the screening process are responsible for adding value and productivity gain, where there are losses due to waste and which actions are necessary to minimize this. Given that, such improvements will provide the transfer of greater financial gains to its cooperators in addition to increasing social recognition and appreciation, bearing in mind that for cooperatives there is the challenge of professionalizing their value-adding processes. Among the operations in a waste pickers' cooperative, in the processes of separating the various recyclable materials, are the activities in the sorting belt, which is the stage where the highest value is added to the final result of the cooperative and the financial gain of the cooperators. It is on the sorting belt that the materials are separated into quantities for sale to the recycling market, so this operation contributes directly to the increase of productivity, determining value to the cooperative's revenue (result). Thus, a more detailed study centered on the screening operation is essential, observing the occurrence of waste, its causes and what improvements can be applied to the process.

The case study developed in this research is applied (generating knowledge with practical application), quantitative, descriptive and based on data analysis. The data analyzed are collected through the application of filming and timing techniques and on-site observations. The specific objectives of the study refer to the following questions: (i) what is the current productivity (kg/cooperated) in the sorting operation (ii) which wastes occurred (iii) which proposals for improvements can be implemented to increase productivity.

Thus, the present case study seeks to contribute to the advancement of this social, environmental and economic debate, considering the gap in the literature in this field involving productivity studies in the production activities

of recyclable materials sorting plants. It is important to note that the case study discussed in this article is limited to a waste pickers' cooperative that adopts the screening mat in its process and does not apply to processes using stationary tables or cage benches for sorting materials. The investigation is contemporary considering that it promotes the opportunity to apply technical knowledge of production engineering in a category of organization that needs improvements in productivity for its production processes.

The results obtained in the survey are not representative of the population of waste picker cooperatives, but are important indicators for other cooperatives to carry out a detailed investigation of their sorting operations and identify the causes of the loss of productivity.

## II. THEORETICAL REFERENCE

The theoretical framework in this article aimed to bring some important definitions and concepts regarding the subject under study, which later served as the starting point for the construction of the research. Based on this purpose, the topics investigated were delimited in the search for academic content on (i) the management of solid urban waste in Brazil, (ii) the participation of sorting centers (cooperatives of waste pickers) in the material recycling system, (iii) their sorting processes and (iv) the importance of productivity in the economic, social and environmental results of these recycling plants.

### a. Urban solid waste in Brazil

The collectors of reusable and recyclable materials play a key role in the implementation of the National Solid Waste Policy (PNRS), with emphasis on integrated solid waste management. In general, they operate in the activities of selective collection, sorting, classification, processing and marketing of reusable and recyclable waste, contributing significantly to the recycling production chain (MMA, 2020). PNRS highlights the importance of waste pickers in the integrated management of solid waste, establishing as some of its principles "recognition of reusable and recyclable solid waste as an economic asset of social value, generating work and income and promoting citizenship" and the "shared responsibility for the life cycle of products" (MMA, 2020).

The figures for municipal solid waste generation in Brazil (RSU) show an annual total of 79 million tons in 2018. Of this amount generated, 72.7 million tons were collected, recording a 92% coverage index for the country, which also shows that 6.3 million tons of waste were not collected and consequently had improper destination (ABRELPE, 2019). In 2018, the appropriate final

disposition of RSU registered an index of 59.1% of the annual amount sent to landfills, and the difference (40.9%) is still destined to inadequate units such as controlled landfills and dumpsters (ABRELPE, 2019). This exerts influence on problems related to the correct disposal of waste, involving environmental, economic and social factors (Ramos, Castilhos, Forcellini, & Graciolli, 2013). Other important data refer to the selective collection of post-consumer materials and the process of screening these materials. Only 22% of Brazilian municipalities have selective collection installed and, in this scenario, 50% of materials selectivity is carried out by waste picker cooperatives (CEMPRE, 2019). According to the National Sanitation Information System NSIS (2016) the percentage of dry and recycled collected materials in Brazil is 2.1%, which figures as a very small percentage.

The gravimetric composition of the selective collection of solid waste, which can be recycled and offered for sale by cooperatives, is composed of 22% paper and cardboard, 13% plastic, 12% aluminum, 10% ferrous metals, 9% glass, 3% electronics, 3% other, 2% long life. In addition to these materials, there are 26% of waste that cannot be used for recycling (CEMPRE, 2019). The financial revenue of waste picker cooperatives is directly related to the productivity of the process of sorting these 74% recyclable materials. Higher productivity means higher profit and consequently a higher income distribution to the co-operated (Fattor, & Vieira, 2019).

### b. Central screening: recycling cooperatives

Developing countries in particular have invested in organizing groups of waste pickers, encouraging them to form Solid Waste Picker Cooperatives (CCRS), also known as Recyclable Materials Centers (CMRs) (Magni, & Günther, 2014, Besen, & Fracalanza, 2016). It is estimated that in Brazil there are approximately 800,000 collectors of recyclable materials and that only 30,000 are organized in cooperatives (Fattor & Vieira, 2019), which represents 3.75% of the available workforce. Recyclable materials cooperatives appear as an important link in the logistics chain for sorting after-consumer products that can be reinserted into the production flow, as recycled raw material, transforming them into new products (Souza, Fontes, & Salomão, 2014, Fidelis, & Colmenero, 2018). Promoting the interface between the consumption of society and the recycling industry (Souza et al., 2014) cooperatives are presented as a public policy model to manage solid waste with recycling potential (MSWRP - *Managing Urban Solid Wastes with Recyclable Potential*) (Fidelis, & Colmenero, 2018) and are recognized by the National Solid Waste Policy (PNRS) as key agents in the recycling chain (Demajorovic et al., 2014).



Furthermore, waste pickers contribute to cities in various ways, as service providers for the selective collection of materials, as environmental agents enabling recycling and as key economic actors that feed the market with secondary raw materials (Dias, 2016).

The disposal of recyclable materials can have different destinations: regular collection, selective collection and voluntary delivery points (ENP). Once disposed of in the ordinary waste, the destination of these packages will be a landfill, while those disposed of in the waste destined for selective collection and at voluntary delivery points will be forwarded to the cooperatives of waste pickers, where they will be sorted by type of material, so that a fraction of these materials will be marketed. All else will be disposed of as waste and then sent to the same landfills to which the

post-consumer materials disposed of in the common waste were destined. Those that are marketed automatically generate revenue for collectors (Demajorovic, & Massote, 2017).

A comprehensive chain of work process operations of the sorting plants can be represented in the value flow (material flow) of Fig. 1. The operations of the sorting plants are oriented to the collection, storage, sorting and marketing of products. Production includes the entire internal flow of materials, composed of the pre-screening, screening, pressing and storage stages (Fidelis, & Colmenero, 2018).



Fig.1: Material flow in a sorting center, from collection to internal operations.

Among the operations developed, screening is the main value aggregator, an indicator of this is that the price of the material varies whether it is separate or not (Oliveira, 2010). The speed of sorting and the quality of the sorted materials determine the productivity that the cooperative will have and, consequently, the final financial gain for the cooperators. The lack of attention in this operation can be decisive for the gain by the cooperators at the end of the month (Fattor, & Vieira, 2019). For this reason, particular attention should be paid to strategies in which they can result in an increase or decrease in the value produced and, consequently, in the remuneration of waste pickers (Parreira, 2010).

Among the factors that generate inefficiency in screening, Parreira (2010) describes them in three classifications: external, internal and organizational. The external factors are the mix of the material, the amount of waste, the type and time of transport. The internal ones refer to the form of storage of the material that will be carried out the sorting, manipulation and the space intended for this operation. Regarding to the organizational, the work pace and the form of remuneration are considered (Parreira, 2010).

Properly managing a production process is crucial to achieving organizational objectives, but the lack of technical knowledge makes this management challenging and leads to results that fall short of what the organization could achieve. Associations and cooperatives of recyclable

material collectors are very relevant in the implementation of integrated waste management, however, in most cases, they have an incipient management of their processes and activities (Feitosa, & da Silva, 2018).

The area destined to the operations that add value in a cooperative of recyclable materials must be sufficient for the materials to have production flow, from the stock of the collected material to the shipment of the bales of sorted materials, as defined in Figure 1.

Thus, productivity and value added to products is directly associated with the efficiency and speed of the material flow in the process.

### 2.3. Productivity for recycling materials cooperatives-CMRs

The study of the system of production of goods and/or services involves its basic model composed of inputs, transformation process, and outputs. The capacity of a production process is determined by the resources it has to produce its outputs and concerns the production potential of the process (Feitosa, & da Silva, 2018). Resources (inputs) are raw materials, machinery, equipment, energy, capital, human resources, among others. The results (outputs) are goods and/or services resulting from the transformation of resources by the manufacturing processes. The higher the output with less input, the greater the productivity of the system. It has thus that productivity is usually measured by comparing the quantity of goods and services produced with the inputs used in production (Mankins, 2017).

The fraction between output (system result) and input (resources used to obtain the system result), as such, is typically expressed as an output/input rate. Simple measures of productivity reflect the production units produced per unit of a specific resource (Syverson, 2011). i.e.:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}} \quad (1)$$

Workforce productivity, as a production resource, is the most common measure, although capital or even material productivity measures are occasionally used (Syverson, 2011).

Waste reduction in processing processes is a key point in this relationship, as it leads to increasing results. The process of sorting the cooperative recycling materials (Cmrs) adheres to this production model and considers that the results of the system are classified materials and the resource used would be the labor time of the cooperators.

Manufacturing processes contribute to the competitiveness of companies by continuously improving productivity and making the system more efficient (Rodrigues, Lourenço, & Jorge, 2019). For cooperatives this statement also applies. The establishment of sorting productivity is decisive for the results of the CMRs and for the dimensioning of sorting resources (equipment and collectors). The production capacity of cooperatives is relevant to the construction of performance indicators of screening actions seeking to increase recycling (CEMPRE,

2019). Fidelis and Colmenero (2018) state in their studies that cooperatives underuse their inputs in the generation of products, that is, they could produce more with the same inputs used, and thus be more productive. The implementation of a CMR requires a series of basic conditions of transportation, sorting, storage and commercialization of recyclable materials, as well as support for qualification of its members for the management of its business system. Managing a cooperative means managing every step of your process and setting goals (Fattor, & Vieira, 2019).

### III. RESEARCH CLASSIFICATION AND METHODOLOGY

This paper has a quantitative approach in a case study, which is defined as an empirical method that investigates a given case within a real-life context through evaluations (Miguel ,2010, Y in ,2010). The methodology is also classified as applied (generating knowledge with practical application), with descriptive data analysis, as it is intended to describe the screening process and analyze the impacts of variability on the activities developed in this process. Data collection was based on the application of timing techniques and on-site observations.

Chart 1 summarizes the research classification.

Chart 1: Research Classification

Description	Specification
General Objective	Investigate the current productivity of a collectors' cooperative (kg/cooperative member) in the sorting operation. Identify the waste in the sorting operation and propose improvements that can be implemented in the sorting operation in order to increase productivity.
Classification	Applied research. It aims to generate knowledge for practical application aimed at solving specific problems (Silva & Menezes, 2001).
Objective	Descriptive research. Description of the characteristics of a given population or phenomenon using standardized data collection techniques: questionnaire and systematic observation (Silva & Menezes, 2001, Collis & Hussey, 2005, Gil, 2011).
Approach	Quantitative. Data collection and statistical analysis to describe the observed events (Silva & Menezes, 2001).
Methods	Case study. Timings and observations at the operations site (triage screen). Data was collected by records and filming.

Based on the choice of case study as an investigation approach for the present research, the search for bibliographic references began, which was not limited only

to the most recent dates, but rather to articles published by authors of relevance in the literature. The bibliographic research focuses on keywords where the contents dealt

with (i) studies of solid waste in Brazil, (ii) the importance of sorting centers (collectors' cooperatives), for the process of recycling post-consumer materials and (iii) research on the productivity of sorting processes for the final results of cooperatives.

This case study is delimited to the operations of selections of recyclable materials on the sorting belt. The timing and observations in the operations were made with the presence of the researchers at the site itself as well as filming the selection process on the screening mat. Data collection took place during May 2019.

Timings were divided into value-added time (sorting recyclable materials) and non-value-added time (waste). The value-added time represents the time of operation used to separate the various materials on the sorting belt, i.e., the time that the cooperated remove each type of material from the belt and place it in the respective big bag. The non-added value time refers to times lost by (cooperative) operators without material separation, i.e., waste. In the investigations addressed to the cooperative members working on the sorting mat, we identified four main types of waste of time in the sorting operation, which are: (i) Downtime due to lack of material on the screening belt; (ii) time performing movements that do not add value; (iii) time spent on cleaning and tidying the materials; and (iv) time expended on several other activities.

The identification of types and times wasted have a direct impact on the productivity of the sorting operation, whose resource is the cooperative's workforce. These wastes can be reduced by process improvement actions and it is assumed that the acceptance of improvement proposals by the cooperators will be more efficient using the cooperative context itself (Fidelis, & Colmenero, 2018).

#### IV. CASE STUDY

The case study developed was conducted at Cooperativa Recifavela, located in the municipality of São Paulo, State of São Paulo, Brazil.

The name came from a junction: Recycling and Favela, since the founders were residents of Favela da Vila Prudente, the oldest Favela in São Paulo, which was founded in 1940 on official record. Thus, they linked their origins to the identity of the cooperative. Currently, the cooperative collects three tons per month of the site, which is also where most cooperators live (Recifavela, 2020).

In 2007, in the face of pressure exerted by the government to leave the work carried out under a viaduct in the greater São Paulo, the waste pickers decided to join

the unemployed youth of Favela Vila Prudente and set up a cooperative for sorting recyclable materials. Through this initiative, the Recifavela cooperative was born on December 24, 2007. Previously the cooperative remained for 5 years under the overpass, which was the first space occupied and was an old construction site, without drinking water, electricity or toilets. The perseverance of the group resulted in an agreement with the city of São Paulo that allowed the relocation of Recifavela to a warehouse, where they were able to offer 50 jobs. Currently, the production process has two sorting belts and four presses, with daily work hours and a monthly production of 100 tons of products for recycling (Recifavela, 2020).

The cooperative processes the sorting of recyclable materials, mostly from the selective collections carried out by the city of São Paulo. The Municipal Urban Cleaning Authority (AMLURB) is responsible for the collection and management of solid recyclable waste produced (São Paulo City Hall, 2020).

In 2019, the city of São Paulo collected 80.4 thousand tons of recyclables. In the first four months of 2020 the collection of recyclable materials was 31.8 thousand tons, 16.9% more than in the same period of 2019 (São Paulo City Hall, 2020). This scenario indicates the importance of waste picker cooperatives in the correct disposal of post-consumer materials for the recycling industries, avoiding the deposition of these materials in dumps and landfills.

It is understood that the participation of Cooperativa Recifavela in the production of materials for the recycling industry represents approximately 1.5% of the recyclables collected by the city of São Paulo in 2019.

##### c. Characterization of the screening process

The materials that arrive at the cooperative are transported by municipal collection trucks and by trucks from Recifavela itself. The materials are received, unloaded and stored for further sorting. Of all kinds of sorting materials, three of them cardboard, glass and scrap are separated in a pre-sorting and packed in big bags, as they have an alternative flow and are not fed on the conveyor. The cardboard big bags are transported to the presses, where the material is pressed, packed in bales and stored. Glass and scrap are transported in big bags and dumped in the respective buckets (final stock).

The other materials are fed on the sorting conveyor, classified according to their type and packed in big bags. Each of the sorted products are then transported to the press, pressed into bales and stored for sale, with the exception of mixed paper and white paper, in which the materials are poured into buckets (final stock).

Moreover, of all the mass of materials that reaches the cooperative, a part of it is not classified as recyclable product, it is the waste. The waste is collected in buckets, weighed and stored, for collection by the city and destined to landfills. These wastes represent 26% of the mass, which is not used for recycling (CEMPRE, 2019), but which has added value over several stages in the screening process.

All big bags and bales, of the various sorted materials, are weighed for production management, inventory control

and monitoring of the flow of materials throughout the cooperative's process operations.

For Recifavela, the flowchart drawn in Fig. 2 details the flow of materials at each stage of the process. From the input of the collected material to the final stock of each type of sorted product, through all the internal operations of the process.

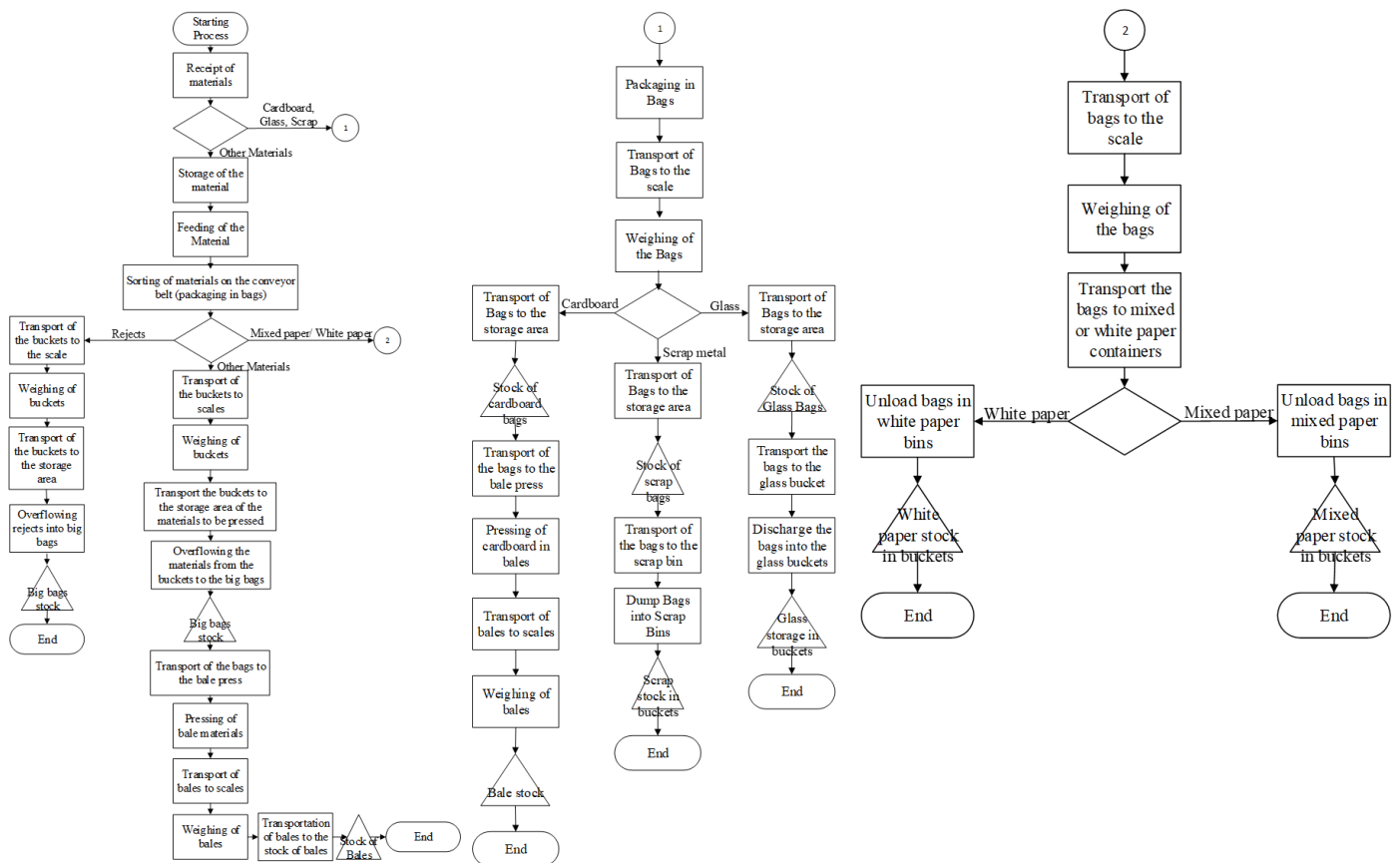


Fig.2: Flow of materials in the sorting processes of Cooperativa Recifavela. Source: Authors

It is worth adding that of the entire flowchart presented in Fig. 2, the study of this article is limited to the productivity of material sorting on the conveyor and the focus of the research is the screening process. Among the operations developed, belt screening is the main value aggregator (Oliveira, 2010). All the materials, which make up the gravimetry of the cooperative (Fig. 7), are fed on the mat to be sorted, only cardboard, glass and scrap do not pass through the mat.

4.2 Sorting operation

The sorting operation is the main activity within the cooperative's production process. It is the stage where the

material is effectively separated into the various different types to be sold (Fattor, & Vieira, 2019).

The screening operation is carried out by the cooperates positioned along a conveyor belt, basically, they separate the various types of materials, while pack them in big bags. With dimensions equal to or greater than 0.90mx0.90mx1.20m for each waste picker there are five big bags around, one for each type of material, as illustrated in Fig. 3. The movement of materials between pre-sorting, sorting, weighing, pressing and storage is done by the so-called "support", who are waste pickers that



carry out these activities manually, with the help of palletizing machines and forklifts.

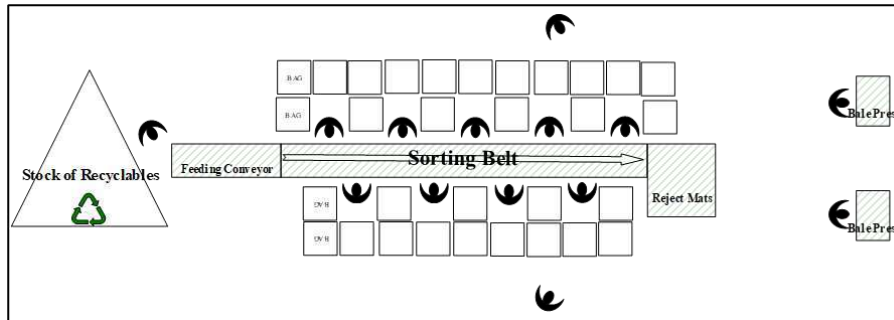


Fig.3: Layout of the sorting mat

In the screening, the value is added to the final result of the operation when the cooperator is making the move to remove the material from the mat and put it in the big bag.

Figure 4 illustrates a mat with the cooperates performing the material sorting operation. Around each

cooperate are allocated four big bags, one for each type of selected material.



Fig.4: Sorting mat. Source: Recifavela

#### 4.3. Data collection and results

The data collected refers to the times of operations that add value to the sorting process and the waste times. According to the methodology adopted the waste times are: (i) Downtime due to lack of material on the screening belt; (ii) time performing movements that do not add

value; (iii) time employed in cleaning and tidying the materials; and (iv) time spent in several other activities.

The sorting conveyor is composed of 10 operators (cooperated) divided into five cooperated for each side of the conveyor, as shown in Fig. 5.

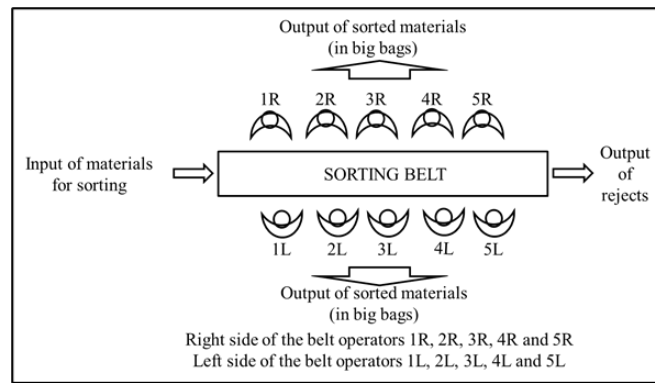


Fig.5: Distribution of cooperates on the screening conveyor. Source: Authors

For each of the positions, samples of 45 times ( $n=45$ ) were collected at different times throughout the filming period. The summary of the timekeeping, both for the activity that adds value to the screening and for the wasted times (non-aggregated value), is presented in Table 1.

**Note:** The Aggregated value is the sum total of the times when operators have made movements by removing the material from the sorting belt and consigning it to the respective containers (big bag). <sup>b</sup>Waste: (i) lack of material on the mat to be separated, (ii) miscellaneous movement refers to movements such as tearing the bags containing materials and dragging/pulling the material on the mat; (iii) cleaning and stowing of materials in big bags; (iv) in the various activities are included parallel conversations, use of mobile, separation of material for own use.

Table 1: Value-added time and waste in the sorting operation

Cooperative operators		Value Added (VA) <sup>to</sup>	Waste <sup>s b</sup>				Non-Added Value (VNA)
			Lack of Material (i)	Miscellaneous Movements (ii)	Cleaning and Tidying (iii)	Miscellaneous Activities (iv)	
1R	Time (min)	45.00	18.50	13.82	3.45	2.30	38.07
	Percentage	54%	22%	17%	4%	3%	46%
2R	Time (min)	37.77	49.00	7.68	20.82	4.73	82.23
	Percentage	31%	41%	6%	17%	4%	69%
3R	Time (min)	44.27	19.00	8.73	2.00	3.00	32.73
	Percentage	57%	25%	11%	3%	4%	43%
4R	Time (min)	45.02	22.65	4.00	3.00	2.30	31.95
	Percentage	58%	29%	5%	4%	3%	42%
5R	Time (min)	44.54	22.18	1.00	5.00	2.28	30.46
	Percentage	59%	30%	1%	7%	3%	41%
1L	Time (min)	44.14	34.62	10.60	12.47	4.17	61.86
	Percentage	42%	33%	10%	12%	4%	58%
2L	Time (min)	44.43	34.22	5.40	7.40	3.55	50.57
	Percentage	47%	36%	6%	8%	4%	53%
3L	Time (min)	44.90	41.87	3.68	13.35	1.20	60.10
	Percentage	43%	40%	4%	13%	1%	57%
4L	Time (min)	44.45	50.55	10.72	9.50	3.78	74.55

	Percentage	37%	42%	9%	8%	3%	63%
5L	Time (min)	44.06	14.87	2.25	1.95	3.87	22.94
	Percentage	66%	22%	3%	3%	6%	34%

The average values (in percentage), of the transaction that aggregates value (VA) and the waste are represented in the graphic in Fig. 6.

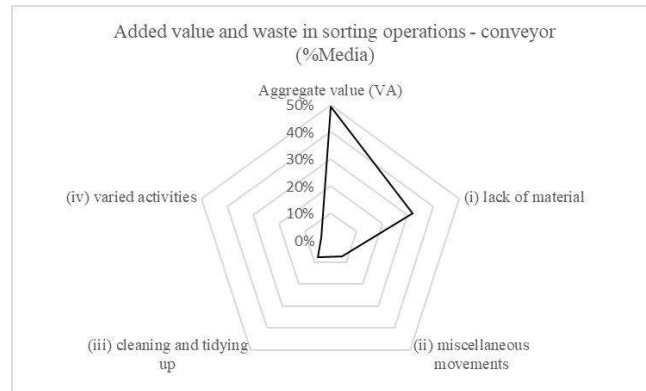


Fig.6: Added value and waste in sorting operations

To measure the amount of each type of solid residue screened in the Cooperativa Recifavela belt, the production was recorded daily during the data collection period. This information is used to calculate the gravimetric composition of the waste, that expresses the percentage of the presence of each component in relation to the analyzed

residue sample, being an information of great importance for understanding the waste and its proper management (Soares, 2011). Figure 7 graphically represents the gravimetry of the products screened in the Recifavela Cooperative.

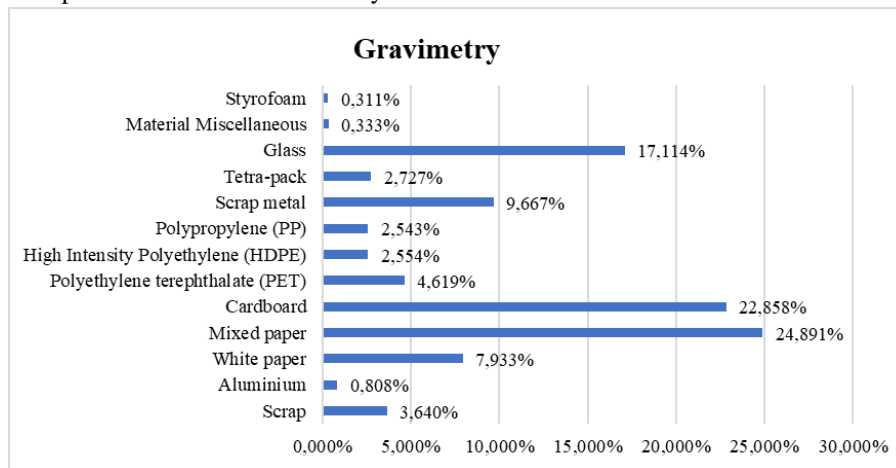


Fig.7: Gravimetry of materials screened in the belt of the Cooperativa Recifavela

The gravimetric dimensioning determines the percentage of the total mass of material that is fed on the screening belt.

The sample, with the mass of each type of recyclable material, was collected during a 30-days period, in May 2019. Pointing out that the cardboard, glass and scrap materials are not fed on the sorting conveyor (according to

the flowchart shown in Fig. 2). In this way, 50.368% of the materials passed through the mat to be separated (sorted).

The total mass produced by Cooperativa Recifavela in this 30-day period was 41,500 kg<sup>1</sup>. Considering only the materials that were screened on the conveyor belt

<sup>1</sup> This value refers to the production of a sorting mat. The Cooperativa Recifavela has two mats.

(50.368% - according to Fig. 7 gravimetric), the mass produced on the conveyor represents 20,902 kg. This mass represents 49.4% of the time of aggregated value (VA), according to information presented in Table 1 and Fig. 6.

The resource used for this production was 10 cooperating operators, five operators on each side of the belt. Thus, the productivity calculated in the period is:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{20.902 \text{ kg}}{10 \text{ operator}} = 2.090 \text{ kg/operator}$$

The lack of material on the conveyor belt is the most expressive waste, representing 32% loss in operational time in aggregated value (Fig. 6). Therefore, the regular feeding of materials on the belt will represent an increase of approximately 32% of the sorting operation time, equivalent to an increase of 13,540 kg of production in the period. The eviction of this waste impacts directly on the increase of productivity in the sorting operation. In this way, it is assumed that the productivity in the sorting belt becomes:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{20.902 \text{ kg} + 13.540 \text{ kg}}{10 \text{ operators}} = 3.444 \text{ kg/operator}$$

The productivity gain with the elimination of waste "lack of material" is linked to the changes in the improvements in the feed operation standards of the screening belt. These operating standards shall be suitable in such a way that there is no interruption in the input of materials into the belt. Supplementarily, the cooperators responsible for the operation have to be trained and qualified for these improvements.

The study did not consider waste in various movements, cleaning and storage, and various activities, due to the fact that they represent low interference in productivity gain, and it was found that the elimination of these losses has little effect on the productivity of the system.

This research does not exhaust itself and there are several other points to be studied that directly interfere in the productivity and financial gains of recycling cooperatives, such as: (i) quality of the materials that reach the cooperatives and oscillation in the quantity of materials for screening (Souza et al., 2014), (ii) waste collection logistics - facilities for transporting recyclable solid materials provides an increase in waste pickers' financial gain (Ramos et al., 2013), (iii) production scale capacity in the other operations of the sorting process, (iv) logistics

distribution and marketing of sorted products directly to the recycling companies (Ramos et al., 2013, Fattor, & Vieira, 2019), (v) further public actions to encourage waste pickers' cooperatives, (vi) increasing the participation of companies that generate recyclable municipal solid waste, among others.

Internally to the picker' cooperative, and dealing directly with the operation of sorting materials on the conveyor belt, there are other important variables that were not considered in this study, such as: (i) belt speed, (ii) ergonomics of the cooperative members, (iii) sequential positioning of the cooperative members on the belt, and (iv) standardization of which type of material each cooperative member separates.

## V. CONCLUSION AND FUTURE RESEARCH

This study is premise on the fact that the mass of collected dry and recycled materials in Brazil is very low (it represents approximately 2.1% of the total mass of recyclable materials - National Sanitation Information System, 2016). On the other hand, one of the alternatives to expand the reinsertion of these materials in the production chain is through the sorting and commercialization of these products as raw material for the industries. Recycling is a viable alternative to minimize the impacts of municipal solid waste on the environment. In this way, preventing waste from being sent to landfills, or even to unsuitable facilities such as dumps and controlled landfills, necessarily requires greater process sorting capacity in cooperatives. The increase of capacity, and consequently the search for greater productivity (less waste), in the main operation of the process of sorting of recyclable materials, is fundamentally important for the economic survival of cooperatives as well as the improvement of the quality of life of cooperatives.

Paschoalin Filho, Ghermandi, Dias, da Luz, & Cortese (2021) concluded that the low production of materials sorted for recycling is related to public management efforts to promote more active participation of citizens and greater efficiency of collection companies. In their internal production operations, waste pickers' cooperatives have limited productivity due to the lack of technological infrastructures (facilities, equipment and adequate process) and also due to poor working conditions (de Souza, Camarotto, & Fontes, 2019). Also Miranda, Fidelis, Fidelis, Pilatti & Picinin (2020) analyzed the integration of recycling cooperatives in the formal management of urban solid waste as a possibility of increasing productivity with a circular economy structure, overcoming: (i) the technological difficulties of the production resources, (ii)



the lack of technical skills of the cooperative members, (iii) the difficulties of marketing the products, (iv) the lack of attractiveness for corporate investment in raw materials, and others. In none of these papers, the researchers concentrated their studies on evaluating productivity in the operations of the process of sorting recyclable materials in the cooperatives of waste pickers. In this context, this article intended to fill this gap and revealed an opportunity to increase productivity in the sorting operation of cooperatives and the need to expand research in this field.

The study showed that in the main value adding activity (screening conveyor) there is a percentage of waste in the screening operation of 50%, which if reduced becomes a greater result of production and productivity. These identified wastes are largely concentrated in the lack of materials on the conveyor (32%), which can be shortened by operation improvement actions such as standardization of operations involving the screening and training of cooperators.

It is important to ratify that the increase in performance of the screening operation in the belt is one of the fundamental points for the sustainability, over time, of the cooperative as a business system, as well as for the improvement of the quality of life of its cooperators.

The adopted methodology used a quantitative approach that obtained data from timings and observations at the operations site (triage screen). Data collection was performed based on free and systematic observations, photographic records and filming. The work performed in this paper is classified as applied research (knowledge with practical application), with descriptive analysis of the results. The case study of this paper is limited to the operations of selecting recyclable materials on the sorting mat.

The case study presented in this article is a signal for researchers that there is a need to deepen the knowledge regarding the productivity of waste pickers' cooperatives, taking into account the importance of these organizations for the preservation of the urban environment.

It is suggested that new researches include other cooperatives in their studies. It is also necessary to investigate the development of technical training programs for members and cooperatives that involve public authorities, educational institutions and business associations. Also, knowledge projects to enable processes with more advanced technologies of production and management operations should be considered. Although waste pickers' cooperatives are a simple and humble environment, the potential for generating new scientific studies is quite evident, with the aim of enabling these

organizations for greater productivity and better representation of their social, economic and environmental importance within the solid waste recycling chain.

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# Health Literacy and Relation to Adherence to Pharmacologic Treatment of Patients in Hemodialysis

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**Keywords**— *Health Literacy, Renal Dialysis, Medication adherence.*

**Abstract**— *Objective: to analyze the relationship between health literacy and adherence to treatment of dialysis patients. Method: cross-sectional study with 424 end-stage renal disease patients on conventional HD in the West and Middle West of Santa Catarina. The SALPHA questionnaire was used to analyze health literacy and the Brief Medication Questionnaire was used for treatment adherence. Minimental was used to analyze cognition. Results: the mean age was 57.3±15.8 years, 53.3% men, 71.4% with low education level, 10.1% have had a kidney transplant, 5.0% reported having already taken an extra dose of medication, 4.0% said they had missed doses and 22.6% admitted failure of days or prescribed doses. Literacy was inadequate for 67%, 49.1% were considered to have cognitive impairment, 55.2% are adhered to treatment. Low adherence to treatment was related to inadequate literacy ( $p<0.01$ ), literacy and cognition showed a positive correlation ( $r=0.5$ ;  $p<0.00$ ), those who reported taking extra dose of the medication were less adherent ( $p<0.03$ ), as well as those who omitted medication at some point ( $p<0.02$ ). Conclusion: Inadequate literacy was related to low adherence to treatment, and also to cognitive deficit, low education, smoking and old age.*

## I. INTRODUCTION

Patients with Chronic Kidney Disease (CKD) on hemodialysis need to face a complex treatment, which involves changes in lifestyle, dietary adjustments, use of continuous medication and attendance at dialysis sessions<sup>1</sup>. For the treatment to be successful, it is essential that the patient understands the information passed on by the multidisciplinary team and has adequate adherence to the treatment<sup>2</sup>.

To have sufficient understanding of the disease and treatment, it is desirable that the patient has an adequate level of health literacy (HL), which refers to the individual's cognitive and social capacity to obtain, understand and use basic health information for a proper decision-making about your own health<sup>3</sup>.

HL is defined by the World Health Organization (WHO) as a social determinant of health<sup>4</sup> and its relevance concerns the possibility of the patient to identify risks to their health, their family and community and have the

necessary knowledge to seek help from a professional, as well as assimilate the prescribed care and apply them in their daily lives<sup>5</sup>.

As well as literacy, adherence to medication treatment is also fundamental for the success of therapy, and the high number of daily medications favors non-adherence<sup>6</sup>, which contributes to the increase in mortality associated with the disease. Treatment adherence is directly related to the parameters of disease control and care, more specifically in relation to organizational access and bonding indicators<sup>7</sup>.

## II. METHODS

Cross-sectional study, carried out with hemodialysis patients in clinics in the Midwest, West and Far West of Santa Catarina, which currently serve 481 hemodialysis patients. Inclusion criteria were being on dialysis treatment for at least one month, age over 18

years. Those who were not on dialysis on the day of data collection were excluded.

During the hemodialysis session, participants responded to four instruments. The Brief Medication Questionnaire (BMQ) for analyzing adherence to medication treatment; the Mini Mental State Examination (MMSE) for cognitive screening; the Short Assessment of Health Literacy for Portuguese-speaking Adults (SAHLPA) to analyze health literacy and a questionnaire to collect socio-demographic and health status data.

Data were analyzed using the SPSS program, using the Shapiro Wilk normality test. The association of categorical data was performed using the chi square and numerical data using the Student t test. When non-parametric data were used, Mann Whitney of independent samples was used. Pearson was used for correlation analysis and 95% confidence was adopted.

This study was approved by the Ethics and Research Committee of the Universidade do Oeste de Santa Catarina, under opinion n°. 3,600,784 and respected all ethical precepts in research, according to CNS 466/12. All participants signed the Informed Consent Form.

### III. RESULTS

A total of 424 patients participated in the study (88.1% of the total people on hemodialysis considering the three regions), 39 were excluded for not attending dialysis on the day of data collection, whether due to travel, hospitalization or absence without justification. The mean age was  $57.3 \pm 15.8$  years. Dialysis time had a median of 26 months (interquartile range 11-60), mean of 44.06 months, minimum one month and maximum 288 months.

Table 1 shows the profile of the interviewees, their self-reported health habits, medication profile and treatment adherence.

Table 1: Socio-demographic and clinical profile of patients on hemodialysis. N=424

Variables	N	%
Male	226	53,0
Female	198	47,0
Married	327	77,0
Education $\leq$ 8 years	303	71,0
Have had a kidney transplant	43	10,1
Healthy diet (self referred)	214	50,5
Take care of the amount of water ingested (self-reported)	349	82,3
Take care of the amount of salt ingested (self-reported)	390	92,0
Smoker	29	6,8
Multiple Prescription Medications	345	81,4
Took an extra dose of the medication (at least once)	21	5,0
Already omitted doses of medication prescribed	17	4,0
Admitted failure of days or prescribed doses	96	22,6

Regarding adherence, 234 (55.2%) were considered adherent to the treatment and 190 (44.8%) non-adherent. Literacy was considered inadequate for 282 (66.5%) and adequate for 141 (33.3%). From the Minimental, 216 (50.9%) were considered without cognitive deficit, with a mean of MMSE  $23.2 \pm 6.1$  points.

Regarding literacy, the mean in the Salpha questionnaire was  $11.8 \pm 4.3$  points, 33% were considered as having adequate literacy and 67% inadequate. Salpha and MEEN values showed a positive correlation ( $r=0.5$ ;  $p<0.00$ ). Table 2 shows the relationship between literacy and the characteristics of patients on hemodialysis.



Table 2: Relationship of health literacy with characteristics of patients on hemodialysis.

Variables	Health Literacy		p
	Adequated n (%)	Inadequated n (%)	
Adherent to treatment	112 (79,4)	121 (42,9)	<0,00*
Non-adherent to treatment	29 (20,6)	161 (57,1)	
Cognition with deficit	35 (24,8)	172 (60,1)	<0,00*
Cognition without deficit	106 (75,2)	110 (39,9)	
Men	67 (47,5)	158 (56,0)	0,16*
Women	74 (52,5)	124 (44,0)	
Smoker or ex-smoker	32 (22,7)	115 (40,8)	<0,00*
Never smoked	109 (77,3)	167 (59,2)	
Have had a kidney transplant	23 (16,3)	20 (7,1)	<0,01*
Never transplanted	118 (83,7)	262 (92,9)	
Married	102 (72,3)	226 (80,1)	<0,03*
Single	39 (21,7)	56 (19,9)	
Age (years) (mean±SD)	47,8±14,0	62,0±14,4	<0,00**
Dialysis time (months) [median(CI)]	24 (12-60)	29 (11-60)	0,59***
Minimental (points) [median (CI)]	29 (25-30)	22 (18-26)	<0,00***

\*chi square

\*\* T Test

\*\*\*Mann-Whitney

Those who reported taking an extra dose of medication were less adherent ( $p < 0.03$ ), as well as those who reported that they had already missed medication at some point ( $p < 0.02$ ). Other adherence characteristics in relation to hemodialysis patient characteristics are described in Table 3.

Table 3: Adherence to the treatment of patients on hemodialysis. N=424

Variables	Total n (%)	Adherents n (%)	Non-adherents n (%)	p*
<b>Sex</b>				
Male	226 (53,3)	119 (52,7)	107 (47,3)	0,26
Female	198 (46,7)	115 (58,0)	83 (42,0)	
<b>Age</b>				
> 61 years	207 (48,8)	76 (36,7)	131 (63,3)	0,00
< 60 years	217 (51,2)	158 (72,8)	59 (27,2)	
<b>Missed days of medication</b>				
Yes	96 (22,7)	36 (37,5)	60 (62,5)	0,00
No	328 (77,3)	198 (60,4)	130 (39,6)	
<b>Education</b>				
≤8 years	277 (65,3)	138 (49,8)	139 (50,2)	0,00

> 9 years	147 (34,7)	96 (65,3)	51 (34,7)	
<b>kidney transplant</b>				
Yes	43 (10,1)	33 (76,8)	10 (23,2)	0,00
No	381 (89,9)	201 (52,8)	180 (47,2)	
<b>Smoker or ex-smoker</b>				
Yes	148 (35)	66 (44,5)	82 (55,4)	0,00
No	276 (65)	168 (60,9)	108 (39,1)	
<b>Multiple daily doses</b>				
Yes	345 (81,3)	163 (47,2)	182 (52,7)	0,00
No	79 (18,6)	71 (89,8)	08 (10,1)	

\*chi square

The time on dialysis of those who adhered to the treatment was longer, but it was not statistically significant (time on dialysis adherents [median 27.0 months CI 24-35] and time on dialysis for non-adherents [median 24 months CI 23-36]  $p=0.35$ ).

Table 4 shows literacy and treatment adherence in relation to age, Salpha value and dialysis time.

Table 4: Literacy and treatment adherence in relation to age, Salpha value and dialysis time.

Variables	Age (years) (mean±SD)	Salpha (mean±SD)	Dialysis time (months)** (median[CI])
<b>Health Literacy</b>			
Adequated	47,9±14,1	16,0±1,3	24 [12-60]
Inadequated	62,0±14,5*	9,7±3,7*	29 [11-60]
<b>Treatment adherence</b>			
Adherents	51,6±14,8	13,2±3,7	27 [12-60]
Non-adherents	64,4±14,1*	10,1±4,3*	24 [10-60]

\* $p<0,00$  (T Test)

\*\*Mann-Whitney

#### IV. DISCUSSION

Health literacy was considered inadequate for most participants, which was also verified in other studies<sup>8,9</sup>. In the united kingdom, a survey with 6,842 patients with kidney disease also found inadequate HL<sup>11</sup>. This theme has brought challenges to health professionals due to the need for adjustments in health strategies for effective care<sup>11</sup>.

Analyzing adherence, in this study more than half of the interviewees were considered non-adherent, similar studies that evaluated patients undergoing hemodialysis also showed that most of them had low adherence to treatment<sup>12,13</sup>.

HL was positively correlated with treatment adherence, demonstrating that patients with low adherence also had low ls. In a literature review on the association of sl and adherence to drug treatment<sup>14</sup>, other studies showed a positive relationship between the association of sl and adherence to drug treatment, which is currently also being verified worldwide<sup>15,16,17</sup>.

Treatment adherence is a very complex situation and ckd has several impacts on the lives of individuals and their families, especially in the hemodialysis stage where the need for a transformation in the individual and family lifestyle occurs<sup>18,19</sup>.

It was evident that sl and treatment adherence were related to the presence of cognitive deficit and older

age. The relationship with age has already been verified in other studies, as years of education and duration of hemodialysis suggest that older people, with less education and longer duration of hemodialysis had more cognitive impairment<sup>20</sup>. Low educational level contributes to the individual having difficulty in understanding the disease and its clinical picture as complications and associated comorbidities<sup>15,21</sup>.

Marital status was also related to low HL and older age. The fact of having a partner was also found in other studies and was probably related to the factor of advanced age and because it represents a source of emotional support<sup>22</sup>. Family support was verified as a role of protection and socialization of its members, in addition to serving as support in coping with the difficulties arising from the chronic disease and its treatment<sup>23</sup>.

The therapeutic regimen and the amount of medication that patients use were not identified as a difficulty in non-adherence. In a literature review, they concluded that, although there is little evidence, treatment carried out in a structured manner can contribute to improving adherence to treatment of individuals on hemodialysis<sup>24</sup>.

Smokers or former smokers and those who have never had a transplant also had worse results in SL, it is noteworthy that inadequate SL can affect health, so that it reduces their self-management capacity for care<sup>25</sup>, in the same way that the lack of knowledge and skills related to health can be considered as a barrier to the adoption of healthy behaviors and in the prevention or management of acute and chronic diseases<sup>26</sup>.

In this research, the dialysis time of those who adhered to the treatment was longer, but it was not statistically significant. The aspects that motivate treatment adherence include living with the hemodialysis machine, performing laboratory tests, faith and the presence of social support, mitigation of complications and adverse events, requiring interaction between the team and the patient with the purpose of understanding the phenomena that lead to the failure of this process and in the development of educational strategies in order to make individuals aware of the importance of adherence to treatment and possible improvement in quality of life<sup>27</sup>.

The analysis of the HL of patients with CKD can be a tool for situational diagnosis and intervention in the way health professionals work in the management and care of hemodialysis patients, as well as knowing in detail the profile of patients and the difficulties encountered in the its treatment can contribute to the construction of actions that involve their adherence. It ratifies the importance of considering the family context as a

supportive source and, mainly, as a factor to be worked on, being necessary to include the family in the teachings and information of the treatment, as a determining factor for the success in the adherence to the treatment.

## V. CONCLUSION

Inadequate literacy was found in most of the study population and was correlated with low adherence to treatment, this relationship was accompanied by cognitive deficit, low education, smoking, high age and not having undergone a kidney transplant before.

The complexity of the factors involved in the treatment of chronic kidney disease patients, and the patients' difficulties in adapting to imposed health habits, must be known to support the planning of actions, highlighting the need for a multidisciplinary approach and the importance of education in health, not in a simplified and isolated way, but with different analyzes and approaches.

Understanding and accepting the importance of dialysis treatment is fundamental, and should enable patients to have their autonomy and active participation in the quest to overcome difficulties.

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# Gait based Age Estimation using LeNet-50 inspired Gait-Net

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**Keywords**— *Gait, Gait Energy Image, Age Estimation, Gender Estimation, Convolutional Neural Network.*

**Abstract**— *Gait is a behavioural biometric that does not require the subject's collaboration as it can be captured at a distance. The Gait-based age estimation has extensive applications in surveillance, customer age estimation in shopping centres and malls for business intelligence purposes and age-constrained access control to places like liquor shops, etc. In this paper, we propose Gait-Net, a LeNet-50 inspired age classification Convolutional Neural Network (CNN) for Gait-based age estimation. We propose the application of a heat map filter on each Gait Energy Image (GEI), for the enhancement of age differentiating features in the GEI, subsequently followed by the sequential age group and age estimation CNN models. We addressed the inherent class imbalance problem induced by the non-availability of sufficient data for the elderly subjects, by using the image augmentation technique. We evaluated our model on the OU-ISIR Large Population Gait Database and the results confirmed its efficiency.*

## I. INTRODUCTION

Gait-based biometric identification has been extensively studied in the recent years for its comparative viability in certain environments over the physiological biometrics like fingerprints, facial recognition, iris recognition, etc [1-5]. A Gait capturing setup can achieve its task even with a non-cooperative distant subject and a low-resolution camera setup. In addition to the individual identification, lately, numerous studies have extensively explored the Gait-based evaluation of attributes like gender, age group, ethnicity, age, etc [6-8]. While the age estimation has been the primary focus for relatively more applications in visual surveillance, access control, forensics and criminal investigation.

Earlier studies focussed on establishing a relationship between the Gait attributes like arm swing, leg stride, stride frequency, etc. and age of the subject. Davis [9] established a relationship between age and Gait attributes to differentiate between adult and child subjects. Abreu et al. [10] in part established the possibility of gait-based age

estimation using gait analysis. They produced and the used the representations of cyclic movements of limbs called the cyclo-grams as the input to the feature extraction phase. They were successful in creating a model that differentiated between a young and an elderly subject but couldn't differentiate between the two genders. Ince et al. [11] studied the shape of the body as age determining construct by differentiating a child and an adult from their head to body proportion. Callisaya et al. [7] discovered that the gender of a person alters the relationship between the age of the person and their gait as they found a substantial relationship between gender and various Gait attributes.

In conventional image processing or computer vision-based Gait-based age estimation models, a Gait descriptor serves as an input. The common Gait descriptors used in the literature are: Gait Image Contour, Gait Image Silhouette, and Gait Energy Image (GEI) as shown in figure 1. The better feature representation ability and effectiveness of the GEI qualifies it for the most widely used feature descriptor. It is a combined representation of

multiple Gait sequences superimposed on top of each other. The GEI captures both static features like shape of the body

as well as the dynamic features like the arm swing more comprehensively.



Fig 1. Gait Image Contour, Gait Image Silhouette, and Gait Energy Image.

In this paper we put forth Gait-based age estimation using LeNet-50 inspired Convolutional Neural Network. The depth of a deep learning model trained on a GEI based Gait image dataset is restricted by the intrinsic deficiency of features in the GEI, exceeding a certain number of layers in

the CNN results in overfitting. To overcome this shortcoming, we propose a heatmap filtering of the GEIs for the feature enhancement purpose as shown in figure 2. The heatmap representation allows us to train a deeper CNN over the data set without overfitting the training set.

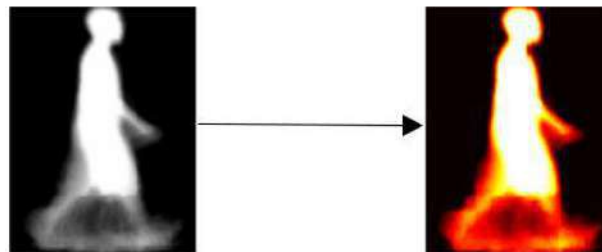


Fig 2. GEI and Heatmap.

The proposed LeNet-50 enthused CNN overcomes the problem of getting stuck in the local minima near the global minima as faced by a conventional CNN that is trained with a uniform learning rate. By ensuring an iterative decrease in the learning rate near the global minima facilitates its convergence at the global minima. A common shortcoming possessed by all the preceding studies has been the low prediction accuracy for the elder and child subjects, the bias which is induced by the scarcity of data for those age groups. To overcome this limitation, we used image augmentation technique to reduce the class imbalance problem in the dataset, thus improving age prediction accuracy for those particular age groups. The performance evaluation of our model was conducted on OU-ISIR Large Population Gait Database [12], which is the largest Gait database with age developed till date, comprising of 63,748 images of subjects aging between 2 and 90 years.

The contributions of this paper are: (1) A LeNet50 inspired sequential algorithm for gender and sequential age prediction and (2) An age estimation model with improved age group prediction accuracy for children and elders.

## II. RELATED WORK

The earlier studies in based upon computer vision would mostly require a manual extraction of features from the gait descriptor. Zhang et al. [13] proposed a Hidden Markov Model based age group classification model. In the feature extraction phase, they generated a Frame to Exemplar distance vector which contained the distances from multiple contour points to the centroid of the contour. They achieved an accuracy of 83.33% in bi-class classification of young and old subjects over a self-developed 14 subject dataset. Mansouri Nabila et al. [14] proposed a novel Gait descriptor which captured both Spatiotemporal Transverse and Spatiotemporal Longitudinal projections of the gait descriptor which was a silhouette in this case. They employed the Support Vector Machine (SVM) over the 4000 subject OU-ISIR database reaching up to a precision of about 74%. Xiang Li et al. [15] performed an age-group classification of the subjects. They used a directed acyclic graph (DAG) for the age group representation and an SVM using a Gaussian kernel to do the classification task. They achieved an average age group classification accuracy of 72.23% and an age estimation Mean Absolute Error (MAE) of 6.78 years over the OULP-Age Dataset comprising of

63846 subjects which included around same number of male and female subjects of varying ages between 2 and 90 years.

Jiwen Lu et al. [16] used a fusion technique for the Gabor feature set like the gait sequence phase and the Gabor magnitude for the purpose of feature enhancement. They used the USF gait database for the model evaluation and achieved a Mean Error Average of 5.42 years. Makihara et al. [17] in one of the first studies to use the Gait Energy Image descriptor used the Gaussian Regression technique to predict the age. For the model training and evaluation, they used a self-created gait database with 1728 subjects of varying ages between 2 and above 90 years. The best MAE they could reach up to was 8.2 years.

M. Hu et al. [18] presented the intensification of mutual information technique using the Gabor filter for feature extraction and Bayes Rule based on Hidden Markov Model (HMM) for the classification. It performed both gender as well as age classification (young and old). The gender classification results were evaluated over the CASIA(B) dataset and IRIP dataset and the age classification on the database used by Zhang et al. [13]. A fresh study by A Sakata et al. [19] put forth a deep learning-based model which employed multiple Convolutional Neural Networks sequentially in the age estimation process. The GEI would firstly go through a Convolutional Neural Network which predicts its gender and sequentially passes through other two CNNs predicting the Age Group and age (achieving an

MEA of 5.84 years). T. Islam et al. [23] presented a comprehensive analysis of the related studies in this area which apparently turn out to be not many. They compared various gait-based age estimation techniques based on various evaluation metrics. They found that the Deep Learning based studies had achieved best results.

The efficiency of Deep Learning based techniques motivated us to drive our research in the specific direction.

### III. PROPOSED METHOD

We propose separate models for age and gender estimation as depicted in the flowcharts in Figure 3 and 4. In the gender estimation process, a heatmap filter is applied on the GEI, which is subsequently fed into the CNN which predicts the binary gender label. A sequential CNN setup first predicts the age group -Toddler (2-5), Child (6-11), Adolescent (12-18), Adult (19-60), Old (61-90) and subsequently the age classification CNN predicts the age of the subject.



Fig 3. Gender Classification Model.

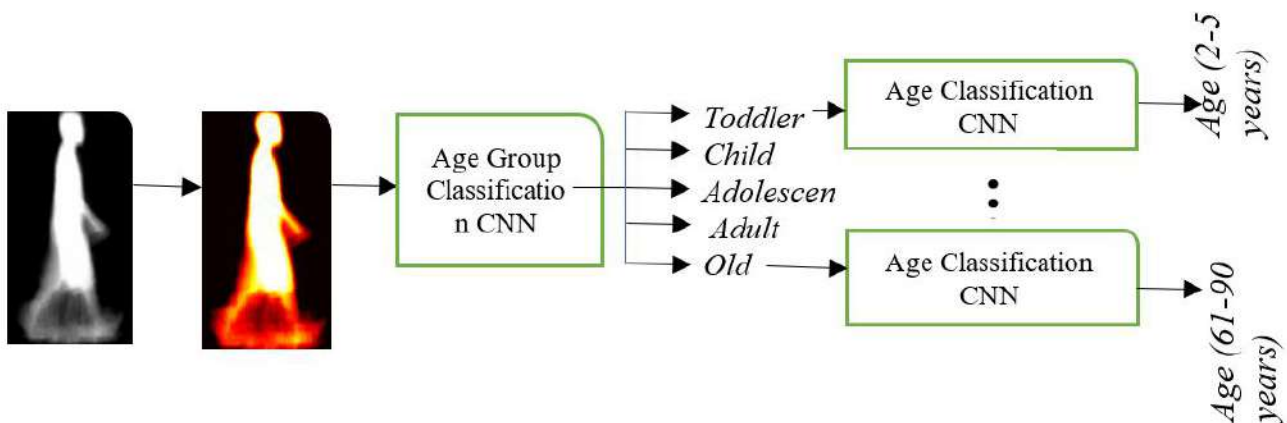


Fig 4. Sequential Age Estimation Model.

#### 3.1. Model Architecture

The proposed CNN architecture is depicted in figure 5. The input GEI of 128x88 pixels, is converted into an heatmap of 128x88 size. The proposed model includes of two pairs of consecutive convolution and max-pooling layers with a

dropout probability of 0.5. The first pair has 81 filters of (5,5) and (3,3) max-pool filters and the second pair comprising of 45 filters of (7,7) and (3,3) max-pool filters. A dropout with probability 0.3 is applied beforehand the flattening operation. We used three fully connected layers with 1024, 256 and 32 nodes with a dropout rate of 0.3.

Finally, last layer being the recognition layer has two nodes in the gender classification model and for each age group

model equal to the number of distinct age values in the respective age group.

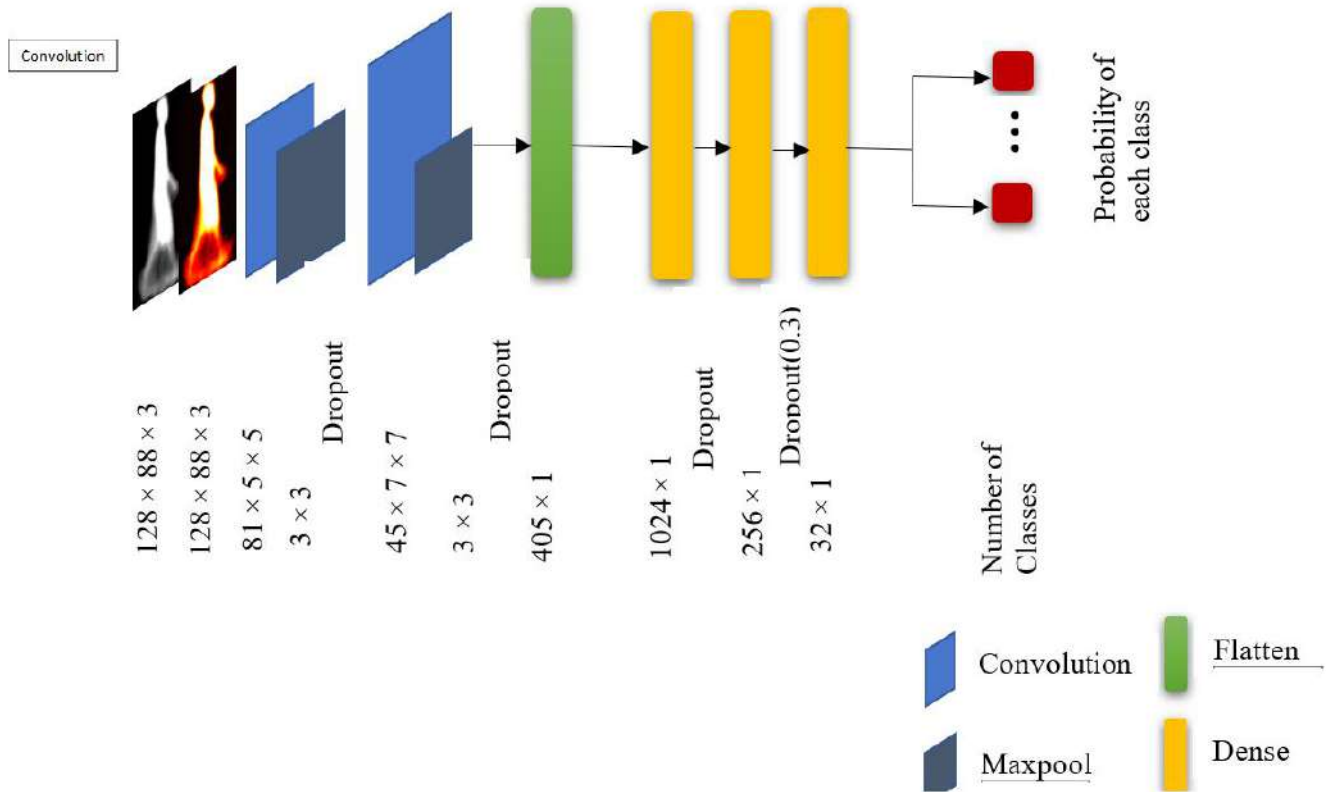


Fig 5. Gait-Net Architecture.

Table 1. Model Architecture.

Operation Layer	Number of Filters	Size
Input Heat Map	-	$128 \times 88 \times 3$
Filtered Image		
Conv2D	81	$5 \times 5$
MaxPooling 2D	81	$3 \times 3$
Dropout	-	-
Conv2D	45	$7 \times 7$
MaxPooling 2D	45	$3 \times 3$
Dropout	-	-
Flatten	-	$405 \times 1$
Dense	-	$1024 \times 1$
Dense	-	$256 \times 1$
Dense	-	$32 \times 1$
Output Layer	-	Number of classes

The dense layers are initialized with the *he\_normal* [20] as kernel\_initializer and bias initialized to zeros. The *relu* [21] activation function is used in the three dense layers and *sigmoid* for the recognition layer. The architecture and

hyperparameter selection were done through a rigorous training and testing of multiple architecture – hyperparameters combinations and to arrive at the combination with best evaluation metrics results.



3.2. Model Training

We propose a two-phase training setup for the CNN. In the initial phase the model is compiled using the *Adam* optimizer with the default learning rate of 0.01 and *categorical\_crossentropy* as the loss function in the first phase. It is trained for twenty epochs on the training set with a batch size of 32. The model checkpointing on *val\_accuracy* ensures that only the model with best validation accuracy is saved. In the second phase the saved model is further trained in multiple subphases with iterative decreasing learning rate. The subsequent sub phases contain three epochs each and the learning rates iteratively decreasing by a factor of  $10^{-3}$ , 0.8, 0.2, 0.08 respectively.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

4.1. Dataset

The model was evaluated on the OU-ISIR Gait Database, Large Population Dataset with Age (*OULP-Age*), which is the largest Gait database developed till date. The OU-ISIR biometric database is a repository of various Gait databases like the Large Population Dataset with Age, Population Dataset with Bag, Inertial Sensor Dataset, etc. They were developed by capturing the side view video of Gait sequence of each subject followed by a three step GEI extraction: segmentation, normalization and averaging. The Large Population Dataset with Age is a collection of 63846 GEI images of both male and female with ages between 2 and 90 years.

Table 2. Gender wise breakup.

Male	Female
31,093	32,753

Table 3. Age Group wise breakup.

Age Group	No. of Subjects
Toddler	1573
Child	9654
Adolescent	8724
Adult	42110
Old	1784

Table 4. Gender wise Train-Test split.

	Train	Test
Male	7829	7767
Female	8132	8195

Table 2 gives the gender wise breakup of the database. The training set – test set split is done at 50% (15961 and 15962 subjects respectively). The split remains the same for all the three classifications processes.

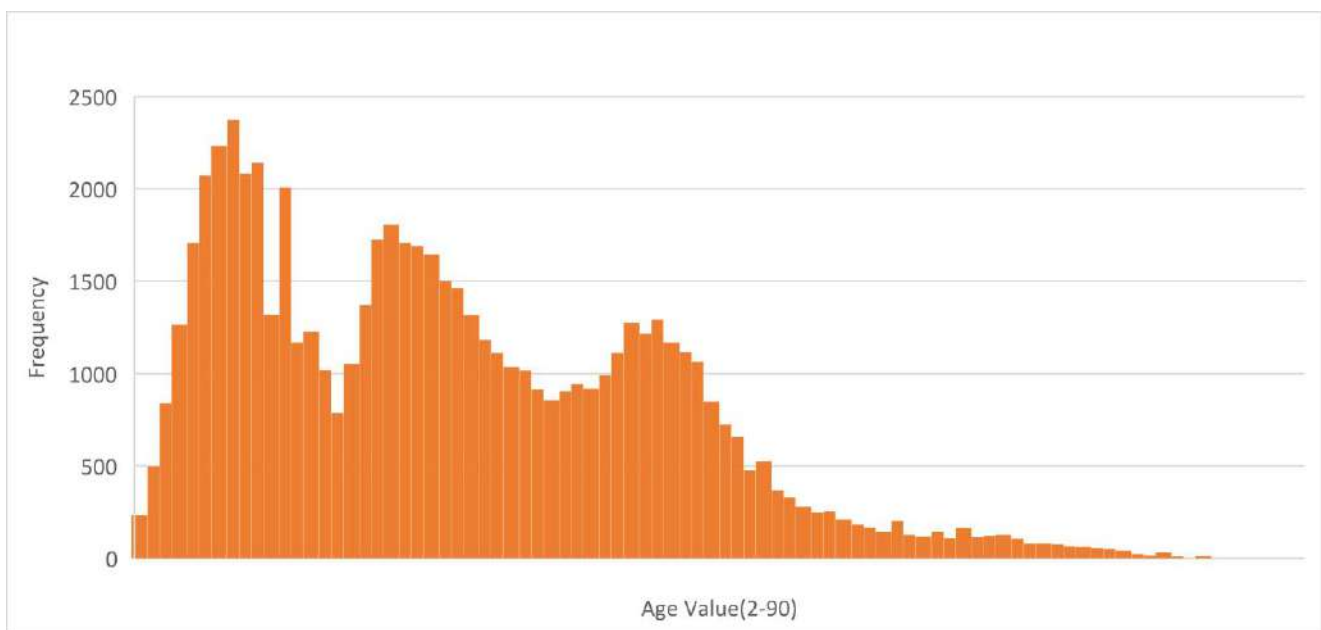


Fig 6. Frequency distribution of distinct age values.

4.2. Performance Evaluation

Since the gender estimation is a bi class classification problem thus, we require a simple evaluation metric like the accuracy, which is given by

$$Accuracy = \frac{NC}{N} \times 100\% \tag{1}$$

where Nc represents the total number of samples that were accurately classified by the model and N gives the total sample size. In age estimation problem (a regression problem), the frequently used performance evaluation metrics are the Mean Absolute Error (MEA) and Standard Deviation (SD) which are given by the following equations:

$$MEA = \frac{1}{N} \sum_{x=1}^n |t_x - p_x| \tag{2}$$

Where N is the total sample size of the test set, t<sub>x</sub> and p<sub>x</sub> are the actual and predicted values of age for the x<sup>th</sup> sample.

The following formula is used to compute the standard deviation:

$$SD = \sqrt{\frac{1}{N-1} \sum_{x=1}^N (|t_x - p_x| - MEA)^2} \tag{3}$$

4.3. CNN without heatmap filtered GEI

[19] used a CNN model with the following architecture: Conv1(81,5,5) – 81 filters of size 5×5, Pool1(3,3), Conv2(45,7,7), Pool2(2,2), fc3(1024) and fc4(1). The model was trained for 20 epochs with model checkpointing over val\_accuracy on the GEI training set for the gender estimation. A batch size of 128 and Adam optimizer with default learning rate of 0.001 were used. The model achieved the classification accuracy of 98.28 % over the training set and 96.03% over the test set. The classification

results over the training set and test set are described in table 5 and 6.

Table 6. Gender prediction results on test set.

		Predicted Label		
		Male	Female	
True Label	Male	15701	672	16373
	Female	294	15159	15453
		16095	15831	Total

Table 5. Gender prediction results on training set

		Predicted Label		
		Male	Female	
True Label	Male	16174	152	16326
	Female	394	15202	15596
		16565	15354	Total

The same CNN architecture when employed for age group estimation yielded the following classification results as shown in Table 7 and 8.

4.4. GaitNet with heatmap filtered GEI:

We improved the gender and age group classification accuracy of the conventional single dense layer CNN with our proposed GaitNet. The training set and test set gender classification accuracy reached up to 99.03% and 96.96% respectively. Table 9 and 10 depict the gender classification results of GaitNet with heatmap filtered GEI over training and test set respectively. Table 11 and 12 present the confusion matrix for age group prediction over the training set and test set respectively.

Table 7. Age group prediction results on training set.

		Predicted Label					
		Toddler	Child	Adolescent	Adult	Old	
True Label	Toddler	692	137	0	0	0	829
	Child	157	4173	305	130	2	4740
	Adolescent	0	623	2569	1171	10	4373
	Adult	2	74	647	20291	130	21144
	Old	0	14	32	455	336	837
		851	4884	3553	22047	478	Total

Table 8. Age group prediction results on test set.

		Predicted Label					
		Toddler	Child	Adolescent	Adult	Old	
True Label	Toddler	527	215	1	1	0	744
	Child	238	4140	388	147	1	4913
	Adolescent	5	758	2266	1310	12	4350
	Adult	5	103	819	19872	168	20966
	Old	0	35	51	574	287	947
		775	5251	3525	21904	468	Total

Table 9. Gender prediction results on training set.

		Predicted Label		
		Male	Female	
True Label	Male	16101	225	16326
	Female	84	15512	15596
		16185	15737	Total

Table 10. Gender prediction results on test set.

		Predicted Label		
		Male	Female	
True Label	Male	15877	496	16373
	Female	767	14686	15453
		16644	15182	Total

Table 11. Age group prediction results on training set.

		Predicted Label					
		Toddler	Child	Adolescent	Adult	Old	
True Label	Toddler	619	210	0	0	0	829
	Child	57	4137	525	18	3	4740
	Adolescent	0	280	3359	718	16	4373
	Adult	1	34	845	20206	58	21144
	Old	0	2	23	500	312	837
		677	4663	4752	21442	389	Total

Table 12. Age group prediction results on test set.

		Predicted Label					
		Toddler	Child	Adolescent	Adult	Old	
True Label	Toddler	469	275	0	0	0	744
	Child	131	3939	748	85	10	4913
	Adolescent	2	469	2871	990	19	4350
	Adult	0	66	1122	19700	78	20966
	Old	0	8	52	629	258	947
		602	4757	4793	21404	365	Total

#### 4.5. GaitNet with image augmentation:

The inherent class imbalance problem in the OULP dataset induces lower classification accuracy for toddler, child and old age groups. We used image augmentation technique over these two age groups to alleviate the problem. To increase the number of subjects in the scarce age groups we cloned the GEI's in the training set of toddler, child and old age groups. We employed the *width\_shift* and *height\_shift*

transformations on the enlarged dataset. The size of the augmented dataset increased up to 76,667 subjects. We can use the adding of lower levels of curated noise for data augmentation such that the new images generated could preserve the discriminating features and at the same time generate new subjects. Table 13 shows the classification results of GaitNet trained over the augmented training set and table 14 describes the test set classification results.

Table 13. Age group prediction results on training set.

		Predicted Label					
		Toddler	Child	Adolescent	Adult	Old	
True Label	Toddler	829	0	0	0	0	829
	Child	17	4608	114	1	0	4740
	Adolescent	0	33	4276	63	1	4373
	Adult	0	9	847	20134	1	20991
	Old	0	0	0	0	837	837
		846	4650	5237	20198	839	Total

Table 14. Age group prediction results on test set.

		Predicted Label					
		Toddler	Child	Adolescent	Adult	Old	
True Label	Toddler	546	198	0	0	0	744
	Child	294	3812	724	70	13	4913
	Adolescent	3	622	2934	760	32	4351
	Adult	3	65	1801	18593	504	20966
	Old	0	8	44	409	486	947
		846	4705	5503	19927	1035	Total



#### 4.6. GaitNet with heatmap filtered GEI:

We improved the gender and age group classification accuracy of the conventional single dense layer CNN with our proposed GaitNet. The training set and test set gender classification accuracy reached up to 99.03% and 96.96% respectively. Table 9 and 10 depict the gender classification results of GaitNet with heatmap filtered GEI over training and test set respectively. Table 11 and 12 present the confusion matrix for age group prediction over the training set and test set respectively.

Although, the effect of gender on the age estimation has been established by various studies in the past and this fact was utilized by previous studies. The improvement in the age estimation results by the sequential models concretes this fact. Using a gender separated sequential model using our model yields detrimental results. These results are ensured by decrease in the training data as gender separation divides the dataset into two subsets of approximately half

the size of the mixed gender dataset. Thus, training a deeper CNN on lesser data ended up overfitting the result thereby degrading the test set results.

#### 4.7. Age estimation results using the GaitNet:

The GaitNet employs a sequential process for the age estimation. First the age group of the subject is predicted followed by age estimation using a sequential CNN trained over the predicted age group. Instead of addressing the age estimation problem as a regression problem we considered it as a classification problem. So, the number of nodes in the final layer of GaitNet are equal to the number of distinct age values in the respective age group, e.g., the CNN for age prediction for toddler age group has 4 nodes as it has age values 2-5 years. Table 14 gives the comparative description of our method with the existing methods in the literature using the MEA and SD evaluation metrics. Figure 7 plots the true age values against the predicted values.

Table 15. Comparison of our GaitNet with previous method on the basis of MEA and SD.

Method	MEA(Years)	SD(Years)
Parallel multi-CNN	5.84	6.5
Sequential multi-CNN [19 ]	6.23	6.61
Makihara et al. [ 17 ]	7.30	6.64
Guo et al. [ 22]	7.66	7.10
GaitNet (Ours)	5.08	4.29

## V. CONCLUSION AND FUTURE SCOPE

In this paper we proposed GaitNet to improve the Gait-based age estimation accuracy and it outperformed all other existing Gait-based age estimation models. The heatmap filter assisted in making it possible to train a deeper CNN by increasing the number of distinguishing features in the GEI. The image augmentation technique alleviated the implications of data scarcity of elder and child subjects. Though we addressed most of the shortcomings of the existing models but some still continue to prevail like the sequential nature of the age prediction process connotes that wrong age group prediction for a subject would subsequently degrade its age prediction.

In future the work can be extended by further feature enhancement of the GEI Gait descriptor eventually making employing a deeper CNN a possibility. The development of OULP Gait database by addition of more subjects in the elder and children age group would further enhance the age group prediction accuracy ultimately improving the age estimation accuracy.

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## Performance of Rural Credit in the Municipalities of Rondônia, Brazilian Amazon

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**Keywords— Investment, Rural Credit, Municipalities, Rondônia.**

**Abstract—** *In this work, objective issues stand out, such as the survey of the number of contracts granted for the agricultural activity in the years 2000 and 2010, classified as "costing" and "investment", and the survey of the volume of financial resources released for agricultural activity in 2000 and 2010, classified as "costing" and "investment" for the municipalities in the micro-region of Vilhena. Based on the institutional incentive of the Brazilian rural development policy (rural credit), granted to the agricultural sector, through financial availability, it was defined as a general objective to analyze the situation of the municipalities in the microregion of Vilhena, State of Rondônia, in order to identify the possible livestock development process. This is an applied, descriptive, cross-sectional research with a quantitative approach. Based on the data analyzed and based on the concept that the cost is linked to the maintenance of what already exists and the investment is expansion, it can be said that there were, in general, investments aimed at strengthening the livestock activity in the microregion, proving the hypothesis of the development of livestock in the*

## I. INTRODUCTION

At the beginning of the creation of the state of Rondônia, rural credit played an important role in the conduct of agricultural policy as an instrument for regional development and, based on it, discussions on the issue of socio-environmental problems, mainly related to the deforestation of native areas, also emerged. and conflicts with indigenous peoples. Based on the colonization policy, the Brazilian State instituted incentive mechanisms, based on land tenure regularization, aiming at promoting economic growth and improving the quality of life, in general. Almost half a century after the beginning of the colonization process, Rondônia still seems to experience the effects of the 1970s policy, configuring itself today as one of the leading states in the production of cattle raising. However, it remains to be seen whether it is possible to analyze, based on the federal government's credit policy, with information and data from the statistical yearbook of rural credit, prepared by the Brazilian Central Bank, if this reality was institutionally stimulated by the State, which could indicate a incentive strategy for the sector in this microregion under the auspices of the federal government.

This work is part of a study program on "livestock raising in Rondônia", linked to the Group of Studies and Research in Social and Environmental Sciences and Public Policies – GEPCAP, under the coordination of Professor Dr. Fábio Robson Casara Cavalcante. To analyze the scenario in Rondônia, data were collected for all municipalities in the state, which were grouped by micro-regional geographic classification.

The results brought in this study are linked to the reality of the microregion of Vilhena, belonging to the Eastern Rondoniense mesoregion. The theme of rural credit was born from the need to analyze the regional scenario in Rondônia in relation to the policy carried out by the federal government to encourage the Brazilian agricultural sector through rural credit. The choice of the theme was materialized by the historical characteristic of Rondônia, mainly during the period of agricultural colonization of its territory, where the issue of rural credit was always present. Thus, based on the colonization policy, the State instituted incentive mechanisms based on land tenure regularization, which required proof of "improvements" on the properties for the purpose of issuing definitive land ownership titles. The Institute for Colonization and Agrarian Reform (INCRA), in this context, was the federal agency responsible for land policy in Rondônia. As a result, access to rural credit was only possible upon proof of the 'improvements' required by INCRA which, after

being guaranteed, made financial resources accessible to rural producers.

The result of this policy in Rondônia was the rapid economic growth of the region, based on agricultural activities, which showed growth rates from that moment on. However, from the socio-environmental point of view, questions about the credit policy also grew based on the basic criteria of analysis by the federal government based on the proof of "improvements".

The problem is that such "improvements" were synonymous with deforestation in the area. And in view of this reality, what can be observed, in general, is that, directly or indirectly, the economic growth of Rondônia, during the period of agricultural colonization, resulted from an accelerated process of regional deforestation, a factor with great national and international repercussions. In this work, objective issues stand out, such as the survey of the number of contracts granted for the agricultural activity in the years 2000 and 2010, classified as "costing" and "investment", and the survey of the volume of financial resources released for agricultural activity in 2000 and 2010, classified as "costing" and "investment" for the municipalities in the micro-region of Vilhena.

Given the above, behold, the epistemological problem of this research arises. Using a spatial cutout, where a micro-regional analysis of Rondônia is glimpsed, can one speak of a process of "pecuarization" in the municipalities of the Vilhena micro-region promoted by the federal government, through the rural credit policy?

Based on the institutional incentive of the Brazilian rural development policy (rural credit), granted to the agricultural sector, through financial availability, it was defined as a general objective to analyze the situation of the municipalities in the microregion of Vilhena, State of Rondônia, in order to identify the possible livestock development process.

## II. METHODOLOGY

### 2.1 Type of Search

It is an applied, descriptive, cross-sectional research with a quantitative approach, since the objectives generate knowledge for practical application, which includes the number of contracts and the volume of financial resources for agriculture and livestock in the municipalities of the microregion of Vilhena, Rondônia, Brazilian Amazon, in a period corresponding to the years 2000 and 2010.



2.2 Data Collection

Data collection took place through reports from the rural credit statistical yearbook of the Central Bank of Brazil for the years 2000 and 2010.

2.3 Microregion Definition Criteria

For definition of microregion, the criterion of geographic microregions was used for statistical purposes of the Brazilian Institute of Geography and Statistics - IBGE [1].

2.4 Municipalities surveyed that make up the micro-region of Vilhena

The micro-region of Vilhena is made up of six municipalities: Chupinguaia, Parecis, Pimenta Bueno, Primavera de Rondônia, São Felipe D'Oeste and Vilhena.

III. RESULTS AND DISCUSSION

3.1 ANALYSIS BY MUNICIPALITIES

3.1.1 Analysis of the municipality of Chupinguaia

3.1.1.1 Number of contracts for agriculture and livestock

By analyzing the data in Table 1, an increase in the number of "costing" and "investment" contracts signed for the agricultural activity in the municipality of Chupinguaia is evidenced, between the periods analyzed, where in 2000 there were 9 contracts and, in 2010, this quantitative increased to 28, that is, an increase of more than 211.11%. When observing the reality of agriculture in the municipality, it was noticed that the most significant increase in this segment was for "investment", which represented 66.7% of contracts signed in 2000 and 71.4% of contracts signed in 2010, which may indicate a trend towards expansion of agriculture in the municipality of Chupinguaia.

In relation to the quantity of contracts for cattle raising in the municipality of Chupinguaia, there was a significant and high increase in the "costing + investment" modalities, reaching 3,030% between the years analyzed. As can be seen in Table 1, in 2000 only 10 contracts were signed, with the "costing" representing 60% of them, showing that the livestock activity was already part of the reality of the municipality of Chupinguaia, which started to maintain it, due to the "costing" data observed this year. The 2010 data show that the livestock activity was strongly stimulated, where the number of contracts signed in the "investment" modality represented 85.9% of the total contracts signed, which represented a jump in relation to the previous period under analysis. A growth of the order of 6.625% compared to 2000 and 2010. Therefore, it is inferred, with this, that there was a strong adhesion of rural producers to the

livestock activity in this municipality, since it was observed that the livestock activity continued to be promoted, when verifying the very sharp increase in the "investment" modality, which translates into expansion, that is, opening new areas.

Table 1 - Numbers of contracts for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	3 (33,3%)	8 (28,6%)	166,67
Investment	6 (66,7%)	20 (71,4%)	233,33
Costing + Investment	9	28	211,11
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	6 (60,0%)	44 (14,1%)	633,33
Investment	4 (40,0%)	269 (85,9%)	6.625
Costing + Investment	10	313	3.030

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

3.1.1.2 Volume of financial resources made available for agriculture and livestock

Table 2 illustrates the volume of resources destined to agriculture, by the rural credit policy, in the municipality of Chupinguaia. From the data, it is possible to observe that agriculture was strongly stimulated in 2000, when a percentage of 98.7% of the volume of resources for "investment" was observed, against 1.37% for "costing". In the following period of analysis, it was observed that, in 2010, the costing represented 63.2% of the volume of resources, which indicates that part of the agricultural activities implemented in 2000 started to be managed with the "costing" resources in 2010, even observing resources destined for "investment" in the last year analyzed. Thus, it can be deduced that there was a brief reduction in new investments, an event that cannot be characterized as a decline in agricultural activity in the municipality of Chupinguaia, as there was still a certain balance in the amounts allocated by the rural credit policy.

Table 2 shows that the resources allocated by the rural credit policy to livestock in the municipality of Chupinguaia represented a very significant increase in this activity segment, recording a 3.306% increase in total resources released (costing + investment) between the two years surveyed.

With regard to the “investment” segment, it was observed that in 2000 it reached 66% of the volume of resources from the federal government's rural credit operations and the “costing” 34%. This result strengthens the idea that such activity started in this period, as was observed in other municipalities in the same micro-region, where the “investment” surpassed the “costing”. When observing the year 2010, it can be seen that between the “costing” and “investment” modalities there was an inversion of values in relation to the previous year surveyed. Thus, in 2010, it was “costing” that prevailed, reaching 66% of the resources against 34% for “investment”. This result indicates a certain maintenance of livestock activity with greater “investment” in 2000, which allowed the expansion of said activity in the region, as explained above.

Table 2 - Volume of financial resources for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	7.749,66 (1,3%)	4.736.820,36 (63,2%)	61,02
Investment	601.899,45 (98,7%)	2.760.043,34 (36,8%)	358,55
Costing + Investment	609.649,11	7.496.863,70	1129
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	156.445,55 (34,0%)	10.345.490,82 (66,1%)	6.512
Investment	303.158,80 (66,0%)	5.310.921,43 (33,9%)	1.651
Costing + Investment	459.604,35	15.656.412,25	3.306

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

From the perspective of the volume of financial resources made available, it was found that in 2000 the volume of resources made available for agriculture was R\$ 609,649, which represented 57.02% of the total volume of resources released to the municipality in that year. For livestock, it was BRL 459,604.35, which represented 42.98% of the contracts. In 2010, R\$ 7,496,863.70 was released for agriculture. When analyzing the volume destined to livestock for the same year, that is, 2010, it was found that there was a significant increase in relation to the previous year, reaching R\$ 15,656,412.25, which corresponds to 67.6% in relation to agriculture.

Thus, it is evident that cattle raising also accounts for the highest percentage of destination of financial resources released, via rural credit, in the municipality of Chupinguaia. This aspect materializes the cattle raising in Chupinguaia arising from the federal government's rural development policy

### 3.1.2 Analysis of the municipality of Parecis

#### 3.1.2.1 Number of contracts for agriculture and livestock

When analyzing the data in Table 3, a strong reduction in the number of contracts signed for agriculture through rural credit is evidenced between the analyzed periods. When verifying the “costing” modality in 2000, it is deduced that the agricultural activity was operating in the municipality of Parecis, as it was responsible for 77.8% of the contracts for this segment, with a small percentage decline in the year of 2010, where 71.4% of the contracts signed were registered. It was not noticed a trend in the continuity of this culture because the "investment" for the years analyzed represented a small portion. In 2000, 8 contracts were signed, representing a percentage of 22.2% and in 2010 it fell to only 2 contracts, so when analyzing the years 2000 and 2010 together, it was noticed that the decrease in the “costing + investment” modalities totaled - 80.55% of the contracts carried out for this culture. It is noteworthy that the largest signature of the contract in the “funding” modality indicates that there is a historical process of coexistence with agricultural practices in the municipality, indicating, in principle, that agriculture is a reality present in the local scenario in the region. However, it is still not possible to verify whether this reality is in fact the consolidation of agriculture as the focus of credit policy in the region.

Based on Table 3, it can be seen that there was a very sharp increase in the number of contracts for "costing" and "investment" in 2010 compared to 2000, and the "investment" modality exceeded "costing" in both surveys. When verifying the 2000 data, it is clear that cattle ranching already showed a strong predominance for this activity, and for the first year analyzed in "costing" it was found that there were 42.9% of contracts made and for "investment" 51.1% of rural credits were obtained for livestock. In 2010, the "investment" was 73.8% (in relation to the cost) and in relation to "investment" for the two periods analyzed, it represented a growth of 1.062% in the number of contracts for this modality, indicating, with this, a new impetus to livestock activity encouraged by the federal government in 2010.

Table 3 - Numbers of contracts for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	28 (77,8%)	5 (71,4%)	-82,14
Investment	8 (22,2%)	2 (28,6%)	-75
Costing + Investment	36	7	-80,55
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	6 (42,9%)	33 (26,2%)	450
Investment	8 (57,1%)	93 (73,8%)	1.062,5
Costing + Investment	14	126	800

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

### 3.1.2.2 Volume of financial resources made available for agriculture and livestock

By analyzing the financial scenario through Table 4, it appears that in 2000 the volume of financial resources acquired through rural credit for this activity achieved a balance between the "costing" and "investment" modalities, with the "costing" surpassing with 56.4% "investment", inferring that agriculture was already part of the local scenario before the year under analysis in the municipality of Parecis. In 2010, the volume of resources for the "costing" modality had a strong increase, reaching 97.2% of the resources acquired and only 2.8% of the resources were destined for the "investment" modality. This scenario indicates that agriculture is stagnant in the region, where it is verified, through the rural credit policy, that the activity has not expanded, indicating that a large part of the resources released by the credit policy were for the maintenance of agriculture.

Table 4 shows the financial amounts applied to the livestock activity in the municipality, arising from rural credit. Observing the amounts injected in 2000 for the "costing and investment" modalities, it appears that, in a way, the cattle raising activity was already part of the local scenario before 2000, this because 58.2% of the resources were linked to "funding" in 2000. This percentage indicates that there were resources to maintain the activity that was already being practiced in the region. In 2010 there was an increase in livestock activity under the

stimulus of the federal government when it verified that the "investment" was 62.8% of the resources released in relation to the contracts signed that year.

Table 4 - Volume of financial resources for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	85.603,71 (56,4%)	688.934,21 (97,2%)	704,8
Investment	66.119,51 (43,6%)	19.848,44 (2,8%)	-69,98
Costing + Investment	151.723,22	708.782,65	367,2
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	220.590,00 (58,2%)	1.708.288,73 (36,99%)	674,4
Investment	158.648,51 (41,8%)	2.887.966,63 (62,83%)	1.720
Costing + Investment	379.238,51	4.596.255,36	1.111

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

Based on the number of contracts, it can be seen that in 2000 36 contracts were signed for agriculture, which represented 72% of the total and for the livestock activity there were 14 contracts, equivalent to 28%. In 2010, only 7 contracts were signed for agriculture, equivalent to 5.3%, and for livestock, 126 contracts were signed, which today represents 94.7% of the contracts. It is observed that agriculture in the municipality of Parecis, in 2000, received R\$ 151,723.22 from rural credit, equivalent to 28.6% of the total volume of resources and livestock, even with few contracts, was responsible for a volume of resources from rural credit greater than that allocated to agriculture, that is, R\$ 379,238.51, which represented 71.4% of the total released by rural credit for the year 2010. This fact is important to highlight. Although with fewer contracts signed, the volume of resources from 2000, as the data show, was always favorable to cattle raising, probably indicating a greater degree of specialization and a greater technological level. Thus, it can be inferred that there was a concentration of resources for livestock in 2010, which reached R\$ 4,596,255.36 of the total volume of resources destined for the municipality in that year, and the agricultural activity was left with only R\$ 708,782.65, equivalent to 13.4% of this volume. Thus,

it appears that the process of “cattle raising” in the municipality of Parecis had been growing since 2000 and its picture expanded in 2010, as a result of the federal government's credit policy.

**3.1.3 Analysis of the municipality of Pimenta Bueno**

**3.1.3.1 Number of contracts for agriculture and livestock**

When analyzing the data in Table 5, a strong reduction in the number of “costing and investment” contracts is evidenced. In the case of “costing”, this reduction was 78.5% between 2000 and 2010 and an 89.4% reduction in the “investment” modality, indicating a significant decrease in the number of contracts signed between the years surveyed. Based on numbers, it appears that this corresponded to the "investment" having dropped from 369 to only 39 contracts effected by the rural credit policy, and for the "funding" modality the fall was from 335 to 72 contracts effected, in relation to the period 2000 and 2010. Analyzing each modality in isolation, it appears that the “investment” obtained a greater number of contracts in relation to the “costing” modality, indicating signs of expansion of the agricultural activity in that municipality. However, it was important to note that even though the number of contracts for the "investment" segment was lower in 2000, it can, in a way, be inferred that the municipality was already developing the agricultural activity at that time, as it obtained 47, 6% of the contracts signed for this modality of "costing". Based on the year 2010 and considering the “investment” to have been higher in 2000, it was expected that the “costing” would be higher in 2010, which gives an idea of maintaining what was stimulated previously, as can be seen confirm by analyzing the available data, where “costing” represented 64.9% of contracts and “investment” 35.1% of them. However, the hypothesis of a process of deceleration in agricultural activity is something that cannot be actually verified yet.

In relation to the previous item, it was found that the agricultural activity in the municipality of Pimenta Bueno has been suffering a drastic drop in the number of contracts signed with the rural credit sector of the federal government. In 2000, in the livestock activity, the "investment" represented 78.8% of the contracts and the "costing" only 21.2%, which indicates that the livestock activity was stimulated through the rural credit policy this year in Pimenta Bueno and, in 2010, it was observed that this activity continued to expand as the number of contracts for “investment” purposes remained at the level of 74.7% in relation to “costing”. Even so, there was also a generalized reduction in the number of contracts, both for “investment” and for “costing” in relation to the two

periods analyzed, reaching a reduction of 73.8% and 67.1%, respectively.

*Table 5 - Numbers of contracts for agriculture and livestock.*

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	335 (47,6%)	72 (64,9%)	-78,51
Investment	369 (52,4%)	39 (35,1%)	-89,43
Costing + Investment	704	111	-84,23
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	143 (21,2%)	47 (25,3%)	-67,13
Investment	530 (78,8%)	139 (74,7%)	-73,77
Costing + Investment	673	186	-72,36

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

**3.1.3.2 Volume of financial resources made available for agriculture and livestock**

Differently from what was previously observed when there was a reduction in the number of contracts, here, however, in terms of volume of resources, this trend was not observed in relation to the period analyzed. On the contrary, there was an increase in resources, both for “costing” and for “investment”, reaching 919.7% and 258.6%, respectively, between 2000 and 2010. This behavior may indicate that a smaller number of rural producers now have access to a larger share of resources, which may indicate a concentration of resources and also greater specialization of activities in technological terms. When analyzing the financial scenario, through Table 6, it can be seen that in 2000 the "investment", which reached 56.9% of the resources, surpassed the "costing", which represented 43.1% of the total resources contracted. This scenario, as already seen, indicates a certain expansion of agricultural activity in the mycoregion. In 2010, the fact that “costing” reached 68.3% of the resources against 31.7% of the “investment” indicates that that year there was a certain stabilization of the agricultural activity, where the resources were, for the most part, destined for the maintenance of agricultural activity in the microregion.

Table 6 shows the volume of resources from the rural credit policy for the livestock sector. Thus, when comparing the year 2000 with the year 2010, the values arising from "costing + investment" there was an increase



of 105.2%, with the "investment" segment being superior to "costing" in the two years surveyed, indicating an expansion trend in 2000. In 2000, the "investment" corresponded to 55% of the resources destined to cattle raising and the "costing" to 45%. In 2010 there was an increase aimed at "investment", which reached 68.6% of the volume of resources contracted against 31.4% of the "costing". This scenario indicates expansion of livestock activity in the microregion in the two periods in question

Table 6 - Volume of financial resources for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	1.661.956,08 (43,1%)	16.947.654,71 (68,3%)	919,7
Investment	2.195.391,16 (56,9%)	7.873.338,01 (31,7%)	258,6
Costing + Investment	3.857.347,24	24.820.992,72	543,5
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	2.438.073,58 (45,0%)	3.496.780,15 (31,4%)	43,42
Investment	2.978.593,25 (55,0%)	7.621.607,51 (68,6%)	155,8
Costing + Investment	5.416.666,83	11.118.387,66	105,2

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

It can be observed a decrease in the number of contracts for both agriculture and livestock in the two periods analyzed. Regarding agriculture, 704 contracts were observed, which corresponded to 51.1% of the contracts and cattle raising formalized 673 of them, representing 48.9%. In 2000, agriculture was the main reason for the signing of contracts signed with the federal government. In 2010, livestock was the one to formalize the largest number of contracts (62.6%), surpassing the agricultural sector (37.4%), even observing a reported drop of both in relation to the period analyzed. In terms of volume of resources, the largest share in 2000 was for livestock, even though in terms of contract it was observed for agriculture. In 2000, the volume of resources destined to agriculture was R\$ 3,857,347.24, which represented 41.6%, and R\$ 5,416,666.83 was destined for the livestock activity, which represented 58.4% of the total volume of resources from the rural credit policy. In 2010, although the number of

contracts for cattle raising was higher, the volume of resources contracted by the rural credit policy was greater for agriculture, with R\$ 24,820,992.72, representing 69.1% of the resources. For livestock, R\$ 11,118,387.66 was earmarked, which represented 39.9% of the total resources.

### 3.1.4 Analysis of the municipality of Primavera de Rondônia

#### 3.1.4.1 Number of contracts for agriculture and livestock

By analyzing the data in Table 7 it is evident that the agricultural activity was already a reality in the municipality when observing that the "funding" modality represented 86.1% against 13.9% of the "investment" in 2000 in relation to the signed contracts. In 2010 the "investment" in agriculture reached 89.7% against 10.3% in "costing", indicating a strong trend towards the strengthening of agriculture in the micro-region.

It was found that agricultural activity in the municipality of Primavera de Rondônia suffered a very sharp drop in the number of contracts signed with the federal government's rural credit sector for 'funding', that is, maintenance of what is already consolidated. In 2000, there is a small predominance in the livestock segment for the "costing" modality (58.5%), revealing that this activity was already part of the scenario of the micro-region. The "investment" was equivalent to 41.5% of the contracts. In 2010 there was a very significant increase in the livestock activity where "investment" represented 86.9% of contracts, that is, it doubled compared to the previous year analyzed and in the "costing" modality there was a decrease, recording 41.7%

Table 7 - Numbers of contracts for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	210 (86,1%)	4 (10,3%)	-98,10
Investment	34 (13,9%)	35 (89,7%)	2,94
Costing + Investment	244	39	-84,02
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	24 (58,5%)	14 (13,1%)	-41,66
Investment	17 (41,5%)	93 (86,9%)	447,06
Costing + Investment	41	107	160,98

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

3.1.4.2 Volume of financial resources made available for agriculture and livestock

Table 8 illustrates the volume of resources destined to agriculture, by the rural credit policy, in the municipality of Primavera de Rondônia. In 2000, it can be observed that in the “funding” modality 69.2% of the resources, which may, therefore, infer that there was already an agricultural activity operating in the municipality before that period of time. In 2010 “costing” represented 54.3% of the resources and “investment” was responsible for 45.7%. Although there was a certain superiority of “costing” in relation to “investment”, looking more closely, it is possible to verify that both “costing” and “investment” had a decrease in contracted resources from 2000 to 2010 in the order of 88.7 % and 78.6%, respectively. This fall in resources can characterize a crisis scenario for the agricultural sector in the microregion, as this reduction was significant.

Table 8 shows the volume of resources from the rural credit policy for livestock. When analyzing the 2000 scenario, it is noted that a higher amount was allocated to the “investment” modality in the order of 71.6%, while for the “costing” modality it was only 28.4%. This scenario indicates a strong attempt to grow the livestock activity in the microregion. In addition, the level reached by the “investment” modality indicates that cattle raising was institutionally stimulated, indicating an increase in activity in this municipality. In 2010, the numbers continued to rise for the “investment” modality (79.1%), indicating an increase in livestock activity in the region, against 20.9% for “costing”, that is, the percentage destined to the maintenance and management of activities already existing. It is worth noting that from 2000 to 2010, both "costing" and "investment" had an increase in the amounts transferred by the government, where there was an increase of 191.5% and 336.7%, respectively, for the period analyzed.

Table 8 - Volume of financial resources for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	741.986,37 (69,2%)	83.818,14 (54,3%)	-88,70
Investment	331.059,49 (30,8%)	70.692,50 (45,7%)	-78,65
Costing + Investment	1.073.045,86	154.510,64	-85,60
Year / Livestock			
Contract	2000	2010	V.P.(%)

Costing	139.305,58 (28,4%)	406.120,37 (20,9%)	191,5
Investment	351.266,35 (71,6%)	1.533.808,43 (79,1%)	336,7
Costing + Investment	490.571,93	1.939.928,80	295,4

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

It can be noted that there was an inversion from agriculture to livestock, where, in 2000, the number of contracts made available for agriculture was 244, which corresponded to 85.6%. For livestock, the number of contracts was only 41, equivalent to 14.4% of the total number of contracts entered into. In 2010, the number of contracts for agriculture dropped to 39, which represented 27.7% and livestock was responsible for 107 contracts, equivalent to 73.3% of the total.

In 2000, R\$ 1,073,045.86 were contracted, equivalent to 68.6% of the resources of the credit policy destined to agriculture and R\$ 490,571.93 or 31.4% of the resources for livestock. In 2010, livestock led the concentration of values, with BRL 1,939,928.80, equivalent to 92.6% of the volume of resources, and in agriculture only BRL 154,510.64 were injected, which represented 7.4% of the resources offered. In this case, the cattle raising process in this municipality was evidenced, which had institutional encouragement from the federal government, through the rural credit policy.

3.1.5 Analysis of the municipality of São Felipe D'Oeste

3.1.5.1 Number of contracts for agriculture and livestock

Analyzing the data in Table 9, there is a large reduction in the number of “costing and investment” contracts signed for agricultural activity in the municipality of São Felipe D'Oeste between the periods analyzed, reaching 95.9%. In 2000, the “financing” modality represented 76.9% of the contracts signed by the rural credit policy, which allows us to infer that agriculture was already consolidated in the micro-region even before that year under analysis. The “investment” was responsible for only 23.1% of the number of contracts. In 2010, it was found that the variations in the number of contracts had decreases for both "costing" and "investment", so it is noticeable that there is a significant stagnation of agricultural activity for the municipality of São Felipe D'Oeste, which reinforces that the agricultural activity decelerated between the years of study.

Thus, in 2000, when analyzing the data, it is immediately verified that there was a great attempt to expand the livestock activity, as for the first year analyzed 97.5% of the contracts were formalized in the “investment” modality and only 2, 5% for “costing”. In 2010, even with a drop of 37.39% in the two "costing + investment" modalities, it is clear that there was an attempt to grow the livestock activity because the 'investment' modality, which represents expansion, was still responsible for 96.6%.

Table 9 - Numbers of contracts for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	474 (76,9%)	8 (32%)	-98,31
Investment	142 (23,1)	17 (68%)	-88,03
Costing + Investment	616	25	-95,94
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	6 (2,5%)	5 (3,4%)	-16,66
Investment	232 (97,5%)	144 (96,6%)	-37,93
Costing + Investment	238	149	-37,39

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

### 3.1.5.2 Volume of financial resources made available for agriculture and livestock

Table 10 shows the volume of resources from the rural credit policy for the livestock sector. In 2000, the investment value corresponded to 86.4%, while the costing value represented only 13.6%. Thus, it is possible to observe that the livestock activity was strongly stimulated by the rural credit policy, where the year 2000 represented the largest investment of resources for its expansion. In 2010, the value for investment reached 97%, thus indicating a strong livestock activity in the region being increased with more federal resources, through the rural credit policy. This reality effectively demonstrates the livestock development process in this municipality.

Table 10 - Volume of financial resources for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	1.462.957,09	183.802,45	-87,44

	(74,1%)	(40,8%)	
Investment	512.009,06 (25,9%)	267.039,87 (59,2%)	-47,84
Costing + Investment	1.974.966,15	450.842,32	-77,17
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	109.659,45 (13,6%)	42.233,53 (3,0%)	-61,49
Investment	696.572,11 (86,4%)	1.347.847,03 (97,0%)	93,50
Costing + Investment	806.231,56	1.390.080,56	74,42

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

It can be seen that, in 2000, agriculture held 616 contracts, which represented 72.1% of the total number. Livestock was responsible for 238 contracts, equivalent to 27.9%. In 2010, there was a decrease in the number of contracts for both activities. Agriculture, that year, signed only 25 contracts, which represented 14.4%, and livestock had 149 contracts, equivalent to 85.6% of the contracts.

Agriculture in the municipality of São Felipe D’Oeste, in 2000, received R\$ 1,974,966.15 from rural credit, equivalent to 71% of the volume of resources. In that same year, cattle raising involved the amount of R\$ 806,231.56, equivalent to 29% of the total. In 2010, cattle raising advanced, reaching BRL 1,390,080.56, equivalent to 75.5% of the total volume of resources allocated to the municipality in that year, while only BRL 450,842.32 was allocated to agriculture, which represented 24.5% of the total volume of rural credit resources.

### 3.1.6 Analysis of the municipality of Vilhena

#### 3.1.6.1 Number of contracts for agriculture and livestock

By analyzing the data in Table 11, a reduction in the number of “costing” and “investment” contracts signed for the agricultural activity in the municipality of Vilhena is evidenced, in which a drop of 55.81% was registered for the two years surveyed. It is possible to verify that both in 2000 and in 2010, the number of contracts for “investment” surpassed the number of contracts for “costing” in the order of 62.2% and 57.9%, respectively.

By analyzing table 11, it can be seen that in the livestock activity there was a succinct decrease in the number of contracts in which “costing + investment” fell by 21.57%.

By analyzing the data in table 11, it appears that "costing" in 2000 represented 20.6% and "investment" represented 79.4% of the contracts, indicating that the livestock activity was strongly stimulated, giving impetus to livestock in the region. In 2010 the same trend is observed, which translates into the strong trend of this activity, which is still in full growth in the region, under the stimulus of the federal government's rural credit policy. However, it is necessary to analyze the volume of financial resources made available for agriculture and livestock to complement the analyzes carried out on this economic segment in the region in question.

Table 11 - Numbers of contracts for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	130 (37,8%)	64 (42,1%)	-50,77
Investment	214 (62,2%)	88 (57,9%)	-58,88
Costing + Investment	344	152	-55,81
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	63 (20,6%)	53 (22,1%)	-15,87
Investment	243 (79,4%)	187 (77,9%)	-23,05
Costing + Investment	306	240	-21,57

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

### 3.1.6.2 Volume of financial resources made available for agriculture and livestock

The increase from 2000 to 2010 in relation to the volume of resources contracted, both for "costing" and for "investment", reached the order of 944.7% and 379.1%, respectively, of growth in financial resources released for the projects contracted. When analyzing the volume of resources for "costing", which in 2000 came to represent 47.4% of the total volume made available, one can make a reservation to what was previously stated. That is, this percentage indicates that the livestock activity had already been developed in the region before the year 2000, since the "costing", although lower than the "investment", has

reached a significant percentage, demonstrating that there was an activity before this period of time.

In 2010, resources destined to the "costing" modality reached 66.2% of the volume of resources and only 33.8% of these resources were destined to "investment". This scenario indicates that the activity is being maintained without expansion, but with maintenance of existing areas.

Table 12 shows the volume of resources from the rural credit policy for the livestock sector. By analyzing the data in Table 12, it is evident that for the first year analyzed, the livestock activity was strongly stimulated by the rural credit policy, indicating a percentage of "investment" corresponding to 67.1%, while the value of "funding" represented only 32.9% of the resources. In 2010, even with a small drop, the "investment" modality was still responsible for 63.5% of the resources for livestock in Vilhena and the "costing" modality represented 36.5%. Also noteworthy is the increase in resources for "funding" and "investment" in relation to the years surveyed, which showed a growth in the order of 415.5% and 339.7%, respectively. This reality demonstrates the strength of livestock in the region. However, agriculture, even so, is an equally strong reality in the region.

Table 12 - Volume of financial resources for agriculture and livestock.

Year / Agriculture			
Contract	2000	2010	V.P.(%)
Costing	1.951.344,33 (47,4%)	20.385.926,75 (66,2%)	944,7
Investment	2.167.932,33 (52,6%)	10.387.340,53 (33,8%)	379,1
Costing + Investment	4.119.276,66	30.773.267,28	647,1
Year / Livestock			
Contract	2000	2010	V.P.(%)
Costing	764.727,35 (32,9%)	3.942.227,63 (36,5%)	415,5
Investment	1.559.258,45 (67,1%)	6.855.675,86 (63,5%)	339,7
Costing + Investment	2.323.985,80	10.797.903,49	364,6

Source: Statistical Yearbooks of Rural Credit 2000 and 2010 [2].

In 2000 there was a certain predominance of the agricultural activity, where the number of rural credit



contracts granted by the federal government was 344, equivalent to 52.9%. For livestock, in that same year, 306 contracts were signed, which represented 47.1%. In 2010 there was a drop in the number of contracts for both activities. For agriculture, 152 contracts were signed, which represented 38.8% of the total and for the livestock activity, 240 were signed, equivalent to 61.2% of the total contracts.

As for the amounts of credit financing, it appears that the volumes of financial resources released by the rural credit line in the years analyzed prevailed in a higher quantity for agriculture, that is, even with the decrease in the number of contracts carried out in 2010, the segment has obtained very significant financial resources. In 2000, the agricultural activity contracted R\$ 4,119,276.66, which corresponds to 63.9% of the total volume of resources. For livestock, R\$ 2,323,985.80 was made available, equivalent to 36.1%. In 2010, agriculture obtained R\$ 30,773,267.28, equivalent to 74%, and R\$ 10,797,903.49 were injected into livestock, which represents 26% of the volume of resources made available by the rural credit line. Thus, it is possible to deduce that there was an intensification of agricultural activity in the municipality, however, obtaining resources indicates a certain concentration of resources in few properties. It is, therefore, important to note that the largest portion of the volume of resources injected into the municipality of Vilhena was destined for funding, that is, maintenance of the cultures inserted in years prior to the research.

It is noteworthy that even with a lower volume of resources than agriculture, the greatest demand in the livestock activity was for investments, which can be characterized as activity growth, which can infer that there was a livestock development process in the municipality of Vilhena, although agriculture is still an activity with strong evidence in the microregion. Soybeans, among other crops, could be one of the examples of agricultural production in Vilhena.

According to Silva [3] both agriculture and livestock were encouraged since the 1960s by the federal government through credit policies and since then Brazilian agribusiness has increased its production volume. For Almeida and Zylbersztajn [4] the proper functioning of the credit market represents one of the foundations for production, particularly in agribusiness. In the current Brazilian economy, the agribusiness sector has been very important in generating income and positive balances in the trade balance. Its Gross Domestic Product (GDP) reached, in constant 2009 values, R\$735.3 billion [5]. Based on GDP and trade balance data, agribusiness is characterized as one of the main economic activities in

Brazil and in recent years it has favored the advancement of the Brazilian economy worldwide, placing the country as one of the largest producers and exporters in the world, especially in the production and export of food [6].

In this sense, in recent decades the national cattle raising has leveraged its production in a way that considerably increased its herd. According to data from the Brazilian Institute of Geography and Statistics (IBGE) the national cattle herd in 2014 was 212,343,932 heads of cattle. The herd in the North region has 45,826,142 heads (21.58% of the national total). The region known as the Brazilian Amazon has undergone countless transformations in recent decades. The demographic "emptiness" and the "late" occupation have given way to cities driven by agribusiness, whether in soybeans, rice or cattle raising [3].

To stimulate economic activities in the Legal Amazon, the federal government, in addition to investments in infrastructure (such as the construction of highways) and the colonization projects it carried out, instituted tax incentive policies and credit lines to stimulate economic activities in the region [7].

The development plans for the Amazon were aimed at favoring the implementation of large projects, through subsidies and tax incentives offered by the federal government and facilitated access to land for large private groups, which caused profound changes to the environment [8]. Silva [3] reports that cattle ranching expanded in the Amazon from the integration policies of the region in the 1960s, in which several factors contributed to its more accelerated expansion. Santos [8] highlights that the introduction of livestock in the late 1960s was sponsored by government incentives through SUDAM and the Superintendence of the Manaus Free Trade Zone (SUFRAMA), which privileged livestock enterprises through exemption from income and tax direct financing for pasture implantations with the resulting practice of deforestation.

According to Carvalho [9], between 1965-1967 institutions (laws and agencies) were created to support the process of occupation of the Amazon frontier based on encouraged livestock, that is, modern and business livestock farming that had the support of the policy of fiscal and fiscal incentives provided by the Federal Government through SUDAM and BASA. For the authors Santos and Braga [10], in the 1970s and 1980s, a period in which credit was subsidized and distributed according to the size of establishments owned by borrowers, a large portion of rural credit was directed to large landowners. This aspect ended up being a credit restriction generator, mainly for small farmers, who could not offer the proper guarantees

“generally land”. According to Greenpeace [11], cattle ranching in the Amazon developed mainly within the territory known as the “Arc of Deforestation”, whose activity has been in constant growth since the 1970s. The massive presence of cattle in the Amazon stems from more than 30 years of public policies that stimulated the construction of infrastructure “roads and dams”, occupation of the territory “induced migration” and financing of the activity with public funds from SUDAM and, more recently, from the Fund Constitutional of the North (FNO) and National Development Bank. For Silva [3], the expansion of cattle ranching in the Amazon has been questioned for its environmental impacts and low social contribution, as it is associated with high rates of illegal deforestation and for employing little labor. Employees are mostly informal workers. Added to this is the fact that many of the properties used to carry out the activity do not have titles, that is, they face land regularization problems

A study of the causes of deforestation indicates that the cause of deforestation is associated with land use and directly affects the environment and vegetation cover. The study associates the proximate causes (here called direct causes) of deforestation into three categories, namely: expansion of pastures and agricultural areas, logging and expansion of infrastructure. Such land use changes are driven by economic processes that sustain them [12]; [13]. For Cooney et al [14] the deforestation process is basically growing as a result of some key activities: logging, soy growth, cattle expansion and family farming. Another prominent factor is the range of government subsidies that help facilitate the expansion of these processes. FNO, SUDAM and PRONAF are clear examples of government support for activities strongly associated with deforestation. Public financial subsidies for livestock continue and there are signs that they encourage deforestation. The subsidized loan provided by the Constitutional Fund of the North - FNO should only be used to improve the quality and productivity of livestock, as the Fund prohibits investments in deforestation [15]. However, as FNO constitutes a subsidy, it tends to increase investment in this activity more than would be normal (using market interest rates) and may even indirectly stimulate deforestation. As an example, Barreto; Pereira and Arima [15] mention that a farmer can deforest new areas without a loan, because he knows he will get good income using the subsidized loan to buy the herd. For these authors, subsidized rural credit for the Amazon should exclude agroculture and livestock, as they indirectly stimulate deforestation. If it is to maintain some type of subsidy for the region, which is directed to activities that produce public benefits, such as

environmental and ecological services - for example, reforestation that encourages the conservation of biodiversity and carbon sequestration.

According to Vale and Andrade [16] Rondônia is a state that well synthesizes the different facets of the Amazon. At the same time that it still has two thirds of its area fully forested, it is home to one of the most dynamic economic areas in the region, with older, more deforested municipalities and with high human development, both in relation to the region and in relation to Brazil. And, above all, it is the state where cattle raising has expanded the most in relation to other parts of the Amazon – an ideal place, therefore, to study the intensification of this activity. Furthermore, there are regions in the State characterized by medium/large sized properties, in which colonization projects favored rural companies, and regions where agrarian reform projects left a land structure much more based on small and medium properties. Other important references dealing with the national system of rural credit and rural credit applied in the Amazon, in addition to the theoretical foundation of the regional development policy for the Amazon and environmental sustainability for the Amazon region, can be consulted at BACEN [17], Antao and Campanholo [18], Pizaia et al [19], Oliveira; Trindade and Fernandes [20], Chalala and Chalala [21], Serra and Fernández [22], Cavalcante [23], Becker [24], Ferreira and Alves [25], Brito [26], Boiser [27], Sachs [28], Barbosa [29], Letter from Ottawa [30], Veiga [31], Opschoor and Straaten [32], Abramovay [33], Feil and Screiber [34].

#### IV. FINAL CONSIDERATIONS

Based on the data analyzed and based on the concept that the cost is linked to the maintenance of what already exists and the investment is expansion, it can be said that there were, in general, investments aimed at strengthening the livestock activity in the microregion, proving the hypothesis of the development of livestock in the microregion of Vilhena.

It is also worth noting that all municipalities had a greater tendency to invest in cattle raising. There was a strong increase in rural credit resources in 2010 for investments in the municipalities of Primavera de Rondônia and São Felipe D'Oeste. These two municipalities in comparative terms with the other municipalities invested significantly in cattle raising also in 2010.

It is observed that the municipality of Chupinguaia received a higher amount of resources than other municipalities in the form of credit for funding, understanding that the activity was already strongly supported and promoted in this municipality by the rural credit policy of the Federal government. The municipality

received an excellent incentive for investment in the sector, this being in the amount of R\$ 5,310,921.43. Thus, in relation to the municipality of Chupinguaia, the livestock activity shows that, in 2010, cost resources were used to maintain the livestock development process, which can be reinforced in the analysis of investment data, which indicates that such activity continued to grow.

It was also observed that the municipalities of Parecis, Pimenta Bueno and Vilhena obtained very significant resources in the credit subsidized by the federal government to maintain the livestock activity, as well as an appreciable increase in investments in new areas, characterizing the expansion and continuation of the livestock activity.

From what was studied in this research, it is believed that there was, indeed, a livestock development process in the Vilhena microregion in the analyzed period. It was observed that all six municipalities in the Microregion of Vilhena started to receive many tax incentives for livestock projects, not only for their maintenance, but also for the expansion of livestock activities. A fact that draws attention is that the municipalities of Pimenta Bueno, São Felipe D'oeste and Vilhena reduced the number of contracts from 2000 to 2010, however, they increased the resources available for investment in the livestock activity. This allows for evidence of a clear livestock development process in the micro-region.

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# Active Learning with Experiment Whole Numbers in Fifth Grade of Elementary School

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**Keywords—** Active Learning,  
Experiment, Whole Numbers

**Abstract—** The purpose of this study was to determine the level of student activity and student learning outcomes in active learning by experimenting with whole numbers in fifth grade elementary school. The subjects in the study were fifth grade students of SD N 173189 Sosorpahu Kec. Sipahutar Taput for the academic year 2020/2021, while the objects of research were student activities and student learning outcomes as a result of active learning by experimenting with whole numbers. This type of research is descriptive research which aims to describe how student activities and learning outcomes achieved by students in active learning. by experimenting with whole numbers. The instruments used in this study were student activity observation sheets and student learning outcomes tests in the form of descriptions. The data taken are student activity data obtained from observations made by two observers, and student learning outcomes obtained from learning outcomes tests. From the analysis of the research data, it was found that: The level of student activity in the first learning was 75.71 (active) with an average level of student activity reliability of 82.62% (high), and the level of student activity in the second learning was 88.62 (active). with the average level of student activity reliability of 84.61% (high); Active learning with experiments on whole numbers in class V SD N 173189 Sosorpahu Kec. Sipahutar Taput Academic Year 2020/2021, the achievements have been completed with the following details: (a) The level of classical student mastery is 77.02% classified as moderate, (b) ) The absorption of individual students was obtained by 31 people from 29 students or 93.55% of many subjects had completed learning, meaning classically had been completed, (c) The achievement of specific learning objectives was completely achieved.

## I. INTRODUCTION

In the development of thought processes, children go through various cognitive levels. Although sometimes they think like adults, their reasoning is often very different, partly due to their lack of experience with the concepts being discussed. Therefore, it is the teacher's obligation to deliver lesson materials that are proportional to the level of student development. One way to minimize the difference between the two is to help students find their own ideas and methods needed to solve a problem.

So far, teachers, including writers, teach mathematics by providing definitions/concepts, then working on examples of questions followed by practice solving questions for students. Students are not trained to understand the concept and how the concept is obtained, while the expectations or what is desired from students are not only skilled at solving problems.

Successful teachers always stimulate their students to engage in a process and discover the rules for themselves, and then follow it up with a discussion. Competent teachers and learning theorists have realized the value and benefits of this principle. Students need time

to investigate and discover patterns and relationships. They have to make observations and organize those observations, then make assumptions and test them. The ability to make generalizations is at the core of the learning process.

The importance of students doing their own investigations becomes very clear when we realize that learning mathematics is an active participation and not like watching a sports match. The number of investigations and discoveries by students determines among other things: what they learn, how long they can retain what they have learned, the ability to apply it, the behavior that arises during the learning activity.

In terms of the learning process, teacher lecturing activities showed an increase, while teacher-student interaction, student activities in discussions, explorations, and investigations related to mathematical ideas, showed a decrease (World Bank Research, 2007-2011). Whereas such learning activities will train students in finding and thinking at a higher level in solving problems.

To learn mathematics, students need direct interaction with their environment. Direct interaction with the environment can develop students' sense of the field of mathematics. Interaction with the environment can also activate students in learning. The activeness of students in learning is important so that they understand mathematics well. The "real world", in mathematics learning is used to build mathematical concepts and as a place to apply them. Thus mathematics is not given in finished form, but mathematics as an activity. Mathematics is the study of patterns, relationships, and logical thinking, so learning mathematics should be an ACTIVITY to investigate and/or find patterns/relationships that at the same time trigger and hone logical thinking.

## II. REVIEW OF LITERATURE

### Cognitive Learning Theory

There are various theories that help develop students' understanding of mathematics, but generally these theories are not mutually exclusive even though each theory has certain characteristics that distinguish it from one another. Hatfield (1993: 38) suggests that broadly these learning theories are included in three groups of thoughts (ideas), namely cognitive groups, behavioral groups and information processing groups. One of the cognitive learners is constructivist theory. Constructivism was born from the ideas of Piaget and Vigotsky, both of which emphasized that cognitive change only occurs if previously understood conceptions are processed through an imbalance process in an effort to understand new

information. According to this theory, the most important principle in educational psychology is that teachers cannot simply impart knowledge to students. Students must build their own knowledge in their minds. Teachers can facilitate this process, by providing opportunities for students to discover for themselves and teaching students to consciously use their own strategies for learning. This is reinforced by Slavin (1994: 225) who likens that the teacher can give students a ladder that can help them reach a higher level of understanding, but efforts must be made so that students themselves climb the ladder. Piaget and Vigotsky (in Slavin, 1994: 49) also emphasize the social nature of learning, and suggest using study groups with different abilities of group members to seek conceptual change. Furthermore, Vygotsky emphasizes the socio-cultural nature of learning, students learn through interaction with adults and peers who are more capable. In groups of students, it is expected that the thinking process of their peers, this method not only makes learning outcomes for all students, but also makes the thinking processes of other students open to all students, namely that learning occurs when students work or learn about tasks that are not can be done alone and have not been studied in general but are still within the range of the ability of students or these tasks are in the zone of proximal development, namely the level of cognitive development is slightly above the level of cognitive development of the child. Furthermore, Vygotsky (in Slavin, 1994: 59) says that higher mental functions generally appear in conversation or collaboration between individuals, namely interactions with adults and peers who are more capable, before the higher mental functions are absorbed into the human body. the individual. Another important idea that can be drawn from Vygotsky's theory is scaffolding, namely providing a large amount of assistance to a student during the early stages of learning and then the student takes on increasing responsibility as soon as he can do it. Vygotsky's theory emphasizes that scaffolding is an important thing in modern constructivist thought. A recent interpretation of Vygotsky's ideas is that students should be given complex, difficult and realistic tasks and then provided with sufficient assistance to complete these tasks (rather than being taught bit by bit the components of a complex task which one day is expected to become a reality). an ability to complete the complex task). The help can be in the form of instructions, warnings, encouragement, describing the problem into solving steps, giving examples or anything else that allows students to grow on their own. Vygotsky's socio-cultural core in learning activities is placed as student interaction with the teacher (as an expert) through the concept of instructional scaffolding. According to Vygotsky learning

is a development of understanding. He distinguishes the existence of two meanings, namely the spontaneous and the scientific. Spontaneous understanding is an understanding that is obtained from the daily experiences of children. This definition is not defined.

While the scientific understanding is the understanding obtained from the class. This understanding is a formal understanding that is defined logically in a wider system. According to Fosnot (in Suparno, 1997: 45), in the learning process there is a development from a spontaneous understanding to a more scientific one. Constructivist philosophy assumes that knowledge is the result of human construction. Humans construct their knowledge through their interactions with objects, phenomena, experiences and their environment. A knowledge is considered true if it is useful for dealing with and solving appropriate problems or phenomena. Constructivists view that knowledge cannot be simply transferred from one person to another, but must be interpreted by each person himself. Knowledge is not something that has been made, but a process that develops continuously. In this process the activity of someone who wants to learn or who wants to know is very important in the development of his knowledge. In line with this, Millan and Driver, Pines and West, Driver and Bell (in Sutrisno, 1993: 2) essentially argue that the constructivist tradition views learning as an active process of a person in finding meaning about something around him that is meaningful for himself through his interactions. with the environment by forming a relationship between the knowledge already possessed and the phenomenon being studied.

Fosnot (in Suparno, 1997: 73) suggests a reference to a group of teachers using the principle of constructivism to develop teaching methods that emphasize student activity both in self-study and in group learning. Teachers look for ways to better understand what is thought and experienced in the learning process. They think of some activities and activities that can stimulate students' thinking. Interaction between students in the class is turned on, students are given the freedom to express their ideas and thoughts. Furthermore, Suparno stated that in mathematics education, the principles that are often used include the following:

1. Knowledge is built by students actively.
2. The pressure in the learning process lies on the students.
3. Teaching is helping students.
4. The teaching and learning process is more emphasized on the process, not on the final result.
5. The curriculum emphasizes student participation.

6. The teacher is a facilitator.

In line with cognitive development, Piaget's theory states that a person experiences a certain stage of cognitive development at a certain age period in his life. Each stage must be passed before one can improve in the next stage. Piaget divided the four stages of development of the human operating structure from birth to adulthood, namely the sensorimotor stage (0-2 years), preoperational stage (2-6 years), the concrete operations stage (6-12 years) and the formal operational stage (> 12 years). ). According to Piaget (in Suparno, 1997, 30) that the theory of knowledge is basically a theory of adaptation of the mind into a reality, as organisms adapt to their environment. It is also said that at the stage of formal operations, children have developed abstract thinking and logical reasoning for various problems. At this cognitive level, the child's schema continues to develop. Because a child's schema about a particular object may not be the same as an adult's schema. This inequality does not mean the child's schema is wrong, it's just that his understanding of the object is in accordance with the development of his thinking at that time. Suparno (1997: 34) explains that there is nothing "wrong" in a child's scheme, but perhaps it is "not suitable" for higher levels of thinking. Piaget (in Suparno, 1997: 35) also suggests that a person's cognitive development has three elements, namely content, function and structure. Basically Piaget explains that content is what a person knows, which can be observed from behavior that reveals intellectual activity.

### **Multi-Intelligence Learning Theory (Plural Intelligences)**

In general, each individual has intelligence (intelligences) that are different from one another. Likewise, students have different intelligences from each other. As stated by Susanto (2001) that: In reality that applies everywhere, humans are different from each other in various ways, including intelligence, talents, interests, personality, and social circumstances. However, the difference in intelligence is not an obstacle in solving problems, especially in the teaching and learning process in schools.

The theory of multiple intelligences is also known as the theory of multiple intelligences, multiple intelligences, and multiple intelligences. This theory contradicts the traditional learning theory of intelligence.

Jasmine (2007:232) suggests that: "IQ is believed to be quite stable throughout a person's life, whereas according to Gardner, the level of intelligence can change positively (increase) through teaching and awareness or turn negative (decrease) due to lack or not being used".

This means that a person's intelligence can develop optimally if it is honed and given the appropriate approach in ongoing learning and vice versa, intelligence will decrease if it is rarely or never used in learning.

Gardner (in Budinungsih, 2005:113) suggests that the main idea of the multi-intelligence theory is, humans have the ability to increase and strengthen intelligence, intelligence in addition to being able to change can also be taught to others, intelligence is a multiple reality that appears in different parts of the world. the system of the human brain or mind, at certain levels this intelligence is a unified whole. The same thing was stated by Anita Lie (2003: 9) that every child needs to get the opportunity to develop minimal intelligence in various dimensions (musical, gestures, visual, spatial, mathematical logic, linguistics, intrapersonal, natural spiritual, and existential). Thus, in learning that applies the theory of multi-intelligence learning, students play an active role in the classroom, with a note that teachers must pay attention that not all students have the same intelligence.

### **Learning To Increase Student Activity**

In today's learning what is expected is active students, students are directed to seek and find these concepts for themselves. In the learning process the teacher must create an atmosphere in such a way that students actively think, ask questions, question, express ideas, experiment, practice the concepts learned, and be creative. Learning is indeed an active process of students in building their knowledge, not a passive process that only accepts the teacher's lectures about knowledge. If learning does not provide opportunities for students to think actively, then the learning is contrary to the nature of learning.

A concept (eg addition, multiplication, flat shapes, etc.) which is explained through lectures is actually very difficult for students to understand because the concept is explained in an abstract way. Abstract things are difficult to understand because children's thinking level which tends to be concrete will be easier if stated/delivered in a real form. If in teaching the teacher uses media such as pictures, films, demonstrations and so on, the concepts learned become more concrete (real) and easier for students to understand.

However, the easiest way to make a concept concrete is when students are involved in direct and active experience in discovering for themselves from the experience a concept that is the goal of learning. For example, students find the meaning of addition after they engage in the activity of adding up using real objects (peanuts, pebbles, paper clips). The real experience and the

process of applying it provide a way for them to actively build their own understanding of the concept of addition.

Edgar Dale (1946; in USAID: 2013, 14) shows that the types of media or activities that can be used to teach a concept and its relationship to the level of concreteness of the concept that can be conveyed. Learning that relies only on verbal pads (lectures, reading) contains the highest level of abstraction, while direct experience that makes students actively discover and apply a concept has the highest level of concreteness. Edgar also argues by saying that "What I hear, I forget; What I see, I remember; What I do, I understand." This opinion was also added by Melvin, the author of 101 Ways of Active Learning which supports student activity to provide maximum learning outcomes by saying; "What I hear, I forget; What I hear and see, I remember; What I hear, see, ask, or discuss, I begin to understand; What I hear, see, and I discuss and do, I acquire knowledge and skills; What I teach others, I master." The active role of students is very important in the context of forming a creative generation, which is able to produce something for the benefit of themselves and others. Broadly speaking, the learning carried out in the classroom should describe the following:

- a. Students engage in various activities that develop their understanding and abilities with an emphasis on learning through doing.
- b. Teachers use various tools and various ways to stimulate students' enthusiasm for learning and help students build knowledge and understanding. These ways include using the environment as a learning resource to make learning interesting, fun, and suitable for students.
- c. The teacher organizes the class by displaying books and learning materials that are more interesting and provides a reading corner.
- d. Teachers apply more cooperative and interactive teaching, including group learning.
- e. The teacher encourages students to find their own way of solving a problem, to express their ideas, and to involve students in creating their school environment.
- f. The role of the teacher as a facilitator is not as a lecturer, meaning that the teacher designs active learning activities, during learning activities, the teacher no longer just stands in front of the class explaining the subject matter, but goes around monitoring student activities and helping students in the learning process.

### **Experiment for Students**

Mathematics lessons in the classroom at the same time function as a place and a procedure or method. It is



said to be a place because it is a space for students to take part in an experimental approach to mathematics, and it is said to be a procedure or method because in that space students learn, carry out and discuss experiments, collect and summarize data to find mathematical concepts. The space may just be students sitting on their own benches, or on the floor, or in the playground under a tree. Sometimes even a playground or excursion can become a laboratory.

Regardless of its physical form, learning mathematics in front of the class is the basis for an activity-oriented program, which helps achieve the goals of a mathematics curriculum that has been prepared/set. It is not intended as a substitute for regular classroom lessons, but simply as an effective way of teaching, designed to stimulate individual or small groups of students to carry out experiments in order to better understand what it takes to be able to work with symbols. Experiments are often carried out with concrete objects, either purchased or homemade or available in the environment. The teacher reads what must be done, or writes it on the blackboard, or on an assignment card and the tools to be used. In some experiments, students study a series of numbers, or geometric figures to find a pattern or examine and interpret the arrangement of objects, pictures, or symbols. On other occasions they may investigate ways of solving problems. So the teacher uses the laboratory as a way to accommodate the differences in students' abilities/intelligence.

The mathematics laboratory is only effective if it is included in the curriculum and used when experience in the laboratory is the best way to achieve the goal. Activities in the laboratory can serve to introduce a topic. For example, children who are just starting to learn triangles might group triangle models into triangles with all sides the same length, or one in which none of the sides are the same length. The laboratory is also an effective continuation of the discussion in class. Furthermore, topics can be repeated with laboratory experiments. Regardless of the framework of use, the laboratory experience is

designed to enhance the student's own discovery of concepts. While there is still much to learn about its use, the benefits are clear: many students progress from the excitement of discovering something, and become better at understanding the concepts being taught.

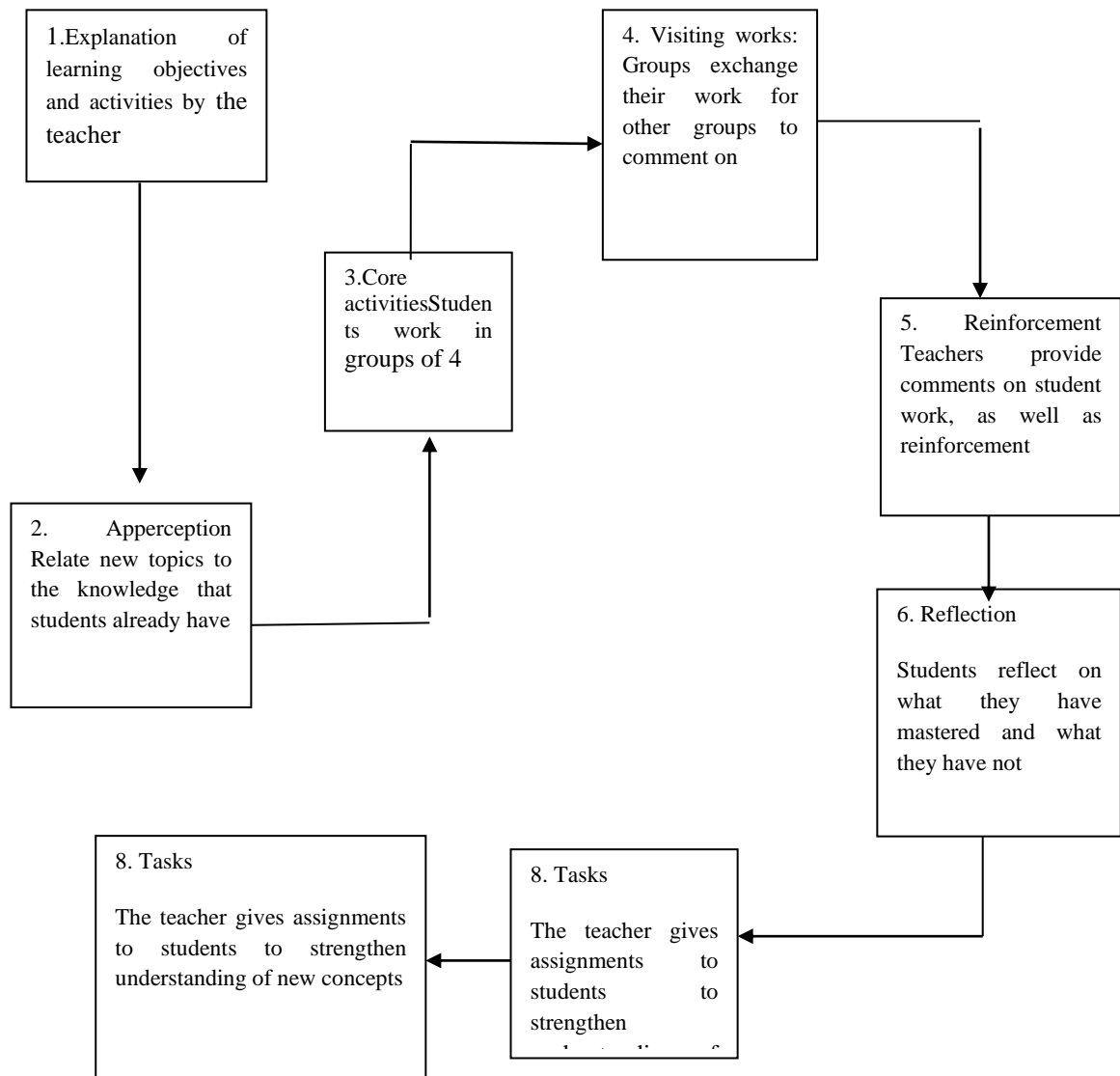
Introducing the mathematics laboratory, many problems arise if we want to start a mathematics laboratory. First, the teacher must be willing to try. This is a very difficult step because there are so many plans to be made and implemented; and for many teachers this is a step into the realm of ignorance. A suggestion if you want to carry out a mathematics laboratory is as follows.

Start gradually. Teachers can start experimental activities in the laboratory once a week. Of great importance is to study the math program for the week in question, determine what goals can best be achieved through the laboratory, and organize the activities for its implementation. Teachers can write their experiments on cards to share with students. If the collection of experiments more and more, the teacher can automatically choose.

Teachers can also outline laboratory activities for a particular topic. For example, the teacher wants to introduce the meaning of remainder in a division. Experiments on this subject can be planned, using existing tools to help students discover and understand these meanings.

### III. RESEARCH METHODOLOGY

This research was conducted at SD N 173189 Sosorpahu Kec. Sipahutar Taput. The subjects in this study were fifth grade students of SD N 173189 Sosorpahu Kec. Sipahutar Taput for the academic year 2020/2021. Meanwhile, the object of this research is the activity and learning outcomes of learning by experimenting on whole number material. This research is descriptive research that describes the actual state/outcome of learning.



Source: Middle School Mathematics Learning at LPTK, USAID PRIORITAS

#### IV. RESULTS AND DISCUSSION

Based on the results of calculations and data analysis of research results obtained the following results:

- a. The average score of learning outcomes obtained by students is 24.64 with an average grade of 77.02 or with a mastery level percentage of 77.02%. This shows that the level of mastery of students classically is still classified as moderate.
- b. Student learning completeness  
Individual absorption; the number of students who finished studying was 29 people, while those who had not finished studying were 4 people. Classical absorption; of 31 students there are 29 people who have finished studying or 93.55%, while those who have not finished studying are 4 people out of 31 people or 6.45%. This shows

that classically students' learning mastery has been achieved.

- c. Achievement of specific learning objectives (TPK)  
The achievement of specific learning objectives were all above 65.0%. Thus the learning has reached the completion of the TPK.
- d. Student activities  
From the results of observations made by two observers on student activities during learning, the results showed that students played an active role during learning, with the activity level in the first learning of 75.71 and the average level of student activity reliability of 82.62%; the level of student activity in the second learning is 88.82 and the average level of student activity reliability is 84.61%, thus there is an increase in student

activity during learning. From the description of the data analysis of the research results above, it illustrates that the level of student mastery in learning mathematics with "Active learning with experiments on whole numbers in class V SD N 173189 Sosorpahu Kec. Sipahutar Taput Academic Year 2020/2021" is moderate with the level of student mastery overall. classically of 77.02%, from 31 students there are 29 people or 93.55% of many subjects have completed learning, meaning classically learning has achieved complete learning. All TPK achievements are above 65%, which means that they have been completely achieved, the results of observations made indicate that students play an active role during learning.

Thus, that "Active learning with experiments on whole numbers in class V SD N 173189 Sosorpahu Kec. Sipahutar Taput Academic Year 2020/2021", the achievement has been completed.

## V. CONCLUSION

The conclusions of this study are: (1) The level of student activity in the first learning is 75.71 (active) with an average level of student activity reliability of 82.62% (high), and the level of student activity in the second learning is 88.62 (active). with an average level of student activity reliability of 84.61% (high), (2) Active learning with experiments on whole numbers in class V SD N 173189 Sosorpahu Kec. Sipahutar Taput Academic Year 2020/2021, the achievement has been completed.

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# Applied Study on Visual Identity Configuration Allied to Intellectual Property Protection in Pernambuco: guidelines for designers

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**Keywords— Visual identity, intellectual  
property, brands, intellectual protection**

**Abstract—** This article presents a proposal to combine the development of brands with the knowledge of the legal requirements for their protection, with a view to bringing this knowledge closer to designers so that they can develop brands that can be registered and legally protected. An almost nonexistent or very punctual practice has been the discussion of such content for designers in training. With the lack of knowledge of such requirements, it is very common for conceived brands to consolidate themselves in the market gaining intangible value, but that they can be prevented from legal protection by not meeting one or more of the requirements of legal protection. Despite being a knowledge coming from another area of knowledge, it is necessary to approach in a way to guide as to the requirements and inform the designer of the limitations so that the designer can develop more efficient visual identities, subject to protection. The research was applied, qualitative, exploratory with bibliographic and documentary procedures. A research protocol was defined based on Silva & Menezes (2011). As a result, the guidelines based on the Industrial Property Law are presented, highlighting 7 impediments to registration and guidance on the search for precedence to avoid collisions of brands and impediment of registration.

## I. DESIGN, VISUAL IDENTITY AND THE DEMAND FOR INTELLECTUAL PROTECTION

Given the rapid developments in technology development in recent decades, we face a challenge when dealing with the development of new products or services, because with the democratization of technology there is a much greater demand for both time and investment to

produce innovative results in the face of equalization of the technological level achieved. It should be noted that most of the times manufacturers in the same segment have the same resources available to develop the products. In this perspective, design assumes a referential role, as it confers creative value compared to competitors, being able to contribute to innovation and being recognized as a competitive factor (PATROCÍNIO, 2013).



We can see design as a central factor in the innovative humanization of technologies and a crucial factor between cultural and economic exchange. Because design is recognized as an important factor by companies and organizations around the world not only for isolated product designs, but also for product systems, hardware, software, and service design. In this way, we are referring to a theme that is increasingly important: Corporate identity and corporate design (BÜRDEK, 2006).

And it is through the differentiation acquired using corporate design, reinforcing the corporate identity - essential to communicate values and forms of relationship and positioning - that companies can stand out in the market and be recognized by the public. This differentiation is important both for the development of services and products, as well as for identifying the companies that produce them, through the construction of brands.

For Strunck (2001), the brand represents a design (logo and/or symbol) that over time acquires a specific value due to the relationships made to it, whether real or virtual, and thus starts to have a specific value. Martins (2000) emphasizes that the brand makes the difference between a certain product and that of a competitor, it is the soul of the business, and it is with it that the consumer dreams and sighs. In this sense, the brand, also from a commercial point of view, is the company's identity and must translate the image that one wishes to convey to the consumer. (GOMES, 2005).

According to Cunha (2000), design and specifically graphic design from the development of visual identities has the power to deal with the image of a company or institution and produce results that add value to that company's brand, making it stronger and respected and therefore helping to consolidate it. Also, for the author, the graphic designer has skills and abilities to organize symbolic content that can be interpreted by the receiver of the visual message. Thus, it is understood that the brand has symbolic content, serving as a strategy of differentiation and competitiveness. (CUNHA, 2000)

It is in this context of innovation that the power of design to guarantee new means of intellectual development for countless fields, including brand development, is found, and in this way, it is emphasized that without adequate protection, there are clear threats to innovation and competitiveness. For Patrocínio (2013) Design Policies are principles established by the government to use design as a tool to drive industrial, economic, regional, and social development.

We have a long way to go to ensure the development of Design Policies more effectively in our country, there is an

example of some initiatives such as the Guidelines for Good Design Services Practices, launched by ABNT, which despite superficially mentioning related issues to Intellectual Property - discussed in detail in the next topic - among other procedures that should be taken into account when contracting design services, do not delve into the issue of managing intellectual property rights over design (ABNT, 2017). This perspective can be changed by encouraging the engagement of registrations (brands and others) as an effective design management activity, especially in small and medium-sized companies that often do not usually engage in these practices.

It is noteworthy that with the expansion of the means of information and dissemination, it is much easier to have access to the visualization of project details, for Costa (2008) projects accessible to the public have chances of being 100% copied or pirated, so it is necessary to take the necessary measures to safeguard the rights, as if this does not occur there is nothing that can prevent the future industrial or commercial exploitation of projects without registration of intellectual property.

This demonstrates the importance of a closer look by the professional to the issue inherent in their performance, emphasizing that in addition to the creative and innovative proposal that provides input to emerging technological issues and of importance for the designer's performance, the importance of the legal apparatus in the daily exercise of the profession.

Based on this scenario, the purpose of this research was to propose guidelines for designers regarding the development of brands from the knowledge of the requirements for their legal protection. Therefore, this article briefly addresses intellectual property, legal provisions, and definition of a brand in accordance with the legal provisions.

## II. INTELLECTUAL PROTECTION AND TRADEMARK REGISTRATION

### Scope Of Intellectual Protection

Intellectual property has great relevance for relationships in the globalized world by encouraging innovative practices and regulating the protection of inventive activities and other legal relationships derived from human intellectual ingenuity. Its prediction in the legal systems of the National States is recent, despite the dimension and capillarity of this theme, and has origins during the thirteenth century.

In the region of Bordeaux, France, in 1236, the iconic Intellectual property protection inaugural event took place, when the local monarch granted exclusive privileges for

the use of weaving and dyeing wool materials (FURTADO, 1996) to a producer in the respective area. As for Trademarks of industry and commerce, one of the most common types of intellectual activity, it is possible to indicate that their protection became publicly known in 1445 (STRENGER, 2004), when it was agreed that blanket weavers should have their own sign when identifying their products. In the period, the scope of the marks was, therefore, to distinguish the goods according to who produced them and, according to Schechter (1999), to grant the holder of the right the monopoly of the distinctive signs.

This theme continued to receive the attention of European governments, however, especially with the advent of the Industrial Revolution, which occurred in the 17th century, inventive and commercial activities were intensified, accelerating the globalization process and the need for a more collective standardization of the intellectual property, which occurred incisively, in fact, in the Paris Convention of 1883 and, later, with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) of 1994 (GRAU-KUNTZ, 2015). These agreements aimed not only at protecting the monopoly of their nationals' businesses, but at creating an environment of fair competition in the market.

Brazil, a member of both treaties, enacted its main normative instruments on intellectual property in the late 1990s, the current Laws 9.279/96 and 9.610/98 on industrial property (LPI) and copyright, respectively. The Federal Constitution of 1998 itself made it clear that intellectual property is a basic pillar in the Brazilian legal system, including provided for in Art. 5, XXIX, as a fundamental guarantee, thus being a matter of high relevance to society.

### **Types of Intellectual Property Protection**

Following the definition of the World Intellectual Property Organization (WIPO), this matter can be understood as the sum of rights, strongly influenced by international norms, in which there is the protection of intangible assets, which may or may not have a commercial purpose. The doctrine, in the voice of Barbosa (2017), complements by stating that it is the conception of the intellect, the economic exploration of aesthetics, an investment in images or in technical solutions for services and products. For didactic purposes, it is pertinent to classify the significant part of Intellectual Property in two major fields of study: Copyright and Industrial Property.

Author's rights are those that protect the authorship of literary, artistic, or scientific works that, taken by creations of the human spirit, are expressed by any physical or

virtual means, in accordance with Article 7 of Law 9,610/98. Thus, the design of logos, the illustration of characters, as well as the expression of any other illustrations or engravings present in the identification of a product or service, can be considered works covered by copyright. It is important to confirm that, in the wake of the provision and doctrine, exemplified by the thoughts of Bittar (2015), the legal protection of copyright is inherent in its externalization, regardless of registration in official bodies.

Industrial property, in parallel, is perceived by the set of rules and principles capable of legally protecting the intangible assets of a business (RAMOS; GUTERRES, 2016). The protection of these assets has a strong economic and competition bias, to grant the company a monopoly over its intangible properties. According to the provisions of Law 9,279/96, patents capable of protecting the inventive act of a product are examples of industrial property; industrial designs, responsible for the protection of aesthetics, ornament, a product, or ornamental pattern applied to it; and the brands.

### **Fundamental characteristics of brands**

According to the definition present in Art. 122 of the Industrial Property Law, marks are the visually perceptible distinctive signs, not provided for in the legal prohibitions, found mostly in the same Law. the protection for sounds and odors, as opposed to alien legislation, such as the North American one. It is interesting to note that the concept of brand can be equally appreciated by other areas of knowledge, which, each in its own way, reveal ideas that are complementary to the one intended by the legal norm, eg Kotler (2004), who, for marketing, makes evident the need for the sign to be distinctive in order to distinguish it from the competition.

Perhaps the most basic and unique characteristic of brands is their distinctiveness (SCHMIDT, 2013), as this quality is intrinsic to their own reason for existence, namely, differentiating services and products from one another. A brand must be composed of elements which, by its visual, phonetic, and marketing set, indicate it as unique in the market and do not make it be confused with others in the senses of the consumer public. The brand also loses its purest meaning if it is constituted by a set of common, generic, and descriptive elements, since it is not possible to establish a monopoly on signs already diluted to the products and services themselves (BEEBE, 2005).

In parallel, Article 129 of the LPI prescribes that the ownership of the trademark obeys the attributive principle, that is, it is only valid upon registration valid in Brazil. Applications for registration of national and international trademarks are evaluated by the INPI, the federal agency

responsible for dealing with the application of the matter throughout the country. The same provision also manifests the principle of territoriality of trademarks by limiting the owner's property rights over these signs only to the national territory once the registration is satisfied.

Finally, the validity of the registration of trademarks, unlike patents and industrial designs, for example, is unlimitedly extendable for a period of ten years, provided that the sign continues to exercise its respective distinctive function in the market, in accordance with Art. 133 of the LPI.

#### **Moral and economic advantages of trademark registration**

Owning the registration of a trademark guarantees its owner rights capable of enabling him to obtain advantages in the market. By holding the monopoly of a sign, the trademark fulfills the common function of industrial property, namely, to prevent the improper use of its assets by a third party, and this is particularly important because, unlike patents and industrial designs, trademarks rarely have value after obtaining the registration, taking, in some cases, many years to do so.

The value of a brand is an asset that is difficult to measure, however, it is known that excellence in the quality of the product and service, as well as the company's reputation regarding its business and outstanding advertising produce positive effects over time, indicating Saint-Gal (1959) that the public prefers branded articles, as they represent security of origin and origin.

This feeling is only possible if the public can correctly identify the product and service the company that sells it against the competition because, in the event of confusion, the consumer may receive a negative opinion about a similar brand and this effect will have repercussions on the original sign. Therefore, a distinct brand has a social, public function, by individualizing the origin of a product or service to the consumer (SCHMIDT, 2013).

The holder of the trademark registration has the clear right to use the trademark, however, the power to license or assign this asset to third parties, as appropriate, is also granted. This right, provided for by Arts. 134 and 139, respectively, allow the holder to promote franchise agreements, for example, the brand so that other companies have certain rights under certain conditions to make use of the brand or any of its distinctive elements. Such contracts may also be entered into with competitors in areas whose holder does not have, for economic, logistical or any other similar reasons, activity.

The monopoly of use of the brand is ensured by the Arts. 189 and 190, which impute a crime to anyone who

reproduces it, registers a trademark, or imitates it, in whole or in part, inducing confusion to the public, as well as anyone who commercially circulates a product with an imitated or reproduced trademark, in whole or in part.

### **III. MATERIAL AND METHODS**

This research is defined as applied, as it proposes "knowledge aimed at solving specific problems" (SILVA & MENEZES, 2011, p.20). As for the approach, it is a qualitative research, as it does not need statistical or quantifiable data to weave the analyzes and interpretations. It is still exploratory research.

The technical procedures used were bibliographic and documental research.

### **IV. GUIDELINES FOR DESIGNERS**

With the contemporary work panorama, the traditional commercial success mentality of societies, namely, the industrial production and the trade of the largest possible quantities of goods, was transformed to adapt to new demands. Limited by the stabilization of consumption, the industry invested primarily in quality and innovation rather than the quantity of its products, stimulating, according to De Masi (2001), intellectual knowledge and creativity. Products and businesses never seen before having emerged in the market and, with them, the need to individualize them through strong competition and, often, already consolidated markets. On this track, creative professionals stand out, like designers, capable of providing vital tools to create and consolidate remarkable images of products and services to their consumers.

Thus, the designer's job can be the conception and elaboration of the brand of the client's business, bringing together both marketing and aesthetic elements and those intrinsic to the profile of the company or entrepreneur. Chalhub, Cid and Campos (2019) defend the strategic prudence of developing distinct brands, since they are the communication channel between the company and the public, transmitting ideas and values. While such communication is effective, the brand is more relevant and profitable.

The designer professional must be aware, however, that the conception and presentation of a brand to its client cannot take place only through creative ways, so that the observation of the intended sign is essential to be included in the legal provisions notably present in the list of Art. 124 of Law 9,279/96, the Industrial Property Law (LPI).

Among some of the items in this device, it is possible to highlight that the designer does not elaborate a brand

containing coats of arms, flags, public monuments, national or foreign, and other signs considered official (I); expressions or signs capable of offending morals, good customs or other feelings worthy of respect and veneration (III); a sign of a vulgar, descriptive, necessary character, except when covered in a sufficiently distinctive way (VI); expression used only for advertising purposes (VII); Sign responsible for inducing the consumer to falsely indicate the origin, quality or usefulness of a product or service (X); Signs protected by copyright law, except with the owner's consent (XVII); And signs that reproduce or imitate other previously registered trademarks for similar products or services (XIX).

Except for item XIX, it is fully possible for designers to conceive brands potentially capable of obtaining registration, since most of the restrictions pointed out by Article 124 do not depend or depend very little on the analysis of the contemporary market scenario, it being sufficient to have basic references from known every day.

However, the responsible professional should not limit themselves to inert knowledge of their activity, to make good use of caution and research the previous existence of conflicting marks to avoid further financial and professional losses. Thus, it is crucial that designers carry out the prior search for the trademark application based on their work not to be rejected by the incidence of Art.124, XIX, of the LPI.

As trademarks comply with the attributive principle, they can only be protected through proper registration with the National Institute of Industrial Property (INPI), which attends to requests in person and virtually. It is also on the INPI website where all valid and active processes in Brazil are found, constituting an excellent public and free database for those interested.

When faced with the database, the competence of knowing how to search for other brands should be necessary, as the INPI provides a series of resources to facilitate the user to find potential conflicts. This moment is crucial, but it is unusual to be performed by designers, both in the sense of being able to delimit their searches in the system, as well as knowing what could be considered a conflict trademark.

There are two basic principles for determining trademark conflict. The first values the similarity, not of every detail of the sign, but of the set of the most expressive elements of the brand (BARBOSA, 2010). The second, in parallel, determines the presence of conflict between brands according to the perception of the common consumer when examining them, similarly taking into account the circumstances, nature and environment in which it is usually consumed (CERQUEIRA, 1956).

Such concepts, pointing out the expressiveness of the brand's elements and observing the consumption habits regarding the respective product and service, are quite nebulous and of significant weight in the decision of the INPI judge, corroborating the designer's difficulty in having guaranteed success in their requests, it is sometimes convenient and recommendable to hire specialists, such as lawyers and industrial property agents.

For greater security, the creative professional can carry out background research in places other than the official government database. It is possible on a provisional basis, however, precarious, to look for conflicts in diverse and highly popular environments, such as social networks and online search engines, as many companies do not register their brands and, despite potentially being vulnerable by exposure, they publicize their products and services, facilitating the subsequent search, however, at the INPI.

## V. FINAL CONSIDERATIONS

This study aimed to provide guidance for designers on intellectual property protection, specifically on the brand intellectual asset. This need was perceived by the absence of such knowledge both in training and by some market professionals. Although it is extremely important to know so as not to incur errors from the point of view of preventing the registration of the trademark, in practice, such knowledge has been neglected, although dissemination actions by the INPI, OAB, and other bodies are recurrent trying to bring these together. knowledge.

It is necessary to broaden the discussion, bring training closer, as well as promote design policies for innovation allied to the protection of intellectual property.

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# Apical microleakage evaluation of a new proposal for endodontic sealer associated with hydroxyapatite: an *ex vivo* study

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**Keywords**— *Endodontics, Root canal filling,  
Dye penetration, apical leakage.*

**Abstract**— *The filling of the root canal system has a fundamental role in endodontic treatment, since it will take the place of the root pulp, thus the material must act by isolating the root canal system, preventing the penetration of microorganisms and their toxic by-products, which can compromise the prognosis of the procedure. The present study was carried out to evaluate the apical microleakage of a hydroxyapatite modified sealer. After removal of crowns and endodontic instrumentation, 40 selected maxillary single root teeth were randomly divided into two experimental groups (n = 15 each) according to the sealer: GENDO – Endomethasone Sealer / GENDOHX - Endomethasone Sealer +5% hydroxyapatite, and two control groups (n = 5 each). The root canals of specimens from the experimental group were filled with the cold lateral condensation technique. To assess apical microleakage, the apical linear dye penetration was measured microscopically from apex to most coronal part and data were statistically analyzed. Descriptive analyses were performed, followed by the Mann-Whitney test. The mean values of leakage observed in the groups were GENDO –  $0,95 \pm 1,80$  and GENDOHX –  $1,01 \pm 1,82$ . No significant differences were found between experimental groups ( $p > 0,05$ ). Conclusion: The addition of hydroxyapatite to the endomethasone sealer did not interfere with its apical sealing capacity.*

## I. INTRODUCTION

For the endodontic treatment to be successful, a sequence of procedures must be performed inside the root canals, starting with the removal of all organic and inorganic content present inside the root canal [1]. Although the chemical-mechanical preparation is a very

important step in the endodontic treatment, modeling and decontamination of the canal will be of no use if the sealing promoted at the end by the endodontic filling is faulty [2].

A three-dimensional root canal filling has a fundamental role in endodontic treatment, since it will take

the place of the root pulp, thus the filling must act by isolating the root canal system, preventing the penetration of microorganisms and their toxic by-products, which can compromise the prognosis of the procedure [3]. The majority of endodontic failures are caused by the microleakage resulting from incomplete obturation [4].

The obturation technique using a main gutta-percha cone wrapped in sealer is the most widely used in endodontics worldwide [5].

Root canal sealers are important in achieving a three-dimensional filling by reducing apical and coronal microleakage [6]. Thus, such material must meet the following requirements: biocompatibility, allow healing and an adequate apical sealing [7]. Therefore, new possibilities may arise regarding the active principle of new endodontic cements, and hydroxyapatite represents one of these alternatives.

Hydroxyapatite within the dental area is used to prevent bone loss in alveolar regions after extraction of one or several dental elements, as well as recovery of areas with bone resorption. Hydroxyapatite coated titanium pins are used in the implant for root replacement and are being researched in other areas such as endodontics [7]. Other dental specialties can benefit from the use of this hydroxyapatite-based biomaterial, such as endodontics. Therefore, the possibility of formulating a new material or integrating hydroxyapatite into an existing sealer is justified.

In order to analyze the apical sealing promoted by endodontic cements, several methodologies have been proposed, but the most widely used analysis is the linear measurement of dye penetration in the apical region through the foramen [8]. Thus, new possibilities for endodontic sealers must still be tested, with the objective of comparing and observing better possibilities of materials to be applied clinically.

Thus, the aim of this study was to evaluate the apical sealing capacity of Endomethasone N (Saint-Maur-des-Fossés Cedex - França) associated with hydroxyapatite in 5%. The null hypothesis tested in this study was that there is no difference in the apical sealing capacity between the endodontic sealers groups tested.

## II. MATERIALS AND METHODS

### *Specimen selection and preparation:*

Once approval from the Human Research Ethics Committee of the Pontifical Catholic University of Campinas had been obtained (no. 3.653.397), 40 freshly maxillary incisors had been extracted for various reasons were included in the present study based on the inclusion

and exclusion criteria. Tooth with root caries, fracture line, open apex, external/internal resorption, calcified canals or curved roots were replaced. Teeth were selected and disinfected by soaking in 1% chloramine-T trihydrate solution for ten days.

The crowns of the all teeth were decoronated at cemento-enamel junction with a diamond disc (Horico Dental Hpf; Ringleb, Berlin, Germany) coupled to a slow-speed handpiece powered by a micromotor, under constant refrigeration, standardizing roots segments of 15 mm in length. Working length was determined by passing a size K#15 (Dentsply Maillefer, Ballaigues, Switzerland) into the canal until the tip of the file was just visible through the apical foramen. The final working length was obtained after shortening 1 mm from the real root canal length.

The biomechanical preparation was carried using WaveOne Gold Large 45.05 (Dentsply Maillefer, Ballaigues, Switzerland) reciprocating system following the manufacturer's recommendations. A crown-down approach was employed in preparing the root canals using the X-Smart Plus (Dentsply Maillefer, Ballaigues, Switzerland) electric motor.

The canals were irrigated with 5 ml of 2.5% sodium hypochlorite (NaOCl) solution for each preparation per root third to rinse the canal and remove organic residues. In all groups, after each cycle of instrumentation and irrigation, foramen patency was controlled with a #10 K-file advanced 1 mm beyond the foramen. After instrumentation was completed, 5mL of 17% EDTA were introduced and ultrasonically activated in 3 cycles of 20 seconds [10]. Next, a final flush with 5 ml of NaOCl followed by 5.0 mL of saline was performed. The root canals were dried with paper point size 45.05 (Dentsply Maillefer, Ballaigues, Switzerland).

### *Group allocation:*

The samples were randomly allocated into two experimental groups (n=15) and two control groups (n=5) using a computer algorithm (www.random.org). The endodontic sealer used in endodontic filling represented each experimental group:

- GENDO = Endomethasone N Sealer
- GENDOHX = Endomethasone N Sealer associated with 5% hydroxyapatite
- Control Group (+) = roots were obturated with gutta-percha but without sealer;
- Control Group (-) = Samples in the negative control group did not receive root canal fillings.

**Root Canal Filling:**

Obturation of the root canal was performed using lateral compaction technique associated with the main cone of gutta percha wave one gold large 45.05 (Dentsply Maillefer, Ballaigues, Switzerland) and the respective sealers.

The Endomethasone sealer was manipulated according to the manufacturer’s instructions. In group GENDOHX a 5% amount of hydroxyapatite was added to the endomethasone sealer powder using a precision analytical balance.

The tip of each pre-selected master cone was slightly coated with its respective sealer and inserted into the prepared canal using in-and-out pumping motion until reaching the full working length.

Lateral compaction was done and accessory cones with light coats of sealer around them were placed. The spreader was placed beside the gutta-percha to create sufficient space for the accessory cones.

Excess gutta percha from the canal orifice was removed by using a heated endodontic plugger and then vertically condensed with other could endodontic pluggers to the level of the canal orifice. The access cavity was sealed with glass-ionomer cement.

The quality of root canal filling was assessed radiographically. The specimens were stored in saline (100% humidity) at 37°C for 1 week to allow completes setting of sealers.

**Preparation of Specimen for Microleakage measurement:**

After 1 week, teeth (experimental and positive control groups) were air-dried and the external root surface was coated with 3 layers of nail varnish, except for the apical 4 mm. The roots including apical foramen in the negative control group were entirely covered with nail varnish.

Apical leakage was estimated using a dye penetration test then all samples were immersed in 1% methylene blue dye and stored at 37°C for 72 h.

After a diamond disk was used to longitudinally section the root in a bucco-lingual direction.

The split segments were examined using an operative microscope (8X magnification) to evaluate the linear dye penetration from the apex to the most coronal part of the root in millimeters using Image J software program (Fig.1).

A single operator completed all preparations and testing procedures.

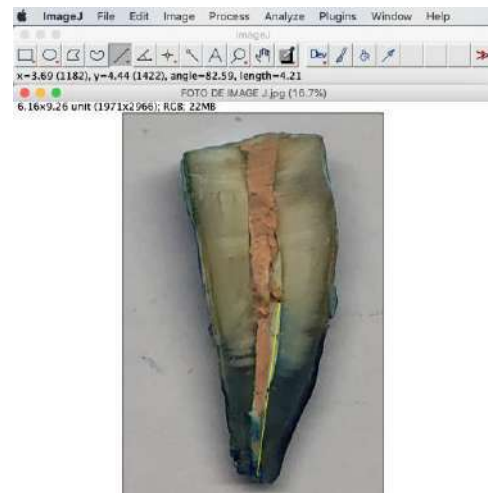


Fig. 1: Measurement of apical infiltration with Image J software

**Statistical analysis:**

The results were statistically analyzed by Shapiro-Wilk and Mann-Whitney test using IBM SPSS version 20 (IBM Corporation 1 New Orchard Road Armonk, New York 10504-1722, United States), at a significance level of 5%.

**III. RESULTS**

The mean values and standard deviations of apical dye penetration for experimental groups are presented in Table 1.

Table.1: Mean apical linear dye penetration values (in mm)

	<b>GENDO</b>	<b>GENDOHX</b>
<b>MINIMUM</b>	<b>0,00</b>	<b>0,11</b>
<b>MAXIMUM</b>	<b>4,21</b>	<b>4,02</b>
<b>MA (SD)</b>	<b>1,44 (1,30)<sup>A</sup></b>	<b>1,48 (1,35)<sup>A</sup></b>
<b>MD (IQD)</b>	<b>0,95 (1,80)<sup>A</sup></b>	<b>1,01 (1,82)<sup>A</sup></b>
<b>(P-MW)</b>	<b>0,4098</b>	

Abbreviations: MD, Median; IQD, interquartile deviation; MA, Mean; SD, standard deviation.



The evaluation of the dye linear infiltration indices showed no statistical difference between the experimental groups ( $p>0,05$ ).

The negative control group showed no leakage, while the positive control groups showed complete leakage through the canal space, which confirms and validates the experimental method (Fig. 2).

No specimens were damaged in the split process.

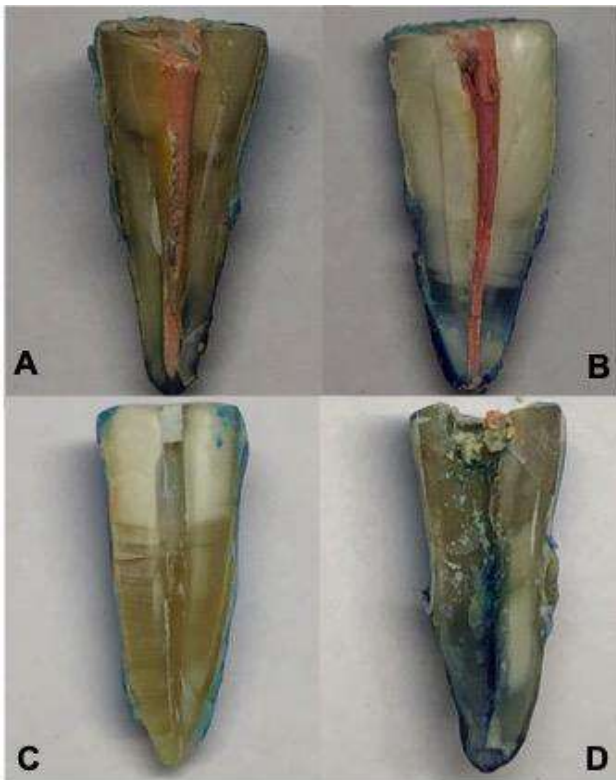


Fig. 2: Microscope images of tested samples showing linear dye penetration: A: GENDO (GP/Endomethasone), B: GENDO+HX (GP/ENDomethasone + 5% Hydroxyapatite), C: Negative control group, D: Positive control group.

#### IV. DISCUSSION

Incomplete endodontic filling of the root canal system with inadequate apical and coronal sealing has been pointed out as one of the main causes of endodontic failures [11,12]. Therefore, the root canal filling should seal the canal space both apically and coronally to prevent microorganisms and tissue fluids from entering the canal space.

Thus, this study was carried out to evaluate the apical sealing capacity of a variation of endodontic sealer in which 5% hydroxyapatite was added with the possibility of later analyzing a possible improvement in its biocompatibility.

In the present study, the linear measurement of dye penetration technique with 1% methylene blue dye was used to compare the apical infiltration in root canals after endodontic filling. Linear measurement of dye penetration is the one such method that is most common, relatively easy and fast to gauge the microleakage of the sealers [13].

A range of methodologies to assess microleakage of the root canal space is reported in the literature. Among them the use of scanning electron microscopy, radioisotope penetration, bacterial penetration, electrochemical analysis, fluid filtration and dye penetration employed in the study. In the analysis performed by Wu et al. 1993 [14], radioisotope penetration or dye infiltration has been used in more than 80% of the sealing studies performed in endodontics.

Different dyes are used in sealing studies such as India ink, Eosin, Procion, brilliant blue, 50% silver nitrate, Pelican ink and, most common, methylene blue. In the case of Methylene Blue, the most used concentrations are 0.25, 1 and 2%. In present study, was used 1% as it is the most commonly indicated as in studies [15, 16]. Ahlberg KM et al. 1995 [17] noted that methylene blue at 1% is superior to other options in terms of penetration and has a low molecular weight comparable to some bacterial by-products [18, 19, 20, 21, 22].

The cold lateral gutta-percha condensation technique was used and has been considered a gold standard filling technique by many studies, reflecting the good clinical results observed [23,24]. Some studies in the literature do not mention significant differences in the cold technique compared to other filling techniques used [25,26,27].

After the filling of the specimens, the roots were stored at 37 °C and 100% humid for seven days, as in other researches, to promote the complete setting of the sealer and provide an environment similar to the oral cavity [28,29,30,31].

The results of the study mention that in both groups, regardless of the sealer formulation tested, they did not totally prevent the apical infiltration of the dye. The positive control group resulted in higher levels of infiltration, indicating that the sealing ability of single-cone gutta-percha is deteriorated when used without a root canal sealer. On the other hand, the negative control group did not show apical leakage, which confirms the sealing of the varnish used in this methodology.

The incorporation of hydroxyapatite to zinc oxide sealer can be an alternative in the condition of improved biocompatibility with endodontic sealer.

According to the results of the present study regarding dye infiltration, the zinc oxide eugenol sealer and its

version incorporated at 5% hydroxyapatite did not differ from each other. This result demonstrates that such biocompatible substrate extracted from the dental element itself did not minimize its apical sealing capacity of the root canal system.

A chemical process of decalcification and reduction of substrates from the tooth itself or even from eggshells, bovine bone or even fish scales can be sources for obtaining hydroxyapatite [32,33,34,35].

The endodontic sealer Endomethasone N has a vast amount of publications in the literature and, even though it is not a resin or even bioceramic sealer, it presents satisfactory results in several aspects when evaluated [36,37,38,39,40].

As observed in the literature, endodontic sealers based on zinc oxide and eugenol have a disadvantage in terms of biocompatibility, and from this point came the possibility of incorporating a substrate to their compound that could provide a better condition for interaction and less cytotoxicity with the periapical tissues [40,41,42].

The zinc oxide eugenol sealer was chosen to be added to hydroxyapatite due to its previous presentation in powder condition. Paste-paste sealers such as resinous ones would make it difficult to pre-handle hydroxyapatite to its previous weight.

It is known that other tests need to be carried out in relation to the possible new sealer formulation, including the variation of the percentage added to the material.

Hydroxyapatite has been used in several fields in the health area and, specifically in dentistry, as a biomaterial applied in the condition of grafts or bone defects [43,44,45,46,47, 48].

New formulations of endodontic sealers must be tested, mainly with active principles of biomaterials that allow the sealing of the root canal system and concomitantly a biocompatibility, stimulating apical repair when necessary.

## V. CONCLUSION

According to the methodology employed, it was possible to conclude that the addition of hydroxyapatite to the endomethasone sealer did not interfere with its apical sealing capacity.

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# Pharmacological and toxicological aspects of barbatimão (*Abarema cochliacarpus* (GOMES) Barneby & J.W. Grimes)

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**Keywords** — *Abarema cochliacarpus*,  
**Biological Essay**, **Pharmacology**,  
**Phytotherapy**, **Toxicology**.

**Abstract**— *Goal: To observe pharmacological and toxicological studies of Abarema cochliacarpus (GOMES) Barneby & J.W. Grimes which indicate efficacy and safety in its use as an herbal medicine. Method: Systematic review study in the BVS, PubMed and SciELO databases. The descriptors “Abarema”, “cochliacarpus”, “pharmacological”, and “toxicological” and Boolean operator “AND” were used. Inclusion criteria: Abarema cochliacarpus (GOMES) Barneby & J.W. Grimes; pharmacological action; toxicological action. Exclusion criteria: review study and duplicated articles. The studies were analyzed regarding the in vivo characteristics (mice and rats) or in vitro (cell and bacterial lines), pharmacological or toxicological action, derived from plant drug/part of plant and authorship. Results: 11 articles selected in the review pointed out: analgesic activity tested in Swiss mice; antibacterial in lineages such as Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa; anti-inflammatory tested in Wistar Rats and Swiss mice; antioxidant in vitro model on oxidative damage and also in a Swiss mouse model; antiulcerogenic analyzed in Wistar rats; myoprotective in Swiss mice; estrogenic and thyroid modulation tested in cell lineage. The toxicological essay found approached the hepatotoxicity induced by A. cochliacarpus in Mus musculus mice. Conclusion: A. cochliacarpus has phytoactive constituents with analgesic action, antibacterial, myoprotective, anti-inflammatory, antioxidant, antiulcerogenic, estrogenic and thyroid modulation in animal models in vivo and in vitro, with the bark being the most used part in extracts and fractions. Faced with the need for proof of safety in the use of plants as herbal medicines, toxicological tests have to get conducted to ensure the safe use of the species, as correlated with the barbatimão.*

## I. INTRODUCTION

Phytotherapy is an ancient practice based on the use of plants for medicinal purposes, with preventive and curative

purposes, and its use is encouraged by the World Health Organization (WHO, 2019). The barbatimão is widely used as a medicinal plant by the population, being also

known as barba-de-timão, casca-da-virgindade, faveira and barbatimão branco. The plant species evaluated by the National Health Surveillance Agency (ANVISA) and registered for using in phytotherapy is *Stryphnodendron adstringens* (MART.) Coville. However, other related species, native or exotic are also called barbatimão: *Abarema cochliacarpus* (Gomes) Barneby & J.W. Grimes, *S. coriaceum* Benth., *S. pulcherrimum* (Willd.) Hochr. and *S. pumilum* Glaz (Brasil, 2014; Tenório, RFL., MS, JVML, & MCDOC., 2016).

The barbatimão, *Abarema cochliacarpus* (GOMES) Barneby & J.W. Grimes is a native plant from Brazil, which belongs to the family called *Fabaceae* and subfamily *Mimosoidae* (Iganci, JRV, & MP., 2012). The therapeutic properties of phytochemicals are due to active substances present in several parts of the plant, obtained as a total or processed extract. Popularly, the barks of barbatimão are used after a decoction process to heal wounds, ulcers, treatment of sore throats and bleeding (Souza-Moreira, Queiroz-Fernandes, & Pietro, 2018). These healing actions are possible for the presence of the plant phytoactive constituents. The phytochemistry analysis of barbatimão showed the presence of catechin compounds (its dimers and trimers), and others phytoconstituents such as saponins, tannins and proanthocyanidins, anthraquinones, alkaloids, flavonoids, terpenes and steroids (da Silva, Sánchez-Fidalgo, et al., 2010; A. Dias, De Araújo, De Araújo, & Estevam, 2014).

The most of plant species used in folk medicine do not have pharmacological evidence, nor toxicological studies as recommended by resolution 90/2004 (Carvalho, Balbino, Maciel, & Perfeito, 2008), which governs plant toxicity studies for phytotherapeutic purposes. In addition, the designation of plants of several species with the same name (barbatimão), points to the need to verify scientific evidence of the efficacy and safety in the use as herbal medicine. This study aimed to observe pharmacological and toxicological studies of *Abarema cochliacarpus* (GOMES) Barneby & J.W. Grimes which indicate efficacy and safety in its use as an herbal medicine.

## II. METHODOLOGY

### 2.1. TYPE OF STUDY

This is a Systematic Review study according to the Preferred Reporting Items for Systematic Reviews (PRISMA) method (Moher, Liberati, Tetzlaff, & Altman, 2009).

### 2.2. STUDY LOCATION

The consulted databases were: the BVS (Biblioteca Virtual de Saúde), PubMed (National Library of Medicine – NIH) and SciELO (Scientific Electronic Library Online).

### 2.3. ELIGIBILITY CRITERIA

The inclusion criteria involved: (i) *Abarema cochliacarpus* (GOMES) Barneby & J.W. Grimes; (ii) pharmacological action; (iii) toxicological action. Exclusion criteria: (i) review study and (ii) duplicated articles. Thus, original research involving pharmacological and toxicological analyzes of barbatimão were selected.

### 2.4. INSTRUMENTS AND TECHNIQUES RESEARCH

The search was carried out on February 26, 2021, and updated on June 6, 2021. It performed analysis of all studies which were published up to the year 2021. In this study were selected articles involving pharmacological and toxicological barbatimão tests. It was used the descriptors “*Abarema*”, “*cochliacarpus*”, “pharmacological”, and “toxicological” associated with the Boolean operator “AND”.

### 2.5. DATA EXTRACTION

Each article was examined for eligibility by two independent evaluators. A third evaluator resolved disagreements regarding to the inclusion of articles. Data on doses of *A. cochliacarpus* used, characteristics of in vivo and in vitro research, type of pharmacological or toxicological action, derived from a plant drug/part of the plant and the authorship of the studies were extracted for two tables pre-edited by two evaluators.

## III. RESULTS

Observing the pharmacological and toxicological studies of *A. cochliacarpus*, in in vitro models (cell and bacterial lineages) and in vivo (mice and rats), 100 articles were found in the databases, 44 articles in the BVS portal, 25 articles in the PubMed portal and 31 articles in the SciELO portal (**Table 1**). In compliance with the object of the study, 30 articles were excluded for not treating with *A. cochliacarpus*, or for portraying other species such as *Abarema auriculata*, *Abarema pittier* and *Pithecellobium cochliacarpum*; 14 were excluded for not being original articles and 45 articles were duplicated. Eleven articles remained to be analyzed in order to verify efficacy and safety in the use of *A. cochliacarpus* for therapeutic purposes (**Figure 1**).

Table. 1: Distribution of studies in the databases.

Search strategy	BVS	PubMed	SciELO
Abarema	23	11	22
Abarema cochliacarpus	10	6	6
Abarema AND farmacológica	6	1	0
Abarema AND pharmacological	3	5	2
Abarema AND toxicológica	0	1	0
Abarema AND toxicological	2	1	1
<b>Total</b>	<b>44</b>	<b>25</b>	<b>31</b>

### 3.1. CHARACTERIZATION OF THE STUDY

To understand the pharmacological potential of barbatimão, the original works were grouped by pharmacological activity involved in the studies, including analgesic (17%) (Saturnino-Oliveira et al., 2014; N. Silva et al., 2009), antibacterial (17%) (Santos, Ferreira, Rossi-Alva, & LG., 2007; Tenório et al., 2016), anti-inflammatory (25%) (da Silva, Sánchez-Fidalgo, et al., 2010; Sánchez-Fidalgo et al., 2013), antioxidant (17%)(A. S. Dias et al., 2013; Sánchez-Fidalgo et al., 2013), antiulcerogenic (8%)(da Silva, de Almeida, et al., 2010), myoprotective (8%) (Saturnino-Oliveira et al., 2014) and estrogenic and thyroid modulation (8%)(Reis et al., 2018) (Fig. 2; Table 2). Regarding to the toxicological potential of *A. cochliacarpus*, the found study involved the hepatotoxic activity (Oliveira et al., 2013) (Table 3).

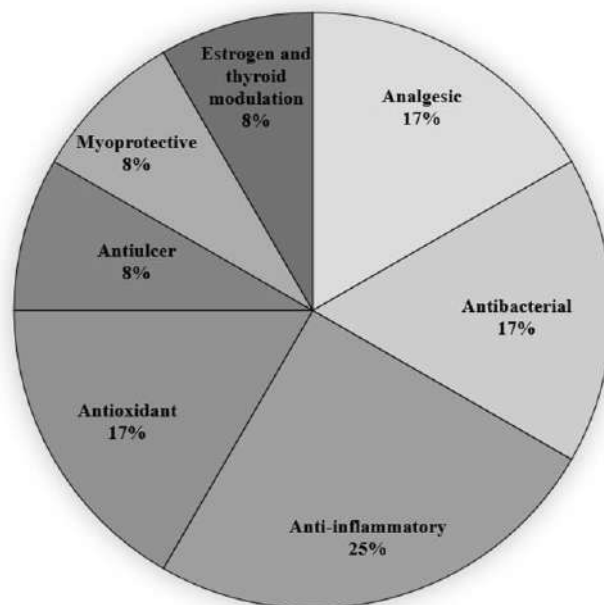


Fig.2: Pharmacological actions of *A. cochliacarpus* selected to compose the article.

### 3.2. CHARACTERIZATION OF PHARMACOLOGICAL STUDIES

#### 3.2.1. Analgesic Activity

Saturnino-Oliveira et al.(2014) observed the anti-inflammatory action in Swiss mice treated with doses (100 and 200 mg/kg) of the hydroethanolic extract of *A. cochliacarpus* and a decrease (39%) of oedema with 400 mg/kg of the extract. When analyzed the functional motor activity in mice on the effect of *Bothrops leucurus* snake venom and treated with the extract, they observed that muscle fibers were preserved, the oedema and pain decreased and improvement in motor functional activity.

In another study (Silva et al., 2009), the analgesic action was verified through modulation in abdominal contractions induced by acetic acid, in mice treated with cold (CA) and hot (HA) aqueous extracts and methanolic (ME) extract of *A. cochliacarpus* at 10 mg/kg, it occurred 73% of abdominal contortion by CA, 68% by HA and 39% by ME. The ME (10 mg/kg) also influenced the neurobiological response of animal defense reactions such as licking and/or biting when injected capsaicin, noting 62% inhibition.

#### 3.2.2. Antibacterial Activity

The antibacterial action was tested by two studies. One of them used the hydroalcoholic extract of barbatimão at 1, 2 and 3 mg/mL doses against the following bacteria: *Staphylococcus aureus* (MIC of 0.3125 mg/mL), *Micrococcus luteus* (MIC of 0.1562 mg/mL), *Escherichia coli*, *Pseudomonas aeruginosa* and *S. aureus* (MIC of

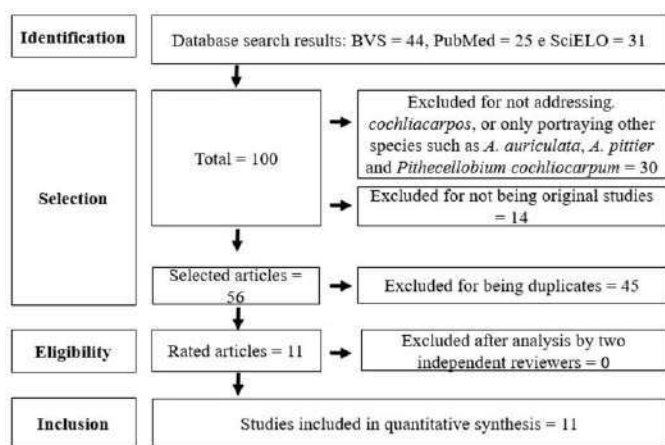


Fig.1: Study selection process to compose the review.

0.3125 mg/mL) isolated from samples of infected individuals (Santos et al., 2007).

Tenório et al. (2016), tested the acetic (EA), cyclohexanic (ECH) and ethanolic (EE) extracts of the bark (6.25; 12.5; 25; 50 and 100 mg/mL), in vitro, against *Bacillus* sp., *E. coli*, *S. intermedius* and *Pasteurella* sp. bacteria collected from dogs with trauma and bruise lacer skin loss. Phytoactive constituents of EA, ECH and EE extracts from the bark of *A. cochliacarpus* at 25; 50 and 100 mg/mL were able to inhibit the bacterial growth of the tested species.

### 3.2.3. Anti-inflammatory activity

Silva et al. (da Silva, Sánchez-Fidalgo, et al., 2010) pointed out the anti-inflammatory action of *A. cochliacarpus* by using the butanolic fraction (FB) of the methanolic bark extract (100 and 150 mg/kg) and used a model of acute ulcerative colitis induced by intracolonic injection of sulphonic trinitrobenzene acid (TNBS) in Wistar rats. The authors showed that FB decreased the macroscopic damages compared with TNBS in Wistar rats; through histological analysis they noticed that there was an improvement in the microscopic structure and preserved some areas of the structure of the colonic mucosa. Another study (M. Silva et al., 2011), also with the FB of the methanolic extract of barbatimão (150 mg/kg) in Wistar rats used the same colitis induction model, showing an improvement in inflammation with a decrease in the lesion and healing induction, with a decrease in TNF- $\alpha$  and the increasing of anti-inflammatory cytokine (IL-10).

### 3.2.4. Anti-inflammatory and antioxidant activity

Sánchez-Fidalgo et al. (2013) tested the butanolic fraction of the methanolic extract (12.5, 25 and 50  $\mu$ g/mL) in Swiss mice. The FB at a dose 50  $\mu$ g/mL reduced the inflammatory response induced by bacterial lipopolysaccharides (LPS) in murine peritoneal macrophages in in vitro cell model. Additionally, a negative regulation was observed in the expression of

cyclooxygenase-2 (COX-2) and nitric oxide inducible synthase (iNOS) in cells treated with 50  $\mu$ g/mL of the fraction.

### 3.2.5. Antioxidant activity

The antioxidant activity of the hydroethanol extract (EE) and its ethyl acetate (EAF) and hydromethanol (HMF) fractions of *A. cochliacarpus* (10, 100 and 1000  $\mu$ g mL<sup>-1</sup>) against oxidative damage were analyzed by Dias et al. (A. S. Dias et al., 2013) The authors also noticed an immediate nullifying effect against peroxy radicals induced by  $\alpha,\alpha$ -but-azodiisobutyramidine dihydrochloride (AAPH) when used in the total antioxidant reactivity test (TAR). The phytoactive present in the extracts and fractions showed the potential hijacking of reactive nitrogen species (RNS) reducing the formation of nitric oxide (NO) at a dose of 100  $\mu$ g mL<sup>-1</sup> (29.7% EE, 34.3% EAF and 36, 7% HMF) and 1000  $\mu$ g mL<sup>-1</sup> (52.7% EE, 18.4% EAF and 30.5% HMF).

The chloroform (200 and 400 mg/kg) and methanolic (100, 200 and 400 mg/kg) extracts and the butanolic fraction of the methanolic extract induced an anti-ucrogenic effect in ulcer models caused by absolute alcohol in Wistar rats. The mechanisms of action proposed by the authors involve activation of vascular endothelial growth factor (VEGF) and thermal shock protein (HSP70) and inhibition of COX-2, promoting cell proliferation, healing and regeneration of tissue injury (da Silva, de Almeida, et al., 2010).

### 3.2.6. Anti-ulcer activity

Chloroform (200 and 400 mg/kg) and methanol (100, 200 and 400 mg/kg) extracts and the butanolic fraction of *A. cochliacarpus* methanolic extract an anti-ucrogenic effect in ulcer models induced-absolute alcohol in Wistar rat. Activation of vascular endothelial growth factor (VEGF) and heat shock protein (HSP70) and COX-2 inhibition appear to be involved in cell proliferation, healing and tissue injury regeneration (da Silva, Sánchez-Fidalgo, et al., 2010).

Table 2: Dose/effect profile of *A. cochliacarpus* in vivo and in vitro models pharmacological.

Pharmacological activity	Vegetable drug derivative / Plant part	Dose	Model	Author
Analgesic	- Hydroethanolic extract /stem bark	100, 200 e 400 mg/kg	Male Swiss mice	Saturnino-Oliveira et al 2014
	- Cold aqueous extract/ stem bark	3, 6, 10 e 100 mg/kg	Male Swiss mice	Silva et al 2009
	- Methanolic extract/ stem bark			
	- Hot aqueous extracts/ stem bark			



Antibacterial	- Hydroalcoholic extract/ bark	1, 2 e 3 mg/mL	<i>In vitro</i> - <i>Staphylococcus aureus</i> , <i>Micrococcus luteus</i> , <i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , <i>S. aureus</i> clinical sample isolate	Santos et al 2007
	- Acetone extract/ bark - Cyclohexane extract/ bark - Ethanol extract/ bark	6,25; 12,5; 25; 50 e 100 mg/mL	<i>In vitro</i> - <i>S. intermedius</i> , <i>Bacillus</i> sp., <i>Pasteurella</i> sp. and <i>E. coli</i>	Tenório et al 2016
Anti-inflammatory	- Butanolic fraction of the methanolic extract/stem bark	100 e 150 mg/kg	Male and female Wistar rats	Da Silva et al 2010
	- Butanolic fraction of the methanolic extract/stem bark	150 mg/kg	Male and female Wistar rats	Da Silva et al 2010
	- Butanolic fraction of the methanolic extract/ stem bark	6,25; 12,5; 25; 50.; 100 e 200 µg/mL	Swiss mice	Sánchez-Fidalgo et al 2013
	- Flavonoid, (+)-catechin	1,875; 3,75; 7,5; 15 e 30 µg/mL		
Antioxidant	- Ethanol extract/ stem bark - Ethyl acetate fraction of the ethanol extract - Hydromethanol fraction of the ethanol extract - Hexane fraction of the ethanol extract - Chloroform fraction of the ethanol extract	10, 100 e 1000 µg mL <sup>-1</sup>	<i>In vitro</i> - oxidative damage	Dias et al 2013
	- Butanolic fraction of the methanolic extract/ stem bark	6,25; 12,5; 25; 50.; 100 e 200 µg/mL	Swiss mice	Sánchez-Fidalgo et al 2013
	- Flavonoid, (+)-catechin	1,875; 3,75; 7,5; 15 e 30 µg/mL		
Antiulcer	- Chloroform extract/ bark	100, 200 e 400 mg/kg	Male Wistar rats	Da Silva et al 2010
	- Methanolic extract/ bark			
	- Butanolic fraction of the methanolic extract - Ethyl acetate fraction of the methanolic extract - Aqueous fraction of the methanolic extract	12,5; 25, 50, 50, 100, 150 e 200 mg/kg		
Myoprotective	- Hidroethanolic extract /stem	100, 200 e 400	Male Swiss mice	Saturnino-Oliveira

	bark	mg/ kg		et al 2014
Estrogen and thyroid modulation	- Methanol extract/ whole plant	50 e 100 µg/mL	<i>In vitro</i> - ER and TR gene-reporter assays, using 17-estradiol and triiodothyronine as the positive controls.	Reis et al 2018

Table 3: Toxicological profile of *A. cochliacarpus*.

Toxicological activity	Vegetable drug derivative / Plant part	Dose	Model	Author
Hepatotoxicity	- Hydroalcoholic extract/ stem bark	125, 250, 500, 1000 mg/ mL	Mice <i>Mus musculus</i>	Oliveira et al 2009
	- 1 mL the bark infusion	12,5; 25; 50% v/v		

3.2.7. Myoprotective activity

The myoprotective effect of the hydroethanolic extract of *A. cochliacarpus* in Swiss mice was evaluated after injecting the venom of *B. leucurus* (Saturnino-Oliveira et al., 2014). The myoprotective activity was observed in the microscopic evaluation, at which the treated muscles showed preserved structures, decreasing edema and inflammatory infiltrate compared with untreated animals. It was also noted that the extract of *A. cochliacarpus* reduced the myonecrotic effect induced by the snake venom, and less areas of hypercontracted myofilaments being able to be observed or hemorrhagic components with a decrease in edema and plasmatic creatine phosphokinase activity (Saturnino-Oliveira et al., 2014).

3.2.8. Estrogenic and thyroid modulating activity

Another pharmacological activity of *A. cochliacarpus* highlighted in the studies, using the methanolic extract obtained from several parts of the plant at the doses of 50 and 100 µg/mL is the positive modulation of the thyroid, increasing gene expression, comparing the effect with classic drugs such as 17β-estradiol and triiodothyronine. Phytoactive constituents present in *A. cochliacarpus* extracts were also able to activate estrogen receptor as far as the positive control (17β-estradiol) (Reis et al., 2018).

3.3. CHARACTERIZATION OF THE TOXICOLOGICAL TEST

3.3.1. Hepatotoxic activity

The only study that presented toxicological tests during the search in the databases showed that phytoconstituents of the hydroalcoholic extract of the bark of *A. cochliacarpus* (125, 250, 500, 1000 mg/mL) and 1 mL of infusion of the plant bark, orally and nasogastric, induced

hepatic steatosis (hepatotoxicity) in *Mus musculus* mice (R. Oliveira et al., 2013).

IV. DISCUSSION

*Abarema cochliacarpus* (GOMES) Barneby & JW Grimes is a related plant species of the *Stryphnodendron adstringens* (Mart.) Coville species, both popularly known as barbatimão. *S. adstringens* has a monograph organized by the Ministry of Health and ANVISA, which also deals with information on the safety and efficacy of the species in the use as an herbal medicine. However, *Abarema cochliacarpus* is identified as a correlated species of *S. adstringens*, which motivated the search for scientific evidence on its use in the phytotherapy (Brasil, 2014).

The systematic review made it possible to realize that *Abarema cochliacarpus* has phytoactive substances with antioxidant, anti-inflammatory, antibacterial, myoprotective, estrogenic and thyroid modulator activities. The indications of *S. astringens* in phytotherapy point to antinociceptive (Melo et al., 2007), antibacterial (Ferreira et al., 2010; D. Oliveira et al., 2007; Pinho, Souza, Sobrinho, Almeida, & Martins, 2012; Souza, Moreira, Pietro, & Isaac, 2007) antiinflammatory (Lima, Martins, & Junior, 1998), gastroprotective and anti-ulcer action (Audi et al., 1999; Martins, Lima, & Rao, 2002).

The acute and chronic models of inflammation, in male Wistar rats, an anti-inflammatory action of the methanolic extract of the of *S. adstringens* stem is showed (Lima et al., 1998). One of the main effects of the action of snake venom of the species *Bothrops leucurus* in the tissue, due to the inflammatory reaction (local mediators such as histamine and serotonin) is the presence of oedema and necrosis that can lead to functional loss or even

compartment syndrome (Anz et al., 2010). The increased sensitivity to painful stimuli after the induction of this venom and the lack of antitropic serum that neutralizes this shows the importance of studies in the area and the development of therapeutic processes to control hyperalgesia (Picolo, Chacur, Gutiérrez, Teixeira, & Cury, 2002).

A gastric disease that affects many people is the peptic ulcer, which can be caused by reasons such as stress, alcohol, smoking, use of medications, among others. The gastroprotective effects of barbatimão in a stress gastric injury model was also tested in male Wistar rats by using extracts (100 and 400 mg/kg) of the bark of stem of the *S. adstringens* (Audi et al., 1999; Martins et al., 2002).

The monograph of *S. adstringens* (Brasil, 2014) does not approach studies with hepatotoxic action, but it is noteworthy that as the use of the infusion of the bark of barbatimão is widely popularly used to treat gastric conditions, it is necessary to carry out more studies on this respect because its use without a safe dosage can cause liver diseases (Rebecca et al., 2003). As the present data indicate, the regularization of the phytotherapy requires ethnobotany evidence, laboratory studies and pre-clinical tests necessary to ensure efficacy and toxicological tests recommended to ensure safety.

## V. CONCLUSION

Pharmacological studies on *A. cochliacarpus* showed considerable heterogeneity in the pharmacological actions identified as analgesic, antibacterial, myoproter, anti-inflammatory, antioxidant, antiulcerogenic and estrogenic and thyroid modulation. The studies involved in vivo and in vitro animal models, with the bark of the plant being the most used part in extract and fraction production. Among 11 selected studies, only one study carried out a toxicological test, in which the hepatotoxicity of *A. cochliacarpus* was scored. In this sense, further studies on *Abarema cochliacarpus* (GOMES) Barneby & J.W. Grimes have to get conducted so that they can be used as a safe and effective correlated phytotherapeutic effect of *Stryphnodendron adstringens*. It is also important to prove its safety for using in folk medicine or phytotherapy in the long term, as the use of barbatimão can also be a cause of intoxication depending on the dose used and the time of use.

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# Social and Environmental Responsibility at Pratigi EPA: Shrimp farming and riverside communities in Barra do Serinhaém - Ituberá-BA

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**Keywords** — **Environmental  
Responsibility; Social Responsibility;  
Social Entrepreneurship; Mariculture;  
Pratigi APA.**

**Abstract**— Analyze the role of economic agents in Pratigi's Environmental Protection Area (EPA) in order to understand the balance between environmental conservation, income generation, green marketing and entrepreneurship. In particular, aspects of environmental law on environmental damage and Corporate Social Responsibility (CSR) will be observed. The study region comprises the estuarine zone of Ituberá/BA, the socio-environmental aspects of the riverside communities and its relationship with an innovative project for the cultivation of shrimp in cages and canvas tanks in Barra do Serinhaém, conceived by Litoral Sul Maricultura (LSM) in partnership with IFREMER of France. The production model analyzed showed that there is a possibility for private capital to contribute to social entrepreneurship, also generating social and environmental benefits through its Social Responsibility.

## I. INTRODUCTION

Since it is everyone's duty to defend and protect the environment from degradation and pollution, Brazilian environmental law defines that it is the responsibility of the Public Authority to protect the environment, and other agents - economic and social - must collaborate in this regard, especially those that most affect the environment, due to the effects of degradation and pollution arising from

its production activities. According to Paulo Affonso Leme Machado, "the action of the collectivity, unlike that of the Public Power, is generally optional [...]" (apud SIRVINSKAS, 2012, p. 153), however, economic agents, by virtue of their conduct harmful or environmental damage, must have the environmental responsibility,

already provided for in art. 14, § 1 of the National Environmental Policy<sup>1</sup>.

The Government's inertia in the face of environmental issues in Environmental Protection Areas (EPA) translates into the difficulty of managing and inspecting an expressive territorial area, with relative demographic density and significant economic activity, all combined in a space of ecosystems endowed with accentuated environmental fragility or that suffered intense anthropic action, therefore, a region that needs the tutelage of the State for the maintenance of environmental services and conservation of natural resources and scenic beauty of its landscapes.

Given this difficulty in reconciling economy with the environment, this article discusses the conceptual basis of social and environmental responsibility of private capital, passing through the understanding of entrepreneurship or innovation, having as object of study a pioneer (and innovative) shrimp farming project (breeding of shrimp) developed by Litoral Sul Maricultura (LSM) in Barra do Serinhaém, municipality of Ituberá, Pratigi EPA, territory of the Baixo Sul of Bahia.

Therefore, the objective is to analyze, from the development of economic activity of shrimp farming in Pratigi EPA, the impacts on the processes of income generation and environmental conservation, environmental marketing, in addition to reflecting on the process of social entrepreneurship and formation of social capital developed with the participation of the riverside population.

As a methodological approach, a bibliographic review was carried out on the themes of social and environmental responsibility, environmental legislation in areas of environmental protection and business (and social) entrepreneurship in shrimp farming, associated with the generation of income and development of social capital. Other additional information was obtained. *in loco* during technical visits to riverside communities and the pilot project in Barra do Serinhaém, owned by Mr. Eduardo Lemos, as well as obtained through contacts with social agents in the community of Barra do Serinhaém.

Therefore, the topic to be addressed in the article will follow the following topic structure: (ii) Aspects of Environmental Legislation, Entrepreneurship and Social Responsibility; (iii) Social and environmental profile of EPA Pratigi; (iv) Social and Environmental Liabilities of the Pratigi EPA; (v) Coastal aquaculture and environmental damage; (vi) Performance of private entities in the Pratigi EPA and (vii) Conclusion.

## II. ASPECTS OF ENVIRONMENTAL LEGISLATION, ENTREPRENEURSHIP, ECONOMY GREEN AND SOCIAL RESPONSIBILITY

Access to an ecologically balanced environment is a right guaranteed in Article 225 of the Federal Constitution of 1988. In order to guarantee the effectiveness of this right, the Government must create protected spaces, called Specially Protected Territorial Spaces (SPTS), which includes any environmental space that provides legal protection for its natural attributes. The SPTS include the Conservation Units (CU), considered the best strategy for the conservation of biodiversity and maintenance of environmental services (Leuzinger & Scardua, 2010).

In Brazil, the creation and management of Conservation Units is the role of the State, as defined by the National System of Nature Conservation Units (SNCU), as it is the driver of environmental protection and management policies for these areas.

The SNCU establishes parameters for the creation and management of protected areas in the country, within a system that presents several categories that vary in terms of the degree of protection, ranging from units that do not even allow visitation, to those that include industries and cities in their interior, as is the case of the EPA (Guerra & Coelho, 2009). In its art. 15, defines the EPA as an extensive area with a certain degree of human occupation, endowed with abiotic, biotic, aesthetic and cultural attributes important to the well-being of human populations and which aims to ensure the sustainability of the use of natural resources.

The EPA highlights the possibility of maintaining private property and the traditional lifestyle, enabling environmental protection programs to be implemented without the need for expropriations. For the Brazilian reality, this strategy has become advantageous, as the lack of financial resources or government inertia limit the implementation and consolidation of other more effective protection programs (Oliveira HH, 1995). However, the EPA is configured as a problematic area due to human occupation and the development of economic activities that, to a greater or lesser degree, bring environmental liabilities. The major obstacle in the matter is to reconcile development with environmental preservation in these areas, bringing problems regarding the management of human activities. One possibility for solving this issue lies in the effectiveness of the duty of social and environmental responsibility of companies, thus contributing to partially meet social and environmental demands, in return for the benefits of environmental marketing.

<sup>1</sup> BRAZIL. Law no. 6.938/81, of August 31, 1981. Provides for the National Environmental Policy (PNMA).

It is also necessary to consider the forms of appropriation and use of territories in the EPA based on studies of the fragility of their ecosystems and their support capacity. Law 6,902/1981 requires sustainable management of natural resources to conserve or improve local ecological conditions and ensure the well-being of human populations. Carrying capacity is based on the notion of resilience, the concept of which refers to the ability of a system to respond to externalities, through its recomposition or restructuring, establishing, for example, the relationship between the carrying capacity of an area and its population. To this end, it establishes rules limiting or prohibiting mainly the implementation of industrial activities of high polluting power (Zanoni *et al.*, 2000).

Faced with the increase in anthropic pressures on nature and its consequences, society has been demanding a reorganization in the developmental perspective, so that it has a stamp of social responsibility, commitment to sustainable development. The latter brings with it the understanding as the growth of something or the physical or material increase in production, with the purpose of maintaining itself in a continuous manner (Sartori, Latrônico, & Campos, 2014).

Sustainable development in tune with the environment requires a balance in the manipulation of ecosystems, in a way that guarantees their sustainability, their capacity for absorption and recomposition from the aggressions suffered by anthropic actions. Thus, there is harmony between man and the environment, not establishing a dichotomy between them (Meneguzzo, Chaicouski, & Meneguzzo, 2009). In this sense of considering several dimensions in development, the expression Green Economy emerged, which is explained by the encounter between economy, well-being and ecosystem (Abramovay, 2012).

Economic growth is a condition for building infrastructure and offering services that will meet the basic needs of humanity, but it is imperative to change the way in which the content of this growth materializes, setting limits, such as respect for the capacity of ecosystems and ethics in decision-making processes (Abramovay, 2012).

The Green Economy involves three fundamental dimensions which are energy efficiency, use of products and services from biodiversity, and reduction of pollutant emissions. Together they form a new paradigm for economic life, based on the idea that capital and labor can replace what is offered by nature, through eco-efficiency, reducing pressure on natural resources, that is, “increasingly less matter, less energy, less emissions...”, even so, guaranteeing the reproduction of human societies (Abramovay, 2012).

In this scenario, environmental or green marketing emerges, which has become an important tool in the life of corporations, as consumers and society in general have demanded products and services from companies that reflect an idea of environmental and social responsibility, as discussed above. However, consumer distrust will require more than isolated or one-off actions from the company, but responsible business management, respecting above all the consumer and the environment. Actions aimed at improving the quality of life or preserving the environment are no longer exclusive banners of non-governmental organizations. Private initiative discovered in the green wave an excellent locus of business and has now become, many of them, ecological partners of these NGO.

According to Gibbons, from the consultancy Good Business, it is a mistake when companies use sustainability and Corporate Social Responsibility (CSR) programs as communication tools, when in fact they are management tools that help organizations measure their social and environmental impact. The survival of the company today, in the face of the growing ecological movement, must consider its CSR as a management goal and not only as a form of communication. The corporation can take advantage of this issue, but it must satisfactorily meet this new consumer standard, more attentive to changes, demanding, analytical and that expects results and ethical behavior from companies that look after their well-being.

Within a logic in which sustainability is an important challenge in the emergence of a new economy, it seems increasingly sensible and urgent to establish connections between private capital and Social Entrepreneurship and Social Responsibility, thus bringing the ideal of sustainable development.

According to Melo Neto and Froes (2002) apud Andrade (2016), Social Entrepreneurship has the characteristics of being collective and integrated, producing goods and services for the community, focusing on finding solutions to social problems and community needs, its performance it is measured by social impact and transformation, and should generate social capital, inclusion and social emancipation (Andrade *et al.*, 2016).

Social Entrepreneurship is related to third sector organizations or organizations of government actions or entrepreneurs in the social field. Social Entrepreneurship actions emerge at a time of crisis for the State in the face of neoliberalism and the concern to meet social needs. Hence the need for a large number of organizations to adopt tools and strategies from private companies, finding a way to survive, previously subsidized by the government. Private companies, in turn, encouraged the

process of transferring knowledge and management tools for social intervention (Oliveira EM, 2019).

Given the understanding of development beyond profit, in the various dimensions it contemplates, companies are required to be Socially Responsible to the community, not limited to meeting only the organizational demands and interests of their employees (Oliveira et al., 2020). In this sense, social responsibility is linked to an action committed to the end of social transformation applied by an innovative management model (Melo Neto & Brennand, 2004). Therefore, in addition to quality products, companies are required to have their benefits well publicized so that the consumer is interested in the product or service, but also social initiatives, which have in their guiding principles the company's social responsibility, with the environment, inclusion, respect for differences, among other needs. Today's consumers demand information about production, which principles and philosophy of companies.

The legal framework of CSR, as defined by ABNT, brings the ideas of responsibility in the company's decisions and activities, towards society and the environment, ethical and transparent behavior, in order to contribute to the well-being of society. The ETHOS Institute, an organization created by entrepreneurs in Brazil, also supports this understanding, whose vision should not be limited to simple aspects of social marketing or appearance, but a commitment to concrete values and actions (Oliveira EM, 2019).

It is evident the existence of the relationship of Social Entrepreneurship with the third sector and as a CSR movement. private companies, which in turn contributed to the social field by encouraging the process of transferring knowledge and management tools. Despite the ambivalences of CSR, imposed by its process of competition and accumulation, possible connections can arise in working to share knowledge, resources and efforts to achieve the goals of a fair and sustainable society (Oliveira EM, 2019).

In this way, Business Entrepreneurship can connect to Social Entrepreneurship through the so-called CSR by proposing an integration action, meeting common and ambivalent objectives, which somehow generates an innovation process that, despite the market logic, contributes in the social field, benefiting the community and the formation of its social capital.

### III. SOCIAL AND ENVIRONMENTAL PROFILE OF THE PRATIGI EPA

The Pratigi Environmental Protection Area currently has 85,686 hectares and is located in the *Baixa Sul* of *Bahia* (Figure 1), covering the municipalities of *Ibirapitanga*, *Igrapiúna*, *Ituberá*, *Nilo Peçanha* and *Pirai do Norte*. It was created in April 1998 and expanded by State Decree No. 8036 of September 20, 2001, with the objective of protecting large stretches of beaches, restingas, mangroves and remnants of dense rainforest (Atlantic Forest), as well as promoting tourism, ecotourism and the ordering of economic activities in the municipalities that are part of it (Bahia, 1998).

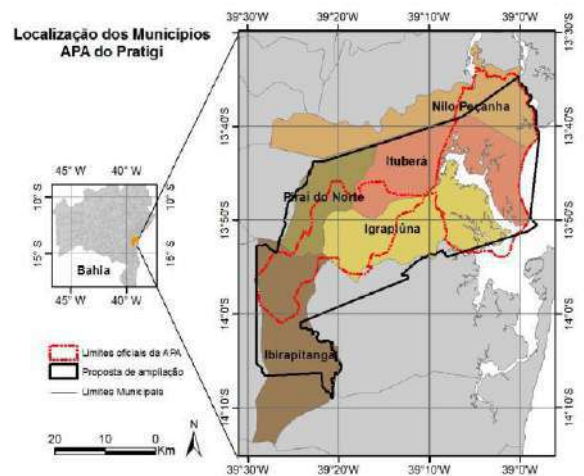


Fig. 1: Location of Pratigi EPA. Source: (Macedo, Oliveira & Rocha, 2010)

*Pratigi* EPA owns some of the most important Atlantic Forest ecosystems in the country, where one of the greatest biodiversity on the planet can be found, forests at an advanced stage of regeneration, hilltops with numerous springs, hydrographic basins, as well as environments such as restingas, mangroves, estuary, beaches and islands. All this biodiversity has attracted the Federal and State Governments, multilateral development agencies, NGO, private companies and investors, in addition to the local communities themselves, which have been realizing the value of the environmental assets that belong to them. As it is considered a priority area for the conservation of Atlantic Forest remnants, it is included in the Atlantic Forest Central Corridor Project and, therefore, due to its strategic position, was chosen to be the pilot area of the *Bahia Baixo Sul* EPA Mosaic Integrated and Sustainable Development Program, with the support of the UN (United Nations) and the IDB (Inter-American Development Bank) (Campos et al., 2008).

It is worth mentioning that the mangroves in the *Baixa Sul* region of the state represent about 58% of the total



110,000 hectares existing in the South Coast and that almost all remain with the original vegetation cover intact. This reality can be justified by the spatial distribution, generally located on islands and areas of difficult access, and of low population density. In terms of preservation, the same happens with the restingas, as they are located outside the municipal seats and many of them on privately owned islands, where extensive coconut and oil palm plantations are developed, and has served as a limiting factor to the implementation of subdivisions (Bahia, 1996). Much of the forest area is still preserved. The location of the *Pratigi* EPA, as part of a mosaic of EPA and inserted in the Central Ecological Corridor of the Atlantic Forest, makes it serve as a connection between the other forested areas, enabling movement and ensuring the preservation of numerous species (OCT, 2011).

The *Pratigi* EPA region has a population of approximately 89,350 inhabitants (2020 Census), of which 36.4% make up the EAP (Economically Active Population) and need the sustainability of the regional economy for its survival. According to the Agricultural Census (2017), the area of agricultural establishments occupies 127,646 hectares, distributed among 9,830 properties and 8,382 owners, which highlights the prevalence of small production units, operated on a family basis and with extremely diversified agriculture in terms of permanent crops, which include oil palm, rubber, palm hearts, guaraná and cocoa, in addition to other products such as bananas, cassava and pepper. These cultures represent the family income of a large portion of the rural population, and also of urban dwellers who thus complement the family income (IBGE, 2017).

Due to the number of rivers that form eleven hydrographic basins in the *Baixo Sul* of *Bahia*, it is considered as the “water circuit”, with the presence of countless waterfalls. Coastal formation, bays and estuaries are favorable environments for the production of fish, shellfish and crustaceans, making this area a great potential producer in this sector. The EPA expansion in 2001 was due to the need for environmental protection of the Juliana River Hydrographic Basin, which is part of an exuberant water complex that includes the Igrapiúna estuary areas to the mouth of the Pinaré River, including the Cachoeira da Pancada Grande, important tourist attraction in the region that is part of a Private Natural Heritage Reserve (PNHR) (CRA, 2004).

#### IV. SOCIAL AND ENVIRONMENTAL LIABILITY OF PRATIGI EPA

Human activities generate situations of risk and imbalance in natural systems, and due to the degree of

environmental fragility, they become more vulnerable to processes that are caused by the inadequate occupation, use and management of these spaces. The coastal and fluvial-marine ecosystems, associated with the biodiversity of its fauna and flora, make the *Pratigi* EPA a region endowed with degrees of environmental fragility and vulnerability.

The environmental liability refers to any negative impact, whether foreseen or not, in the phases prior to the implementation and operation of any undertaking, perceived a posteriori, without having sought to repair it. It reflects the environmental damage resulting from the degradation character of any economic activity, especially industrial.

The initial occupation of the *Baixo Sul* region of *Bahia* is linked to sugar production, which did not achieve the success expected by the colonizers and, as a result of the failure of this activity, became economically dependent on the *Recôncavo Baiano*. Only in the 19th century, with the expansion of the demand for tropical products to supply Europe and the United States, the South Coast shows promise for the cultivation of cocoa. From that period and in the first decades of the 20th century, cocoa farming expanded and the regional economy changed with the replacement of subsistence crops by cocoa, which came to dominate the economic scenario of *Bahia*. And so, with the growing demand for cocoa on the foreign market, the price remains high for a long period, but today it is no longer the main agricultural product in the region, mainly due to the crisis triggered by the witch's broom plague (Macedo, Oliveira, & Rocha, 2010).

In this process of occupation and consolidation of the cocoa culture, the impact on native vegetation took two forms. At first, the replacement was total, with the clearing and burning of the Atlantic Forest to introduce the crop. In the second moment, the forest was partially removed and replaced by dispersed crops associated with subsistence polycultures and pastures in the middle of the forest. But with the intensification of production, the occupied parcels increased at the expense of original vegetation, which today was restricted to scattered fragments. Even so, 41% of the remnants of the original Atlantic Forest remain in this area (Macedo, Oliveira, & Rocha, 2010).

However, these activities, generally associated with inadequate planting techniques, such as the use of fire and disorderly deforestation, made the soil more vulnerable to erosion, accelerating the siltation process of a large part of the riverbeds in this region. According to official data from the Coordination of Agrarian Development of *Bahia* (CAD), there is a large portion of land in the *Pratigi* area occupied by squatters who mostly practice slash-and-burn

agriculture for planting bananas and cassava, resulting in a model of vulnerability for families and inefficient use of work and the use of natural resources (Campos et al, 2008).

The remnants of the Atlantic Forest are the ones that have suffered most from the predatory action of man. The purpose of wood extraction was to supply sawmills, charcoal plants and meet the expansion of cultivated areas. On the main highways that give access to this sub-region, there was a constant flow of trucks transporting wood in logs, originating from primary and secondary vegetation, verified during times of little inspection. In some cases, the wood was extracted from unauthorized areas, with the contribution of agrarian reform settlements, which became suppliers of wood for sawmills, due to the lack of credit support from financial and government agencies (Bahia, 1996).

According to fishermen's complaint, the closed season was not respected in the coastal strip (temporary interruption of fishing), thus harming the renewal of natural stocks of the various species of shrimp. The estuarine waters and the formation of mangroves in the Southern Lowlands exert ecological and nursery functions for the development of species that have them as habitat or use it as a breeding area, however they have been constantly attacked. The degrading action was related to predatory fishing, such as the use of bombs, the use of trawling boats in the estuarine channels, the use of nets with meshes below the recommended specification, as well as the use of traditional and most harmful cambodies, the so-called line or net *camboa*, also widely used to encircle mangrove areas in *Maraú* and *Camamu* (Bahia, 1996).

Among other factors that cause environmental liabilities in this sub-region, strongly affecting water resources, the various urban agglomerates that release domestic effluents without any type of treatment into watercourses are listed. It is also common to observe the practice of implanting dumps in spillways in the basins, which act as a permanent source of river pollution. In the city of *Ituberá*, in addition to the *Serinhaém* river, the streams that cut through the city receive sewage "*in natura*", through rainwater drainage, and together with the effluents from the Municipal Slaughterhouse, they drain into the aforementioned river. Finally, it is worth noting the hunting of wild animals, which is a common practice in rural areas, no longer having only a subsistence character and becoming an alternative source of income through illegal trade (Bahia, 1996).

During the surveys carried out for the Management Plan, in 2004, all these environmental liabilities were confirmed, added to others, such as construction of dams

and roads, capture of wild animals, contamination by agrochemicals, shrimp farming, which have caused a series of negative impacts causing, for example, damage to fauna and flora, fragmentation of natural habitats, occupation of fragile areas such as restingas and mangroves, increased surface runoff, accentuated erosion processes, siltation and contamination of soil and springs, which together constitute a picture degradation that compromises the biodiversity and natural resources of this region (CRA, 2004).

## V. COASTAL AQUACULTURE AND ENVIRONMENTAL DAMAGE

Damage is any injury to a protected legal asset, and environmental damage, in turn, is any aggression against the environment derived from an economic activity of potential pollution and may also be an act of imprudence practiced by any person or by omission resulting from negligence. There is thus a responsibility to repair or indemnify the damage caused as a legal duty. However, some problems arise there, as not every asset can be recovered, and there is also a difficulty in quantifying the environmental damage. In both cases, an indemnity amount should be set for the damage caused (Sirvinskaskas, 2012).

To understand the idea of environmental responsibility, one must start from the analysis of damage repair theories. As there was a great difficulty in proving the guilt of the cause of the environmental damage, the legislation started to adopt the objective theory, where the demonstration of guilt is not required, just demonstrating the existence of the fact or act. In this way, the agent causing the damage is held liable regardless of having acted at fault. Thus, it has already been established in the doctrine and jurisprudence that anyone who causes damage to the environment or to a third party will be obliged to reimburse him even if the negligent or intentional conduct was committed by a third party. Remembering that every company has risks inherent to its productive activity, and for this reason, it must assume the duty to indemnify the damage caused to third parties (Sirvinskaskas, 2012).

As mentioned about the difficulty of quantifying or repairing the damage to the environment, given the obligation to indemnify the causer, in the case of economic agents, it is perfectly feasible for this repair or compensation to take place in the form of investments and support for environmental preservation projects, guaranteeing these companies the counterpart of green marketing. Sirvinskaskas (2012) states that "business [...] can be an excellent partner in protecting the environment,

regardless of whether or not it is responsible for the degradation we are experiencing."

As aquaculture is an economic activity that transforms natural resources into products for society, as such, it produces impacts and environmental damage. According to Nascimento (1998), the three biggest impacts are related to the consumption of natural resources, the transformation process of these resources and the production of waste. The author emphasizes that aquaculture modifies the structure and dynamics of the ecosystem to increase the production of selected species, and from an ecological point of view, local modifications of lesser impact may occur, as well as others on a regional scale, harmful to the point of rendering the natural environment incapable of sustaining this activity. Thus, adequate management is needed to make the activity sustainable, instead of using the ecosystem only as a repository for waste and a supplier of natural resources.

Given the logic of sustainable development, there is a need to take into account the limits of support for the ecosystem, which includes the availability of light and nutrients in the primary production of the cultivated area; the ability to renew living resources; the availability of water that supports organisms in cultivation, oxygen transport and waste removal. In addition to other resources such as land or aquatic space for the installation of marine farms, offspring (larvae) for storage and the food offered, construction material, industrial energy, chemical substances and services (Nascimento, 1998).

The implantation of marine aquaculture in tropical and subtropical regions takes place in flooded coastal areas, called mangroves. The greatest environmental impact resulting from aquaculture is the degradation of mangroves, especially for the implementation of shrimp farming projects. In Brazil, the biggest degradation factor has been the expansion of urban areas for industrial, port, tourist and housing use. Deforestation in mangroves causes coastal erosion, affects nutrient production and species reproduction. Mangroves have great ecological and socioeconomic value, as they serve as a biological filter for pollutants, store nutrients, recycle organic matter, reduce flooding, prevent sediment deposition, in short, it is a high productivity ecosystem (Nascimento, 1998).

Nascimento (1998) lists the most significant impacts related to shrimp farming: habitat destruction and loss of biodiversity in mangroves; acidification or salinization of coastal soils; use of areas to supply the resources that sustain the activity, estimated to be between 35 and 190 times larger than the area under cultivation; water requirement for replacement in the nurseries and replacement of losses and return in a more degraded form

with an increase in the organic load and nutrients (onshore nurseries); threat to natural stocks to ensure the fattening of the offspring. Given this scenario of continuous expansion of aquaculture worldwide, it is necessary to search for clean technologies, in order to mitigate these impacts and ensure the sustainability of the activity (Nascimento, 1998).

Brazil, according to FAO (2007) apud Bessa-Junior (2014), is one of the countries that has shown the greatest growth in aquaculture, whose productivity grew six times between 1997 and 2003, mainly due to shrimp farming, especially in the Northeast, which holds 95% of the national production of shrimp, bringing together the best edaphoclimatic conditions for shrimp farming due to high temperatures and its relative climatic stability. In addition to these conditions, the region is home to a coastal zone with a large number of estuaries and mangroves, providing enormous potential for mariculture. According to the author, the latest census released by the Brazilian Association of Cameroon Breeders shows that the Northeast has approximately 1,428 farms, that is, 92% of farms in the country, totaling 19,610 hectares of arable land, with a production of 69,088 tons (Bessa-Junior, 2014).

Mariculture, in addition to being a relevant economic activity in food production, which has been showing great growth, is also a prominent factor in the income generation within the socioeconomic scenario, which, combined with the region's enormous potential for these activities, can bring one contribution to local development, including improvements to the lives of fishermen and riverside dwellers. However, it is necessary to guarantee the sustainability of these activities in order to preserve the coastal ecosystems for future generations, as well as to maintain the ways of life of riverside communities and their cultural values.

## VI. PERFORMANCE OF PRIVATE ENTITIES IN THE PRATIGI EPA AND SOCIAL RESPONSIBILITY

The option for the LSM shrimp farming project in *Barra do Serinhaém* is due to being the best example of the analysis of the idea of social entrepreneurship, social and environmental responsibility, income generation and local development, involving estuarine communities in Bahia's *Baixo Sul*, a region endowed with enormous ecological potential, but with low human development, mainly in the riverside populations, formed by farmers and fishermen.

O Estuário do Serinhaém faz parte da zona costeira da APA do Pratigi e está dentro dos limites de Ituberá e

Igrapiúna, com uma extensão de aproximadamente 30 km (Figura 2).

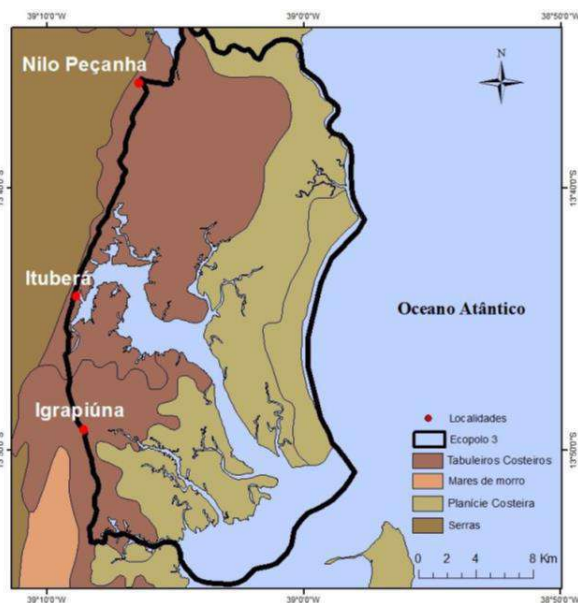


Fig. 2: Location of the Serinhaém Estuary. Source: (Santos & Nolasco, 2017)

The first experiments in the cultivation of shrimp in cages were carried out by Eduardo Lemos, in 1985, in *Rio de Janeiro*, in *Barra de Guaratiba*. The first results led to the creation of the company *Litoral Sul Maricultura* (LSM) in 1988, with KIEPPE Investments as a partner, and thus a pilot station was implemented in *Barra de Serinhaém, Ituberá, Bahia*. In 1991, a cooperative work was established between LSM, *Bahia Pesca* and IFREMER<sup>2</sup> (Ifremer, 1995).

With its vast experience and cooperative work, IFREMER was effective for the project's success, bringing an important contribution to zootechnics, which was a 90% reduction in the cost of cages and an increase in production per m<sup>2</sup> from 750 g to 2,250 g. improvements ensured the profitability of the project. *Bahia Pesca* together with *Institut Supérieur Technique d'Outre Mer* studied the regional shrimp market seeking competitive advantages of the project (IFREMER, 1995).

The innovative and pioneering experience developed by LSM brought encouraging results, whose final report published by IFREMER highlighted the main advantages and analyzes of the *Barra do Serinhaém* project in terms of

productivity, environmental quality and social development. For three years, from 1992 to 1994, satisfactory results can be verified that attest to the viability of the method with good prospects for the domestic market (Paquette, 1996).

In analysis, biological productivity was high, with yields above 16 tons per hectare, with low negative effects on the quality of the natural environment, and local fishermen also appreciated the new practice in addition to their traditional activity (Paquette, 1996).

The project's productivity proved to be a zootechnical success, since the yield obtained was four times higher than the average yield of the main producing countries in the world, which confers certain economic success on the innovative experience. The economic analysis showed a forecast of profitability evaluated at 27% and labor costs that reach 21%, but that one can still seek competitiveness beyond production costs, with emphasis on the good quality of the product obtained by the improvement. technical, as well as in the control of the commercialization channels (IFREMER, 1995).

The negative effects on the quality of the natural environment are very low compared to cultivation on land. These farms with floating cages, therefore, had multiple advantages from an environmental point of view: mangrove preservation; structures are mobile and shrimp are not in contact with the sediment, eliminating problems with contact with accumulated organic matter; this type of aquaculture is potentially low polluting and the residues can be consumed by fish; and there was no measurable impact on oxygen balances and organic matter concentrations in the sediment; the cages are mobile offering multiple advantages from an environmental point of view (IFREMER, 1995).

In the social aspect, with regard to the participation of the riverside community, it was found that the project would provide a complementary activity for fishermen on the spot, being practically one of the only possibilities to generate additional income. The traditional fishing activity provides a very low and fluctuating income, in addition to involving a small amount of personal capital. Thus, the work of monitoring the cages is compatible with your daily life as a fisherman, since family members can also collaborate, thus generating a complementary income (IFREMER, 1995).

The communities of the *Serinhaém* river estuary are made up of traditional populations of fishermen, shellfish gatherers and farmers, and their local production is mainly based on shrimp and crab fishing, as well as on the extraction of oil palm, palm heart, coconut, cocoa and latex. Local tourism brings a complementary income

<sup>2</sup> Institut Français de Recherche pour L'exploitation de la Mer (French Institute for Research for the Exploration of the Sea) is an institute public of an industrial and commercial nature. It is jointly supervised by the Ministry of National Education, Higher Education and Research and the Ministry of Environment, Energy and Marine Affairs. Ifremer carries out research missions, offers expert advice and acts as a funding agency. Available in: <https://www.euromarinenetwork.eu/membership/organisations/ifremer>



during the high season in December, but in the estuary region there is a lack of infrastructure in general, except for *Barra do Serinhaém*, whose village has a small network of restaurants, inns and river transport. In general, artisanal fishing has some social and environmental problems such as the impact generated by the use of fine mesh nets and bombs, and fishermen are vulnerable to changes in weather, temperature and tide variations, what affects work and daily productivity. Thus, the low yield and the intense physical wear and tear provided by artisanal fishing end up generating insufficient financial return, as well as health problems arising from poor food and hard work on boats in the sun or rain. Such difficulties also affect young people and minors, who from an early age help their parents with daily tasks.

Based on the previous successful experience, in partnership with IFREMER, LSM sought to innovate once again, expanding the results obtained with the cultivation of shrimp in cages, creating a new experimental technique, also promising, and with less impact on the ecosystem local. Thus, the participation of riverside dwellers was maintained, now with a less exhaustive work, as the tasks include monitoring the shrimp in canvas tanks located in areas with grass and palm trees, in order to create an environment with thermal comfort for the cultivation of shrimp, projecting a milder microclimate from shading vegetation. The technical training of cooperative fishermen and shellfish collectors, with estimates of reaching an average income of up to two minimum wages, will undoubtedly provide a substantial gain in the worker's earnings.

The expansion of the pilot project in *Barra de Serinhaém*, according to the testimony of its creator, Mr. Eduardo Lemos, intended to expand to the installation of up to 300 canvas tanks on properties in the estuary, in order to ensure improved productivity and competitiveness. In addition to the conservation aspect of the mangrove area, in a way guaranteed by the need for thermal comfort maintained by the palm trees and grass, shrimp waste serves as fertigation, used to maintain the project's vegetation cover environment, which reduces impacts if they were returned directly into the estuary channel.

Given the socioeconomic and environmental situation, LSM's shrimp farming project has the potential to remedy part of the region's socio-environmental difficulties, providing less exhaustive work with higher yields, combined with a lower environmental impact in the area, while ensuring local productivity more sustainable. Odebrecht supported the project in expanding the pilot project in *Barra do Serinhaém*, participating in the infrastructure and training cooperative fishermen and

shellfish collectors, also acquiring properties in the estuary region for the installation of canvas tanks. The project combines productivity and efficiency, ensuring a competitive product in the market, with satisfactory and stable financial returns throughout the year.

## VII. CONCLUSION

In general, conventional shrimp farming projects have serious social and environmental impacts in the regions where they are installed. Shrimp farms cause conflicts with artisanal fishermen and shellfish collectors, as they disrupt the extractive productive system, which cannot compete with large-scale production. Business mariculture will also have impacts on mangrove areas, especially on soils and aquatic environments, compromising the sustainability of these fluvial-marine ecosystems with the deposition of waste and deforestation in forest areas. However, the methodology developed by the company LSM has shown positive points by reducing the environmental impacts on the estuary ecosystem and contributing to the strengthening of social capital by generating income and work for local communities.

The possibility of reconciling a shrimp farming project with the work of riverside communities allowed for the development of a business entrepreneurship process, also establishing connections in the social field. Even if the business mission is profit, private capital can collaborate with actions geared towards social entrepreneurship, which contributes to the social, economic and environmental quality of life. This posture defines the idea of socially sustainable companies or Corporate Social Responsibility (CSR), bringing other benefits, for example, from environmental marketing, a highly positive and advantageous vision for the public image of the business.

The economic exploitation of shrimp farming in the *Pratigi* EPA with the effective participation of riverside communities in *Barra de Serinhaém* is an innovative business venture in terms of production in cages and canvas tanks, and its proposal is the social commitment to local communities in the generation of income and mitigation of environmental damage in mangrove and sandbank areas. The training of local workers has the advantage of having the experience of fishermen and shellfish gatherers, therefore, they can also add traditional knowledge to the project, in addition to contributing to the creative potential of these individuals, with innovative knowledge and practices that strengthen the social capital of these communities. This exchange of knowledge can be enriching, allowing such communities to still exercise their role as social entrepreneurs.

In this sense, Nature Conservation Units are powerful tools for environmental management and protection, however, the Government, which is responsible by law for ensuring a balanced environment and a healthy quality of life, has become negligent or ineffective in this task, as analyzed in the Pratigi Environmental Protection Area management problem.

Generally speaking, the EPA suffer from the difficulty of managing and monitoring ecosystems in areas of human occupation, where economic activities are also included. As a result, there is a low effectiveness of environmental legislation, thus generating environmental liabilities, mostly resulting from these predatory economic activities and the urbanization process, which has harmed the quality of life of traditional and riverside communities, which suffer directly with the negative impacts.

Economic agents, endowed with technical and financial capacity, can be included in the EPA, through sustainability programs, where they can fulfill their Social and Environmental Responsibility. The Environmental Law understands that every company has risks inherent to its production activity, and for this reason, it must also assume the damages caused to society and the environment, carrying out its due environmental compensation.

Sustainable development is linked to several dimensions such as economic, social, environmental, political, and its practices are imbued with social responsibility, thus these are the guiding principles of companies that must work at EPA *Pratigi*. In this sense, social entrepreneurship is on the way with the aim of guaranteeing the transformation of the reality of the riverside communities surrounding EPA *Pratigi*, such as quality of life, job and income generation and, above all, environmental conservation. Thus, the results of such initiatives can reflect as environmental marketing, attesting that these organizations are concerned with the well-being of society and take care of the environment. In addition, we were able to prove, through the performance of the LSM company, that such income and job generation projects can promote economic growth and local development, taking advantage of the region's potential for mariculture, which makes expansion, maintenance and dissemination of such initiatives.

In this way, Corporate Social Responsibility becomes an important instrument for the protection of the environment, with the potential to contribute to social entrepreneurship in local communities and also serving as a complementary and co-participatory measure, given the low effectiveness of public authorities in actions of environmental protection, complying with what the

Federal Constitution recommends about the duty of all to defend and protect the environment.

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## ON A MODEL OF GENERALIZED PELL NUMBERS

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**ABSTRACT.** In this study we investigate a model of generalized Pell numbers. Combinatorial representations are provided and some new identities and combinatorial identities are established. Moreover, analytic results are exhibited, where some special cases are discussed. Illustrative examples and applications are given.

*Key Words :* Model of Generalized Pell numbers, Combinatorial Representation, Combinatorial Identities, Analytic Representations.

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### 1. INTRODUCTION

Several families of integers defined by recursive relations are studied in the literature. These sequences of numbers are at the origin of many interesting identities, in particular of combinatorial or analytic types. It is possible find in-depth results on these families of integers and their generalizations. Specially among these families, the Pell numbers  $P_n$ , ( $n \geq 0$ ) is one of the most well-known sequence of integers with important role in various topics of mathematics, and also in exact and applied sciences (see more in [4–6, 17]). These integers defined by the initial conditions  $P_0 = 0$ ,  $P_1 = 1$  and the classical recurrence relation,  $P_{n+1} = 2P_n + P_{n-1}$  for  $n \geq 1$ , have been widely discussed from both algebraic, analytical and combinatorial perspective. Furthermore, diverse generalizations of the sequence  $\{P_n\}_{n \geq 0}$  of Pell numbers have been considered in various research papers (see for example [4–7, 10, 11, 17]). Such generalizations are defined by recurrence relations of second order. The first proposed generalization is defined by,

$$P_{d,n} = 2^d P_{d,n-1} + P_{d,n-2} \text{ for } n \geq 2,$$

with appropriate initial conditions  $P_{d,1} = 1$  and  $P_{d,2} = 2^d$  (see [17]), and the second generalization is given by,

$$P_{h,n} = 2P_{h,n-1} + hP_{h,n-2} \text{ for } n \geq 2,$$



where  $h$  is a positive real number, and with appropriate initial conditions  $P_{h,0} = \alpha_0$  and  $P_{h,1} = \alpha_1$  (see [4–6]). Another type of generalization of Pell numbers is defined by the following linear recursive relation of order  $r \geq 2$ ,

$$P_{n+1} = 2P_n + P_{n-1} + \cdots + P_{n-r+1}$$

for  $n \geq r - 1$ , where the initial conditions  $P_0 = \alpha_0, \dots, P_{r-1} = \alpha_{r-1}$  are chosen adequately (see [12, 13, 16]). In general, the initial conditions for this kind of Pell numbers are given by  $P_0 = \dots = P_{r-2} = 0, P_{r-1} = 1$ .

The present study deals with the model of generalized Pell numbers defined with integer parameters  $d \geq 0, i (0 \leq i \leq r - 2), h \geq 1$  by the following linear difference equation of order  $r \geq 2$ ,

$$P_{d,i,h,n+1} = 2^d P_{d,i,h,n} + P_{d,i,h,n-1} + \cdots + h P_{d,i,h,n-r+1} \quad (1)$$

for  $n \geq r$ , where the initial conditions  $P_{d,i,h,0} = \alpha_0, \dots, P_{d,i,h,r-1} = \alpha_{r-1}$  are chosen adequately. Expression (1) extends the preceding generalizations. That is, if we set  $a_0 = 2^d, a_1 = 1$  and  $a_j = 0$  for  $2 \leq j \leq r - 1$  or  $a_0 = 2, a_1 = h$  and  $a_j = 0$  for  $2 \leq j \leq r - 1$ , or  $a_0 = 2, a_1 = \dots = a_{r-1} = 1$ , respectively, in  $u_{n+1} = \sum_{i=0}^{r-1} a_i u_{n-i-1}$ , we get the expressions defining the three preceding generalizations of Pell numbers.

We investigated the model of generalized Pell numbers defined by the difference equation (1) through properties of an associated basic fundamental system. Our approach is also issued from the general setting and properties of  $r$ -generalized Fibonacci sequences (see for example, [8, 14, 18]). These methods allow us to obtain various statements for the generalized model of Pell numbers. More precisely, the combinatorial representation is formulated and some new identities are provided. The analytical representations were studied for some special cases, namely,  $i = 0, h = 1$  and  $i = r - 2$ , given by the expressions

$$P_{d,0,1,n+1} = 2^d P_{d,0,1,n} + P_{d,0,1,n-1} + \cdots + P_{d,0,1,n-r+1} \quad (2)$$

for  $n \geq r$ ,

$$P_{d,r-2,h,n+1} = 2^d P_{d,r-2,h,n} + h P_{d,r-2,h,n-r+1} \quad (3)$$

for  $n \geq r$ , with  $d \geq 0$  and  $h \geq 1$ . Furthermore, the analytical representations for the general setting for two special cases were established, namely,  $r = 4, i = 1$  and  $r = 5, i = 1$  or  $i = 2$ , with positive integers  $d$  and  $h$ .

Note that by taking  $d = 0$  we obtain Expression (2) defining the generalized Fibonacci numbers (see more in [15]), and for  $d = 1$  Expression (2) is the recursive relation for generalized Pell numbers studied in [16]. For parameters  $d = 0$  and  $h = 1$ , Expression (3) is a recursive relation defining Fibonacci  $r$ -numbers. Moreover, it is worth noting that for the generalized Pell numbers (3), equipped with the following kind of initial conditions  $\alpha_0 = \dots = \alpha_i = 0$  or  $\alpha_{i+1} = \dots = \alpha_{r-1} = 1$  are considered in [12], and labeled the generalized  $(r, i)$ -Pell numbers.

The content of this paper is organized as follows. In Section 2 we study the combinatorial representation of the families of sequences of the model of generalized Pell numbers, defined with the aid of the difference equation (1). Moreover, some new identities and combinatorial identities are provided in Section 3. Section 4 concerns a special model of

generalized Pell numbers. Also the analytical aspect of the Fibonacci numbers is provided. In addition, properties of the analytical representation of the generalized Pell numbers (3) are exhibited. Section 5 is devoted to analytical expression of some special cases of generalized Pell numbers (1). Finally, discussion and concluding remarks are given.

For reason of simplicity and clarity, in this work we will omit the parameters  $d$  and  $h$  and the model of generalized Pell numbers  $P_{d,i,h,n}$  defined by Expression (1) will be notated in general case by  $P_{d,i,h,n} = P_{i,n}$ , notated by  $P_{d,r-2,h,n} = R_n$  for  $i = r - 2$  and notated by  $P_{d,0,h,n} = P_n$  for  $i = 0$ .

## 2. COMBINATORIAL REPRESENTATION OF THE MODEL OF GENERALIZED PELL NUMBERS

The preceding generalizations represent special cases of the sequences  $\{u_n\}_{n \geq 0}$  defined by,

$$u_{n+1} = \sum_{i=0}^{r-1} a_i u_{n-i-1} \quad \text{for} \quad n \geq r, \quad (4)$$

known in the literature as linear difference equation of constant coefficients  $a_i \in \mathbb{R}$  or  $\mathbb{C}$  ( $0 \leq i \leq r - 1$ ). When the initial data  $u_0 = \alpha_0, u_1 = \alpha_1, \dots, u_{r-1} = \alpha_{r-1}$  are specified, sequences defined by the recursive relation (4) are known in the literature as *r-generalized Fibonacci sequences*. It is well known that the combinatoric formula of sequences (4) have been largely studied in the literature (see, for example, [14, 18] and references therein). Indeed it was shown in [14] that,

$$u_n = \rho(n, r)A_0 + \rho(n - 1, r)A_1 + \dots + \rho(n - r + 1, r)A_{r-1}, \quad \text{for every } n \geq r, \quad (5)$$

such that  $A_m = a_{r-1}u_m + \dots + a_m u_{r-1}$  and

$$\rho(n, r) = \sum_{k_0+2k_1+\dots+r k_{r-1}=n-r} \frac{(k_0 + \dots + k_{r-1})!}{k_0! k_1! \dots k_{r-1}!} a_0^{k_0} a_1^{k_1} \dots a_{r-1}^{k_{r-1}}, \quad \text{for every } n \geq r, \quad (6)$$

where  $\rho(j, r) = 0$  for  $0 \leq j \leq r - 1$  and  $\rho(r, r) = 1$ . When in Expression (4) the coefficients are given by  $a_0 = 2^d, a_1 = \dots = a_i = 0; a_{i+1} = \dots = a_{r-2} = 1$  and  $a_{r-1} = h$  and the initial conditions  $\alpha_0, \dots, \alpha_{r-2}, \alpha_{r-1}$ , we get Expression (1) defining the model of generalized Pell numbers. Therefore, the construction did in [14] and Expression (6) implies the following result on the combinatorial aspect of the model of generalized Pell numbers (1).

**Theorem 2.1.** *Let the generalized Pell numbers  $P_{i,n}$  defined by Expression (1) with arbitrary initial conditions  $\alpha_0, \dots, \alpha_{r-1}$ . Then, for  $i = 0$  we have*

$$P_n = \rho_0(n, r)A_0 + \rho_0(n - 1, r)A_1 + \dots + \rho_0(n - r + 1, r)A_{r-1},$$

for every  $n \geq r$ , such that  $A_0 = 2^d \alpha_{r-1} + \sum_{k=1}^{r-2} \alpha_k + h \alpha_0, A_1 = h \alpha_1 + \sum_{k=2}^{r-1} \alpha_k, \dots, A_{r-1} = h \alpha_{r-1}$ , and

$$\rho_0(n, r) = \sum_{k_0+\dots+r k_{r-1}=n-r} \frac{(k_0 + \dots + k_{r-1})!}{k_0! \dots k_{r-1}!} 2^{d k_0} h^{k_{r-1}},$$

for every  $n \geq r$ , where  $\rho_0(j, r) = 0$  for  $j \leq r - 1$  and  $\rho_0(r, r) = 1$ . And, for  $1 \leq i \leq r - 2$ , we have,

$$P_{i,n} = \rho_i(n, r)A_0 + \rho_i(n - 1, r)A_1 + \cdots + \rho_i(n - r + 1, r)A_{r-1}, \quad (7)$$

for every  $n \geq r$ , such that  $A_0 = 2^d \alpha_{r-1} + \sum_{k=1}^{r-i-2} \alpha_k + h\alpha_0$ ,  $A_1 = h\alpha_1 + \sum_{k=2}^{r-i-1} \alpha_k, \dots, A_{i-1} = h\alpha_{i-1} + \sum_{k=i}^{r-3} \alpha_k$ ,  $A_i = h\alpha_i + \sum_{k=i+1}^{r-2} \alpha_k$ ,  $A_{i+1} = h\alpha_{i+1} + \sum_{k=i+2}^{r-1} \alpha_k, \dots, A_{r-1} = h\alpha_{r-1}$  and

$$\rho_i(n, r) = \sum_{k_0+(i+2)k_{i+1}+\cdots+r k_{r-1}=n-r} \frac{(k_0 + k_{i+1} \cdots + k_{r-1})!}{k_0!k_{i+1}! \cdots k_{r-1}!} 2^{dk_0} h^{k_{r-1}}, \text{ for every } n \geq r,$$

where  $\rho_i(j, r) = 0$  for  $j \leq r - 1$  and  $\rho_i(r, r) = 1$ .

*Proof.* It is a direct application of Expressions (5) and (6) to Expression (1) for every  $i$  ( $0 \leq i \leq r - 2$ ).  $\square$

Let consider the sequence  $\mathcal{S}_j = \{\rho(n - j, r)\}_{n \geq 0}$  ( $0 \leq j \leq r - 1$ ). Then, Theorem 2.1 shows that the set  $\{\mathcal{S}_0, \mathcal{S}_1, \dots, \mathcal{S}_{r-1}\}$  is a basic fundamental system for generating the model of generalized Pell numbers (1).

**Proposition 2.2.** *Let the generalized Pell numbers  $R_n$  defined by Expression (3) with arbitrary initial conditions  $\alpha_0, \dots, \alpha_{r-1}$ . Then, we have,*

$$R_{n+1} = \rho_{r-2}(n, r)A_0 + \rho_{r-2}(n - 1, r)A_1 + \cdots + \rho_{r-2}(n - r + 1, r)A_{r-1},$$

for every  $n \geq r$ , such that  $A_0 = 2^d \alpha_{r-1} + h\alpha_0$ ,  $A_1 = h\alpha_1, \dots, A_{r-1} = h\alpha_{r-1}$  and

$$\rho_{r-2}(n, r) = \sum_{k_0+r k_{r-1}=n-r} \frac{(k_0 + k_{r-1})!}{k_0!k_{r-1}!} 2^{dk_0} h^{k_{r-1}}, \quad (8)$$

for every  $n \geq r$ , where  $\rho_{r-2}(j, r) = 0$  for  $j \leq r - 1$  and  $\rho_{r-2}(r, r) = 1$ .

*Proof.* It is obtained by applying the Theorem 2.1 to Expression (3) for  $i = r - 2$ .  $\square$

As mentioned before, when the initial conditions are  $\alpha_0 = \cdots = \alpha_{r-2} = 0$ , and  $\alpha_{r-1} = 1$ , we get the usual generalized Pell numbers, largely studied in the literature. In this context, the following corollary established the combinatorial expression for this important sequence of generalized Pell numbers. That is, comparing Expressions (1) and (7), we can establish the following result.

**Corollary 2.3.** *(Fundamental Combinatorial expression) For the sequence (1), with initial conditions  $\alpha_0 = \cdots = \alpha_{r-2} = 0$ , and  $\alpha_{r-1} = 1$ , we have the combinatorial expression,*

$$P_{i,n} = \rho_i(n + 1, r) = \sum_{k_0+(i+2)k_{i+1}+\cdots+r k_{r-1}=n+1-r} \frac{(k_0 + k_{i+1} + \cdots + k_{r-1})!}{k_0!k_{i+1}! \cdots k_{r-1}!} 2^{dk_0} h^{k_{r-1}}, \quad (9)$$

for every positive integer  $i$ , and  $n \geq r$ , where  $\rho_i(j, r) = 0$  for  $j \leq r - 1$  and  $\rho_i(r, r) = 1$ .

Expression (9) will play a fundamental role in the sequel, where the sequence  $P_{i,n_{n \geq 0}}$  is considered as a fundamental solution of the difference equation (1). Moreover, we can show that Proposition 4.3 established in [16] is a particular case of Corollary 2.3 by taking  $i = 0, d = h = 1$ .

Consider the set  $\{\{P_{i,n}^{(s)}\}_{n \geq 0}, 1 \leq s \leq r\}$  of sequences of generalized Pell numbers  $P_{i,n}^{(s)} = P_{d,i,h,n}^{(s)}$  defined as follows,

$$P_{i,n+1}^{(s)} = 2^d P_{i,n}^{(s)} + \sum_{k=i+1}^{r-2} P_{i,n-k}^{(s)} + h P_{i,n-r+1}^{(s)} \quad \text{for } n \geq r-1, \quad (10)$$

$$P_{i,s-1}^{(s)} = 1 \text{ and } P_{i,n}^{(s)} = 0 \text{ for } 0 \leq n \neq s-1 \leq r-1,$$

where in the special case  $i = r-2$ , we put  $P_{r-2,n}^{(s)} = R_n^{(s)}$ .

We call the set  $\{\{P_{i,n}^{(s)}\}_{n \geq 0}, 1 \leq s \leq r\}$  as the Pell fundamental system associated with the model of generalized Pell numbers defined by (1).

The Table 1 describes the list of the first terms of set  $\{\{R_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq 5\}$  of the generalized Pell number of order  $r = 5, i = 3, d = 1$  and  $h = 5$ . The sequences of generalized Pell numbers are defined as follows,

$$R_{n+1}^{(s)} = 2R_n^{(s)} + 5R_{n-4}^{(s)} \quad \text{for } n \geq 4,$$

$$R_{s-1}^{(s)} = 1 \text{ and } R_n^{(s)} = 0 \text{ for } 0 \leq n \neq s-1 \leq 4.$$

n	0	1	2	3	4	5	6	7	8	9	10	11	...
$R_n^{(1)}$	1	0	0	0	0	5	10	20	40	80	185	420	...
$R_n^{(2)}$	0	1	0	0	0	0	5	10	20	40	80	185	...
$R_n^{(3)}$	0	0	1	0	0	0	0	5	10	20	40	80	...
$R_n^{(4)}$	0	0	0	1	0	0	0	0	5	10	20	40	...
$R_n^{(5)}$	0	0	0	0	1	2	4	8	16	37	84	188	...

Table 1 : First terms of set  $\{\{R_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq 5\}$

The Table 2 describes the list of the first terms of set  $\{\{P_{2,2,3,n}^{(s)}\}_{n \geq 0}, 1 \leq s \leq 5\}$  of the generalized Pell number of order  $r = 5, i = 2, d = 2$  and  $h = 3$ . The sequences of generalized Pell numbers are defined as follows,

$$P_{2,2,3,n}^{(s)} = 2^2 P_{2,2,3,n-1}^{(s)} + P_{2,2,3,n-4}^{(s)} + 3P_{2,2,3,n-5}^{(s)} \quad \text{for } n \geq 5,$$

$$P_{2,2,3,s-1}^{(s)} = 1 \text{ and } P_{2,2,3,n}^{(s)} = 0 \text{ for } 0 \leq n \neq s-1 \leq 4.$$

n	0	1	2	3	4	5	6	7	8	9	10	11	...
$P_{2,2,3,n}^{(1)}$	1	0	0	0	0	3	12	48	192	771	3105	12504	...
$P_{2,2,3,n}^{(2)}$	0	1	0	0	0	1	7	28	112	449	1806	7273	...
$P_{2,2,3,n}^{(3)}$	0	0	1	0	0	0	1	7	28	112	449	1806	...
$P_{2,2,3,n}^{(4)}$	0	0	0	1	0	0	0	1	7	28	112	449	...
$P_{2,2,3,n}^{(5)}$	0	0	0	0	1	4	16	64	257	1035	4168	16784	...

Table 2 : First terms of set  $\{\{P_{2,2,3,n}^{(s)}\}_{n \geq 0}, 1 \leq s \leq 5\}$

**Remark 2.4.** As mentioned before in the Introduction, for  $d = 0$ , Equation (2) is none other than the one that defines the generalized Fibonacci numbers. Therefore, results of this Section are still valid for the generalized Fibonacci sequences, especially, Theorem 2.1 and Corollary 2.3. For the



recurrence given by Expression (2) with  $d = 0$ , it was proved in [Proposition 3.3, Proposition 3.4, [15]] the identities,

$$P_n^{(s)} = \sum_{j=1}^s \rho(n + s - j, r), \text{ for } n \geq r + s, \text{ when } 2 \leq s \leq r,$$

$$P_n^{(1)} = P_{n-1}^{(r)} = \rho(n, r), \text{ for } n \geq r + 1,$$

where the  $\rho(n, r)$  are given as in (6) with  $a_0 = 1, a_1 = \dots = a_{r-1} = 1$ . As an analogous result, for recurrence given by Expression (2) with  $d = 1$ , it was proved in [Proposition 4.4, [16]] the identities,

$$P_n^{(s)} = \sum_{j=1}^s \rho(n + s - j, r), \text{ for } n \geq r + s, \text{ when } 2 \leq s \leq r,$$

$$P_n^{(1)} = P_{n-1}^{(r)} = \rho(n, r), \text{ for } n \geq r + 1,$$

where the  $\rho(n, r)$  are given as in (6) with  $a_0 = 2, a_1 = \dots = a_{r-1} = 1$ .

The application of Theorem 2.1 implies the more general propositions bellow.

**Proposition 2.5.** Fixed positive integers  $r$  and  $i$ , where  $1 \leq i \leq r - 3$ , let  $\{\{P_{i,n}^{(s)}\}_{n \geq 0}; 1 \leq s \leq r\}$  be the Pell fundamental system defined as in (10). The combinatorial expression of each element  $P_{i,n}^{(s)}$ , where  $1 \leq s \leq r$ , is given by,

$$P_{i,n}^{(s)} = \sum_{j=s-r+i+1}^{s-2} \rho_i(n - j, r) + h\rho_i(n - s + 1, r), \text{ when } 2 \leq s \leq r, \quad (11)$$

$$P_{i,n}^{(1)} = hP_{i,n-1}^{(r)} = hP_{i,n-1} = h\rho_i(n, r), \text{ for } n \geq r + 1, \quad (12)$$

with  $n \geq r + s$ , where the  $\rho_i(n, r)$  are given as in (6) such that  $a_0 = 2^d, a_1 = \dots = a_i = 0, a_{i+1} = \dots = a_{r-1} = 1$ .

Moreover, for  $i = r - 2$  we can establish the combinatorial expressions of the sequences of generalized Pell numbers  $\{R_n\}_{n \geq 0}$  defined as in (3). Indeed, we obtain the result analogous to Proposition 2.5.

**Proposition 2.6.** For  $i = r - 2$ , let consider the Pell fundamental system  $\{\{R_n^{(s)}\}_{n \geq 0}; 1 \leq s \leq r\}$  defined as in (10). Then, the combinatorial expression of each element  $\{R_n^{(s)}\}_{n \geq 0}$ , where  $1 \leq s \leq r$ , is given by,

$$R_n^{(s)} = h\rho_2(n - s + 1, r), \text{ when } 2 \leq s \leq r - 1, \quad (13)$$

$$R_n^{(1)} = hR_{n-1}^{(r)} = hR_{n-1} = h\rho_2(n + 1, r), \text{ for } n \geq r + 1, \quad (14)$$

with  $n \geq r + s$ , where the  $\rho_2(n, r)$  are given as in (6) such that  $a_0 = 2^d, a_1 = \dots = a_{r-2} = 0, a_{r-1} = 1$ .

**Remark 2.7.** As mentioned before in the Introduction, for  $d = 0$  and  $h = 1$ , Equation (3) defines Fibonacci  $r$ -numbers. Therefore, results of this Section are still valid for this sequence of numbers, especially, Proposition 2.6.

Let  $\{W_{i,n}\}_{n \geq 0}$  be a sequence of generalized Pell numbers (1), with arbitrary initial conditions  $\alpha_0, \alpha_1, \dots, \alpha_{r-1}$ . Let  $\{\tilde{W}_{i,n}\}_{n \geq 0}$  be the sequence defined by,

$$\tilde{W}_{i,n} = \alpha_0 P_{i,n}^{(1)} + \alpha_1 P_{i,n}^{(2)} + \dots + \alpha_{r-1} P_{i,n}^{(r)} \text{ for every } n \geq 0.$$

We show that  $\tilde{W}_{i,0} = \alpha_0, \tilde{W}_{i,1} = \alpha_1, \dots, \tilde{W}_{i,r-1} = \alpha_{r-1}$ . On the other hand, the general term of the sequence  $\{\tilde{W}_{i,n}\}_{n \geq 0}$  satisfies the recursive relation (1). Therefore, for every  $n \geq 0$ , we have  $W_{i,n} = \tilde{W}_{i,n}$ . Especially, when  $d = h = 1, \alpha_0 = \dots = \alpha_i = 0$  and  $\alpha_{i+1} = \dots = \alpha_{r-1} = 1$ , we get the associated sequence of generalized Pell numbers  $\{\tilde{R}_n\}_{n \geq 0}$ , defined by the recursive relation (3) and called the generalized Pell  $(r, i)$ -numbers (see [12]).

**Proposition 2.8.** *Let  $\{W_{i,n}\}_{n \geq 0}$  be a sequence of generalized Pell numbers (1), with arbitrary initial conditions  $\alpha_0, \alpha_1, \dots, \alpha_{r-1}$ . Then, for every  $n \geq 0$ , we have,*

$$W_{i,n} = \alpha_0 P_{i,n}^{(1)} + \alpha_1 P_{i,n}^{(2)} + \dots + \alpha_{r-1} P_{i,n}^{(r)},$$

*Especially, for the generalized Pell  $(r, i)$ -numbers  $\tilde{R}_n$ , we have*

$$\tilde{R}_n = R_n^{(i+1)} + \dots + R_n^{(r)}.$$

In other terms, the set  $\{\{P_{i,n}^{(s)}\}_{n \geq 0}; 1 \leq s \leq r\}$  is a basis of the vector space  $\mathcal{E}_{\mathbb{K}}^{(i,r)}$  (over  $\mathbb{K} = \mathbb{R}$  or  $\mathbb{C}$ ) of solutions of Equation (1) considered as a difference equation.

The Proposition 2.8 is general case of Proposition 2.1 in [16]. Since the generalized Pell is also linked to the generalized Pell  $(r, i)$ -numbers considered in [12], we deduce from Proposition 2.8 and Expressions (13)-(14), a combinatorial expression of the generalized Pell  $(r, i)$ -numbers, namely,

$$\tilde{R}_n = \sum_{j=i+1}^r \rho_2(n-j+1, r),$$

for every  $n \geq 0$ , where the  $\rho_2(n, r)$  are given as in (6) such that  $a_0 = 2, a_1 = \dots = a_{r-2} = 0, a_{r-1} = 1$ .

### 3. SOME IDENTITIES AND COMBINATORIAL IDENTITIES FOR THE MODEL OF GENERALIZED PELL NUMBERS

In this section we are interested in some generalized Pell numbers identities and the related combinatorial identities. To this aim, let us proceed as in [15] by considering the notion of the generalized Pell fundamental system. Let consider the vector column  $P(i, j, n) = (P_{i,n}^{(j)}; P_{i,n+1}^{(j)}; \dots; P_{i,n+r-1}^{(j)})^t$ , for every  $n \geq r-1$ , and  $j$  ( $1 \leq j \leq r$ ), and the matrix,

$$\widehat{C}_{\mathfrak{P}}(i, n) = [P(i, 1, n), \dots, P(i, j, n), \dots, P(i, r, n)],$$

Let  $\mathcal{S}_j = \{P_{j,n}^{(s)}\}_{n \geq 0}$  ( $0 \leq j \leq r-1$ ) and consider the basic set  $\mathfrak{S}_r = \{\mathcal{S}_0, \mathcal{S}_1, \dots, \mathcal{S}_{r-1}\}$ , called the Pell fundamental system, related to the model generalized Pell numbers (1). Then, the matrix  $\widehat{C}_{\mathfrak{P}}(i, n) = (c_{kj}^{(n)})_{1 \leq k, j \leq r}$ , represents the Pell Casoratian matrix associated with  $\mathfrak{S}_r$ .

The main goal here, is to exhibit the explicit expressions for the entries  $c_{kj}^{(n)}$  of the matrix  $\widehat{C}_{\mathfrak{P}}(i, n)$ , and derive some identities, related to the model of generalized Pell numbers (1). A direct verification shows that the Casoratian matrix can be written under the form,

$$\widehat{C}(n) = J \times \mathbb{M}_n \times J,$$

where  $J = (b_{k,j})_{1 \leq k, j \leq r}$  is the anti-diagonal unit matrix, namely,  $b_{k,j} = 1$ , for  $k+j = r+1$ , and  $b_{k,j} = 0$ , otherwise and  $\mathbb{M}_n = (P_{i,n+r-k-1}^{(j)})_{1 \leq k, j \leq r}$ . We show that the matrix  $\mathbb{M}_{i,n}$ , can be written under the form  $\mathbb{M}_{i,n} = \mathbb{A}_i^n$ , where  $\mathbb{A}_i$  is the classical companion matrix,

$$\mathbb{A}_i = \mathbb{A}[2^d, 0, \dots, 1, \dots, 1, h] = \begin{pmatrix} 2^d & 0 & \cdots & 1 & \cdots & 1 & h \\ 1 & 0 & \cdots & 0 & \cdots & 0 & 0 \\ 0 & 1 & 0 & \cdots & \cdots & 0 & 0 \\ \vdots & \ddots & \ddots & \ddots & \ddots & \ddots & \vdots \\ 0 & \cdots & 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$

(for more details see, [2] and references therein). Hence, we get the following property.

**Proposition 3.1.** *Consider the Pell fundamental system  $\{\{P_{i,n}^{(s)}\}_{n \geq 0}; 1 \leq s \leq r\}$  defined as in (10). Then, the associated Casoratian matrix  $\widehat{C}(n)$  and the powers  $\mathbb{A}_i^n$  of the companion matrix  $\mathbb{A}_i$  are similar. More precisely, we have the matrix identity,*

$$\widehat{C}(n) = J \mathbb{A}_i^n J = (c_{kj}^{(n)})_{1 \leq k, j \leq r}, \quad (15)$$

for every  $n \geq 0$ , where the entries  $c_{kj}^{(n)}$  are given by  $c_{kj}^{(n)} = P_{i,n+i-1}^{(j)}$  ( $1 \leq k, j \leq r$ ), and  $J = (b_{k,j})_{1 \leq k, j \leq r}$  is the anti-diagonal unit matrix.

Expression (15) implies the matrix identity  $\widehat{C}(n+m) = \widehat{C}(n) \cdot \widehat{C}(m)$ , for every  $n$  and  $m$ . Hence, the entries of the matrix  $\widehat{C}(n+m) = (c_{kj}^{(n+m)})_{1 \leq k, j \leq r}$ , are expressed in terms of those of the matrices  $\widehat{C}(m) = (c_{kj}^{(m)})_{1 \leq k, j \leq r}$  and  $\widehat{C}(n) = (c_{ij}^{(n)})_{1 \leq i, j \leq r}$  as follows,

$$c_{kj}^{(n+m)} = \sum_{l=1}^r c_{kl}^{(n)} c_{lj}^{(m)} = \sum_{l=1}^r c_{kl}^{(m)} c_{lj}^{(n)}, \text{ for every } n, m \geq 0, \quad (16)$$

where  $1 \leq k, j \leq r$ . In fact, according to Proposition 3.1 and Expression (16), we get the following identities for the model of generalized Pell numbers  $P_{i,n}^{(s)}$ .

**Proposition 3.2.** *(Identities for the model of generalized Pell numbers) Consider the Pell fundamental system  $\{\{P_{i,n}^{(s)}\}_{n \geq 0}; 1 \leq s \leq r\}$  defined as in (10). Then, is valid the following identity,*

$$P_{i,m+s+p}^{(q)} = \sum_{d=1}^r P_{i,m+p}^{(d)} P_{i,s+d-1}^{(q)} = \sum_{d=1}^r P_{i,s+p}^{(d)} P_{i,m+d-1}^{(q)},$$

for any integer  $m, s \geq 0$  and  $p, q$  ( $1 \leq p, q \leq r$ ). Specially for  $q = r$  we have the identity,

$$P_{i,m+s+p}^{(r)} = P_{i,m+s+p} = \sum_{d=1}^r P_{i,m+p}^{(d)} P_{s+d-1} = \sum_{d=1}^r P_{i,s+p}^{(d)} P_{i,m+d-1},$$

where  $P_{i,n+1}^{(1)} = P_{i,n} = \rho_1(n+1, r)$  and  $P_{i,n}^{(s)} = \sum_{j=s-r+i+1}^{s-2} P_{i,n-j-1} + hP_{i,n-s}$ . And more generally, for  $1 \leq q \leq r-1$ , we have,

$$P_{i,m+s+p}^{(q)} = \sum_{d=1}^r \left[ \sum_{j=d-r+i+1}^{d-2} \delta_{m,p} \right] \left[ \sum_{j=q-r+i+1}^{q-2} \delta_{s,q} \right],$$

where  $\delta_{m,p} = P_{i,m+p-j-1} + hP_{i,m+p-d}$  and  $\delta_{s,q} = P_{i,s+d-j-2} + hP_{i,s+d-1-q}$ .

Combining the identities of Proposition 3.2 with Theorem 2.1, Corollary 2.3 and Proposition 2.5, we can establish some combinatorial identities, involving the expressions of  $\rho(n, j)$  and  $\rho(n, r)$ . More precisely, identities of Proposition 3.2 and Expression (9) applied to Expressions (11)-(12) and Expressions (13)-(14), we arrive at the following combinatorial identities.

**Proposition 3.3.** (Combinatorial identities for the model of generalized Pell numbers) The combinatorial expressions of the generalized Pell numbers identity (11), is given by

$$\rho_i(m+s+1, r) = \sum_{d=1}^r \left[ \sum_{j=d-r+i+1}^{d-2} \Delta_{m,s} \right] \rho_i(s+d, r),$$

where  $\Delta_{m,s} = \rho_i(m-j, r) + h\rho_i(m-s+1, r)$ , and

$$\sum_{\mathcal{S}_1} \rho_i((m+s+p)-j, r) + h\rho_i((m+s+p)-q+1, r) = \sum_{d=1}^r \left( \sum_{\mathcal{S}_2} \Delta_{m+p,d} \right) \left( \sum_{\mathcal{S}_3} \Delta_{s+d,q} \right),$$

where  $\mathcal{S}_1 = \{j, \text{ with } q-r+i+1 \leq j \leq q-2\}$ ,  $\mathcal{S}_2 = \{j, \text{ with } d-r+i+1 \leq j \leq d-2\}$ ,  $\mathcal{S}_3 = \{j, \text{ with } q-r+i+1 \leq j \leq s-2\}$ , and  $\Delta_{m+p,d} = \rho_i(m+p-j, r) + h\rho_i(m+p-d+1, r)$ ,  $\Delta_{s+d,q} = \rho_i(s+d-1-j, r) + h\rho_i(s+d-1-q+1, r)$ .

Propositions 3.2 and 3.3 represent a generalization of the identities linked to the Fibonacci number established in [Proposition 3.3, Proposition 3.4, Corollary 3.5, [15]] and Pell number established in [Theorem 3.1, Proposition 4.2, Corollary 4.0, [16]]. Specially for Pell numbers, with parameters  $d = 1$  and  $h = 1$  in the model of generalized Pell numbers (1), namely the expression

$$P_{1,0,1,n+1} = 2P_{1,0,1,n} + P_{1,0,1,n-1} + \cdots + P_{1,0,1,n-r+1}, \quad (17)$$

for  $n \geq r$ , we have the result.

**Corollary 3.4** (Corollary 4.0, [16]). Consider the Pell fundamental system  $\{\{P_n^{(s)}\}_{n \geq 0}; 1 \leq s \leq r\}$  associated with the sequences of generalized Pell numbers (17). Then, for every  $m, s \geq 0$ ,  $q$  ( $1 \leq q \leq r$ ), we have the following combinatorial identities,

$$\rho_0(m+s+1, r) = \sum_{d=1}^r \left[ \sum_{j=1}^d \rho_0(m-j+1, r) \right] \rho_0(s+d, r),$$

$$\sum_{k=1}^q \rho_0(n+s-k+1, r) = \sum_{d=1}^r \left[ \sum_{\substack{1 \leq i \leq d, \\ 1 \leq j \leq q}} \rho_0(n-i+1, r) \rho_0(s+d-j, r) \right].$$



#### 4. ANALYTIC REPRESENTATION OF PELL NUMBERS (2)-(3)

This section is devoted to the study of the analytic expression of a large class of the model generalized Pell numbers (1), without the use of the determinant techniques. Namely, we are interested in the analytic expressions of the generalized Pell numbers (2) and the generalized Pell numbers (3).

Recall that for linear recursive sequence of Fibonacci type (4), the analytic expression is expressed in terms of the roots of the associated so-called characteristic polynomial and their multiplicities (see, instance, [3, 8, 18]). For the class of Pell numbers (2)-(3), the characteristic polynomials are given as follows,

$$P(z) = z^r - 2^d z^{r-1} - z^{r-2} - \dots - z - 1 \text{ and } R(z) = z^r - 2^d z^{r-1} - 1,$$

where  $d \geq 0$ .

##### 4.1. Study of the case $d \geq 1$ .

**Lemma 4.1.** *The roots of the polynomial*

$$P(z) = z^r - 2^d z^{r-1} - z^{r-2} - \dots - z - 1,$$

*are simple.*

*Proof.* Consider  $d \geq 1$ . Then, the polynomial  $P(z) = z^r - 2^d z^{r-1} - z^{r-2} - \dots - z - 1$  can be written under the form,

$$P(z) = z^r - (2^d - 1)z^{r-1} - (z^{r-1} + \dots + z + 1) = z^r - (2^d - 1)z^{r-1} - \frac{z^r - 1}{z - 1}.$$

Since  $P(1) \neq 0$ , we have  $P(z) = z^r - (2^d - 1)z^{r-1} - \frac{z^r - 1}{z - 1} = \frac{S(z)}{z - 1}$ , where

$$S(z) = z^{r+1} - (2^{d+1} + 1)z^r + (2^d - 1)z^{r-1} + 1.$$

Let  $Z(P) = \{z \in \mathbb{C}, P(z) = 0\}$  and  $\lambda \in Z(P)$ . Since  $P(1) \neq 0$ , we show easily that  $P(\lambda) = 0$  if, and only if,  $S(\lambda) = 0$ , or equivalently,

$$\lambda^{r+1} - (2^d + 1)\lambda^r + (2^d - 1)\lambda^{r-1} + 1 = 0. \tag{18}$$

Suppose that  $\lambda$  is a root of  $P(z)$ , with multiplicity  $m \geq 2$ . Since  $S(\lambda) = 0$ ,  $\lambda \neq 1$  and  $P'(z) = \frac{S(z) - S'(z)(z-1)}{(z-1)^2}$ , where  $P'(z)$  denote the derivative of  $P(z)$ , we derive  $S'(\lambda) = 0$ , namely, we have the

$$S'(\lambda) = [(r+1)\lambda^2 - (2^d + 1)r\lambda + (2^d - 1)(r-1)]\lambda^{r-2} = 0. \tag{19}$$

Since  $P(0) = -1 \neq 0$ , or equivalently  $0 \notin Z(P)$ , we derive the following equation,

$$(r+1)\lambda^2 - (2^d + 1)r\lambda + (2^d - 1)(r-1) = 0, \tag{20}$$

whose roots are given by,

$$\lambda_1 = \frac{(2^d + 1)r + \sqrt{\Delta}}{2(r+1)} \text{ and } \lambda_2 = \frac{(2^d + 1)r - \sqrt{\Delta}}{2(r+1)},$$

where  $\Delta = (2^d + 1)^2 r^2 - 4(2^d - 1)(r^2 - 1)$ .

On the other side, taking into account Expressions (18) and (19), we derive the following equation,

$$\begin{aligned} & (r+1)\lambda^{r+1} - (2^d+1)r\lambda^r + (2^d-1)(r-1)\lambda^{r-1} \\ &= r[\lambda^{r+1} - (2^d+1)\lambda^r + (2^d-1)\lambda^{r-1} + 1] + \lambda^{r+1} - (2^d-1)\lambda^{r-1} - r = 0. \end{aligned}$$

Using Equation (18), we derive  $\lambda^{r+1} - (2^d-1)\lambda^{r-1} - r = 0$ , hence we have the following identity,

$$\lambda^{r+1} - (2^d-1)\lambda^{r-1} = \lambda^{r-1}[\lambda^2 - (2^d-1)] = r. \quad (21)$$

**Case 1.** Let now establish that the root  $\lambda_1$  is not a root of  $P(z)$  of multiplicity  $\geq 2$ . The expression of  $\lambda_1$ , takes the form,  $\lambda_1 = \frac{(2^d+1)r+\sqrt{\Delta}}{2(r+1)} = \frac{(2^d+1)(r+1)+\sqrt{\Delta}-(2^d+1)}{2(r+1)}$ , which implies  $\lambda_1 = \frac{(2^d+1)}{2} + \frac{\sqrt{\Delta} - (2^d+1)}{2(r+1)}$ . Since

$$\Delta = (2^d+1)^2r^2 - 4(2^d-1)(r^2-1) = [2^d(2^d-2)+5]r^2 + 4(2^d-1), \quad (22)$$

a straightforward computation shows that,

$$\frac{\sqrt{\Delta} - (2^d+1)}{2(r+1)} = \frac{(2^d(2^d-2)+5)(r^2-1)}{2(r+1)(\sqrt{\Delta} + (2^d+1))} > 0.$$

Since  $r \geq 3$  and  $d \geq 1$  and  $\frac{\sqrt{\Delta} - (2^d+1)}{2(r+1)} > 0$ , then  $\lambda_1 > \frac{(2^d+1)}{2} > \frac{3}{2}$ . On the other side, we have,

$$\lambda_1^2 - (2^d-1) = \frac{A(r,d)}{4(r+1)^2},$$

where  $A(r,d) = ((2^d+1)r)^2 + 2(2^d+1)r\sqrt{\Delta} + \Delta - 4(2^d-1)(r+1)^2$ , let analyze the sign of the expression  $\Omega(r,d) = A(r,d) - 4(r+1)^2$ . We have

$$\begin{aligned} \Omega(r,d) &= ((2^d+1)r)^2 + 2(2^d+1)r\sqrt{\Delta} + \Delta - 4(2^d-1)(r+1)^2 - 4(r+1)^2 \\ &= ((2^{2d}-2^{d+1})r^2 + r^2 + (2^{d+1})r(\sqrt{\Delta}-4) + 2r\sqrt{\Delta} + \Delta - 2^{d+2}). \end{aligned}$$

Since  $r \geq 3, d \geq 1$ , Expression (22) allows us to derive that  $\Delta - 2^{d+2} > 0$  and  $\sqrt{\Delta} - 4 > 0$ , because  $\Delta > 49$ . Therefore, we obtain  $\Omega(r,d) = A(r,d) - 4(r+1)^2 > 0$ . Hence, we have  $A(r,d) > 4(r+1)^2$ , thus  $\lambda_1^2 - (2^d-1) > 1$ .

Finally, since  $\lambda_1 > \frac{3}{2}$  we show that  $\lambda_1^{r-1} > (\frac{3}{2})^{r-1} > r$ , for  $r \geq 3$ . Therefore, Expression (21), shows that,  $r = \lambda_1^{r-1}[\lambda_1^2 - (2^d-1)] > r$ , which is impossible. Conclusion,  $\lambda_1$  is not a root of the polynomial  $P(z)$  of multiplicity  $\geq 2$ .

**Case 2.** Let us also establish that  $\lambda_2 = \frac{(2^d+1)r - \sqrt{\Delta}}{2(r+1)}$  is not a root of  $P(z)$  of multiplicity  $\geq 2$ . By using Expression (22), we have,

$$\lambda_2 = \frac{((2^d+1)r - \sqrt{\Delta})((2^d+1)r + \sqrt{\Delta})}{2(r+1)((2^d+1)r + \sqrt{\Delta})} = \frac{2(r-1)(2^d-1)}{(2^d+1)r + \sqrt{\Delta}} > 0,$$

and

$$\lambda_2^2 - (2^d-1) = \left[ \frac{4(r-1)^2(2^d-1)}{[(2^d+1)r + \sqrt{\Delta}]^2} - 1 \right] (2^d-1).$$

On the other hand, a straightforward computation shows that,

$$[(2^d+1)r + \sqrt{\Delta}]^2 - 4(r-1)^2(2^d-1) = (2^{2d} - 2^{d+1} + 4)r^2 + 4(2^d-1)(r-2) + 2(2^d+1)r\sqrt{\Delta} + \Delta > 0,$$

which implies that  $[(2^d + 1)r + \sqrt{\Delta}]^2 > 4(r - 1)^2(2^d - 1)$  or equivalently  $\frac{4(r-1)^2(2^d-1)}{[(2^d+1)r+\sqrt{\Delta}]^2} < 1$ . Therefore, we have,

$$\lambda_2^2 - (2^d - 1) = \left[ \frac{4(r-1)^2(2^d-1)}{[(2^d+1)r+\sqrt{\Delta}]^2} - 1 \right] (2^d - 1) < 0.$$

Once again, taking into account Expression (21), namely,  $\lambda_2^{r-1}[\lambda_2^2 - (2^d - 1)] = r$ , we derive,

$$\lambda_2^{r-1}[\lambda_2^2 - (2^d - 1)] = r < 0$$

which is impossible. Consequently, the root  $\lambda_2$  of Equation (20) is not a root of the polynomial  $P'(z)$  or equivalently,  $\lambda_2$  is not a root of multiplicity  $\geq 2$  of the polynomial  $P(z)$ . Therefore, the roots of the polynomial  $P(z)$  are simple.  $\square$

**Remark 4.2.** Note that for  $d = 1$  we recover Lemma 5.1 of [16], namely, Lemma 4.1 is a generalization of [ Lemma 5.1, [16]].

For the characteristic the polynomial  $R(z) = z^r - 2^d z^{r-1} - h$  of the generalized Pell numbers (3), we have the following result.

**Lemma 4.3.** For integers  $d \geq 1$  and  $h \geq 1$ , the roots of the polynomial,

$$R(z) = z^r - 2^d z^{r-1} - h,$$

are simple.

*Proof.* For  $r = 2$  we have  $R(z) = z^2 - 2^d z - h$ , and since  $\Delta = (-2)^2 d + 4h > 0$  the roots of the polynomial  $R(z)$  are simple. For  $r \geq 3$ , if  $\lambda$  is a root of  $R(z)$ , we have,

$$\lambda^r - 2^d \lambda^{r-1} - h = 0 \Leftrightarrow \lambda^{r-1}(\lambda - 2^d) = h. \quad (23)$$

Suppose that  $\lambda$  is a root of multiplicity  $m \geq 2$ , then  $R'(\lambda) = 0$ . Therefore, we have,

$$r\lambda^{r-1} - 2^d(r-1)\lambda^{r-2} = 0 \Leftrightarrow \lambda^{r-2}(r\lambda - 2^d(r-1)) = 0.$$

Since  $R(0) \neq 0$ , we derive that  $\lambda = \frac{2^d(r-1)}{r}$ . And using Expression (23), we show

$$h = \left( \frac{2^d(r-1)}{r} \right)^{r-1} \left( \frac{2^d(r-1)}{r} - 2^d \right) = \left( \frac{2(r-1)}{r} \right)^{r-1} \left( -\frac{2^d}{r} \right),$$

which is impossible, since  $h$  is a positive integer. Therefore, the roots of the polynomial  $R(z) = z^r - 2^d z^{r-1} - h$  are simple.  $\square$

Let apply Lemmas 4.1-4.3 for providing the analytic formula of generalized Pell numbers (2)-(3). The process present in these two lemmas allows us to avoid the heavy techniques of the determinant by considering the result [3, Theorem 2.2]. That is, the combinatorial expression of  $\rho(n, r)$  related to the general case of linear difference equation (4) is expressed in terms of the roots of the polynomial  $P(z) = z^r - a_0 z^{r-1} - \dots - a_{r-2} z - a_{r-1}$ . More precisely, the sequence  $\{\rho(n, r)\}_{n \geq 0}$  defined by (6), is a linear recursive of type (4), and its analytical expression is given in the following lemma.

**Lemma 4.4.** (see [1, 3]) Let  $\{\rho(n, r)\}_{n \geq 0}$  be the sequence defined by (6). Suppose that the roots  $\lambda_1, \dots, \lambda_r$  of its characteristic polynomial  $P(z) = z^r - a_0 z^{r-1} - \dots - a_{r-2} z - a_{r-1}$  ( $a_{r-1} \neq 0$ ) satisfy  $\lambda_i \neq \lambda_j$  for  $i \neq j$ . Then, we have

$$\rho(n, r) = \sum_{i=1}^r \frac{\lambda_i^{n-1}}{P'(\lambda_i)} = \sum_{i=1}^r \frac{\lambda_i^{n-1}}{\prod_{k \neq i} (\lambda_i - \lambda_k)} \text{ for every } n \geq r,$$

otherwise  $\rho(r, r) = 1$ ,  $\rho(i, r) = 0$  for  $i \leq r - 1$ , where  $P'(z) = \frac{dP}{dz}(z)$ .

Following Corollary 2.3 and Proposition 2.5 the combinatorial expression of the sequences  $\{P_{i,n}\}_{n \geq 0}$  of the Pell fundamental system (10) are formulated in terms of the  $\rho(n, r)$ , given by Expressions (9), (11) and (12), namely, we have,

$$P_{i,n} = \rho_i(n + 1, r), \quad P_{i,n}^{(1)} = hP_{i,n-1}^{(r)} = hP_{i,n-1} = h\rho_i(n, r),$$

$$P_{i,n}^{(s)} = \sum_{j=s-r+i+1}^{s-2} \rho_i(n - j, r) + h\rho_i(n - s + 1, r), \quad ,$$

for  $n \geq r$ ,  $n \geq r + 1$  or  $r \geq r + s$ , respectively, and where the  $\rho_i(n, r)$  are given as in (6) such that  $a_0 = 2^d$ ,  $a_1 = \dots = a_i = 0$ ,  $a_{i+1} = \dots = a_{r-1} = 1$ , namely,

$$\rho_i(n, r) = \sum_{k_0+(i+2)k_{i+1}+\dots+rk_{r-1}=n-r} \frac{(k_0 + k_{i+1} + \dots + k_{r-1})!}{k_0!k_{i+1}! \dots k_{r-1}!} 2^{dk_0}, \text{ for } n \geq r.$$

where  $\rho_i(r, r) = 1$  and  $\rho_i(n, r) = 0$  for  $n \leq r - 1$ .

Now using Lemmas 4.1-4.4 and Expressions (11)-(12), we can formulate the analytical expressions of the family of Pell numbers constituting the Pell fundamental system defined as in (10), as follows.

**Theorem 4.5.** Let  $h = 1$  and  $\{\{P_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq r\}$  be the Pell fundamental system defined as in (10). Then, the analytic expression of each  $P_n^{(s)}$ , ( $1 \leq s \leq r$ ) is given by,

$$P_n = \rho_0(n + 1, r) = \sum_{j=1}^r \frac{\lambda_j^{n-1}}{P'(\lambda_j)} = \sum_{j=1}^r \frac{\lambda_j^{n-1}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq r,$$

$$P_n^{(1)} = P_{n-1} = \rho_0(n, r) = \sum_{j=1}^r \frac{\lambda_j^{n-2}}{P'(\lambda_j)} = \sum_{j=1}^r \frac{\lambda_j^{n-2}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq r + 1,$$

$$P_n^{(s)} = \sum_{j=s-r+1}^{s-2} \rho_0(n - j, r) + \rho_0(n - s + 1, r) = \sum_{j=s-r+1}^{s-2} \sum_{t=1}^r \frac{\lambda_t^{n-j-2}}{P'(\lambda_t)} + \frac{\lambda_t^{n-s-1}}{P'(\lambda_t)}$$

where  $\lambda_1, \dots, \lambda_r$  the simple roots of the polynomial  $P(z) = z^r - 2^d z^{r-1} - z^{r-2} - \dots - z - 1$ .

We can show that for  $d = 1$ , Theorem 4.5 is nothing else but the Theorem 5.1 established in [16]. We illustrate Theorem 4.5 by considering the following numerical cases.

**Example 4.6.** For  $r = 3$  and  $d = h = 1$ , we have the fundamental system  $\{\{P_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq 3\}$ . In this case, the roots of the characteristic polynomial associated  $P(z) = z^3 - 2z^2 - z - 1$  are  $\lambda_1 \approx 2.5468$ ,  $\lambda_2 \approx -0.27341 - 0.56382i$  and  $\lambda_3 \approx -0.27341 + 0.56382i$ . Then, applying the Theorem 4.5 we obtain

$$\begin{aligned}
P_n &= \frac{\lambda_1^{n-1}}{3\lambda_1^2 - 4\lambda_1 - 1} + \frac{\lambda_2^{n-1}}{3\lambda_2^2 - 4\lambda_2 - 1} + \frac{\lambda_3^{n-1}}{3\lambda_3^2 - 4\lambda_3 - 1}, \text{ for } n \geq 3, \\
P_n^{(1)} &= \frac{\lambda_1^{n-2}}{3\lambda_1^2 - 4\lambda_1 - 1} + \frac{\lambda_2^{n-2}}{3\lambda_2^2 - 4\lambda_2 - 1} + \frac{\lambda_3^{n-2}}{3\lambda_3^2 - 4\lambda_3 - 1}, \text{ for } n \geq 4, \\
P_n^{(2)} &= \frac{\lambda_1^{n-2} + \lambda_1^{n-3}}{3\lambda_1^2 - 4\lambda_1 - 1} + \frac{\lambda_2^{n-2} + \lambda_2^{n-3}}{3\lambda_2^2 - 4\lambda_2 - 1} + \frac{\lambda_3^{n-2} + \lambda_3^{n-3}}{3\lambda_3^2 - 4\lambda_3 - 1}, \text{ for } n \geq 5.
\end{aligned}$$

The combination of Proposition 2.8 and Theorem 4.5 permit us to get the analytical expression for the general setting of any sequence of generalized Pell numbers, with arbitrary initial conditions without solving the associated Vandermonde linear system, namely, we have the following result.

**Proposition 4.7.** *Let consider the sequence  $\{W_n\}_{n \geq 0}$  defined by,  $W_n = \alpha_0 P_n^{(1)} + \alpha_1 P_n^{(2)} + \dots + \alpha_{r-1} P_n^{(r)}$ , for every  $n \geq 0$ , where  $h = 1$  and  $\{\{P_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq r\}$  is the Pell fundamental system defined as in (10). Then, the analytical expression to  $W_n$  is given by  $W_n = \sum_{k=1}^r \sum_{j=1}^r \frac{\alpha_{k-1} \lambda_j^{n-2}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}$ . where  $\lambda_1, \dots, \lambda_r$  the simple roots of the polynomial  $P(z) = z^r - 2^d z^{r-1} - z^{r-2} - \dots - z - 1$ .*

Similarly, Lemmas 4.3-4.4 and Expressions (13)-(14) allow us formulate the following analogous results of the family of Pell numbers constituting the Pell fundamental systems related to Expression (3) as follows.

**Theorem 4.8.** *Let  $\mathfrak{R}_r = \{\{R_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq r\}$  be the Pell fundamental system related to generalized Pell numbers given by Expression (3). Then, the analytical expression of each  $\{R_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq r\}$  is given by,*

$$\begin{aligned}
R_n &= \rho_2(n+1, r) = \sum_{i=1}^r \frac{\lambda_i^{n-1}}{R'(\lambda_i)}, \text{ for } n \geq 1, \\
R_n^{(1)} &= hR_{n-1} = h\rho_2(n, r) = h \sum_{i=1}^r \frac{\lambda_i^{n-2}}{R'(\lambda_i)}, \text{ for } n \geq r \\
R_n^{(s)} &= h\rho_2(n-s+1, r) = h \sum_{i=1}^r \frac{\lambda_i^{n-s-1}}{R'(\lambda_i)}, \text{ for } n \geq r+s.
\end{aligned}$$

where  $\lambda_1, \dots, \lambda_r$  the simple roots of the polynomial  $R(z) = z^r - 2^d z^{r-1} - h$ .

In best of our knowledge the presented analytical representations are not current in the literature. The analytic formula for generalized Pell  $(r, r)$ - numbers is presented in terms of determinant in [Theorem 6 and Corollary 7, [12]]. Under the precedent discussion and notation this analytic formula, only in terms of powers of roots of characteristic polynomial associated to the generalized Pell  $(r, r)$ - numbers is given by the first representation in 4.8.



Since the Pell fundamental system associated with generalized Pell numbers (1) is also linked to the generalized Pell  $(r, i)$ -numbers, we deduce from Proposition 2.8 and Theorem 4.8, an analytical expression of the generalized Pell  $(r, i)$ -numbers without using determinant.

**Proposition 4.9.** *Let the set of the generalized Pell  $(r, i)$ -numbers  $\tilde{R}_n$ . Then, the analytic expression of each  $\tilde{R}_n$ , for  $n \geq r + i$  is given by,*

$$\tilde{R}_n = \sum_{k=1}^{i+2} \sum_{j=1}^r \frac{\lambda_k^{n-k}}{R'(\lambda_j)}, \quad (24)$$

where  $\lambda_1, \dots, \lambda_r$  the simple roots of the polynomial  $R(z) = z^r - 2z^{r-1} - 1$  and  $R'(z) = rz^{r-1} - 2(r-1)z^{r-2}$ .

**Example 4.10.** For  $r = 3, d = h = 1$  the characteristic polynomial  $R(z) = z^3 - 2z^2 - 1$  associated to  $\mathfrak{R}_3 = \{\{R_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq 3\}$  has roots  $\lambda_1 \approx 2.2056, \lambda_2 \approx -0.10278 - 0.66546i$  and  $\lambda_3 \approx -0.10278 + 0.66546i$ . Then, the application of Theorem 4.8 allow us get the follows identities,

$$R_n = \frac{\lambda_1^{n-1}}{R'(\lambda_1)} + \frac{\lambda_2^{n-1}}{R'(\lambda_2)} + \frac{\lambda_3^{n-1}}{R'(\lambda_3)}, \text{ for } n \geq 1,$$

$$R_n^{(1)} = \frac{\lambda_1^{n-2}}{R'(\lambda_1)} + \frac{\lambda_2^{n-2}}{R'(\lambda_2)} + \frac{\lambda_3^{n-2}}{R'(\lambda_3)}, \text{ for } n \geq 3$$

$$R_n^{(2)} = \frac{\lambda_1^{n-3}}{R'(\lambda_1)} + \frac{\lambda_2^{n-3}}{R'(\lambda_2)} + \frac{\lambda_3^{n-3}}{R'(\lambda_3)}, \text{ for } n \geq s + 3,$$

where  $R'(z) = 3z^2 - 4z$ .

Similar result of Proposition 4.7 can be started for a sequence of generalized Pell numbers of type (3), with arbitrary initial conditions. More precisely, the combination of Proposition 2.8 and Theorem 4.8 permit us to obtain the analytical expression for the general setting of a sequence generalized Pell numbers  $\{W_n\}_{n \geq 0}$  of type (3), with arbitrary initial conditions  $\alpha_0, \alpha_1, \dots, \alpha_{r-1}$ , without solving the related Vandermonde linear system. That is, we have  $W_n = \sum_{k=1}^r \alpha_k R_n^{(k)}$ , where the analytical expressions of the  $R_n^{(k)}$ , with  $R_n^{(r)} = R_n$ , are given as in Theorem 4.8.

**4.2. Study of the case  $d = 0$  : Generalized Fibonacci numbers.** As mentioned above in Remark 2.4, when  $d = 0$  then Equation (2) is nothing else but that defining the  $r$ -generalized Fibonacci numbers  $\{F_n\}_{n \geq 0}$  studied in [15]. And  $P(z) = z^r - z^{r-1} - z^{r-2} - \dots - z - 1$  is the characteristic polynomial associated to  $r$ -generalized Fibonacci numbers. The following results show us that  $P(z)$  has simple roots.

**Lemma 4.11.** *The roots of the polynomial*

$$P(z) = z^r - z^{r-1} - z^{r-2} - \dots - z - 1,$$

*are simple.*

*Proof.* The polynomial  $P(z) = z^r - z^{r-1} - z^{r-2} - \dots - z - 1$  can be written under the form  $P(z) = z^r - (z^{r-1} + \dots + z + 1) = z^r - \frac{z^r - 1}{z - 1}$ . Since  $P(1) \neq 0$ , we have

$$P(z) = \frac{z^{r+1} - 2z^r + 1}{z - 1} = \frac{S(z)}{z - 1},$$

where  $S(z) = z^{r+1} - 2z^r + 1$ . Since  $P(1) \neq 0$ , we show easily that  $P(\lambda) = 0$  if, and only if,  $S(\lambda) = 0$ , or equivalently,

$$\lambda^{r+1} - 2\lambda^r + 1 = 0. \quad (25)$$

Suppose that  $\lambda$  is a root of  $P(z)$ , with multiplicity  $m \geq 2$ , thus  $P'(\lambda) = 0$ . Since  $S(\lambda) = 0$ ,  $\lambda \neq 1$  and  $P'(z) = \frac{S(z) - S'(z)(z-1)}{(z-1)^2}$ , where  $P'(z)$  denote the derivative of  $P(z)$ , we derive  $S'(\lambda) = 0$ , namely, we have the

$$S'(\lambda) = [(r+1)\lambda - 2r]\lambda^{r-1} = 0.$$

Since  $P(0) = -1 \neq 0$  then  $\lambda \neq 0$ . Hence, we derive the following the equality,

$$\lambda = \frac{2r}{r+1}, \quad (26)$$

By Expression (25) we obtain  $\lambda^{r+1} - 2\lambda^r + 1 = (\lambda - 2)\lambda^r + 1 = 0$ . Therefore, we have  $\left(\frac{2r}{r+1} - 2\right)\lambda^r = \left(\frac{-2}{r+1}\right)\lambda^r = -1$ . Following Expression (26), we get  $\lambda^{r+1} = \left(\frac{2r}{r+1}\right)^{r+1} = r$ . For  $r = 2$ , we have  $\lambda^3 = \frac{64}{27} > 2$ . Suppose that  $\lambda^{r+1} > r$ . Since  $r \geq 2$  we have  $\lambda = \frac{2r}{r+1} = 2 - \frac{1}{r+1} > 1, 5$ . Therefore, we have,

$$\lambda^{r+2} = \lambda^{r+1} \times \lambda > 1, 5r = r + 0, 5r \geq r + 1.$$

Therefore, the equality  $\lambda^{r+1} = \left(\frac{2r}{r+1}\right)^{r+1} = r$  is not valid. Consequently, the roots of the polynomial  $P(z) = z^r - z^{r-1} - z^{r-2} - \dots - z - 1$  are simple. □

Therefore, results of Section 4.1 are still valid for the generalized Fibonacci numbers and generalized Fibonacci  $r$ -numbers. More precisely, by considering the parameter  $d = 0$ , we have the analytical formula to each element of Fibonacci fundamental system  $\{\{F_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq r\}$  described in [Section 2, [15]], namely, we have the following results.

**Theorem 4.12.** *Let  $\{\{F_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq r\}$  be the Fibonacci fundamental system. Then, the analytical expression of each  $F_n^{(s)}$  ( $1 \leq s \leq r$ ) is given by,*

$$F_n = \sum_{i=1}^r \frac{\lambda_i^n}{P'(\lambda_i)} = \sum_{i=1}^r \frac{\lambda_i^n}{\prod_{k \neq i} (\lambda_i - \lambda_k)}, \text{ for } n \geq r,$$

$$F_n^{(1)} = \sum_{i=1}^r \frac{\lambda_i^{n-1}}{P'(\lambda_i)} = \sum_{i=1}^r \frac{\lambda_i^{n-1}}{\prod_{k \neq i} (\lambda_i - \lambda_k)}, \text{ for } n \geq r + 1,$$

$$F_n^{(s)} = \sum_{j=1}^s \sum_{i=1}^r \frac{\lambda_i^{n+s-j-1}}{P'(\lambda_i)} = \sum_{j=1}^s \sum_{i=1}^r \frac{\lambda_i^{n+s-j-1}}{\prod_{k \neq i} (\lambda_i - \lambda_k)}, \text{ for } r \geq r + s,$$

where  $\lambda_1, \dots, \lambda_r$  the simple roots of the polynomial  $P(z) = z^r - z^{r-1} - z^{r-2} - \dots - z - 1$ .

The analytical formulas describe in Theorem 4.12 was not established in [15]. In best of our knowledge the analytical representations presented in Theorem 4.12 are new in the literature.

Observe that the Lemma 4.3 is still valid for parameter  $d = 0$ , its proof is derived from a direct computation. Then, Proposition 4.8 still also for this parameter. Specially, we can establish the analytical formulas for the fundamental system  $\{\{R_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq r\}$  related to the sequences of Fibonacci  $r$ -numbers, with parameters  $h = 1$  and  $d = 0$ , namely,

$$R_n = \sum_{i=1}^r \frac{\lambda_i^{n-1}}{R'(\lambda_i)}, R_n^{(1)} = \sum_{i=1}^r \frac{\lambda_i^{n-2}}{R'(\lambda_i)}, \text{ for } n \geq r, \text{ and } R_n^{(s)} = \sum_{i=1}^r \frac{\lambda_i^{n-s-1}}{R'(\lambda_i)}, \text{ for } n \geq r + s,$$

where  $\lambda_1, \dots, \lambda_r$  the simple roots of the polynomial  $R(z) = z^r - z^{r-1} - 1$ .

Taking into account the preceding data, we can assert also that Propositions 4.7 and 4.9 are still valid for  $r$ -generalized Fibonacci numbers and generalized Fibonacci  $r$ -numbers.

## 5. ANALYTIC REPRESENTATION OF PELL NUMBERS (1): SOME SPECIAL CASES WITH $1 \leq i \leq r - 3$

For the linear recursive equation defining the model of generalized Pell numbers (1), the characteristic polynomial is given as follows,

$$P(z) = z^r - 2^d z^{r-1} - z^{r-i-2} - \dots - z - h. \quad (27)$$

We study here the analytic expression of some special cases of the the model of generalized Pell numbers (1), by establishing that the roots of their associated characteristic polynomial are simple. To reach our goal, we consider the notion of Sylvester matrix.

It is well-known that a Sylvester matrix is a matrix associated with two univariate polynomials  $P(z)$  and  $Q(z)$ , whose entries are given by coefficients of these two polynomials [9]. When the determinant of the Sylvester matrix  $S_{P,Q}$ , called the resultant, is zero, then the two polynomials have a common root (in case of coefficients in a field) or a non-constant common divisor (in case of coefficients in an integral domain). Considering the polynomial (27) and its derivative  $P'(z)$ , if the determinant of the Sylvester matrix  $S_{P,P'}$  is different from 0, then the polynomials  $P(z)$  and  $P'(z)$  don't have common roots. This means that if  $\det(S_{P,P'}) \neq 0$ , then the roots of  $P(z)$  are simple.

**5.1. Special case  $r = 4$  and  $i = 1$ .** Taking  $r = 4$ , the possible values for  $i$  are 0, 1 and 2. The cases  $i = 0$  and  $i = 2$ , with  $h = 1$ , have been studied in the previous section as basic cases. Let consider  $r = 4, i = 1$  and positive integers  $d$  and  $h$  in Expression (27). The associated characteristic polynomial is  $P(z) = z^4 - 2^d z^3 - z - h$ , with derivative  $P'(z) = 4z^3 - 3 \cdot 2^d z^2 - 1$ . In this special case the Sylvester matrix associated to  $P$  and  $P'$  is given by,

$$S_{P,P'} = \begin{pmatrix} 1 & -2^d & 0 & -1 & -h & 0 & 0 \\ 0 & 1 & -2^d & 0 & -1 & -h & 0 \\ 0 & 0 & 1 & -2^d & 0 & -1 & -h \\ 4 & -3 * 2^d & 0 & -1 & 0 & 0 & 0 \\ 0 & 4 & -3 * 2^d & 0 & -1 & 0 & 0 \\ 0 & 0 & 4 & -3 * 2^d & 0 & -1 & 0 \\ 0 & 0 & 0 & 4 & -3 * 2^d & 0 & -1 \end{pmatrix}.$$

Computational calculus <sup>1</sup> give us that, for all  $h, d$  positive integers, the determinant of  $S_{P,P'}$  is equal the  $g(d, h) = -27(2^{3d})(2^d)h^2 - 192(2^d)(h^2) - 256(h^3) - 22(2^{2d})(2^d) - 6(2^{2d})h + 18(2^{3d}) - 27$ .

**Lemma 5.1.** *There is no positive integers solutions to the equation  $-27(2^{3d})(2^d)h^2 - 192(2^d)(h^2) - 256(h^3) - 22(2^{2d})(2^d) - 6(2^{2d})h + 18(2^{3d}) - 27 = 0$ .*

*Proof.* In fact, taking  $x = 2^d$ , the equation  $g(d, h) = 0$  is equivalent to  $-256h^3 - (27x^4 + 192x)h^2 - 6x^2h - 4x^3 - 27 = 0$  that have as real solutions the pairs  $(x, h)$  given by  $(1, 1)$ ,  $(0, -\frac{4}{2^{2/3}})$ . The last possibility are not applied because  $x$  is a function with image in positive reals. Then, the only integer solution is  $(1, 1)$ , but in this case,  $x = 1 = 2^d$  or  $d = 0$ , what is impossible since  $d$  is a positive integer. <sup>2</sup>  $\square$

Lemma 5.1 show us that the determinant of  $S_{P,P'}$  is different from zero for all positive integers  $d$  and  $h$ . Then, follows the result.

**Lemma 5.2.** *The roots of the polynomial  $P(z) = z^4 - 2^d z^3 - z - h$ , are simple, for  $d$  and  $h$  positive integers.*

Therefore, for  $r = 4$  and  $i = 1$  we can established the analogous statements given in Section 4. Indeed, using Proposition 2.5 and Lemmas 5.1- 5.2, we can formulate the following result.

**Theorem 5.3.** *Let  $\{\{P_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq 4\}$  be the fundamental system defined as in (10). Then, the analytic expression of each  $P_n^{(s)}$ , ( $1 \leq s \leq 4$ ) is given by,*

$$P_{1,n} = \rho_1(n+1, 4) = \sum_{j=1}^4 \frac{\lambda_j^{n-1}}{P'(\lambda_j)} = \sum_{j=1}^4 \frac{\lambda_j^{n-1}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 4,$$

$$P_{1,n}^{(1)} = hP_{n-1} = h\rho_1(n, 4) = h \sum_{j=1}^4 \frac{\lambda_j^{n-2}}{P'(\lambda_j)} = h \sum_{j=1}^4 \frac{\lambda_j^{n-2}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 5,$$

and for  $n \geq 4 + s$  and  $2 \leq s \leq 3$ , we have,

$$P_{1,n}^{(s)} = \sum_{j=s-2}^{s-1} \rho_1(n-j, 4) + h\rho_1(n-s+1, 4) = \sum_{t=1}^4 \frac{\lambda_t^{n-s}}{P'(\lambda_t)} + h \frac{\lambda_t^{n-s-1}}{P'(\lambda_t)},$$

where  $\lambda_1, \dots, \lambda_4$  are the simple roots of the polynomial  $P(z) = z^4 - 2^d z^3 - z - h$ .

<sup>1</sup>the algebraic results was obtained using software Matlab and CoCalc-SageMath

<sup>2</sup>the numeric results was obtained using software Matlab and CoCalc-SageMath

We have the following illustrative numerical example of Theorem 5.3.

**Example 5.4.** For parameters  $h = 2$  and  $d = 5$  the resultant (namely, the determinant of the associated Sylvester matrix) is equal  $-113391643 \neq 0$ , then the roots of  $P(z) = z^4 - 32z^3 - z - 2$  are simple and we have  $\lambda_1 \approx -0,36933$ ,  $\lambda_2 \approx 32,001$ ,  $\lambda_3 \approx 0,18414 - 0,36785i$  and  $\lambda_4 \approx 0,18414 + 0,36785i$ . Therefore, the analytic expression of each  $P_n^{(s)}$  ( $1 \leq s \leq 4$ ) is given by,

$$P_{1,n} = \rho_1(n+1, 4) = \sum_{j=1}^4 \frac{\lambda_j^{n-1}}{P'(\lambda_j)} = \sum_{j=1}^4 \frac{\lambda_j^{n-1}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 4,$$

$$P_{1,n}^{(1)} = 2P_{n-1} = 2\rho_1(n, 4) = 2 \sum_{j=1}^4 \frac{\lambda_j^{n-2}}{P'(\lambda_j)} = 2 \sum_{j=1}^4 \frac{\lambda_j^{n-2}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 5,$$

$$P_{1,n}^{(2)} = \rho_1(n, 4) + 2\rho_1(n-1, 4) = \sum_{t=1}^4 \frac{\lambda_t^{n-2}}{P'(\lambda_t)} + 2 \frac{\lambda_t^{n-3}}{P'(\lambda_t)}, \text{ for } n \geq 6,$$

$$P_{1,n}^{(3)} = \sum_{j=1}^1 \rho_1(n-j, 4) + h\rho_1(n-2, 4) = \sum_{t=1}^4 \frac{\lambda_t^{n-3}}{P'(\lambda_t)} + 2 \frac{\lambda_t^{n-4}}{P'(\lambda_t)}, \text{ for } n \geq 7.$$

For  $r = 4$  in the model of generalized Pell numbers (1), a similar result of Proposition 4.7 can be started for a sequence of generalized Pell numbers with arbitrary initial conditions. More precisely, the combination of Proposition 2.8 and Theorem 5.3 permit us to get the analytical expression for the general setting of a sequence generalized Pell numbers  $\{W_n\}_{n \geq 0}$ , with arbitrary initial conditions  $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ , without solve the Vandermonde determinant system. That is, we have  $W_n = \sum_{k=1}^4 \alpha_k P_n^{(k)}$ , where the analytical expressions of the  $P_n^{(k)}$  ( $1 \leq k \leq 4$ ), with  $P_n^{(4)} = P_n$ , are given as in Theorem 5.3.

Note that, Theorem 5.3 is about a result established on a special case of the model of the generalized Pell numbers (1), which is not current in the literature.

**5.2. Special case  $r = 5$  and  $i = 1$ .** Let consider  $r = 5, i = 1$  and positive integers  $d$  and  $h$ . The associated characteristic polynomial is  $P(z) = z^5 - 2^d z^4 - z^2 - z - h$ , with derivative  $P'(z) = 5z^4 - 4(2^d)z^3 - 2z - 1$ . The Sylvester matrix associated to  $P(z)$  and  $P'(z)$  is,

$$S_{P,P'} = \begin{pmatrix} 1 & -2^d & 0 & -1 & -1 & -h & 0 & 0 & 0 \\ 0 & 1 & -2^d & 0 & -1 & -1 & -h & 0 & 0 \\ 0 & 0 & 1 & -2^d & 0 & -1 & -1 & -h & 0 \\ 0 & 0 & 0 & 1 & -2^d & 0 & -1 & -1 & -h \\ 5 & -4 * 2^d & 0 & -1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 5 & -4 * 2^d & 0 & -1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 5 & -4 * 2^d & 0 & -1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 5 & -4 * 2^d & 0 & -1 & -1 \end{pmatrix}$$



The determinant of  $S_{P,P'}$ , namely,  $g(h, d) = \det(S_{P,P'})$  is equal,

$$\begin{aligned} g(h, d) = & -256(2^{3d})(2^{2d})h^3 - 480(2^{2d})(2^d)h^2 - 2000(2^{2d})h^3 - 2500(2^d)h^3 \\ & + 3125h^4 - 112(2^{3d})(2^d)h - 292(2^{2d})(2^d)h - 128(2^{4d})h^2 + 320(2^{3d})h^2 \\ & - 50(2^{2d})h^2 - 900(2^d)h^2 - 32(2^{3d})2^d + 60(2^{2d})2^d - 32(2^{4d})h \\ & + 240(2^{3d})h + 24(2^{2d})h - 1020(2^d)h - 2250h^2 + 5(2^{4d}) \\ & - 64(2^{3d}) + 6(2^{2d}) - 192(2^d) - 1708h - 283. \end{aligned}$$

Taking  $x = 2^d$ , the equation  $g(d, h) = 0$  is equivalent to

$$\begin{aligned} & -256x^5h^3 - 480x^3h^2 - 2000x^2h^3 - 2500xh^3 + 3125h^4 - 112x^4h - 292x^3h - 128x^4h^2 \\ & + 320x^3h^2 - 50x^2h^2 - 900xh^2 - 32x^4 + 60x^3 - 32x^4h + 240x^3h + 24x^2h - 1020xh \\ & - 2250h^2 + 5x^4 - 64x^3 + 6x^2 - 192x - 1708h - 283 = 0. \end{aligned}$$

The direct computational verification give us the following lemma.

**Lemma 5.5.** *There is no positive integers solutions of the equation  $-256x^5h^3 - 480x^3h^2 - 2000x^2h^3 - 2500xh^3 + 3125h^4 - 112x^4h - 292x^3h - 128x^4h^2 + 320x^3h^2 - 50x^2h^2 - 900xh^2 - 32x^4 + 60x^3 - 32x^4h + 240x^3h + 24x^2h - 1020xh - 2250h^2 + 5x^4 - 64x^3 + 6x^2 - 192x - 1708h - 283 = 0$ .*

Then, Proposition 5.5 shows us that the determinant of  $S_{P,P'}$  is different from zero, for any positive integers  $d$  and  $h$ . Therefore, we have the following lemma.

**Lemma 5.6.** *The roots of the polynomial  $P(z) = z^5 - 2^dz^4 - z^2 - z - h$  are simple, for every positive integers  $d$  and  $h$ .*

As a consequence of the two Lemmas 5.5 and 5.6, the analogous statements given in Section 4, can be formulated as follows.

**Theorem 5.7.** *Let  $\{P_n^{(s)}\}_{n \geq 0}$ ,  $1 \leq s \leq 5$  be the Pell fundamental system defined as in (10). Then, the analytic expression of each  $\{P_n^{(s)}\}_{n \geq 0}$ ,  $1 \leq s \leq 5$  is given by,*

$$P_n = \rho_1(n+1, 5) = \sum_{j=1}^5 \frac{\lambda_j^{n-1}}{P'(\lambda_j)} = \sum_{j=1}^5 \frac{\lambda_j^{n-1}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 5,$$

$$P_n^{(1)} = hP_{n-1} = h\rho_1(n, 5) = h \sum_{j=1}^5 \frac{\lambda_j^{n-2}}{P'(\lambda_j)} = h \sum_{j=1}^4 \frac{\lambda_j^{n-2}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 6,$$

and for  $n \geq 5 + s$  ( $2 \leq s \leq 4$ ), we have,

$$P_n^{(s)} = \sum_{j=s-3}^{s-2} \rho_1(n-j, 5) + h\rho_1(n-s+1, 5) = \sum_{j=s-3}^{s-2} \sum_{t=1}^5 \frac{\lambda_t^{n-j-2}}{P'(\lambda_t)} + h \frac{\lambda_t^{n-s-1}}{P'(\lambda_t)},$$

where  $\lambda_1, \dots, \lambda_5$  are the simple roots of the polynomial  $P(z) = z^5 - 2^dz^4 - z^2 - z - h$ .

The following numerical example is for illustrating the content of Theorem 5.7.

**Example 5.8.** For the parameters  $h = 3$  and  $d = 5$ , the resultant is equal  $231159740436 \neq 0$ . Hence, the roots of the polynomial  $P(z) = z^5 - 32z^4 - z - 3$  are simple, that is, we have  $\lambda_1 \approx 32.0000$ ,  $\lambda_2 \approx -0.391434 - 0.363206i$ ,  $\lambda_3 \approx -0.391434 + 0.363206i$ ,  $\lambda_4 \approx 0.391418 - 0.419021i$ , and  $\lambda_5 \approx 0.391418 + 0.419021i$ . Then, the analytic expression of each  $P_n^{(s)}$  ( $1 \leq s \leq 5$ ) is given by,

$$P_n = \rho_1(n+1, 5) = \sum_{j=1}^5 \frac{\lambda_j^{n-1}}{P'(\lambda_j)} = \sum_{j=1}^5 \frac{\lambda_j^{n-1}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 5,$$

$$P_n^{(1)} = 3P_{n-1} = 2\rho_1(n, 5) = 3 \sum_{j=1}^5 \frac{\lambda_j^{n-2}}{P'(\lambda_j)} = 3 \sum_{j=1}^5 \frac{\lambda_j^{n-2}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 6,$$

and for  $n \geq 5 + s$  and  $2 \leq s \leq 4$ , we have,

$$P_n^{(2)} = \rho_1(n, 5) + 3\rho_1(n-1, 5) = \sum_{t=1}^5 \frac{\lambda_t^{n-2}}{P'(\lambda_t)} + 3 \frac{\lambda_t^{n-3}}{P'(\lambda_t)},$$

$$P_n^{(3)} = \sum_{j=0}^1 \rho_1(n-j, 5) + 3\rho_1(n-s+1, 5) = \sum_{j=0}^1 \sum_{t=1}^5 \frac{\lambda_t^{n-j-2}}{P'(\lambda_t)} + 3 \frac{\lambda_t^{n-4}}{P'(\lambda_t)},$$

$$P_n^{(4)} = \sum_{j=1}^2 \rho_1(n-j, 5) + 3\rho_1(n-s+1, 5) = \sum_{j=1}^2 \sum_{t=1}^5 \frac{\lambda_t^{n-j-2}}{P'(\lambda_t)} + 3 \frac{\lambda_t^{n-5}}{P'(\lambda_t)}.$$

**5.3. Special case  $r = 5$  and  $i = 2$ .** Suppose that  $r = 5, i = 2$  and consider the positive integers  $h$  and  $d$ . The associated characteristic polynomial is  $P(z) = z^5 - 2^d z^4 - z - h$ , with derivative  $P'(z) = 5z^4 - 4(2^d)z^3 - 1$ . Then, the determinant of the associated Sylvester matrix is given by,

$$g(h, d) = 256(2^{4x})(2^x)h^3 + 2500(2^x)h^3 + 3125h^4 + 436(2^{2x})(2^x)h - 50(2^{2x}h)^2 - 336(2^{3x})2^x - 400(2^{3x})h + 309(2^{4x}) - 256.$$

The same variable change  $x = 2^d$ , gives us the equation

$$256(h^3)u^5 + 3125h^4 + 2500(h^3)u - 50(h^2)u^2 + 36hu^3 - 27u^4 - 256 = 0.$$

We can verify that, the only integers solutions the preceding equation are given by  $h = -1, u = 1$ , and  $h = 1, u = -1$ , which is impossible. Then, it follows the result showing us that the resultant, namely, determinant of Sylvester matrix  $S_{P,P'}$  is different from zero for every positive integers  $d$  and  $h$ .

**Lemma 5.9.** There is no positive integers solutions to the equation  $-256(2^{4d})(2^d)h^3 - 2500(2^d)h^3 + 3125h^4 - 436(2^{2d})(2^d)h - 502^{2d}h^2 - 336(2^{3d})2^d + 400(2^{3d})h + 3092^{4d} - 256 = 0$ .

As a consequence of the Lemma 5.9, we deduce the following proposition.

**Proposition 5.10.** The roots of the polynomial

$$P(z) = z^5 - 2^d z^4 - z - h$$

are simple, for  $d$  and  $h$  positive integers.

Therefore, with the aid of Lemma 5.9 and Proposition 5.10, the following theorem is valid.

**Theorem 5.11.** Let  $\{\{P_n^{(s)}\}_{n \geq 0}, 1 \leq s \leq 5\}$  be the Pell fundamental system defined as in (10). Then, the analytic expression of each  $P_n^{(s)}$  ( $1 \leq s \leq 5$ ) is given by,

$$P_{2,n} = \rho_2(n+1, 5) = \sum_{j=1}^5 \frac{\lambda_j^{n-1}}{P'(\lambda_j)} = \sum_{j=1}^5 \frac{\lambda_j^{n-1}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 5,$$

$$P_{2,n}^{(1)} = hP_{n-1} = h\rho_2(n, 5) = h \sum_{j=1}^5 \frac{\lambda_j^{n-2}}{P'(\lambda_j)} = h \sum_{j=1}^4 \frac{\lambda_j^{n-2}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 6,$$

and for  $n \geq 5 + s$  ( $2 \leq s \leq 4$ ), we have,

$$P_{2,n}^{(s)} = \sum_{j=s-2}^{s-2} \rho_2(n-j, 5) + h\rho_2(n-s+1, 5) = \sum_{t=1}^5 \frac{\lambda_t^{n-s}}{P'(\lambda_t)} + h \frac{\lambda_t^{n-s-1}}{P'(\lambda_t)},$$

where  $\lambda_1, \dots, \lambda_5$  are the simple roots of the polynomial  $P(z) = z^5 - 2^d z^4 - z - h$ .

As an illustrative application of Theorem 5.11, we give the following numerical example.

**Example 5.12.** For the parameters  $h = 2$  and  $d = 6$ , the resultant is equal  $62810960 \neq 0$ . Then, the roots of the associated polynomial  $P(z) = z^5 - 64z^4 - z - 2$  are simple, that is, we have  $\lambda_1 \approx 64.0000$ ,  $\lambda_2 \approx -0.297632 - 0.274181i$ ,  $\lambda_3 \approx -0.297632 + 0.274181i$ ,  $\lambda_4 \approx 0.297630 - 0.319757i$ , and  $\lambda_5 \approx 0.297630 + 0.319757i$ . Then, the analytic expression of each  $P_n^{(s)}$  ( $1 \leq s \leq 5$ ) is given by,

$$P_{2,n} = \rho_2(n+1, 5) = \sum_{j=1}^5 \frac{\lambda_j^{n-1}}{P'(\lambda_j)} = \sum_{j=1}^5 \frac{\lambda_j^{n-1}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 5,$$

$$P_{2,n}^{(1)} = 3P_{n-1} = 3\rho_2(n, 5) = 3 \sum_{j=1}^5 \frac{\lambda_j^{n-2}}{P'(\lambda_j)} = 3 \sum_{j=1}^5 \frac{\lambda_j^{n-2}}{\prod_{k \neq j} (\lambda_j - \lambda_k)}, \text{ for } n \geq 6,$$

and for  $n \geq 5 + s$  and  $2 \leq s \leq 4$ , we have,

$$P_{2,n}^{(2)} = \rho_2(n, 5) + 3\rho_2(n-1, 5) = \sum_{t=1}^5 \frac{\lambda_t^{n-2}}{P'(\lambda_t)} + 3 \frac{\lambda_t^{n-3}}{P'(\lambda_t)},$$

$$P_{2,n}^{(3)} = \sum_{j=1}^1 \rho_2(n-j, 5) + 3\rho_2(n-2, 5) = \sum_{t=1}^5 \frac{\lambda_t^{n-3}}{P'(\lambda_t)} + 3 \frac{\lambda_t^{n-4}}{P'(\lambda_t)},$$

$$P_{2,n}^{(4)} = \sum_{j=2}^2 \rho_2(n-j, 5) + 3\rho_2(n-3, 5) = \sum_{t=1}^5 \frac{\lambda_t^{n-4}}{P'(\lambda_t)} + 3 \frac{\lambda_t^{n-5}}{P'(\lambda_t)}.$$

**Remark 5.13.** It is important to note that for Lemmas 5.2, 5.6 and Proposition 5.10, we succeeded another alternative proof, based on the same process considered for establishing Lemmas 4.1 and 4.3.

It seems for us that, the results of Theorems 5.7 and 5.11 concerning the special case  $r = 5$  and  $i = 1$  or  $i = 2$ , of the model of generalized Pell numbers (1), are not current in the literature. Moreover, for  $r = 5$  in the model of generalized Pell numbers (1), a similar result of Proposition 4.7 can be formulated for sequences of generalized Pell numbers with arbitrary initial conditions. More precisely, for  $r = 5$  the combination of Proposition 2.8 and Theorems 5.7 and 5.11 permit us to get the analytical expression for the general setting of sequence generalized Pell numbers.

## 6. CONCLUDING REMARKS AND PERSPECTIVES

In this paper we have studied the model of generalized Pell numbers (1), where some combinatorial representations of the generalized Pell numbers (1) are provided. Moreover, some identities and combinatorial identities for the model of generalized Pell numbers are established. On the other hand, analytic formulas of a large class of sequences of the model of generalized Pell numbers (1), namely, (2)-(3), are established, without using the usual method of determinant. And in the context of some special cases the use of the determinant of Sylvester matrix allow us to obtain new results. It seems for us that the study of the analytical aspect of the generalized Pell numbers (2)-(3) and for the general model (1), the study of the two special cases  $r = 4, i = 1$  and  $r = 5, i = 1$  or  $i = 2$ , represent an interesting contribution to this model. Several results of our study are not current in the literature.

The analytic approach for the model of generalized Pell numbers (1) can be deepened in order to generalize the results of Section 5. That is, the same process and study with computational effort can be done for all  $r$  and  $i$ , for  $1 \leq i \leq r - 3$ .

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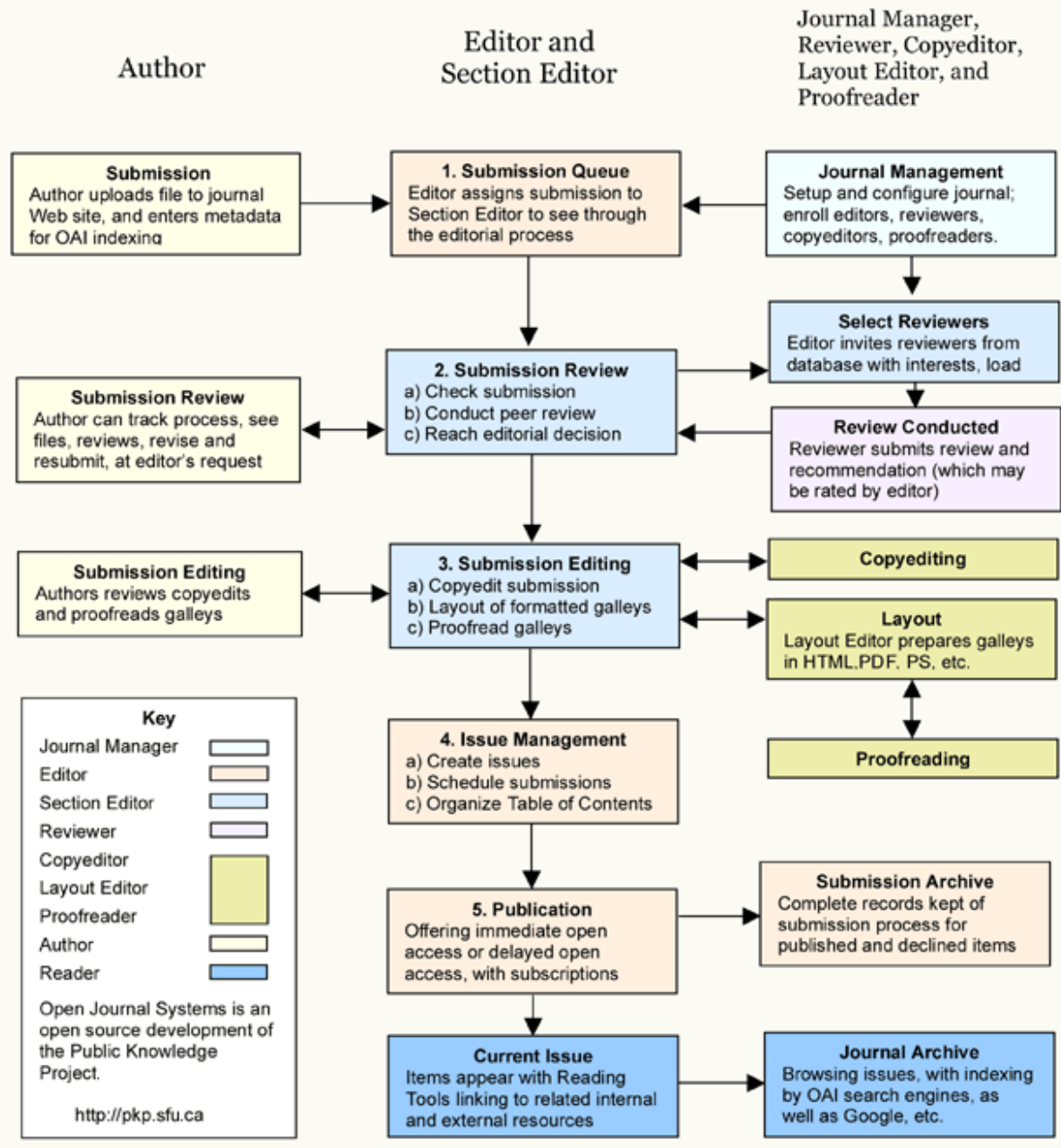
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