8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023

PROCEEDINGS BOOK

December 1-3, 2023

Bandirma/Balikesir, Turkey

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8th International Scientific Conference

"Telecommunications, Informatics, Energy and Management"

TIEM 2023

Onsite – Online (Hybrid) Conference

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Papers reviewed by at least two reviewers presented at the 8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023 are included in this proceedings book. Responsibility for all papers presented at TIEM 2023 and published in this proceedings book belongs to the respective authors of the papers.

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Dear Participants,

We would like to thank all of you for your participation and interest in the 8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023, which was held as Onsite/Online (Hybrid) in Bandirma/Balikesir, Turkey on 1-3 December 2023.

The "Telecommunication, Informatics, Energy and Management" conference, which has been organized since 2016 under the leadership of University of Telecommunications and Post (Sofia, Bulgaria) with the participation of researchers, academicians, sector workers and students from many countries in Bulgaria and Greece, this year, was organized at Bandirma Onyedi Eylul University (Bandirma, Turkey) under the name TIEM 2023 in partnership with Bandirma Onyedi Eylul University (Bandirma, Turkey), Bayburt University (Bayburt, Turkey), University of Telecommunications and Post (Sofia, Bulgaria), and Universiti Putra Malaysia (Selangor, Malaysia).

The purpose of the TIEM 2023 conference is to provide an international forum for researchers, academics, people in industry and students to discuss the latest research results and present and discuss their ideas, theories, technologies, systems, tools, applications, work in progress. In this direction, the participants will experience all the theoretical and practical issues that arise in the fields of global education, other engineering sciences and basic sciences, especially in the fields of telecommunications, informatics, energy and management.

Onsite and online presentations were made by invited speakers and other participants within the scope of TIEM 2023. TIEM 2023, where 125 oral presentations prepared by 192 participants from 12 different countries, took place and opened a direction to new cooperation opportunities.

For this reason, we would like to thank honorary presidents, who provided their support in organizing the conference, Prof. Dr. Suleyman Ozdemir (Rector of Bandirma Onyedi Eylul University, Turkey), Prof. Dr. Mutlu Turkmen (Rector of Bayburt University, Turkey), Prof. Dr. Miglena Temelkova (Rector of University of Telecommunications and Post, Bulgaria) and Dato' Prof. Dr. Ahmad Farhan Mohd Sadullah (Vice-Chancellor of Universiti Putra Malaysia, Malaysia), the invited speakers and all other participants, scientific committee members, session chairs and everyone who contributed to making this conference a great success.

Hope to see you at the next TIEM conference.

Best Regards,

On behalf of the TIEM 2023 Organizing Committe
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Prof. Dr. Grigor Yordanov Mihaylov
Assoc. Prof. Dr. Selahattin Kosunalp
Assoc. Prof. Dr. Yunus Kaya

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TOPICS

Telecommunications & Informatics
Software Engineering
Smart Grid, Power Electronics, and Converters
Renewable Energy and Applied Thermodynamics
Management, Economic, Leadership, and Entrepreneurship
Challenges in Global Education
Management Information Systems
Other Engineering Sciences
Basic Sciences

SCOPE

The scope of the conference includes, but is not limited to:

- Integration of Information and Telecommunication Systems
- Information Technology in Research and Development of Telecom Systems
- Next Generation Networks
- Wireless and Wireline Communications
- Optical Communications and Networks
- Multimedia Communications
- Internet and New IP Services and Applications
- Communication Interfaces (M2M, B2M, H2H)
- Enterprise Infrastructure and Applications
- E-Systems; Mobile e-Health/Telemedicine
- Mobile Terminal/Handsets and Operating Systems/Platforms
- Telecommunication Network Management
- Telecommunication Protocols
- Information Processing and Security
- Network Performances and Quality of Service
- Software Development and Maintenance
- Testing and Measurements
- Improvements Methods and Models
- Power Electronic Converters and Control Systems
- Smart Grid Technology
- Renewable Energy Resources
- Distributed generation and Grid Interconnection
- Electric Vehicles
- Energy Storage & Battery Charging Techniques
- FACTS (Flexible AC Transmission Systems) & Custom Power
- Power Quality & EMI (Electromagnetic Interference)
- Microgrid & Smartgrid
- Energy Policies & Standards
- Wide Band Gap Devices
- Lighting Technology
- Power Electronic Education
- Environment, Sustainability & Risk Management
- Renewable Energy/Alternative Energy Resources & Storage
- Thermal Design and Optimization
- Thermodynamic Instrumentation
- Financial and Business Performance
- Business Scenarios & Strategic Planning
- Consumer Dynamics
- Economic Indicators & Forecasting
- Innovation
- Labor Markets
- Marketing & Brand Strategy
- Urban, Rural & Regional Economics
- Developing Strategic Leadership Capabilities
- Leadership and Management Styles
- Leadership for Sustainability
- Leader's Role in Innovation
- Leading Change and Managing Conflict
- Leadership Challenges – Barriers to Effective Communications
- Entrepreneurship and Sustainability
- New Prospects in Entrepreneurship

- Entrepreneurial Marketing
- Entrepreneurship and Economic Development
- Entrepreneurship and Competitiveness
- Educational Technologies
- Distance Learning and E-Learning
- Mobile Learning, Cognitive Support for Learning
- Impact of ICT (Information and Communication Technologies) on Education and Society
- Contextual and Cultural Challenges in User Mobility
- Learning Process of Digital Nationality
- E-Learning and M-Learning Function in Higher Education
- Management Information Systems
- Chemical Engineering
- Civil Engineering
- Electrical and Electronic Engineering
- Environmental Engineering
- Food Engineering
- Geological Engineering
- Industrial Engineering
- Mechanical Engineering
- Mining Engineering
- Nanoscience and Nanoengineering
- Nanotechnology
- Natural Sciences
- Mathematics
- Chemistry
- Physics

INVITED SPEAKERS

Prof. Dr. Mohd Nizar Hamidon

Universiti Putra Malaysia (Selangor, Malaysia)

Mohd Nizar Hamidon is a Professor at the Electrical and Electronic Engineering Department, Faculty of Engineering and Director of the Institute of Nanoscience and Nanotechnology at Universiti Putra Malaysia (UPM). He received a B.Sc in Physics and M.Sc in Microelectronics from Universiti Malaya (Malaysia) and Universiti Kebangsaan (Malaysia) in 1995 and 2001 respectively. He then obtained Ph.D. degrees in Electronic and Electrical Engineering from the University of Southampton (U.K.) in 2005. He joined UPM after his BSc at the Matriculation Center for 5 years before becoming a UPM engineering faculty member in 2000 until now, where he oversees a research program at the department and faculty. Due to his outstanding research activities, UPM appointed him as the Head of the Functional Devices Laboratory at the Institute of Advanced Technology (ITMA) in early 2012 but later appointed as Deputy Director in the same year. He is now the Director of the institute, currently known as the Institute of Nanoscience and Nanotechnology (ION2) starting in July 2017.

His research is primarily concerned with the study of electronic and microelectronic devices including the materials (such as oxide and carbon-based) and the systems. Specifically, he has contributed significantly to the development of sensor systems such as gas and pressure sensors, and wireless applications. His research has been primarily funded by the international bodies, government, and university internal funding. He has published over 250 technical papers and a few book chapters related to his research area. He also had graduated in total of 10 PhD and 15 M.Sc students under his supervision. At the same time, he had registered a Start-up Company known as Serdang Paste Tech Sdn Bhd.

Mohd Nizar had good international networking, especially with the researchers from Turkey, Japan, Indonesia, and Thailand with whom they were working together on several different research projects. He was also involved in consultancy work for the Ministry of Information, Communication and Culture Malaysia for the Implementation of WSN – Based Structure and Infrastructure Monitoring System and e-halal monitoring system. He has given many lectures, seminars and invited talks at universities, research institutions and international conferences, and has served as a reviewer for several international conferences and journals. He has been the organizing chair and technical member for several IEEE conferences and The Past Chapter Chair for the IEEE Electron Device Malaysia Chapter.

Prof. Dr. Paul Daniel Mitchell

University of York (York, United Kingdom)

Paul D. Mitchell received the M. Eng. and Ph.D. degrees from the University of York, in 1999 and 2003, respectively. His Ph.D. research was on medium access control for satellite systems, which was supported by British Telecom. He has over 20 years research experience in wireless communications, and industrial experience gained at BT and DERA (now QinetiQ). He has been a member of academic staff with the Department of Electronic Engineering, University of York, since 2005, and is currently a Full Professor. Primary research interests lie in underwater acoustic communication networks, terrestrial wireless sensor networks, and communication protocols; including the development of novel medium access control and routing strategies. Other related interests include machine learning, traffic modeling, queuing theory, satellite, and mobile communication systems. He is an author of over 140 refereed journal and conference papers, and he has served on numerous international conference programme committees including ICC and VTC. He was a General Chair of the International Symposium on Wireless Communications Systems, in 2010. He currently serves as an Associate Editor of IET Wireless Sensor Systems journal, International Journal of Distributed Sensor Networks and MDPI Electronics, and has experience as a Guest Editor and as a reviewer for a number of IEEE, ACM and IET journals. He has secured more than >£2.3M + e4.7M funding as principal and coinvestigator. Current projects include Research Council grants on smart dust for large scale underwater wireless sensing, full-duplex underwater acoustic communications, as well as industrial projects. He is a member of the IET.

Prof. Dr. Ali Emre Pusane

Bogazici University (Istanbul, Turkey)

Ali Emre Pusane received the B.Sc. and M.Sc. degrees in electronics and communications engineering from Istanbul Technical University, Istanbul, Turkey, in 1999 and 2002, respectively, the second M.Sc. degree in electrical engineering, the third M.Sc. degree in applied mathematics, and the Ph.D. degree in electrical engineering from the University of Notre Dame, Notre Dame, IN, USA, in 2004, 2006, and 2008, respectively. During 2008–2009, he was a Visiting Assistant Professor with the Department of Electrical Engineering, University of Notre Dame. He then joined the Department of Electrical and Electronics Engineering, Bogazici University, Istanbul, Turkey. His research interests include wireless communications, molecular communications, signal analysis, and coding theory.

Prof. Dr. Genka Petrova

Medical University-Sofia (Sofia, Bulgaria)

Deputy Minister of Education and Science in Bulgaria

Prof. Petrova is a pharmacist and pharmacoeconomist, professor at the Medical University in Sofia and Head Secretary of the MU. She graduated in pharmacy at the Medical Academy - Sofia in 1984 and economics and labor organization at the University of National and World Economy in 1991. Doctor of Pharmacy with a thesis on "Drug needs and use - analysis and forecasting" (1994).

Prof. Petrova majored in health economics at Canterbury Business School. Doctor of Pharmaceutical Sciences with a thesis on "A model of the reform of the pharmaceutical sector in countries in transition from the Balkan region - an analysis of the application of theoretical concepts."

Prof. Petrova is a former vice-rector for Research Activities of the Medical University - Sofia (from 2008 to 2016), and former head of the department "Organization and Economics of Pharmacy" at the Faculty of Pharmacy of the Medical University.

Prof. Petrova is an external expert with the International Society for Pharmacoeconomics and Outcomes Research. She is a guest lecturer at the University of Nantes (France), the University of Belgrade (Serbia), the University of Sarajevo and the University of Banja Luka (Bosnia and Herzegovina), and Carol Davila University of Bucharest (Romania).

In 2010, Prof. Petrova was among the founders of the Bulgarian Association for Drug Information.

Prof. Petrova has authored more than 400 publications in refereed and indexed journals and 15 monographs and textbooks.

Assoc. Prof. Dr. Oguzhan Bilgin

Ankara Haci Bayram Veli University (Ankara, Turkey)

Oguzhan Bilgin received the BSc. and M.Sc. degrees in Social Science from Middle East Technical University, Ankara, Türkiye, in 2007 and 2010. He obtained his Ph.D. degree in Political Science from the University of York, York, U.K., in 2015. He is currently with the Department of Sociology, Ankara Hacı Bayram Veli University, Türkiye. He is an author of several refereed journal and conference papers. Dr. Oğuzhan Bilgin works on subjects such as Political Sociology, Cultural Sociology, Modernization, Social Change, Turkish Political Life, Cultural Policies. He participated in many television programs; His articles and interviews have been published in newspapers and magazines. He is currently working as a full-time Associate Professor.

TIEM 2023 PROGRAMME

Friday, December 1, 2023

Conference Opening

Prof. Dr. Fuat Sezgin Conference Hall (Bandirma Onyedi Eylul University, Central Campus)

09:00 – 10:00	Registration and Tea/Coffee Service	
10:00 – 11:00	Opening Ceremony	Assoc. Prof. Dr. Selahattin Kosunalp – Conference Chairman Prof. Dr. Grigor Yordanov Mihaylov – Conference Chairman Prof. Dr. Suleyman Ozdemir – Rector of Bandirma Onyedi Eylul University Prof. Dr. Miglena Temelkova – Rector of University of Telecommunications and Post Prof. Dr. Ali Savas Bulbul – Vice Rector of Bayburt University Prof. Dr. Mohd Nizar Hamidon – Director of Institute of Nanoscience and Nanotechnology of Universiti Putra Malaysia
11:00 – 12:30	Opening Session	Magnetodielectric Materials for Flexible Patch Antenna in IoT Invited Speaker – Prof. Dr. Mohd Nizar Hamidon (Onsite) Achieving Line-of-Sight Communications Through Reconfigurable Intelligent Surfaces Invited Speaker – Prof. Dr. Ali Emre Pusane (Online) Management and Self-Confidence: Overcoming Barriers in Turkish Energy and IT Sectors Invited Speaker – Assoc. Prof. Dr. Oguzhan Bilgin (Online) Recent Trends in Underwater Acoustic Communication and Networking Invited Speaker – Prof. Dr. Paul Daniel Mitchell (Online)
12:30 – 14:00	Lunch (Bandırma Onyedi Eylül University Dining Hall)	

Onsite Session

Prof. Dr. Fuat Sezgin Conference Hall (Bandirma Onyedi Eylul University, Central Campus)

Onsite Session – 1 Head of Session: Prof. Dr. Grigor Yordanov Mihaylov	
14:00 – 15:00	Wideband Local Antennas Alignment for 890-960 MHz Band *Stanimir Sadinov*, Miroslav Tomov, Boyan Karapenev*
	Limb Tremor Measurement through Wearable Units *Mehmet Akif Alper*, Turgut Ozturk*
	Performance Analyses of a Two-Stage Quadrature RC Generator with Three Integrators *Boyan Karapenev*, Stanimir Sadinov*

	Development of the Microwave Planar Sensor to Characterize Materials with Respect to Material Energy Level *Turgut Ozturk, Mehmet Akif Alper*[*]
	The Effect of the Environment on Performances of Precast Concrete by Solar Energy of the Taksebt Dam *Ben Khadda Ben Ammar*[*]
	THz Metamaterial Absorber Design with Dual-Band and High Absorption Rate *Yunus Kaya*[*]
15:00 – 15:15	Tea/Coffee Break

Online Sessions

Virtual Hall

Online Session – 1 Head of Session: Prof. Dr. Mohd Nizar Hamidon	
15:15 – 16:15	Fabrication of Patch Antenna Utilizing CNT-Ferrite Nanocomposite as Magnetic-Conductive Material *Intan Helina Hasan*[*]*, Mohd Nizar Hamidon, Ismayadi Ismail, Yunus Kaya*
	Design of Vivaldi Antenna for Wideband Applications *Ali Turgut Kizilcik*[*]*, Ugur Cem Hasar, Hamdullah Ozturk*
	Investigation of River Flow Characteristics Using Internet of Things towards Prediction of River Surge (Kepala Air) *Irdina Ridwana Roszaimi, Nursarafina Nadhia Abd Malek, Alyani Ismail*[*]
	Evaluation of Blowfish Encyrption Algorithm on Transport-Triggered Architecture *Latif Akcay*[*]*, Mustafa Alptekin Engin*
	Critical Requirements of Wireless Technologies for Real-time Voice Transmission in Above-Water Environments: A Comparative Study of NB-IoT, LTE, and 5G *Amirun Fahim Faizul Haiza, Alyani Ismail*[*]
	Comparative Analysis of Differential Privacy over Multiple Data Sets *Refik Can Oztas*[*]*, Bulent Tugrul*
16:15 – 16:30	Tea/Coffee Break
Online Session – 2 Head of Session: Assoc. Prof. Dr. Selahattin Kosunalp	
16:30 – 17:30	A Descriptive Survey of Metaverse-Related Studies in the Literature *Nazmiye Eliguzel*[*]
	Scalogram Based Spoken Digit Classification via Deep Learning *Mustafa Alptekin Engin*[*]*, Latif Akcay*
	Imperials vs. Rebellions: An Analogical Comparison of Fear of Missing Out and

	Joy of Missing Out *Fatih Sahin*[*]
	An Intelligent Support System for Online Learners in Difficulty *Ali Seridi*[*]*, Yamina Bordjiba, Riad Bourbia*
	Data Augmentation Effect on Facial Expression Recognition Using Deep Learning Models *Yamina Bordjiba*[*]*, Ali Seridi, Nabiha Azizi, Hayat Farida Merouani, Saber Mehammedia*
	Simple Structured and Easily Realizable Triple-Band Metamaterial Absorber Design *Yunus Kaya*[*]*, Ugur Cem Hasar*
17:30 – 19:00	Free Time
19:00	Dinner (Bandirma Onyedi Eylul University Erdek Practice Hotel Restaurant)

Saturday, December 2, 2023

Online Sessions

Virtual Hall

Online Session – 3 Head of Session: Assist. Prof. Dr. Mustafa Alptekin Engin	
08:45 – 09:45	Comparison of Coverage Map of Different Terrain Type *Ugur Erbas, Md Abdullah Al Imran, Mehmet Baris Tabakcioglu*[*]
	Electromagnetic Shielding Performance of Some Bayburt Stone Based Materials *Ugur Erbas, Ilker Tekin, Mehmet Baris Tabakcioglu*[*]*, Enes Yigit*
	Digital Twin Application in Laser Cutting Machines *Ugur Karanfil, Esra Yalcin*[*]
	A RCS Reduction Method Using the Air-Based Anisotropic Metasurface Polarization Converter *Fatih Tutar*[*]*, Gokhan Ozturk, Rıdvan Tokyurek*
	The Effects of Electromagnetic Fields on Human Health and Occupational Safety *Mustafa Ozdemir*[*]
	CSI Signals and Motion Analysis *Veysel Tilegi, Emir Enes Tas*[*]*, Soner Can Erhan*
09:45 – 10:00	Break
Online Session – 4 Head of Session: Vladimir Bronfenbrenner	
10:00 – 10:20	Policies in the Field of Interdisciplinarity and Resource Sharing in Higher Education in Bulgaria

	Invited Speaker – Prof. Dr. Genka Petrova
10:20 – 12:45	An Extension of the Ignite UI for Angular Library for Accelerating the Design of Web-Based Applications *Pavlinka Radoyska*, Riva Ivanova*
	Main Features of the Digital Transformation of Higher Education *Vihra Dimitrova**
	Basic Syste*matization of Nuances (A*spects) for Understanding Human Factors Pressure in Workplace Differences *Ivaylo Stoyanov**
	Impact of Cyberbullying on the Behavior and Performance of Employees: An Empirical Study in Telecommunication Services Companies in Republic of Bulgaria *Ivaylo Stoyanov*, Gergana Dimcheva*
	Improving the Email Software Security by Identifying the Attacker Tools and Techniques *Falak Hasan*, Mariana Petrova*
	Brief Analysis of Key Aspects of the Digital Workplace *Vihra Dimitrova**
	Navigating the Legal Landscape of Rapid AI Development in European Union *Dragan Stankovski**
	Agile Automation: Enhancing Telecommunication Management through AI-Driven Strategies *Dragan Stankovski*, Dimitar Radev, Ognyan Fetfov, Boyko Ganchev*
12:45 – 13:00	Break

Onsite Session

Prof. Dr. Fuat Sezgin Conference Hall (Bandirma Onyedi Eylul University, Central Campus)

Onsite Session – 2 Head of Session: Vladimir Bronfenbrenner	
13:00 – 14:30	Ensuring and Improving Communications During Crises Caused by Natural Disasters or Mass Events *Todor Gospodinov**
	Challenges and Solutions for Resilient Transport in the Era of New Environmental Requirements *Antoaneta Kirova**
	Individual Time in the Context of Artificial Intelligence *Liubov Ilieva**
	Evaluating the Machine Learning Techniques for Classification of Rice Variety

	Fatime Nur Khalili[*]
	Image Segmentation of Satellite Imagery with U-Net Convolutional Neural Network for Floods Detection *Denis Byalev*[*]*, Egnar Ozdikililer*
	Short Overview of Software Architectural Models *Chavdar Marinov*[*]*, Egnar Ozdikililer, Pavlinka Radoyska*
	Vulnerabilities Testing in Real-Time Wi-Fi Network *Ivan Ivanov, Maya Atanasova*[*]
	Classification of Fire-Affected Areas with Satellite Data and a Multi-Layered Neural Network *Irina Topalova*[*]*, Lyubena Nacheva*
	The Harms and Benefits of Uncensored AI Used for Data Breach and Data Security *Mariyana Dimitrova*[*]*, Ivan Ivanov*
14:30 – 14:45	Break

Online Sessions

Virtual Hall

Online Session – 5 Head of Session: Assist. Prof. Dr. Erman Kadir Oztekin	
14:45 – 15:45	Calculation of the Thickness of Pressure Hydraulic Pipes *Volkan Nuri Yilmaz*[*]
	Tire Pressure Monitoring System for Semi-Trailers *Mehmet Vurgun*[*]
	Effect of Roof Rail Geometry Variation on Trailer Aerodynamic Drag Coefficient *Onur Can Kirit*[*]*, Mehmet Vurgun*
	Usage of Axle Stoppers and Design Modification in Semi-Trailer Vehicles *Gokay Gurbuz*[*]*, Onur Can Kirit*
	Effect of Changing the g/b Ratio on the Aerodynamic Drag Coefficient in Simplified Truck-Trailer Geometry *Onur Can Kirit*[*]
	A THz Metamaterial Based Linear and Circular Polarization Converter *Fatih Kadiroglu, Gokhan Ozturk*[*]
15:45 – 16:00	Break
Online Session – 6 Head of Session: Assist. Prof. Dr. Erman Kadir Oztekin	
16:00 – 17:00	EN 12642 Load Securing (Code XL) Annex-A Static Test with Aluminum and

	Composite Side Profile *Gokay Gurbuz*, Yusuf Can Bulut*
	Improvement of Arms of the Side Protection, Weight Reduction, and Minimization of Welding Operations *Omer Coskun*, Onur Can Kirit, Mehmet Vurgun*
	Reverse Maneuver Technology and Vehicle Safety for Secure Transportation with Semi-Trailers *Gokay Gurbuz**
	Aluminum Tanker Design and Improvement of ECR 111 Regulation *Akin Zengin, Mustafa Yilmaz, Resul Akcali**
	Effect of Iron Diffusion on Fluidity in Casting of A356 Aluminum Alloy *Melek Durmus, Murat Colak, Emin Uslu*, Mehmet Gavgali*
	Investigation of the Effect of Using Scrap at Different Ratios on Liquid Metal Quality in Casting of A356 Aluminium Alloys *Mehmet Tokatli, Emin Uslu*, Murat Colak*
17:00 – 17:15	Break
Online Session – 7 Head of Session: Dr. Ismayadi Ismail	
17:15 – 18:15	EMI/EMC Tests for Shelters: Safeguarding Against Electromagnetic Interference *Okan Dinc*, Ramazan Furkan Koca*
	Malaysian Public Perception on Health Effects of 5G Electromagnetic Field (EMF) Emissions *Alyani Ismail*, Akmar Hayati Ahmad Ghazali, Aduwati Sali, Nadiah Husseini Zainol Abidin, Nurul Adilah Abdul Latiff*
	Sign-Ambiguity-Free Extraction of Permittivity of Materials from Reference-Invariant Expressions *Ugur Cem Hasar*, Yunus Kaya*
	Synergistic Use of Optical and Synthetic Aperture Radar Data for Improving Land Cover Classification: A Case Study for Munich *Mustafa Ustuner**
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	Development of Flexible and Ferrite Film Microstrip Patch Antenna *Suresh Dixit*, Karan Revankar*
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	Modeling and Simulation of a DC-CD Converter with PID Controller *Sangeeta Kumari, Anita Choudhary, Bishal Gurung*, Indra Mani*
	PWM Wave Generator Design with a Simple Approach *Bishal Gurung*, Sangeeta Kumari, Anita Choudhary*
	Design of a 20 kW Wind Turbine *Abderrezak Cherana**
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19:45 – 20:45	Basic Components of Internet of Things (IoT) Architecture and a New Architectural Design *Mohamed Laouer*, Mohammed Amroune*
	Internet of Things (IoT) Current Studies and Today's Applications *Mohammed Amroune**
	Forward-Looking Recommendations in Global Education: Equality, Technology and Human-Centered Approaches *Hamide Basha**
	Obstacles to Effective Communication and Recommendations *Hamide Basha**
	Leadership Challenges and Rules for Overcoming Obstacles: Tips for Strong Leadership *Nurul Alias*, Talhi Khodja*
	The Leader's Role in Innovation: Encouraging and Moving Creativity Forward *Nurul Alias*, Talhi Khodja*

Sunday, December 3, 2023

Online Sessions

Virtual Hall

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09:00 – 10:00	Enhancing Microwave Absorbing Materials Efficiency: Carbon Nanofiber-Mill

	Scale Hybrid for Broadband Electromagnetic Absorption *Ismayadi Ismail*, Intan Helina Hasan, Mohd Hafizuddin Ab Ghani, Mohd Nizar Hamidon, Mehmet Ertugrul*
	Carbon Black Electrospun Nanofiber Produced via Electrospinning Method *Mohd Ali bin Mat Nong*, Che Azurahanim Che Abdullah, Juraina Md Yusof, Ismayadi Ismail, Mohd Hafizuddin Ab Ghani, Intan Helina Hasan*
	Optimizing Environmentally Friendly Drilling Fluid Performance under High-Pressure High-Temperature Conditions through Carbon Nanomaterials *Siti Zulaika Razali*, Robiah Yunus, Juraina Md Yusof, Ismayadi Ismail, G. Abdulkareem-Alsultan, Umer Rashid, Norizah Abdul Rahman, Mohd Hafizuddin Ab Ghani*
	Methylene Blue Adsorption on Composites of Activated Carbon and Sodium Alginate *Fatima Ezzahra Yaacoubi*, Chaima Sekkouri, Imad Rabichi, Zaina Izghri, Abdelaziz Bacaoui, Abdelrani Yaacoubi*
	Enhancing Phosphorus Removal Efficiency through Lanthanum Modified Biochar *Nail Amara**
	Analysis of Inaccurate Information of Sample Holder Thickness in Determining Electromagnetic Properties of Soil Samples *Hafize Hasar*, Ugur Cem Hasar, Yunus Kaya*
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10:15 – 11:15	Effect of Temperature Variation on the Mechanical Behavior of Composite Plates Reinforced on Both Sides by Carbon Fiber Patches *Faycal Mili*, Sarah Guenifa, Toufik Achour*
	Pullulan Active Packaging Incorporated with Green Silver Nanoparticles to Enhance the Shelf-Life of Broiler Chicken Meat *Suriya Kumari Ramiah**
	Development of a Simple, Cheap, and High-Sensitivity Metamaterial Sensor Concept *Yunus Kaya*, Ugur Cem Hasar*
	Current Challenges and Potential of High-Performance Supercapacitors Derived-Metal-Organic Frameworks *Mohd Hafizuddin Ab Ghani*, Ismayadi Ismail, Josephine Ying Chyi Liew, Umer Rashid, Balkis Hazmi, Ruey Shan Chen, Kyle E. Cordova*
	Synthesis and Luminescent Properties of Eu^{3+} doped Lu_2WO_6 Red Phosphors *Amar Khelfane*, Rafik Aba, Abdelmounaim Chetoui, Mourad Derbal, Meftah Tablaoui, Lakhdar Guerbous, Mohamed Issam Ziane*

	Analysing Malaysian Technology Sector Using Minimum Spanning Tree: A Case of COVID 19 *Zurita Ismail*, Masnida Hussin, Hafizah Bahaluddin*
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11:30 – 12:30	Evaluation of ZnO Nanostructures Growth on Carbon Nanotubes Cotton *Juraina Md Yusof*, Ismayadi Ismail, Rahimi M Yusop, Mohd Ali Mat Nong, Siti Zulaika Razali*
	Efficient Wastewater Disinfection through Hydroxide Sludge/Hydrochar Composite-Mediated Photo-Fenton Reaction *Zaina Izghri*, Chaima Sekkouri, Fatima Ezzahra Yaacoubi, Imad Rabichi, Layla El Gaini, Abdelaziz Bacaoui, Abdelrani Yaacoubi*
	Repurposing Elastomeric Tubular Membranes and Nanostructured Adhesive Films for Triboelectric Nanogenerators *Galip Yilmaz**
	Size Separation and Bulk Densification Analysis of UHMWPE Powder Under Vibration *Galip Yilmaz**
	Stochastic Optimization in Renewable Energy Systems: A Comprehensive Literature Review *Gurkan Guven Guner**
	New Permittivity-Moisture Curve for Moisture Evaluation within Soil Samples *Hafize Hasar*, Ugur Cem Hasar, Yunus Kaya*
12:30 – 12:45	Break
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12:45 – 13:45	Evaluation of Passive Radiator Structures in Low-Frequency Radio Astronomy Arrays from the Perspective of Active Antenna Design Methods *Mertcan Altıkardesler*, Salih Mehmed Bostan*
	Analysing Eastern Anatolian Region Food Recipes with Graph Database *Selin Irmak Akpinar*, Yunus Emre Sepetci, Bulent Tugrul*
	Motion Prediction Classification for Wall-Following Robot Navigation *Nazlican Cavli*, Nisa Koban, Emrah Benli, Ayten Atasoy*
	Fixed Point Results of Generalized (ϕ,ψ)–Contractive Mappings in Ordered Non-Newtonian Metric Spaces *Demet Binbasioglu**
	Activated Carbon-Based Adsorbent for Hydrogen Purification

	Seda Tiras, Bilge Coskuner Filiz, Aysel Kanturk Figen*
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13:45 – 14:00	Break
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	Linguistic Summarization for Higher Education Institutions in the Context of Sustainable Development Goals: Analysis of THE Impact Ranking Results *Fatma Sener Fidan*, Sena Aydogan*
	Play to Earn Web 3.0: The Future of Gaming and Marketing *Fatih Sahin**
	Artificial Intelligence in Marketing: Content Analysis of Web of Science Indexed Papers *Mahmut Selami Akın**
	Entrepreneurship and Management Roles in Wealth Creation *Chief Irukwu Onwuka*, Chinenyenwa Marycynthia Obieze, Veena Chiamaka Ezenagu, Tracy Christopher, Marvelous Oluchi Onwuka, Great Irukwu Onwuka*
	Analysis of Occupational Accidents in the Electricity Generation, Transmission, and Distribution Sector in Turkey *Mustafa Ozdemir**
15:00 – 15:15	Break
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15:15 – 16:15	The Mediating Role of Trust in Social Media in the Effect of Influencers on Consumers' Purchasing Actions *Bora Goktas**
	The Effect of Advergame (Game Advertising) Applications on Social Networks on Hedonic Consumption *Meysure Evren Celik Suticer**
	The Relationship Between Personal Branding and Leadership Metaphor in Digital Innovation *Yusuf Esmer*, Adnan Kara*
	Transition to the Circular Economy in the European Union: Is It Really Ready? *Fatma Unlu**

	Notes Concerning 2x2 Type Quaternion Matrices *Ramazan Simsek*[*]
16:15 – 16:30	Break
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16:30 – 17:20	Digital Entrepreneurship Training: E-Learning Platforms and Training Programs for University Students *Adnan Kara, Yusuf Esmer*[*]
	The Effect of the Freudian Subconscious on Purchasing Behavior towards Materialistic Values *Bora Goktas*[*]*, Seyran Cinar*
	Postmodern Language and Discourse: The Example of Ekşi Sözlük *Nihal Kocaaga, Ensar Lokmanoglu*[*]
	Measuring the Industry 4.0 Awareness Level of Students in the Field of Engineering and Information Systems *Sumeyye Selvi, Cagatay Teke*[*]
	Cyprus Issue and Its Effect on Turkey–European Relations *Ergin Kosunalp*[*]
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17:30 – 19:00	Temperature Analysis with MATLAB PDE Toolbox *Abderrezak Cherana*[*]
	Researching the Appropriate Connection Type in the Tower Crane System with Finite Element Analysis *Abderrezak Cherana*[*]
	World Energy Efficiency: Current Status and Strategic Approaches for the Future *Jamel Titouhi, Saber Bouhdjeur*[*]
	Wind Energy, Research on Wind Potential in the World and Tunisia *Saber Bouhdjeur*[*]*, Mohamed Nadir, Abderrahim Amrane*
	Energy Solutions for a Sustainable Future: Geothermal Energy *Mohamed Nadir*[*]*, Saber Bouhdjeur, Abderrahim Amrane*
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Invited Speaker

Oral Presentations

8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023

December 1-3, 2023

Magnetodielectric Materials for Flexible Patch Antenna in IoT

Mohd Nizar Hamidon[*1,2]

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Abstract

Development of 5G and Internet of Things (IoT) is growing at an increasing rate depending on each other. As the Internet of Things, which is already a new technology revolution, becomes more available, there will be a huge increase in 5G technology. The combined use of antennas for 5G and sensors for IoT will increase further in the next century. Perhaps the next century will be the age of sensors and antennas. Many antennas and sensors used in daily life must be wearable in order to perform more effectively.

Antenna plays a very important role in telecommunication technology; without antenna integrated in a communication device, the device cannot send or receive information in the form of signals. There are several types of antennas including dipole antenna, horn antenna, wire antenna and others. Here a microstrip patch antenna (MPA) will be introduced due to its flat or planar profile, easy to fabricate, small size and low manufacturing cost. Patch antenna is typically constructed by fabricating a conductive patch onto a dielectric substrate. The permittivity and thickness of the substrate give influences to the parameters of the antenna, including the resonant frequency, bandwidth and return loss of the antenna. There are few types of materials that are being studied and used as the substrate, such as ceramic, semiconductor, ferrimagnetic, synthetic and composite materials.

Ferrimagnetic materials or ferrites are one type of magnetic materials, having a certain degree of susceptibility to magnetization. Ferrites are divided to two categories, which are hard and soft ferrites. Hard ferrites have high coercivity and high remanence after being magnetized, which makes them perfect as permanent magnets. Soft ferrites on the other hand, have low coercivity that makes the magnetic direction can be easily reversed to normal state with low loss energy. These types of ferrites also have high electrical resistivity and low magnetic losses at higher frequency range, which makes them suitable for microwave applications.

The common fabrication processes for MPA are by printed circuit board (PCB) etching technology, or thick film technology, which utilizes screen-printing method. The latter is preferred however due to its ease of fabrication, with less chemical handling. Thick film technology has been widely used in semiconductor production, either in surface mounted devices (SMT) fabrication or in printed film circuit (PFC) production. On the other hand, flexible antenna also can be developed by using the thick film technology, screen printed onto flexible substrate in which the fabrication method and materials is inexpensive and lack of chemical process. The thick film used in this case is the conductive paste that acts as the radiating patch of the antenna, in which the design itself along with the materials used in the fabrication process can be optimized to improve the antenna performance.

Keywords: *Magnetodielectric, Microstrip patch antenna, Thick film technology*

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8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023

December 1-3, 2023

Achieving Line-of-Sight Communications Through Reconfigurable Intelligent Surfaces

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Abstract

Reconfigurable Intelligent Surfaces (RISs) have emerged as pivotal components in the evolution of next-generation wireless communication systems, offering virtual line-of-sight channels with significantly enhanced capacity. Optimizing the phase configuration of RIS elements is a critical challenge, particularly as their numbers increase. Traditional iterative algorithms, though effective, suffer from high delay and signaling overhead due to the need for receiver performance feedback in each configuration attempt. This talk introduces a novel approach to address this challenge by leveraging Convolutional Neural Networks (CNNs) for efficient RIS phase configuration optimization. After presenting the fundamental model and scenarios for RIS application, the focus shifts to the proposed CNN-based solution. Simulation results for a 40×40 element RIS reveal a remarkable reduction in the number of optimization steps from 3200 to 160, demonstrating the algorithm's efficiency. In the proposed approach, only a subset of the available configurations are optimized and this solution is used to efficiently estimate the global configuration. Moreover, this complexity improvement is achieved with only a marginal degradation in performance. The talk further explores the practical implications of RIS deployment, particularly in scenarios requiring enhanced security at the physical layer.

Keywords: *Wireless communication, CNNs, Physical layer*

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Management and Self-Confidence: Overcoming Barriers in Turkish Energy and IT Sectors

Oguzhan Bilgin*[1]

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8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023

December 1-3, 2023

Recent Trends in Underwater Acoustic Communication and Networking

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Abstract

Recently, Underwater Acoustic Networking (UWA) has been a popular research topic. There have been a lot of studies to solve the issues in UWA with a key focus on medium access protocol (MAC) design. This invited talk will deliver a speech on an outline of underwater networks, applications, research challenges. A specific part of the talk will be dedicated to the development of intelligent MAC schemes in the light of time division multiple Access (TDMA) theme. To solve a particular problem in UWA, TDMA-based MAC approaches will be presented in connection to practical observation conducted on seaside.

Keywords: *Underwater networking, Medium access control, TDMA*

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Policies in the Field of Interdisciplinarity and Resource Sharing in Higher Education in Bulgaria

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[1]Deputy Minister of Education and Science, Republic of Bulgaria
[2]Medical University-Sofia, Sofia, Bulgaria

Wideband Local Antennas Alignment for 890-960 MHz Band

Stanimir Sadinov*[1], Miroslav Tomov[1], Boyan Karapenev[1]

[1]*Technical University, Gabrovo, Bulgaria*

Abstract

The GSM signal quality is unevenly distributed across the provider's network. In fact the power level of LTE signal coverage in particular is usually not constantly stable and not reliable enough in the areas of small villages where people's population is small, although those people also need a high quality mobile service with parameters according to the requirements of the mobile telecommunication standards as it is typically delivered in the territory of the cities. From the perspective of the providers it is not a profitable investment to develop the GSM network infrastructure in low population areas and this is very unpleasant problem for that minority of the people, who prefer to live in small towns, villages or much closer to the wild nature. In those areas, the base stations are rare situated, which means largest possible coverage of the cells and less signal power capacity to provide high quality service if many customers access the network at the same time [1].

This paper presents a design and optimization of a local RF amplifying system for GSM signal entire band (890MHz-960MHz), which is able to improve significantly the quality parameters of the service coverage at the home yard area. The optimization is achieved by impedance match and antennas' alignment to the rest of components of the designed amplifying system.

Keywords: *Amplifying, S-parameters, GSM signal, Antenna alignment*

1 INTRODUCTION

At the present days of the mobile communications, the main coverage share is supported by third-generation systems. Although they succeed to provide only 2 Mbps indoors and 150 kbps in vehicular environments, they still cover practically 100% of all providers' networks. 3G is still the primary technology for voice services, carrying over 60% of this traffic. Next coverage share belongs to LTE and pure 4th generation and the last volume share belongs to 5G and to the 2nd generation systems (which development is stopped, but they are still usable in service in many countries when it is necessary or when there is no other option). The 4G technology supports a maximum data exchange rate of up to 100 Mbps at a bandwidth of 20 MHz. 4G data access is several times faster than 3G, as its architecture is specially adapted for a fast data transfer, which for users means higher speeds and interactive services. The 5G systems are actual nowadays and its development is being designed to provide transfer data rates of 5–250 Mbit/s [2]. Low-band cell towers have a coverage area similar to 4G base stations. Middle band 5G uses 1.7–4.7 GHz microwaves, allowing traffic speed of 100–900 Mbit/s, with each cell tower providing service up to several kilometers in radius. This level of service is the most widely deployed in many metropolitan areas in 2020. Some regions are not implementing the low band, making Mid-band the minimum service level. High-band 5G uses frequencies of 24–47 GHz, near the bottom of the millimeter wave band, although higher frequencies may be used in the future. It provides download traffic speed in Gbit/s range, comparable to coax cable Internet service. But the millimeter waves have a more limited range, requiring a large number of small cells [3]. They can be impeded or blocked by materials in walls or windows or pedestrians [3, 4]. Due to their higher cost, plans are to deploy these cells only in dense urban environments and areas where crowds of people congregate such as sports stadiums and convention centers. The above speeds are those achieved in actual tests in 2020, and speeds are expected to increase during rollout [5]. The spectrum ranging from 24.25 to 29.5 GHz has been the most licensed and deployed 5G mm wave spectrum range in the world [5].

The main quality parameters of the RF signal in the GSM network to be discussed in this exploration are: the maximum and the average power value of the distributed signal and real data traffic speed.
The present paper displays some practical results and analyses of design and exploration of a local RF amplifying system, developed to receive, amplify, transmit and spread the LTE and 4G GSM signals across a small area of a village home yard [2] where 4G service signal is very weak.

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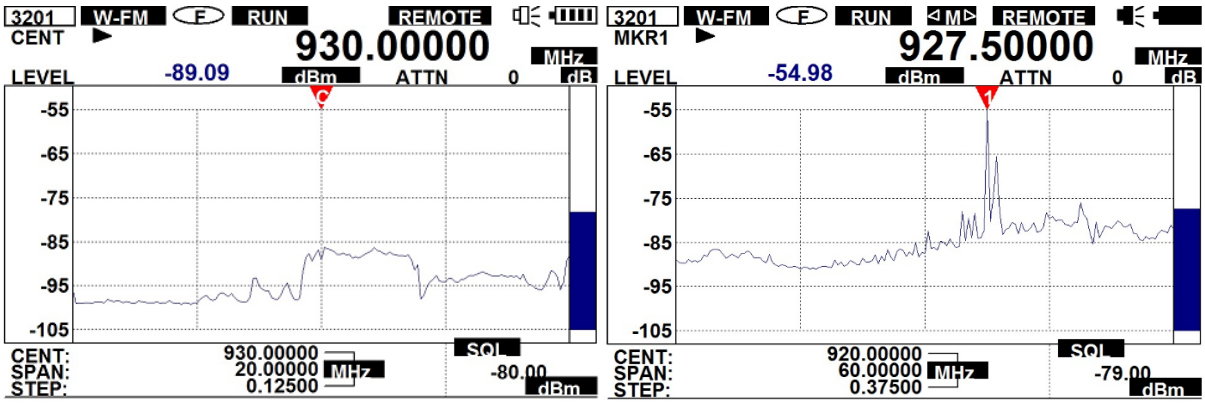
2 DESIGN OF RF SIGNAL AMPLIFYING SYSTEM FOR THE BAND 890-960 MHZ

The major requirements to be supported by the mobile communication systems are high data rate, high mobility, and reliable coverage. Normally it is not easy to realize a system satisfying the requirements. Some systems can support high mobility and coverage, but others could provide high rates of data traffic. In fact, the future integrated system solutions could satisfy all complicated user demands.

In the present days large areas are covered reliably by 3G network only, and LTE or pure 4G infrastructure is far away from the users in the small villages to ensure high quality, or at least enough signal quality. The efforts of this exploration is to produce an effective but simplified solution to improve the LTE (4G) RF signal of GSM service at small local area of home yard of about 1000 square meters. The main elements of such amplifying system (receiving antenna, distribution antenna and wideband RF amplifier) could be easy purchased by the customer who generally is not able to make these elements by himself. Those elements are not expensive at all and there is enough quantity of them on the market. The aim of this exploration is to set an algorithm for proper alignment of antennas, coax-feeders and amplifier by applying impedance match input and output circuits, designed by discreet lumped and / or microstrip components with appropriate parameter values, calculated in the way of the optimized scattering coefficients. This ensures the best possible quality of the amplified signal supplied. The design of the local amplifying system starts with precise measurements of the actual local conditions as parameters of the mobile service signal distributed at the place of the system settlement. After those measurements is evident what value of amplification is necessary to start the project design. In the presented system design are used two different antenna types, factory produced for frequency band from 850 MHz to 990 MHz and wide band RF Amplifier (500 MHz to 2000 MHz) [4].

2.1 Measurements of RF Power Level of the GSM Signal Coverage

The power level of the GSM signal, measured by Protek 3200 RF Field Strength Analyser is depicted on Figure 2. Both graphs displays the maximum and average RF power level across the band 890-960 MHz delivered in both cases by the same mobile service provider – A1 Bulgaria but in different areas. The first graph shows the power level of the signal in the area of a small village, at least 12 km away from the base station, which provides LTE / 4G signal. The second graph show the measured the maximum and average RF power level across the frequency band inside the city area, where the Technical University is situated. The difference in dBm is more than significant: -89.09 dBm in the village versus -54.98 dBm in the city. These measurements practically consider the RF background power level across the explored band, but the level of the signal after the antenna in the receiver of the mobile device is even weaker. This actual level is measured by Android application installed into the mobile device and shows values respectively -113 dBm and -78 dBm.



a) b)

Figure 1. Measured RF Power level of the GSM signal in: a) village; b) city

Power levels of the signal, lower than -90 dBm is not reliable enough for data transfer and even for 3G telephony and this seriously compromises the distributed mobile service. These results emphatically confirm the needs of installing a local RF amplifying system for the entire GSM Band (890-960 MHz). It is possible to focus on narrower and /or separate bands inside the entire range, but this approach requires more exploration concerning the parameters of the broadcast signal from the particular base station, and even more, to keep monitoring of that broadcasting for longer time to be sure witch transmitting/receiving frequencies are mostly used. The aim of this exploration is to find the most flexible and easiest way to amplify the signal locally in order to improve the quality of the mobile service.

2.2 Initial Schematic of the RF Amplifying System Design

The initial block schematic of the designed RF signal amplifying system is shown on Figure 2. The components are presented from the perspective of S-matrix data boxes. The S-parameters data is collected by portable vector network analyzer NanoVNA-F V2.

The used receiving antenna is a standard 9-element Yagi type is constructed with appropriate dimensions of its elements for the optimal performance in the range of frequencies 890 to 960 MHz, with vertical polarization and its direction is pointed towards the closest base station of the available GSM provider network. The distance from the receiving antenna to the base station is about 12 km.

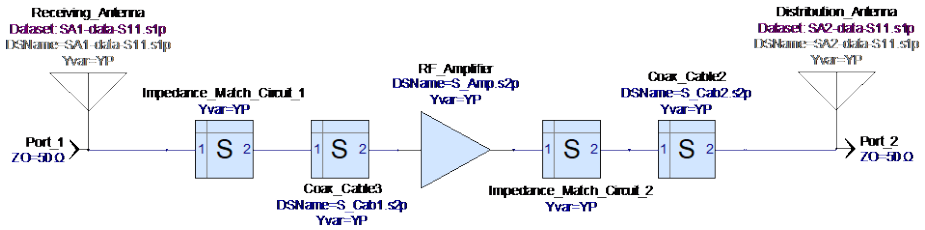


Figure 2. Initial schematic of a local RF signal amplifying system

The receiving antenna is mounted on the roof top of the house and direction is established after some pre-calculations based on the available GPS data concerning the latitude and longitude of the nearest 4G supporting base station of the GSM service provider. The position and direction of the antenna are precised by RF signal power level measurement with the help of Protek spectrum analyser and Network Cell Info Android Application. The antenna is equipped with 50 Ω coax feeder cable RG-58, N-type female connector [3].

A convertor N-type male to SMA female is coupling the antenna feeder to the coax cable RG-58. Both outputs of the cable are equipped with SMA male connectors – the first one is connected to the female SMA side of the convertor N to SMA and the second one is connected to the input terminal of the RF power amplifier [6, 7].

Second coax cable links the output of the amplifier and the distribution antenna connector (also N-type female). That cable is also equipped with SMA male connectors at its both ends, which needs one more convertor SMA male to N-type male.

The above mentioned coupling configuration is subject to changes, as it is necessary to design input and output impedance transforming circuits as well as their connecting terminals to be considered in the final version of the system schematic.

2.3 Design of Input and Output Impedance Transforming Circuits

A proper antennas' alignment is achieved by impedance match calculations and design of the impedance transforming input and output circuits. Those schematics could be realised by lumped discreet elements (passive elements only or configuration of passive and active elements) or by transmission line micro strip structures. Both are appropriate for the explored frequency band [7].

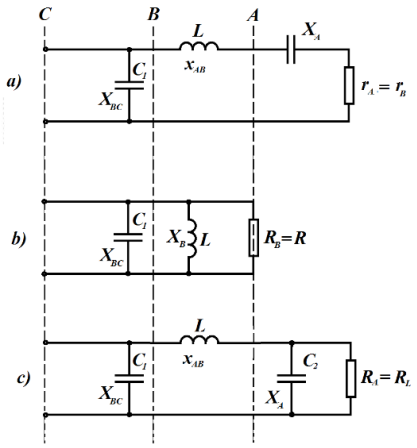


Figure 3. Basic schematic of resistances and reactances conversion for correct impedance match

In accordance with the schematic diagram on Figure 3, the correct values of lumped elements in the input and output impedance match circuits are calculated automatically by Matlab module, integrated in the simulation platform Keysight Genesys by applying the following equations:

$$r_a = r_b = \frac{R_a}{1+q_a^2} = \frac{R_L}{1+q_a^2} \tag{1}$$

$$x_a = \frac{X_a}{1+\frac{1}{q_a^2}} \tag{2}$$

$$x_a = x_{ab} - x_a = \left(\frac{X_{ab}}{r_a} - q_a\right) r_a \tag{3}$$

$$q_b = \frac{x_b(1+q_a^2)}{R_L} = \frac{R}{X_{bc}} = \frac{R}{X_b} \tag{4}$$

$$R_b = R = r_b\left(1+q_b^2\right) \tag{5}$$

$$X_b = x_b\left(1+\frac{X_{bc}^2}{R^2}\right) \tag{6}$$

The resistances in the above equations match the 50Ω load of the respective impedance transforming circuit. The basic schematic on Figure 3 can be applied for impedance transformations in any specific equivalent schematic, designed by lumped discreet elements [8, 9].

3 RESULTS

The calculated values of the lumped elements and the synthesized topology of the impedance matching circuit are shown in the schematic diagram on Figure 4.

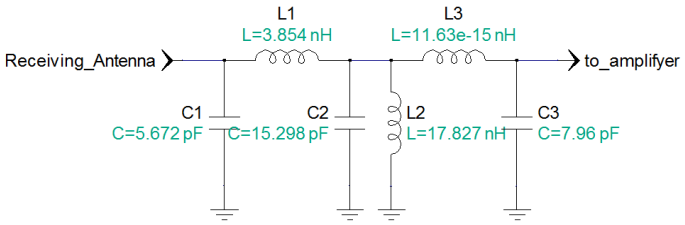


Figure 4. Synthesized schematic for impedance match between the receiving antenna and the amplifier

That schematic aligns the impedance between the receiving antenna and the amplifier. It consist of two LC Pi topology sections, one capacitive, one inductive. The scattering simulation response after optimization and reaching the values depicted, is presented on Figure 5. The biggest reflection coefficient S_{11} (S_{22}) is reaching the value of -14.86 dB across the band.

This is optimal achievement from the perspective of easiest possible realization of the schematic design as the rest of the components of the amplifying system, the receiving antenna and distribution antenna have practically fixed values of S-parameters as they are factory designed for the range 890-960 MHz. The parameters of the wide band amplifier are optimized and fixed for the range 500-2000 MHz [9-11].

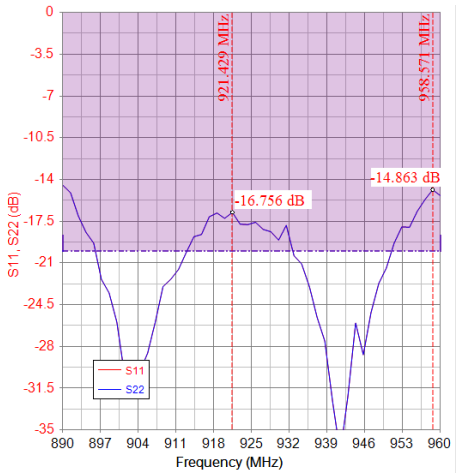


Figure 5. S_{11} (S_{22}) parameters response of the impedance match schematic between receiving antenna and amplifier after optimization

The calculated values of the lumped discreet elements and the synthesized topology of the impedance matching circuit between the amplifier and the distribution antenna are shown in the schematic diagram on Figure 6. That schematic is synthesized as LC bandpass filter topology. The scattering simulation response after optimization and reaching the values depicted, is presented on Figure 7. The biggest reflection coefficient S_{11} (S_{22}) is limited effectively under -20 dB [12].

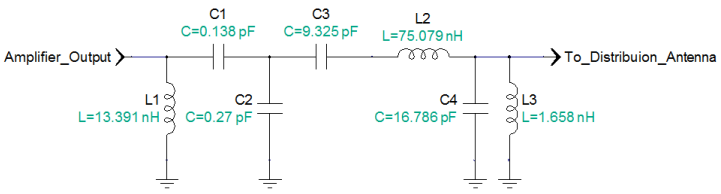


Figure 6. Synthesized schematic for impedance match between the amplifier and the distribution antenna

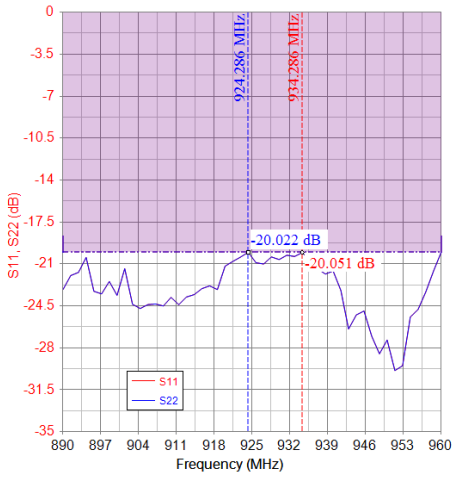


Figure 7. S_{11} (S_{22}) parameters response of the impedance match schematic between the amplifier and distribution antenna after optimization

4 CONCLUSION

The results and analysis of the measurements confirm the significant effect of the impedance matching input and output networks of the amplifying system on the level of amplification, especially between the RF amplifier output port and the distribution antenna.

As the receiving and distribution antennas has fixed construction, the system components which can be improved are the RF amplifier, the length of the feeder coax cables to their optimal values concerning the impedance and the parameters of the discreet elements of impedance matching transformation circuits.

The exploration of the problem could be expanded towards more demanding goals of reaching high effectiveness and quality of RF power distribution of the GSM signal at the particular place concerning the achievement of higher data traffic speed in the aria of weak network coverage, supplied by the GSM service provider.

Obviously the local installed and optimized RF amplifying systems are very effective, easy to apply and not expensive solutions for many customers, who lives in the areas of low GSM signal coverage.

Acknowledgments

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Limb Tremor Measurement through Wearable Units

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Abstract

Tremor in human bodies is a well known symptom of diseases such as Parkinson's disease (PD). PD decreases the quality of human life, so it needs to be diagnosed early and treated correctly. Detection and quantification of human tremors is important and challenging. Therefore, detection and quantification of human tremors help doctors to diagnose and adjust dosage levels of medicine. There are many different techniques to detect and quantify human tremors. On the one hand, Direct methods generally wearable sensors to measure human tremors. On the other hand, indirect methods cover camera, radar systems that enable remote measurement of tremor symptoms. Here, we detect and quantify human tremors with a direct measurement method. We used inertial measurement unit (IMU) to detect human arm tremors. Then, amplitude and dominant frequency of tremor has been computed for doctor evaluations.

Keywords: *Tremor, Parkinson's disease (PD), Wearable units, Dominant frequency*

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Performance Analyses of a Two-Stage Quadrature RC Generator with Three Integrators

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Abstract

This paper presents the special features of RC harmonic oscillation generators and their widespread use and in particular the quadrature generators which provide two output signals dephased at 90º or 270º. Quadrature generators can be classified as those with an aperiodic frequency-determining circuit or with a phase inverter group which are used to generate oscillations of one or more fixed frequencies. Studies of a two-stage quadrature RC generator circuit with three integrators implemented with operational amplifiers have been performed. The results obtained from the simulation and experimental studies performed are presented for the selected circuit. It can be assumed that the experimental and simulation results completely coincide to an accuracy of up to 25% for the amplitude of the generated signals and to the total accuracy for the generated frequency. Quadrature generators are very widely used in communication technology and, most importantly, in the structure of digital frequency, phase and quadrature-amplitude modulators and demodulators, in vector RLC meters and many other electronic circuits and devices in practice.

Keywords: *Quadrature generator, Studies, Results, Analyses, Applications*

1 INTRODUCTION

Generators have an extremely wide and important application in practice. They are used in radio transmitters during the implementation of modulations, in radio receivers during selection of a certain radio station and formation of intermediate frequency signals, in computational equipment for generating clock signals, in measurement equipment during formation of test signals, in automated means of controlling production and others processes and many others. The amplitude and frequency of the generated oscillations are determined by the mode of operation of the active element, the parameters of the selection chain, the feedback and the load.

RC generators are used to generate oscillations with frequencies from several Hz to several MHz. Their selective system is made up of only R and C elements. This determines their main advantages: small overall dimensions, suitable for integrated implementation and incorporation into hybrid ICs, they are not affected by external fields, etc. Because RC selective circuits do not have good selectivity, obtaining oscillations with small nonlinear distortions is related to the introduction of additional nonlinear negative feedback. The negative feedback also stabilizes the amplitude of the oscillations. RC generators are also characterized by relative instability of the generated frequency $\Delta f / f_0$ in the range from 10^{-2} to 10^{-3}.

Very often, in practice, it is necessary for a generator to provide two output signals dephased at a certain angle. The generator is quadrature when the angle is 90° or 270° (-90°). Quadrature generators are widely used in communications technology for the implementation of digital angular modulations [1], and in particular quadrature-amplitude modulation (QAM). Quadrature generators are included in the structure of digital modulators and demodulators as well.

In scientific publications of recent years, e.g. [2-21], no in-depth design, studies, analyses and conclusions of the RC harmonic oscillation generator circuits as well as their selective chains are available.

2 REPRESENTATION

2.1 Quadrature RC Generators of Harmonic Oscillations

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RC generators are divided into two main groups according to the nature of the selective circuit [1]:

- With aperiodic frequency-determining circuit or phase-rotating RC generators;
- With selective frequency-determining circuit - with maximum or minimum feedback transmission coefficient β for the frequency generated and zero dephasing between output and input signals.

Quadrature generators can be classified as those with a phase group which are used to generate oscillations at one or more fixed frequencies. As one RC unit can dephase at an angle less than 90°, a minimum of three units is required to meet the condition of phase-angle balance.

2.2 A Two-Stage Quadrature RC Generator with Three Integrators with Operational Amplifiers Circuit of Harmonic Oscillations

Fig. 1 [22] shows a two-stage quadrature RC generator with three integrators with operational amplifiers circuit. The circuit is built from two series-connected integrators and an integrator connected in the positive feedback.

The quadrature generator is based on third-order characteristic equation. The oscillation condition and oscillation frequency can be obtained as [22]:

$$R_3R_4R_5 = \frac{C_1C_2R_1^2R_2^2}{C_3(C_1R_1 + C_2R_2)}, \tag{1}$$

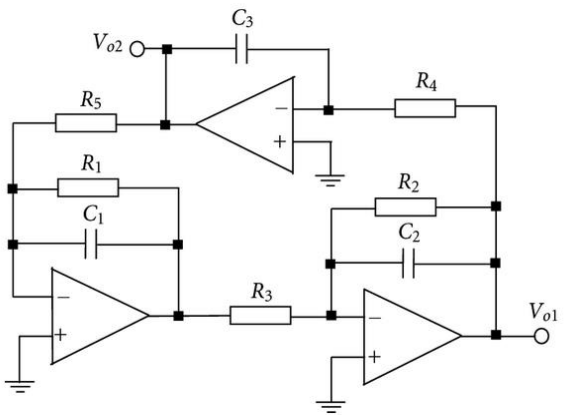

Figure 1. Circuit [22] of chosen two-stage quadrature RC generator with three integrators

$$\omega_0 = \frac{1}{\sqrt{C_1C_2R_1R_2}}. \tag{2}$$

From (1) and (2), the oscillation condition and oscillation frequency are orthogonal. The voltage transfer function from Uo2 to Uo1 is

$$\frac{Uo2}{Uo1} = -\frac{1}{sC_3R_4}. \tag{3}$$

The phase difference φ between Uo2 and Uo1 is 90° and voltage Uo2 and Uo1 to be in quadrature.

2.3 Composed Integrators (Integrating Amplifiers) with Operational Amplifiers from the Structure of the Two-Stage Quadrature RC Generator - Main Dependencies

The output voltage in integrators is an integral of the input signal and is obtained for it

$$\dot{U}_0 = -\frac{\dot{Z}_2}{\dot{Z}_1}\dot{U}_i = -\frac{1}{j\omega RC}\dot{U}_i \tag{4}$$

The transition function in real form is obtained

$$u_0(t) = -\frac{1}{RC}\int u_i(t)dt \tag{5}$$

or the output voltage is proportional to the integral of the input voltage. The amplitude-frequency response (AFR) of the ideal integrator is determined from (4) by finding the complex transmission coefficient

$$\dot{A}_F = -\frac{1}{j\omega RC} \tag{6}$$

whence for AFR follows

$$A_F = \frac{1}{\omega RC}. \tag{7}$$

The bandwidth of the integrator is determined by the first pole frequency and predetermines the use of the integrator as a low-pass filter when working with a wide frequency spectrum of signals.

The main qualitative parameters of OA μA741 which was used to implement the integrators are presented in Table 1.

Table 1. The main qualitative parameters of OA uA741

UA	U_{DD}, V	U_{IO}, μV	BW, MHz	Slew/Rate, V/μs	I_{DD}, μA	Output drive	CMRR, dB
μA741	< ± 18	1000	1	0,5	1700	± 25 mA	90

3 RESULTS AND DISCUSSION

3.1 Simulation Studies of the Two-Stage Quadrature RC Generator with Three Integrators

The circuit of the quadrature generator from Fig. 1 with values of the constituent elements [22], which is the subject of research, has been introduced in the working environment of the MultiSIM module of Circuit Design Suite package. The created connection diagram of the experimental setup is shown in Fig. 2.

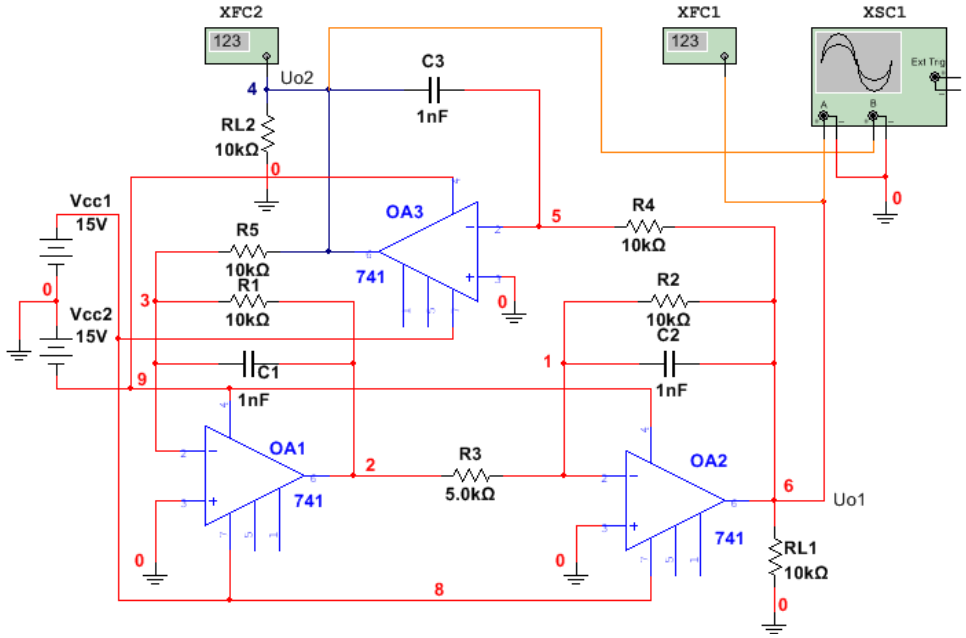

Figure 2. Connection diagram of the experimental setup for simulation study of the two-stage quadrature RC generator with three integrators

The obtained oscillogram from the performed simulation study for the output voltages U_{01} and U_{02} is shown in Fig. 3. It is found that for both output signals the frequencies are the same $f_0 = 9.22$ kHz and their amplitudes are also the same - $U_{o1sin} = U_{o2cos} = 7$ V. The operating frequency of both outputs is also measured with Frequency counter (XFC1 and XFC2) and has the value of 9.22 kHz.

The DC components at both outputs are determined by the performed Fourier analysis and $U_{DCsine} = U_{DCcosine} \approx 1.72$ mV.

3.2 Experimental Studies of the Two-Stage Quadrature RC Generator with Three Integrators

The quadrature RC generator of Fig. 1 is implemented practically using an experimental set for analog circuits Analog experimenter Type 3205.

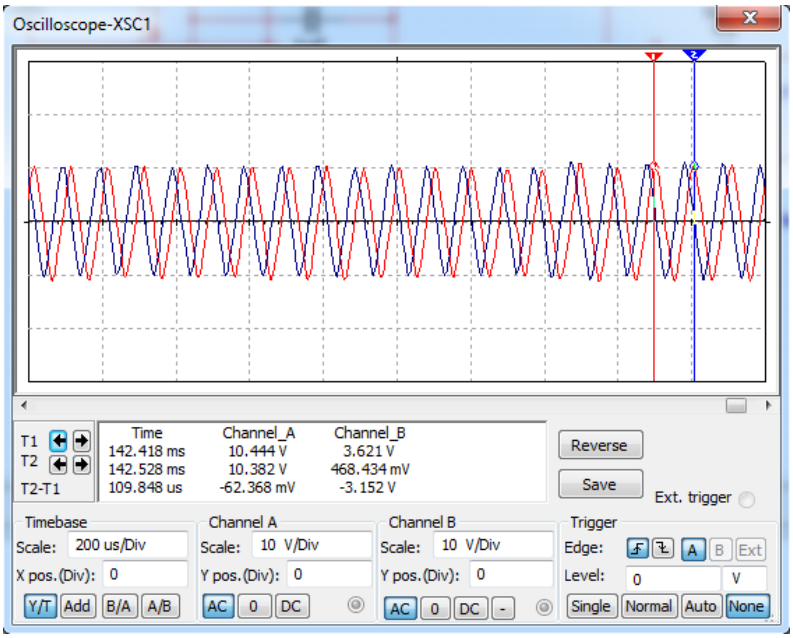

Figure 3. Oscillogram of the output signals of the simulation studied two-stage quadrature RC generator with three integrators

Table 2 presents the measured DC voltages in the specified nodes of the circuit of the implemented quadrature generator.

Table 2. DC voltages in the specified nodes of the quadrature RC generator

Node No	1	2	3	4	5	6
$U_{=}$, V (exper.)	-0.231	-0.317	0.039	0.394	-0.066	-0.067

Figures 4 - 7 show oscillograms and the main parameters of the output signals obtained from the experimental study of an implemented laboratory model of a quadrature RC generator with bipolar power supply ± 15 V (Figure 1), respectively for both outputs o1 (Sine) and o2 (Cosine): frequency $f_0 = 9.22$ kHz, phase-shift $\Delta\varphi \approx 90^o$ and output voltages $U_{o1} = 9.41$ V and $U_{o2} = 9.27$ V. It is found that there is always a minimal difference in the amplitudes of the two orthogonal output signals.

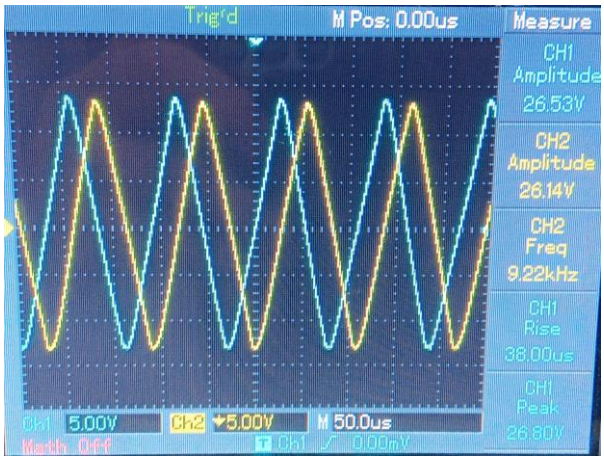

Figure 4. Oscillogram of the output signals of the quadrature RC generator U_{o1} and U_{o2} - f_0 = 9.22 kHz

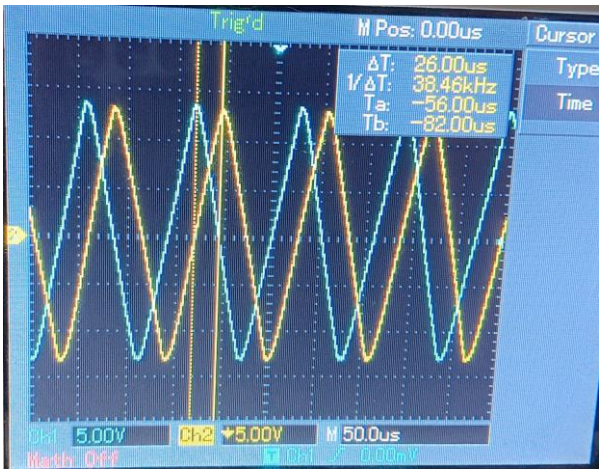

Figure 5. Oscillogram of the dephasing of the output signals U_{o1} and U_{o2} of the quadrature RC generator - $\Delta\varphi \approx 90^o$ ($\Delta t \approx 26$ μs)

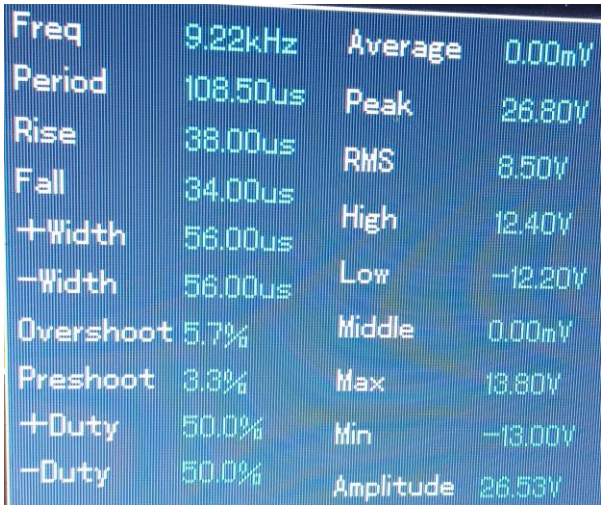

Figure 6. Parameters of the output signal U_{o1sin} of the quadrature RC generator

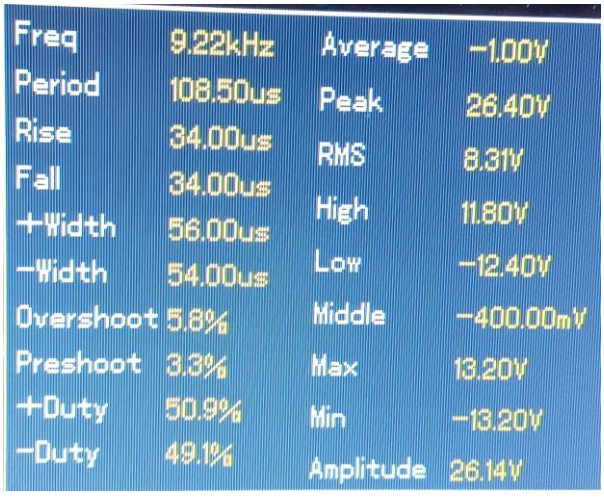

Figure 7. Parameters of the output signal U_{o2cos} of the quadrature RC generator

The THD measured at both outputs using the device Automatic Distortion Meter PMZ-11 is 6.25%.

The experimental studies were carried out with a resistance of the resistor R_3 = 5 kΩ. The amplitude balance condition is not satisfied at lower values of potentiometer resistance and for higher ones the gain is significant and the output signals are accompanied by nonlinear distortions. By setting the values of the R_3 amplitudes of the two outputs and the operating frequency are fixed. The undamped oscillations are lost for significantly larger deviations from the value 5kΩ.

A comparative assessment of the obtained parameters of the quadrature generator circuit is presented in Table 3. It can be assumed that the experimental and simulation results coincide with an accuracy of up to 25% for the amplitude of the generated signals and with total accuracy for the generated frequency. The parameters of the transient characteristic of the two output signals differ by up to 2%.

Table 3. A comparative assessment of the obtained parameters of the quadrature generator circuit

Parameter	Output o1 (Sine)			Output o2 (Cosine)		
	Simulation results	Experimental results	Ɛ, %	Simulation results	Experimental results	Ɛ, %
u_{01}, V	7	9.41	25.6	7	9.27	24.5
f_0, kHz	9.22	9.22	0	9.22	9.22	0

4 CONCLUSION

RC generators with operational amplifiers are limited in operating frequency since they do not have the necessary bandwidth to obtain low dephasing at high frequencies. Modern operational amplifiers with current feedback have a significantly wider bandwidth, but they are very sensitive to the capacities in the feedback circuit. Operational amplifiers with voltage-controlled feedback (with frequency correction) have a limited operating range with frequencies of up to about 100 kHz. The frequency bandwidth is further reduced by cascade connection of the operational amplifiers in order to multiply/add dephasing.

From the performed simulation and experimental studies and the obtained results it is established, that they coincide with an accuracy up to 25% for the amplitude of the generated signals and with total accuracy for the generated frequency f_0. The parameters of the transient characteristic of the two output signals differ by up to 2%. A problem in bringing the implemented quadrature RC generators to operation is determining and setting the necessary gain factor of the operational amplifiers themselves.

Quadrature generators are widely used in communication technology and especially in the structure of digital frequency, phase and quadrature-amplitude modulators and demodulators, in vector RLC meters and many other electronic circuits and devices in practice.

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Development of the Microwave Planar Sensor to Characterize Materials with Respect to Material Energy Level

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Abstract

Designing a planar sensor for material characterization that considers energy level change, return loss, and loss tangent as critical performance parameters can be a complex process. Begin by choosing the sensing technique that best suits your material characterization needs. Common techniques include transmission, reflection, and resonance-based methods. A reflection-based approach is often more convenient according to the performance parameters mentioned above. To assess energy level change, it should be considered to design the sensor to operate in a way that the interaction with the material causes changes in the reflected or transmitted energy. This can be achieved through impedance mismatches, resonance changes, or other methods. Return loss measures the ratio of incident to reflected power and is a critical parameter in material characterization. Ensure that the sensor design minimizes return loss, typically by matching the impedance of the sensor to that of the material under test. To measure the loss tangent accurately, which is another parameter of the planar sensor, it's crucial to design the sensor for precise phase measurements. This might involve incorporating phase-sensitive detection techniques. Thus, the successful design of a planar sensor for material characterization involving energy level change, return loss, and loss tangent measurements will require careful consideration of the specific requirements of the proposed application, thorough testing, and iterative optimization of the design.

Keywords: *Material characterization, Impedance, Return loss*

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8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023

December 1-3, 2023

The Effect of the Environment on Performances of Precast Concrete by Solar Energy of the Taksebt Dam

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[1]*University of Biskra, Civil and Hydraulic Engineering Department, Algeria*

Abstract

The study presented deals with the mechanical consequences and the degradations caused by the external attack of sulphates from the marine environment on the prefabricated concretes of the spillway and the dyke of the Taksebt dam in Tizi-ouzo (Algeria). Three different external sulphate attack protocols were applied for three types of concrete based on crushed aggregates (dry concrete, ordinary concrete and water-hardened concrete), the samples are immersed in a 5% H_2SO_4 solution.

The results show that the impact of the age of the material on its degradation in contact with the sulfuric acid solution was highlighted, visual observations then a rapid and brutal degradation on the surface then in depth towards the core then a loss of mass and cracking and finally the ruin of the material.

Keywords: *Taksebt dam, Precast concrete, External sulphate attack, Marine environment, Degradation*

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December 1-3, 2023

THz Metamaterial Absorber Design with Dual-Band and High Absorption Rate

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Abstract

Radars operating at THz frequency are preferred for automatic detection and detecting hidden objects because they offer wider bandwidth and obtain higher resolution images than other radars. Due to the increasing use of THz radar due to its advantages, research on materials that will provide invisibility against these radars attracts great interest from researchers. Under normal circumstances, it is a very difficult task to find natural materials and absorber materials that can provide invisibility against THz frequency signals. For this purpose, metamaterial-based absorber structures, which are artificial electromagnetic materials, have been developed. This paper focuses on THz metamaterial absorber design, and high absorption rate in two bands at THz frequencies (99.91% at 10.5 THz and 98.21% at 18.1 THz) is achieved.

Keywords: *Metamaterial, Absorber, Dual-band, THz frequencies, High absorption*

1 INTRODUCTION

The ability to move without being caught by radar systems has gained great importance, especially in military technologies and defense industry. Since obtaining a clearer image is possible with THz level radars, researching the structures that provide radar invisibility, that is, the absorption of the incoming signal, has become an important subject of study [1]. Since natural materials are very weak against THz waves and absorption at THz levels cannot be achieved with natural materials, artificially designed metamaterial-based absorbers that do not exist in nature have been turned to [2].

Perfect metamaterial absorbers, first introduced to the scientific world by Landy et al., were designed from a grounded metal base, dielectric layer and electrical resonator structure [3]. After Landy et al.'s study in microwave frequency regions, studies operating in different microwave [4], terahertz [5], and optical frequency [6] regions and offering different absorption rates were carried out. In this suggested study, a high absorption rate (99.91% at 10.5 THz and 98.21% at 18.1 THz) was obtained in two bands at THz frequencies. In addition, it is thought that the designed THz metamaterial absorber structure will have an important place in THz applications by providing a high absorption rate at desired frequencies with its scalability feature.

2 MATERIAL AND METHOD

The absorption (A) of the metamaterial absorber device can be given by $A = 1 - T - R$; where T and R are the transmission and reflection of the metamaterial absorber, respectively [2-6]. T and R are $|S_{21}|^2$ and $|S_{11}|^2$, respectively, in terms of scattering (S-) parameters. Again, where S_{21} and S_{11} are the transmission and reflection S-parameters, respectively. In the design, there is an electrical resonator at the front of the metamaterial absorbers, a dielectric layer in the middle and a grounded metal ground at the bottom, and since the thickness of the metallic film at the bottom is greater than the surface depth of the incoming light, the transmission T of the metamaterial absorber is equal to zero (0) [7]. As a result, absorption A can be simplified to $A = 1 - R = 1 - |S_{11}|^2$. In the suggested metamaterial absorber device, 100% absorption can be achieved when the reflection R is completely suppressed.

Considering the simple absorption equation and basic metamaterial absorber design principles, the 3D representation of the THz metamaterial absorber consisting of a metal electrical resonator–dielectric layer–grounded metal ground adaptation is given in Figure 1(a). Additionally, the front and side views of the suggested absorber are shown in Figures 1(b) and 1(c), respectively. Copper with an electrical conductivity of 5.8×10^7 S/m was used as the metal and Arlon AD 250C with a relative dielectric constant of 2.5 and a loss tangent of 0.0013

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was used as the dielectric layer. Information about the geometric shape and thickness of the suggested THz metamaterial absorber is summarized in Table 1.

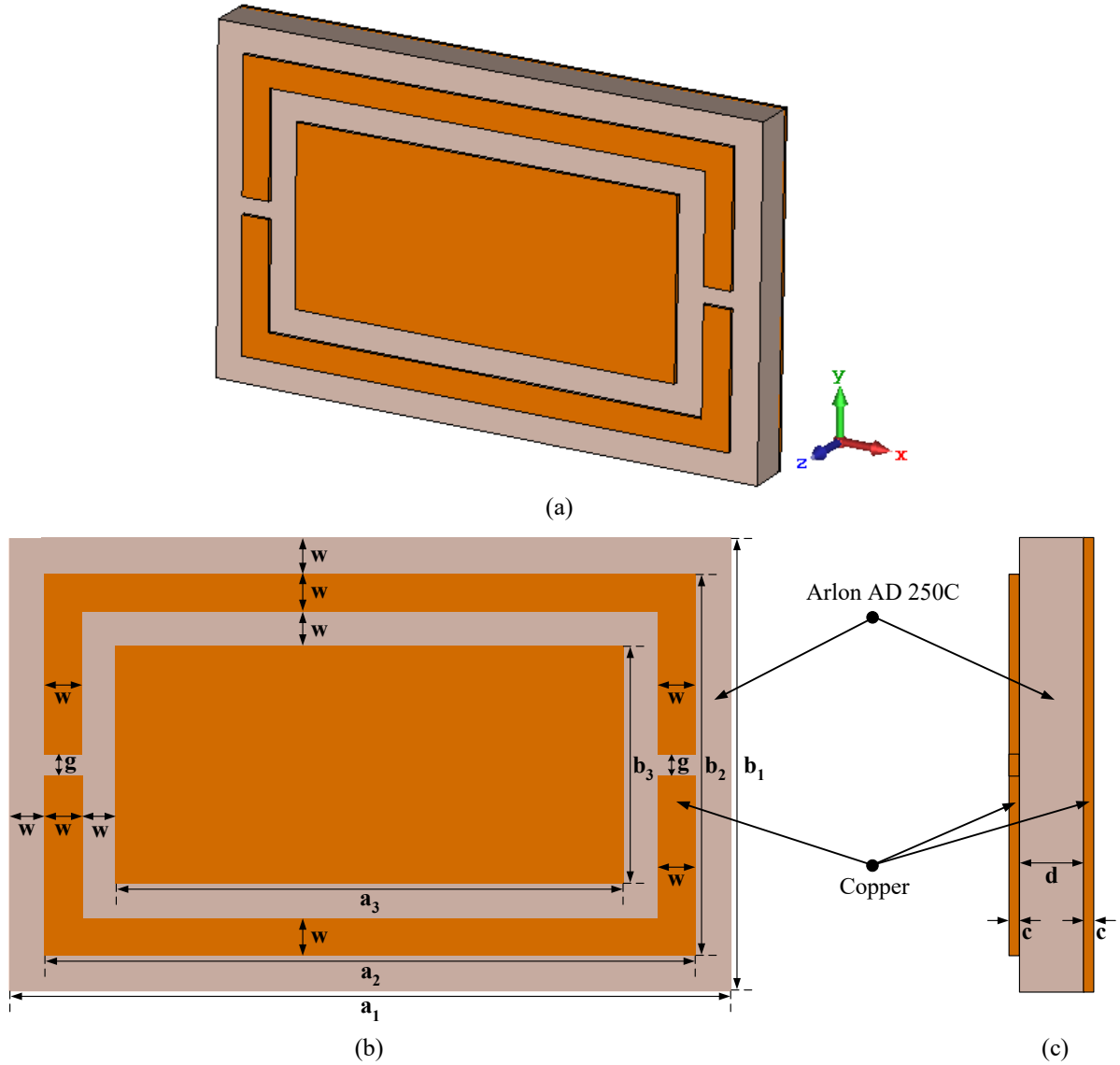

Figure 1. (a) 3D view of the suggested THz metamaterial absorber with dual-band and high absorption rate designed in CST Microwave Studio and dimensioning of the suggested absorber geometry in (b) front and (c) side views

Table 1. The dimensions of the suggested THz metamaterial absorber with dual-band and high absorption rate according to the designations shown in Figures 1(b) and 1(c) are

a_1	a_2	a_3	b_1	b_2	b_3	w	g	c	d
16 µm	14.4 µm	11.2 µm	10 µm	8.4 µm	5.2 µm	0.8 µm	0.5 µm	0.1 µm	1.2 µm

3 RESULTS

For the absorber geometry designed and simulated in the electromagnetic simulation program CST Microwave Studio, the dB and amplitude values of the S_{11} and S_{21} parameters in the 5–22 THz frequency range are given in Figures 2(a)–2(d). As mentioned in Section 2, the transmission scatter parameter is zero (0) in the 5–22 THz frequency range (as seen in Figure 2(d)). It can also be said that for the high absorption rate, the reflection scattering parameter approaches zero (0) in two bands at 10.5 THz and 18.1 THz (as seen in Figure 2(b)).

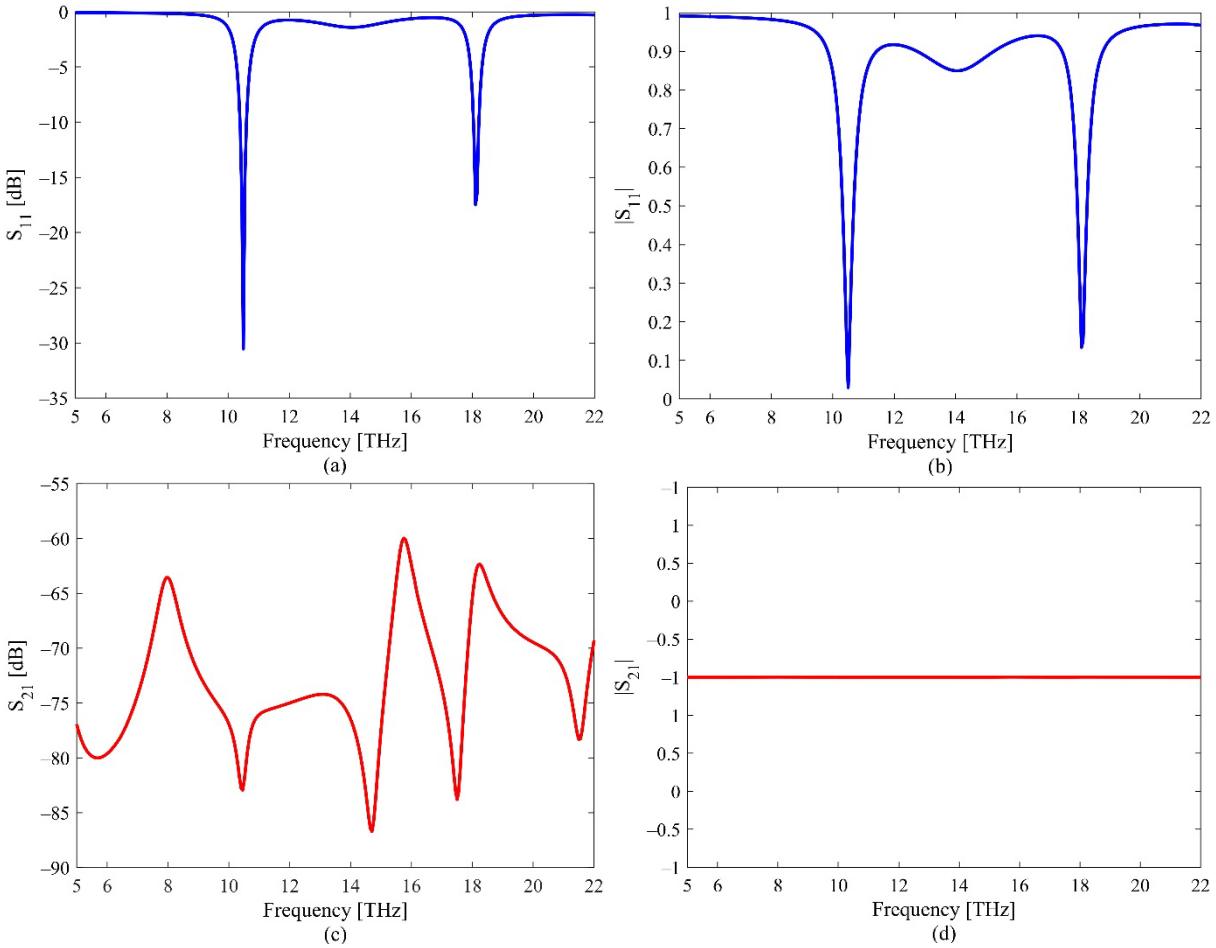

Figure 2. (a) S_{11}, (b) $|S_{11}|$, (c) S_{21}, and (d) $|S_{21}|$ simulation results for the suggested THz metamaterial absorber with dual-band and high absorption rate

If the scattering parameters in Figure 2 are used in the simple absorption equation in Section 2, the A% rate is found as in Figure 3. Accordingly, when Figure 3 is examined, it can be said that the suggested THz metamaterial absorber structure shows a high absorption rate of 99.91% and 98.21%, respectively in two bands, 10.5 THz and 18.1 THz. In addition, these high absorption rates are not only valid for the specified frequencies, but with the scalability feature of the THz metamaterial absorber structure, the high absorption rate may be achieved at the desired frequencies.

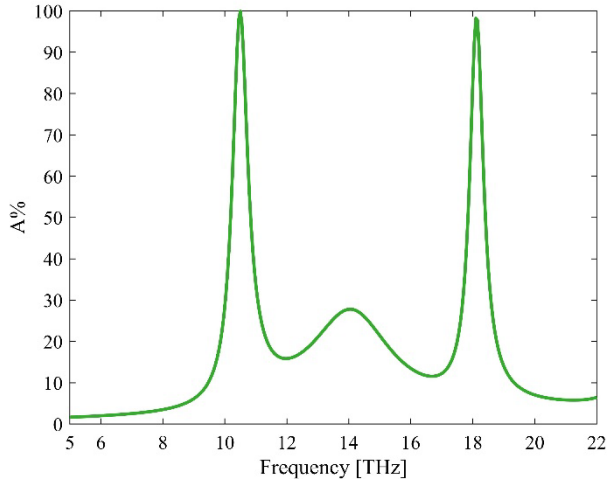

Figure 3. A% simulation results for the suggested THz metamaterial absorber with dual-band and high absorption rate

4 CONCLUSION

In this study, a THz metamaterial absorber design was carried out in a simple configuration for THz frequency applications. Designs and simulations for the suggested absorber consisting of copper electrical resonator–Arlon AD 250C dielectric layer–grounded copper ground layer were made in CST Microwave Studio. According to the simulation results, a high absorption rate of 99.91% and 98.21% was obtained in two bands, 10.5 THz and 18.1 THz, respectively. In addition, these high absorption rates are not only valid for these frequencies, but the high absorption rate can also be achieved at any desired frequency in THz frequencies with its scalability feature.

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Fabrication of Patch Antenna Utilizing CNT-Ferrite Nanocomposite as Magnetic-Conductive Material

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Abstract

In this work, CNT-ferrite nanocomposite has been successfully synthesized using chemical vapour deposition (CVD) with yttrium iron garnet nanopowders as a catalyst, ethanol as carbon stock and Argon as carrier gas. Carbon nanotubes (CNT) were observed to have grown from ferrite nanopowders with bamboo-like structures. CVD synthesis temperatures of 700°C and 900°C were set as varying parameters to study the effect of temperature on the CNT growth. Field emission scanning electron microscopy (FESEM) and Raman spectroscopy characterization indicated that CNT-ferrite nanocomposite with a synthesis temperature of 900°C exhibited growth of bamboo-like CNT with high graphitization compared to CNT-ferrite at 700°C. Further investigation using High-resolution transmission electron microscopy (HRTEM) proved that the CNT were grown from the ferrite catalyst via tip growth mechanism. The electrical, dielectric and magnetic properties of the samples concluded that CNT-ferrite nanocomposite grown at 900°C has significant properties resulted in improved performance of patch antenna which was fabricated using the synthesized nanocomposite as the active material in the thick film paste for the radiating patch.

Keywords: *Carbon nanotubes, Ferrites, Nanocomposite, Patch antenna*

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December 1-3, 2023

Design of Vivaldi Antenna for Wideband Applications

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Abstract

In this study, we have designed a Vivaldi antenna for wideband applications. This antenna design is commonly employed in radio and microwave communications, radar, medical imaging devices, wireless communication systems, and various other RF applications. The primary objective of this study is to propose a new Vivaldi antenna design and assess its performance characteristics. The analysis is performed using a commercial full 3D electromagnetic simulation program (CST Microwave Studio) – a powerful tool specifically designed for antenna design simulation and evaluation. Thanks to its broadband nature, the antenna exhibits the capability to operate across a wide frequency range. This feature, along with its lower return loss, enhances the efficiency of signal transmission and reception, particularly in challenging RF environments. The research methodology includes the use of rigorous simulation techniques to examine the behaviour of the antenna under various operating conditions. Antenna performance is optimized by making changes to feed-point location, slot dimensions, and other parameters.

Keywords: *Antenna, Vivaldi antenna, Radar, Microwave, CST Microwave Studio*

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Investigation of River Flow Characteristics Using Internet of Things towards Prediction of River Surge (Kepala Air)

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Abstract

The study presents an investigation into river flow characteristics utilizing Internet of Things (IoT) technologies with a primary focus on predicting river surges (kepala air) phenomenon. The research emphasizes the significance of understanding river flow rates as a crucial parameter for accurate surge predictions. The current method for monitoring rivers often lacks real-time data, hindering the precision of surge predictions. The integration of IoT in river flow monitoring offers an approach to overcome these limitations. This research employs a multidisciplinary approach, combining sensors and data collection and analysis to enhance the understanding of river flow dynamics. The objective is to implement real-time monitoring that can provide early warning alerts for potential river surges. IoT devices, such as water level sensors and water flow rate sensors, are deployed on-site to collect real-time data. These sensors provide continuous measurement, allowing for an accurate representation of the river flow characteristics. The collected data are transmitted to cloud computing software, where data analytics techniques are employed to analyze and interpret the patterns in river flow characteristics preceding or indicating the onset of river surges. The study also delves into developing a warning system to notify authorities of dangerous water speeds, generating alert messages when hazardous conditions arise. By detecting surges in the river early on, authorities can execute evacuation plans, safeguard infrastructure, and implement flood control strategies on time. This will help reduce the impact of such events on both communities and ecosystems This is an innovative effort that aims to mitigate the risks associated with river surges, and enhance disaster management. The research findings have the potential to save lives and protect the environment, leading to the sustainable development of riverine regions.

Keywords: *River surge, IoT, River flow, Warning system, Real-time monitoring, Sensor*

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Evaluation of Blowfish Encryption Algorithm on Transport-Triggered Architecture

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Abstract

Cryptography plays a vital role in protecting sensitive information in today's interconnected digital systems. This study delves into the importance of processor design in low-power embedded systems using for security applications. The primary objective is to state the advantages conferred by the Transport-Triggered Architecture over traditional processors. In this context, we propose the design and implementation of application-specific instruction set processors for Blowfish symmetric-key encryption algorithms in a fully open-source and free development environment. Performance, maximum clock frequency, resource utilization, and power consumption are analysed under various scenarios. In addition, suggestions are included to guide future research on how these metrics can be further improved. Preliminary findings indicate that the proposed core architecture may be a suitable alternative for energy-efficient Internet-of-Things systems. Besides, this study can be considered an exemplary design from the perspective that highly flexible, scalable, and customizable core architectures will replace custom accelerators in future advanced system-on-chip designs.

Keywords: *Symmetric key cryptography, Application-specific processor, Information security , RISC-V, TTA*

1 INTRODUCTION

Cryptography has a historical importance in ensuring information security since ancient times. In recent years, the rapid increase in digital data production and developments in the field of information technologies have made the security of sensitive data even more critical. In this context, the application of encryption algorithms on efficient processor platforms has become an important research topic.

Nowadays, the requirements in embedded system designs are becoming more and more stringent. Devices that are expected to provide high performance within a limited energy budget are also expected to be implemented in a small chip area [1]. In addition, data security in these systems also emerges as a separate design challenge [2]. It is difficult to use strong encryption algorithms at the required level in such resource-constrained systems. This is because running these algorithms consumes more resources than running the actual applications of the system. However, security is not a negligible requirement. Therefore, the only solution seems to be to use encryption algorithms as efficiently as possible. This is only possible with an application-specific computing hardware. At this point, the importance of processor design comes to the fore. However, general purpose processors are generally used in embedded system designs due to the various difficulties of developing custom processors [3]. However, application-specific processors are particularly well suited to embedded systems that are designed to run only a specific set of applications. However, a flexible architecture that can be customized for each application is required to develop such processors. This requires a large number of tools such as compilers, simulators, modellers and code generators with compatible interfaces. Transport-Triggered Architecture (TTA) provides a highly adaptable structure for the development of Application-Specific Instruction Set Processors (ASIPs) [4]. OpenASIP [5] is a complete toolset for designing, testing, customizing and generating TTA-based ASIPs.

Blowfish is a fast and lightweight symmetric encryption algorithm designed in 1993 [6]. It operates on 64-bit data blocks with a variable key length from 32-bit to 448-bit. Although algorithms such as Advanced Encryption Standard (AES) [7] are known to be more secure, Blowfish's advantages of speed and low resource requirements make it a more suitable solution for most embedded system applications. Therefore, the algorithm is still widely used in many software and hardware applications.

In this study, custom TTA processors are proposed for the Blowfish algorithm. To demonstrate the effectiveness of the operations, a simple ASIP design was made using OpenASIP. The rest of the paper is organized as follows:

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Literature review is given in this section. We summarize Blowfish, TTA, and OpenASIP in Section 2. Custom core design is explained in Section 3. The work is concluded and future studies are shared in Section 4.

1.1 Literature Review

There are many studies in the literature on hardware implementations of the Blowfish algorithm [8-10]. In [8], an efficient design was introduced for secure data transmission in Internet of Things (IoT) applications. A similar work is proposed in [9]. The performance of the algorithm was evaluated on a reconfigurable platform in terms of both power consumption and throughput in [10]. Instruction set extension techniques were applied in [11] to increase efficiency and performance. On the other hand, an optimized software implementation was developed in [12]. To the best of our knowledge, there has not yet been any study on the design of a TTA processor for the Blowfish algorithm. However, there are a lot of work for some Post-quantum cryptography algorithms [13-15].

2 ARCHITECTURE AND APPLICATION

In this section, we briefly explain the Blowfish algorithm. We also explain the general computational philosophy of TTA and the foundations from which the architecture is inspired. Moreover, the complete TTA processor design environment is introduced.

2.1 Blowfish Encryption Algorithm

Blowfish is a symmetric-key block cipher designed as an alternative to existing encryption algorithms by Bruce Schneier [6]. The algorithm operates on fixed-size data blocks with variable key lengths. The Blowfish encryption structure uses a Feistel network [16], which means that the data is processed iteratively through multiple rounds. The secret key is expanded into subkeys which are then used in the rounds. In each round, the left half of the input data is XORed with the subkey and entered into a function block called **F**. This portion is also recorded as the right half of the input data for the next round. The **F** function is a combination of addition, XOR and S-boxes. The result is then XORed with the right half of the input data and stored as the left half of the input data for the next round. The decryption process of the algorithm is similar to the encryption structure, which is a common state like other algorithms using the Fiestel networks.

2.2 Transport-Triggered Architecture

TTA's computational approach is based on the Very Long Instruction Word (VLIW) principles [4]. TTA is basically a processor design method that aims to take advantage of instruction-level parallelization (ILP). Data is moved between functional units (FUs) where arithmetic, logic and control operations are performed. Instead of being written to the register file (RF), the processed data is transported via multiple parallel transport buses to the FU where the next operation is performed. This usually reduces power consumption by increasing the register file bypass rate. The FUs are not triggered until a relevant data reaches the input ports. One of the most important differences that distinguishes TTA from the classical VLIW architecture is that RF is treated as an ordinary FU. In the TTA method, programme scheduling is done statically at compile time. The entire computation process is managed by the Global Control Unit (GCU). General structure of a TTA core is given in Figure 1. TTA is a highly modular, flexible and customizable processor template, making it an ideal method for ASIP development.

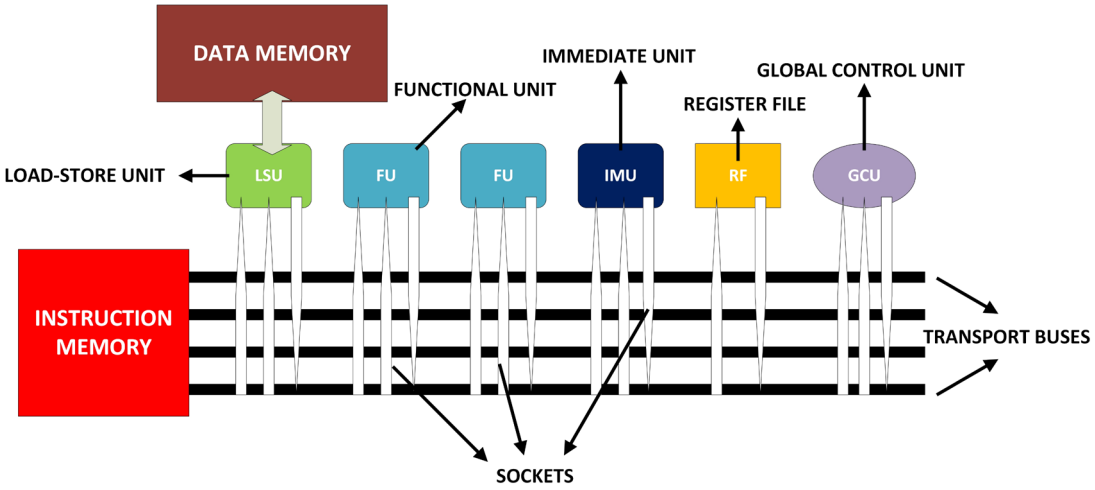

Figure 1. General structure of a typical TTA processor

2.3 OpenASIP

OpenASIP, formerly known as TTA-Based Co-Design Environment (TCE), is a free and open-source toolset developed in Tampere University, Finland [5]. It contains several tools for modelling, simulating, customizing, profiling, and generating TTA processors. LLVM-based retargetable compiler produces executable code for an application compatible for the target machine. If the designer changes the core, then the compiler needs to be regenerated. A typical design process is shown in Figure 2. The designer generally starts a design process with a high-level application code and an architecture definition file (ADF) which states a TTA processor template. The ADF file is compiled together with the application. Then, the designer tests the application and processor in a cycle accurate simulator called Proxim. It provides all the profiling statistics about the machine. After that, the designer can revise the processor model using the Processor Designer (ProDe) tool. Custom operations can be defined and managed in the Operational Set Editor (OSEd). OpenASIP can also generate Verilog and VHDL implementation of the developed core. Designers can add their own HDL implementations using the Hardware Database Editor.

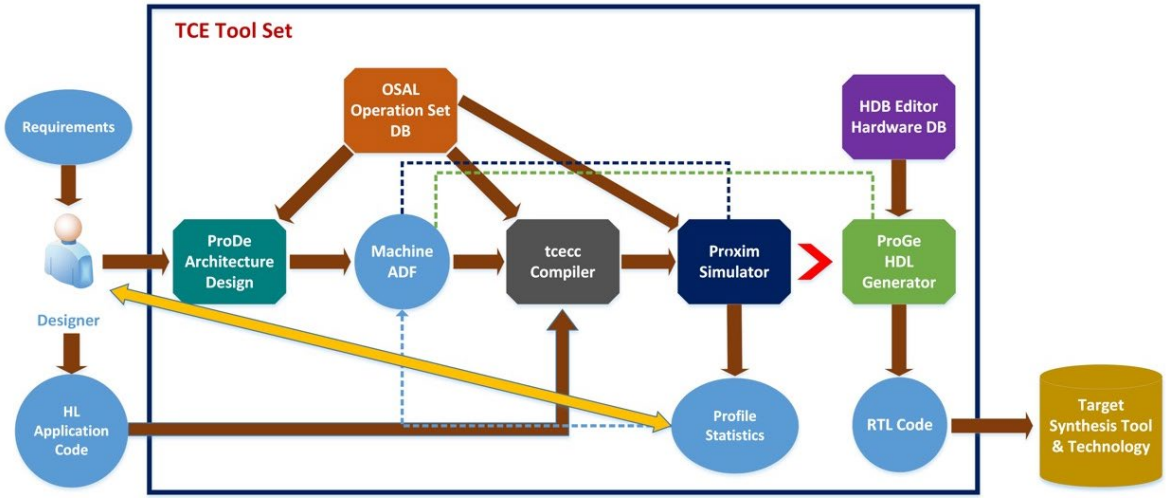

Figure 2. TTA processor design process with OpenASIP tools

3 PROCESSOR DESIGN AND TESTS

In this section, TTA-based ASIP design and custom operations developed for Blowfish algorithm are introduced. In addition, performance evaluation of the design is explained using the results of performed tests.

3.1 Base TTA Processor

We started the design process with an elementary TTA processor template, which we call the BaseTTA. It contains the basic arithmetic and logic operations (add, subtract, and, or, xor, shift right-left) inside its FUs. The ProDe model of the BaseTTA core can be seen in Figure 3. Firstly, we prepared a test code implements the encryption and decryption phases of the Blowfish algorithm. The code is then compiled for the BaseTTA core. We obtained profiling data using the Proxim simulator. To determine the ideal transport bus count for the best performance, we repeated the test for more buses. We also increased the number of registers from 5 to 32 in the RF unit to decrease the number of memory load-store operations. The Blowfish test results for various configuration of the BaseTTA processor is given in Table 1.

3.2 Design of Custom TTA Operations

We identified computational bottlenecks by analysing profiling data from the BaseTTA processor's cycle-accurate simulation and the structure of the Blowfish algorithm. It is possible to define and integrate many new operations into the processor to overcome these bottlenecks. However, such a strategy could significantly reduce maximum clock frequency and increase required the chip area to implement the processor. For this reason, we designed two simple operations that will substantially improve performance:

- SHFOR4: Shift the 4 inputs with constants and OR the results each other.
- SWAP: Swap the left, right and temporary values in Blowfish rounds.

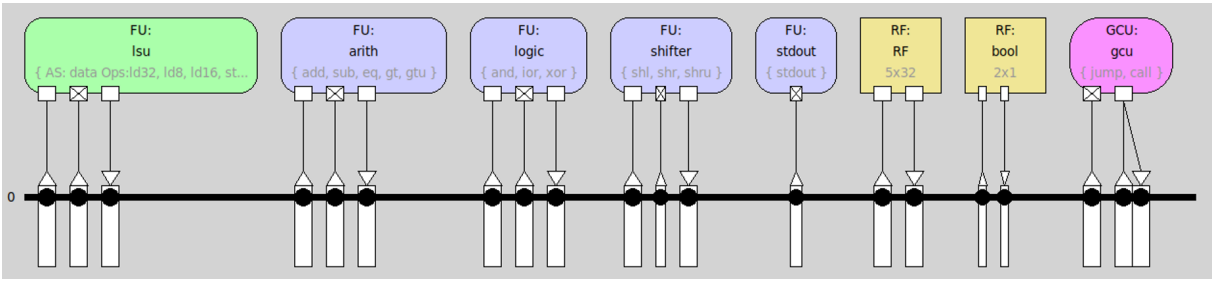

Figure 3. The structural model of the BaseTTA processor

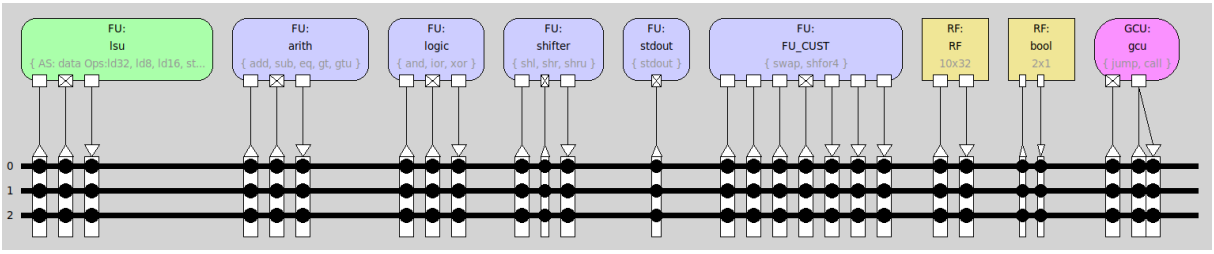

Figure 4. The structural model of the CustTTA processor

We introduced the custom operations to the OpenASIP environment using the OSEd tool. Then, we added a new FU to the BaseTTA design to integrate the custom operations into the processor. The revised processor model, which we call the CustTTA is presented in Figure 4. After the final design process, Blowfish tests were repeated on the CustTTA. The required cycle count results are shared in Table 1. The Blowfish test code was also run on a 64-bit RISC-V processor, CVA6 (RV64GC) [17], for a more meaningful comparison. The results show that the developed operations increase the performance at a reasonable level compared to the BaseTTA processor.

Finally, we implemented the custom operations and FU in VHDL. The rest of the core was generated using ProGe tool. HDL codes were synthesised for the xc-7a100t coded FPGA part using Xilinx Vivado [18]. The Blowfish test was then run in the Vivado environment using the post-synthesis simulation tool. Table 1 shows the FPGA resources, maximum clock frequency and estimated power consumption for the processors used in the study. These values can be easily improved using OpenASIP IC optimization techniques given in [5].

Table 1. Total number of clock cycles required for running the Blowfish test

Processor	Bus Count	Register File	Cycle Count	LUT, FF	Frequency	Estimated Power
BaseTTA-1	1	5x32-bit	3.045.964	1069, 726	125 MHz	102 mW
BaseTTA-2	2	5x32-bit	1.814.358	1478, 764	120 MHz	104 mW
BaseTTA-3	3	10x32-bit	802.136	1745, 904	120 MHz	108 mW
CVA6	-	32x64-bit	1.334.781	9567, 4729	40 MHz	122 mW
CustTTA	3	12x32-bit	621.230	2068, 1047	120 MHz	110 mW

4 CONCLUSION

With the increasing use of embedded systems in areas such as IoT, the issue of securing sensitive data is becoming increasingly important. Embedded system designers face serious challenges to achieve both performance and low power consumption in restricted chip areas. This makes ASIPs the most appropriate solution for embedded systems. TTA is an ideal processor template for ASIP development due to its flexible and customizable structure. In this work, we designed a few custom TTA operations for a lightweight symmetric encryption algorithm. We proved the effects of the developed operations by integrating them on a simple TTA processor. Tests on a cycle-accurate simulator showed that the number of clock cycles required is significantly reduced. We also implemented our design in HDL to measure required hardware resources. In light of the obtained results, it can be said that TTA-based ASIPs can be used to overcome the design challenges in embedded systems. In future studies, we plan to develop custom TTA operations for similar encryption algorithms. We will also investigate the applicability of TTA in other areas where ILP may provide superior advantage.

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Critical Requirements of Wireless Technologies for Real-time Voice Transmission in Above-Water Environments: A Comparative Study of NB-IoT, LTE, and 5G

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Abstract

This research investigates the critical requirements of real-time voice transmission in above-water environments, with a specific focus on the key parameters of bandwidth, latency, and data rate. In this study, Narrowband Internet of Things (NB-IoT), Long-Term Evolution (LTE), and 5th Generation (5G) wireless technologies are subjected to a comparative analysis, centred on their performance in terms of these crucial parameters. The unique challenges posed by above-water environments necessitate a nuanced understanding of how each technology addresses the demands of bandwidth-intensive voice transmission, minimizes latency, and achieves optimal data rates. Through a systematic evaluation of these parameters, this work aims to provide valuable insights into the comparative strengths and weaknesses of NB-IoT, LTE, and 5G. Decision-makers and engineers involved in applications such as maritime operations, security surveillance, environmental monitoring, and emergency response systems will benefit from the findings, guiding the selection and implementation of wireless communication solutions tailored to the specific demands of above-water scenarios.

Keywords: *Real-time voice transmission, Above-water environments, Narrowband Internet of Things (NB-IoT), Long-Term Evolution (LTE), 5th Generation (5G)*

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Comparative Analysis of Differential Privacy over Multiple Data Sets

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Abstract

In this study, we investigate Differential Privacy as an alternative to secure data processing and how it impacts machine learning performance. Differential Privacy, in its simplest definition, involves adding noise to a dataset based on mathematical distributions like Laplacian or Gaussian, providing "plausible deniability" for each individual's data. The accuracy values obtained from machine learning algorithms on noisy datasets are compared with those obtained from algorithms applied to the original datasets. Additionally, the effects of the privacy budget ϵ associated with Differential Privacy are also discussed in the final section.

Keywords: *Data privacy, Differential privacy, Machine learning*

1 INTRODUCTION

With the growth of current applications, the likelihood of cyber-attacks exposing stored data has increased, thus expanding the attack surface and leading to increasing demand for data processing operations. As a result, data security has become one of the top concerns over the past few years. Although data security is commonly understood as ensuring the safety of stored data, it equally concerns the security of data that data scientists, artificial intelligence engineers, and other individuals need to process. Anonymizing data, particularly in fields such as the medical sector, is of significant importance from security and ethical perspectives [1].

Data security involves protecting digital data from unauthorized access, usage, disclosure, interference, modification, or destruction. To ensure the privacy, accuracy, and accessibility of data, it is necessary to implement diverse measures and safeguards. It is crucial to ensure data security to protect sensitive and valuable data from malevolent individuals, hackers, or cybercriminals who may retrieve, steal, or manipulate the data [2]. Data privacy is a concept related to maintaining the confidentiality of data. Its aim is to anonymize the data without affecting its mathematical, statistical, or other similar values. The anonymized data can be publicly shared. It involves de-identifying personal or sensitive information in the dataset.

One common data privacy method is to delete identifying data, such as names and ID numbers, from a medical data set to make it anonymous. However, it is known that this approach is not always effective. The Netflix-IMDB data set incident that occurred in the 2010s serves as a prime example of its limitations [3]. Netflix published a dataset of about 10 million ratings by 500,000 users, with all user information fully anonymized. Despite the anonymization, a group of people was able to de-anonymize about 60% of this data set after cross-referencing the user ratings on IMDB, thus demonstrating the limitations of this approach. Anonymizing data through a simple method may seem effective at first, but it may not work due to several other factors in the current world of big data.

2 RELATED WORKS

Differential privacy significantly impacts machine learning models. Differential privacy provides provable privacy guarantees, making it a popular approach for addressing privacy concerns in sensitive domains. Nonetheless, there exists a trade-off between privacy and utility as differential privacy may reduce learning accuracy. Wang et al. investigate the learnability of problems under differential privacy constraints [4]. They uncover complex associations between privacy, stability, and learnability. The study indicates that a problem can be privately learnable if and only if there exists a private algorithm that asymptotically minimizes the empirical risk. This finding suggests that the pursuit of private learning algorithms can be limited to those that satisfy this condition.

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According to McMahan et al., achieving differential privacy on large-scale datasets entails increased computation costs instead of decreased utility [5]. The study indicates that private LSTM language models trained on a large dataset are qualitatively and quantitatively similar to un-noised models. This indicates that the impact on utility can be reduced by using differential privacy techniques. Differential privacy can be employed in federated learning to ensure that user-level privacy is protected. The addition of user-level privacy protection to the federated averaging algorithm enables the training of large recurrent language models while guaranteeing user-level differential privacy without compromising predictive accuracy significantly. This illustrates the possibility of integrating differential privacy into federated learning systems.

The use of differential privacy techniques in machine learning systems can introduce additional computational and communication overhead. According to Hong et al., encrypting and decrypting gradient parameters in the communication process can increase computing and communication costs in scenarios involving a large number of participants, which may be intolerable [6]. Thus, achieving a balance between privacy protection and model performance is crucial in practical implementations.

The impact of differential privacy on machine learning models presents a complex trade-off between privacy guarantees and utility. As indicated in recent studies, while differential privacy can introduce computational and communication overhead, it is possible to achieve it without significantly sacrificing predictive accuracy. Further research is necessary to devise more efficient and effective techniques for incorporating differential privacy into machine learning models while minimizing their impact on utility.

3 MOTIVATION AND METHOD

This research investigates the impact of adding noise within the concept of Differential Privacy on machine learning datasets. The objective of this study is to analyze the effects of Differential Privacy on simpler machine learning methods.

3.1 Differential Privacy

It was proposed by a Microsoft research team [7]. The goal is to add plausible deniability to each row of a data set by introducing noise data that does not distort its mathematical or statistical properties. For example, in a health test, it may be necessary to maintain the privacy of individuals with Virus A. If the data column consists solely of binary values and we assign the value 1 to everyone with Virus A and 0 to those who do not have it with a probability of 50% for each, it is impossible to know with certainty if John Doe has Virus A. Nevertheless, the added noise to the dataset is mathematically and proportionally known, enabling us to determine the overall characteristics of the data.

This idea is being rapidly adopted by many large companies and appears in two simple ways. The first way is achieved by adding noise to the database during data entry, whereas the second implementation, which was employed in this report, involves adding noise to a pre-existing database as chosen by the data scientist. The first method is referred to by the terms ’randomized response’ or ’local differential private,’ while the second method is known as the ’additive noise mechanism,’ which incorporates Laplacian and Gaussian mechanisms. As previously mentioned, this study concentrated on the additive noise mechanism.

3.2 IBM Differential Privacy Framework

Several differential privacy frameworks are available, each with its unique strengths and weaknesses. The IBM differential privacy framework is among the most prevalent frameworks and offers several features that make it a great option for a variety of applications [8]. The followings are some of the main features of the IBM differential privacy framework.

- Support for a variety of data types: It can handle a wide range of data types, encompassing integers, floats, strings, and categorical data. As a result, it is a suitable option for a wide variety of applications, including machine learning, data analysis, and statistical testing.
- Robustness to noise: This feature is valuable for applications where accuracy is paramount because it has been engineered to withstand noise.
- Ease of use: It is quite user-friendly, even for those without prior knowledge in this area. As a result, it’s a great option for organizations that want to implement differential privacy without significant initial investment.

- Open-Source: It has an open-source format, which al-lows it to be freely used and modified. This makes it a preferable option for organizations seeking to tailor the framework according to their specific requirements.

4 ALGORITHMS, MECHANISMS AND DATA SETS

4.1 Machine Learning Algorithms

Since the used library is based on scikit-learn [9], it offers a wide range of machine learning-based functionalities and, being open-source provides everyone with the opportunity for implementation. Although many of them were tried during this study, only classification algorithms were used to see meaningful, comparable, and unbiased results in this report.

Gaussian Naive Bayes (GNB): Naive Bayes is a classification algorithm that utilizes probability and is based on Bayes' theorem. Gaussian Naive Bayes is a particular version of Naive Bayes that assumes the features in the dataset conform to a normal (Gaussian) distribution. This algorithm generally performs well on datasets containing continuous numerical features. The algorithm calculates the mean and standard deviation of each feature for each class within the training data to determine the probabilities of the Gaussian distribution.

Random Forest (RF): A decision tree is a model for predicting outcomes in data mining and machine learning for both regression and classification tasks. Each internal node of the tree represents a feature or attribute, each branch corresponds to a decision based on that feature, and each leaf node indicates the predicted outcome or classification. The structure bears similarity to that of a tree. Random Forest extends the concept of a single decision tree, by building a set of multiple decision trees and then aggregating their predictions to arrive at a conclusion.

Logistic Regression (LG): Logistic regression is a statistical method utilized for binary classification to assess the probability of an outcome. Logistic regression, despite its name, is not a regression technique but rather a classification tool deployed for evaluating categorical data.

4.2 Mechanisms

Laplace Mechanism: It adds random noise from a Laplace distribution to the output of a query to protect individual privacy. The sensitivity of the query and the privacy parameter (ϵ) determine the amount of noise added. Increasing ϵ provides stronger privacy protection but may result in less accurate results.

4.3 Data Sets

Table 1 provides comprehensive information on the data sets used in this study.

Table 1. Overview of the datasets

Data sets	Size	Explanation
Wine Quality (Red) [10]	1.6k	This is a dataset where the quality of red wines is classified. It consists of numeric and binary values. As a preprocessing step, only normalization has been applied.
Wine Quality (White) [10]	5k	This is a dataset where the quality of white wines is classified. It consists of numeric and binary values. As a pre-processing step, only normalization has been applied.
California Housing Prices	20k	This is a dataset used for the regression of California house values. It consists of numeric and binary values. As a pre-processing step, the average house prices were taken, and the problem was converted into a binary classification problem based on whether the house prices are higher or lower than the average house price. Normalization was also applied.
Iris [11]	150	This is a dataset used for the classification of the Iris flower. It consists of numeric values. Only normalization has been applied as a pre-processing step.

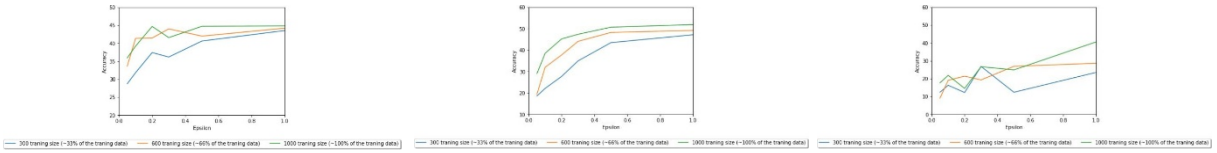
5 ANALYSIS AND RESULTS

Two methods were chosen for the comparative analysis. The first method entails comparing the Differential Privacy algorithm with the regular algorithm using the same dataset with constant parameters. The second method is to examine the effect of ϵ in the implementation of Differential Privacy. Table II shows that ϵ = 1, which is the default privacy budget value, was used for all three algorithms. We applied the described preprocessing technique and used the entire dataset with a training ratio of 0.66 and a test ratio of 0.34. The algorithms were executed for the batch size values indicated on the side, and the average accuracy values resulting from them were computed. In Differential Private algorithms, Laplacian noise is included as the noise data.

Table 2. Accuracy values

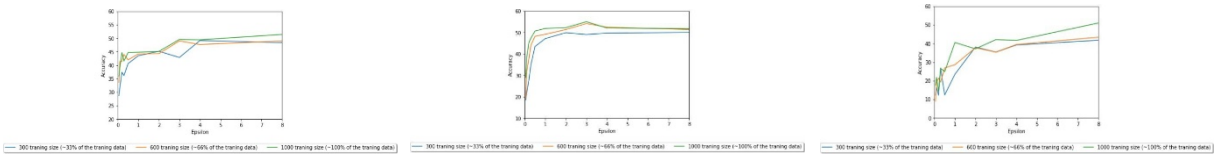
	GNB		RF		LG	
	Original	**With DF**	**Original**	**With DF**	**Original**	**With DF**
Wine Quality (White)	54.44	46.10	66.99	52.61	61.36	36.51
Wine Quality (Red)	45.26	41.33	65.85	44.37	51.70	35.21
California Housing	75.33	70.51	87.90	61.52	82.77	82.12
Iris	69.00	58.84	96.08	79.98	92.00	38.53

The following results were obtained by varying three parameters and utilizing different algorithms, as shown in detail in the graphs below. Throughout the procedure, a training set ratio of 0.66 and a test set ratio of 0.34 were deliberately chosen, with the algorithms being executed ten times and the average result being calculated. Simultaneously, the variable epsilon (ϵ) was analyzed in two separate graphs ranging from 0 to 1 and from 1 to 8. The epsilon values utilized in all algorithms are listed below: ϵ = [0.05, 0.1, 0.2, 0.3, 0.5, 1.0, 2.0, 3.0, 4.0, 8.0].



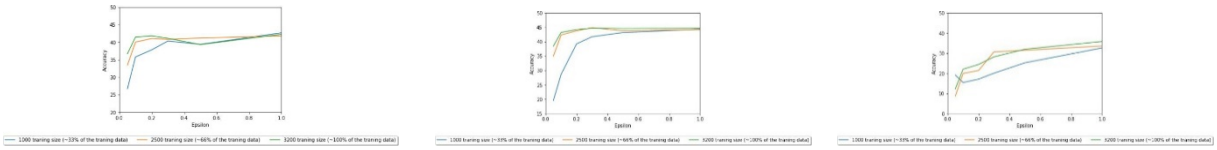
(a) (b) (c)

Figure 1. Winequality-red dataset (a) *GNB* (b) *RF* (c) *LR*



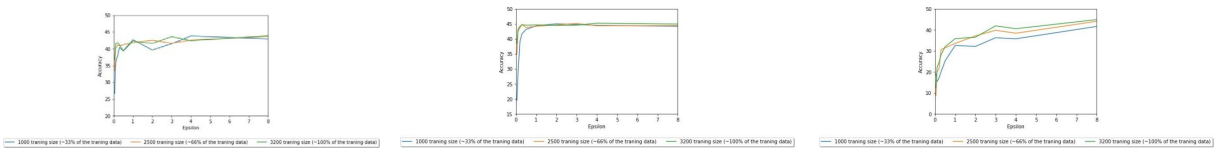
(a) (b) (c)

Figure 2. Winequality-red dataset (a) *GNB* (b) *RF* (c) *LR*



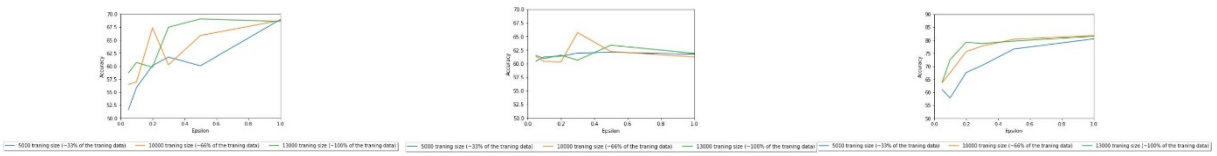
(a) (b) (c)

Figure 3. Winequality-white dataset (a) *GNB* (b) *RF* (c) *LR*



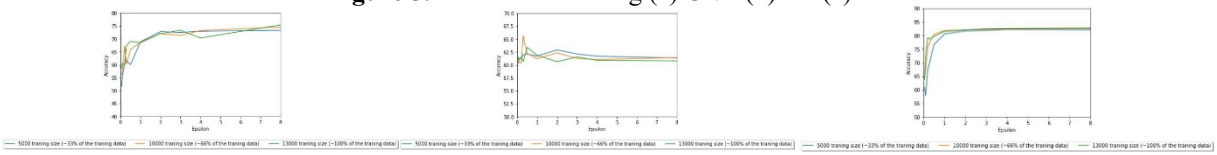
(a) (b) (c)

Figure 4. Winequality-white dataset (a) *GNB* (b) *RF* (c) *LR*



(a) (b) (c)

Figure 5. California Housing (a) *GNB* (b) *RF* (c) *LR*



(a) (b) (c)

Figure 6. California Housing (a) *GNB* (b) *RF* (c) *LR*

The results indicate an expected direct relationship between the training size and accuracy. When we use larger training sizes with the same ϵ values, our machine learning algorithm using Differential Privacy approaches the accuracy achieved in its non-private state. The curve slopes exhibit similar patterns between the intervals 0-1 and 1-8. In addition, contrary to expectations, a continuous increase in accuracy is not observed as ϵ increases. An" elbow" point is observed in all the graphs, and the elbow method can be used for selecting the optimal value in a real-world application of Differential Privacy.

6 CONCLUSION

Maintaining data security is crucial to safeguard sensitive and valuable information from malicious individuals, hackers, or cybercriminals who may view, steal, or manipulate data. However, despite implementing several security measures and products, incidents of hacking still occur. Differential privacy is a popular technique used in sensitive domains because it has a significant impact on machine learning models, and it offers provable privacy guarantees. A trade-off between privacy and utility exists when using differential privacy, which can reduce learning accuracy. This study investigates whether Differential Privacy is a viable option for secure data processing and its effect on machine learning performance. We compare the performance of machine learning techniques applied to noisy data with the performance of the same techniques applied to original data. Finally, we discuss the impact of the privacy budget associated with Differential Privacy.

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A Descriptive Survey of Metaverse-related Studies in the Literature

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Abstract

With the improvement of technology along with increased access to the internet, there has been a growing interest in the concept of the metaverse. Over the years, academic research on the topic of metaverse has been conducted in a variety of fields, including literature, art, entertainment, and education. In the proposed study, papers including the "metaverse" keyword in all fields in the Scopus database are analyzed. The aim of the study is to provide a comprehensive descriptive analysis related to the metaverse field. The proposed study is different from the other descriptive studies as follows: Firstly, a general overview is provided with bibliometric and social network analysis of all documents that include the metaverse keyword. Secondly, all documents are divided into clusters by using clustering algorithms such as particle swarm optimization (PSO) and genetic algorithm (GA) in order to obtain the center papers of each document. In order to conduct a cluster process, latent semantic analysis (LSA) is used as topic modeling. Lastly, all clusters are evaluated separately with co-word and n-gram analysis, and center papers are given in detail. As a result, a comprehensive descriptive analysis is provided in order to offer a general perspective on metaverse-related studies.

Keywords: *Clustering, Descriptive analysis, Latent semantic analysis, Metaverse, Social network analysis*

1 INTRODUCTION

The term "metaverse" means "beyond the universe". The term "metaverse" was first used in 1992 by Neil Stevenson in his science fiction novel Snow Crash to describe a future where virtual and real worlds collide and generate value through diverse social activities [1]. The definition of the metaverse can be divided into two parts: the early metaverse and the current metaverse [2]. Early metaverse includes second life based content. However, with the improvement of technology, the metaverse has evolved to cover novel concepts. According to the authors [2], the current metaverse can differ from the early metaverse in three aspects. The first one is related to the development of deep learning. This development enhances visual and language recognition accuracy substantially, while the creation of generative models allows for a more immersive environment and natural movement. Multimodal models were used as E2E (end-to-end) solutions using a multimodal pre-trained model to minimize processing time and complexity. Second, the metaverse was formerly reliant on PC access and had poor consistency due to time and space limits, but thanks to mobile devices that can connect to the Internet at any time, it is now able to effortlessly access the metaverse anytime, anywhere. Finally, the current metaverse varies from the previous one in that program coding can be done in the metaverse environment, and it is more connected to real life through virtual currency.

The metaverse concept needs to be understood well. In order to answer "What exactly is a metaverse" question, the elements of the metaverse (according to the Gartner report [1]) is given in Figure 1 and clearly defined.

[1]https://www.gartner.com/en/articles/what-is-a-metaverse

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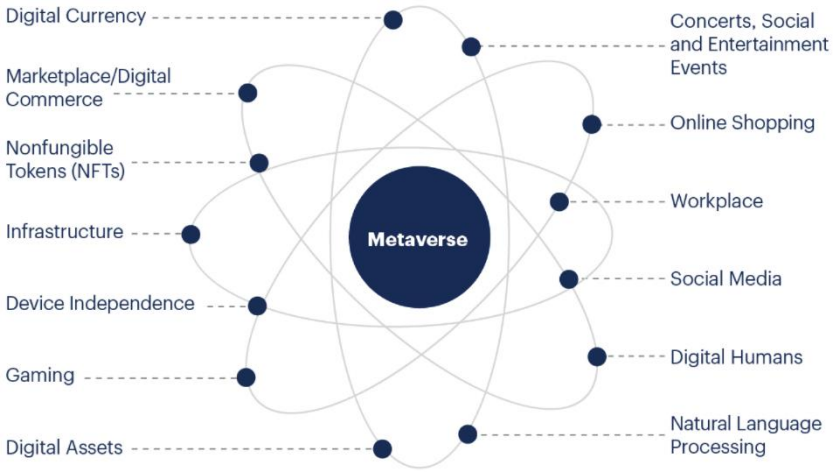


Figure 1. Elements of a metaverse (gartner.com)

"Digital Currency" is one of the elements of the metaverse. Although "digital currencies" often have some, but not all, of the features of a currency, they can also have those of a commodity or other asset. Their legal status varies from one country to the next. The subgroup has determined three key factors relating to the development of digital currencies. The first is the assets used in many digital currency schemes (such as bitcoins). The second important factor is how these digital currencies are transmitted, which is usually done through a built-in distributed ledger. The third factor is the number of third-party institutions, especially non-banks, that have been involved in the development and operation of digital currency and distributed ledger systems [3].

Customers may purchase goods and services through an interactive and self-service experience with "digital commerce". It encompasses the people, processes, and technology required to implement development content, analytics, promotion, pricing, customer acquisition, retention, and customer experience at all stages of the consumer purchasing cycle[2]. A "marketplace" is a platform that allows customers to purchase products and services from a variety of sellers [4]. Customers buy products from online shops as well as marketplaces. The word "marketplace" is sometimes misused to refer to "online shops" having a large selection of items. Services can also be provided on marketplaces [4]. An "online shop" is different from a marketplace. In an "online shop", you have complete control over everything. However, in a "marketplace", you sell your items on a third-party platform, pay fees, and have certain things outside of your control, such as customer service and return policies[3].

The other element of the metaverse is "non-fungible tokens" (NFTs). "NFTs" are rights to any digital asset, including images, videos, music, and even parts of virtual worlds, that can be traded on the block chain [5]. Some see "NFTs" as a craze, while others see them as the future of digital art. An "NFT" is a digital information (token) unit that is kept on a block chain and is not convertible with other digital assets [6].

Computation, communication, block chain, and storage are all part of the "infrastructure" layer, which is responsible for enabling the functioning of a virtual world [7]. One of the components of the metaverse to focus on is the technical and physical infrastructure.

"Device independence" refers to the ability of an end-user application's functionality to be accessed on any suitable end-device without requiring the application to be modified. Device independence is usually achieved by isolating the application from the device's lower layers [8]. A metaverse is a collaborative virtual shared area generated by the merging of virtual reality and digital reality. It is permanent, delivering more immersive experiences, and it is "device independent", making it available from tablets to head-mounted displays[4].

"Gaming" is a highly popular element in the metaverse. Many new advancements and paradigms began with the turn of the millennium, ranging from massively multiplayer online role-playing games to serious networked gaming to just living in virtual reality [9]. According to Reis et al. [10], video game technology and culture are the entry points to the metaverse. Virtual reality has long been a strong contender in the gaming industry. Early immersive 2D games, such as Minecraft and Second Life, had components of the now-unfinished metaverse, such

[2]https://www.gartner.com/en/information-technology/glossary/digital-commerce
[3]https://blog.saleslayer.com/differences-between-ecommerce-and-marketplace
[4]https://www.gartner.com/en/newsroom/press-releases/2022-02-07-gartner-predicts-25-percent-of-people-will-spend-at-least-one-hour-per-day-in-the-metaverse-by-2026

as 3D avatars, world-building, and observation as gameplay. “Gaming” has some characteristics such as games-as-platforms, social gaming, play to earn, the possibility of portable game assets, and mixed reality experience [11].

The introduction of a new term “digital asset” and the rapid growth of associated processes have resulted from the development of the digital economy in general and digital technology in particular [12]. Financial innovation in capital markets has created a whole new asset class—“digital assets”—as well as new fundraising and trading methods in recent years. “Digital assets” are digital representations of value that include cryptocurrencies, crypto-assets, and digital tokens, among others. Depending on their features, some “digital assets” are subject to security laws and regulations, regardless of the terms utilized to define them. “Digital assets” are assets that are created and transferred using block chain or distributed ledger technology [13].

“Concerts, social, and entertainment events” in the metaverse are one of the important issues. Many VR platforms, such as VRChat and AltspaceVR, now allow artists to create and construct their own virtual worlds, and some of these platforms have millions of users worldwide as a potential audience. The virtual world has emerged as an appropriate arena for music performances and festivals, given the terrible impact of the coronavirus epidemic on the live-music performance sector [14]. The COVID-19 pandemic, which caused the whole globe to shift to the internet for entertainment, has demonstrated to the music business that ticketed, well-produced, and compelling live streaming is here to stay. The most important live events and festivals will almost certainly have a dedicated, sleek, and transactional online component in the future. The metaverse is here to stay in music for that reason alone [15].

With metaverse, the concept of “virtual workplace” comes to the fore more. The “virtual workplace” is a place where a group of people, whether from the same country or from all over the world, collaborate using various communication technologies regardless of where they are, when they start or finish their tasks, or how they complete their daily tasks, and regardless of their culture, nationality, race, gender, disability, or age" [16]. Virtual workplaces, in which people work away from their coworkers and bosses, are now a reality and will become more so in the future [17].

The metaverse began to attract the attention of the general public when social media titans and major technological corporations declared it to be the internet's future. Given the importance of “social media”, particularly for the Z generation, investments in the metaverse are influencing future technology [18].

“Digital humans” are 3D virtual objects that resemble humans and can mimic human qualities such as physical motions, facial expressions, conversational back-and-forth, and so on[5]. Virtual simulation, which is related to virtual reality and “digital human modeling” technologies, employs computer modeling and simulation technology, which has been widely used in education, health, entertainment, culture, sports, engineering, the military forces, and other fields for more than a half-century. “Digital human modeling” is a quick, virtual portrayal of humans that uses a computer to imitate a real-world situation but does not include interactivity [19].

The last element of the metaverse is “natural language processing (NLP)”. “NLP” is a technique that enables spoken human-computer communication. NLP parses the inputs and extracts application-specific, grammatically accurate content, which it then matches with a specific domain knowledge base, utilizing speech recognition as the input modality [20]. When it comes to intelligent virtual assistants, “NLP” plays a critical role in the metaverse (a.k.a., chat bots). “NLP” is primarily responsible for allowing chat bots to comprehend complex human communication in the context of many dialects and tones [21].

One of the contributions of this research is to find the most focused papers in the area of metaverse by comparing the various meta-heuristic techniques such as genetic algorithm (GA) and particle swarm optimization (PSO). The aim of applying different clustering techniques is to provide optimum results in order to find the most accurate centers. In addition, latent semantic analysis (LSA) is used to obtain a document-to-topic matrix before the clustering process. The other contribution is to provide an analysis related to each cluster obtained by meta-heuristic techniques. Each cluster is examined with n-gram and co-word analysis techniques. Another contribution is to implement a bibliographic analysis tool for all documents related to the metaverse in order to demonstrate social networks. Thanks to all these contributions, the current status of the metaverse concept can be realized. The research questions for the proposed paper are listed as follows:

[5]https://www.xrtoday.com/virtual-reality/what-are-digital-humans-conversational-bots-like-youve-never-seen-before/

Q1. What are the papers' years, types, and subject areas?
Q2. In which research areas are metaverse concepts studied?
Q3. What are the results of clusters after applying GA and PSO?
Q4. What are the center papers of each cluster?
Q5. Which words are mostly seen in each cluster together?
Q6. What are the possible gaps in the literature about the metaverse concept?

The aim of the proposed study is answer these questions and provide a descriptive analysis about metaverse concept. Therefore, some useful insights on metaverse can be provided.

The rest of the paper is organized as follows: section 2 represents the methodology including initial assessment of the literature, pre-processing stage, application of LSA, and GA and PSO applications. Section 3 presents the results and discussions. Finally, conclusion part is provided.

2 MATERIAL AND METHOD

This section represents the methods used in the proposed study. Different from the traditional bibliometric and social network analysis, papers related to the metaverse are divided into clusters and each cluster is evaluated separately. The proposed study represents the center papers among the all other papers that include "metaverse" keyword. A descriptive analysis is applied to provide a comprehensive analysis about the metaverse related academic papers. In Figure 2 flowchart of the proposed methodology is given.

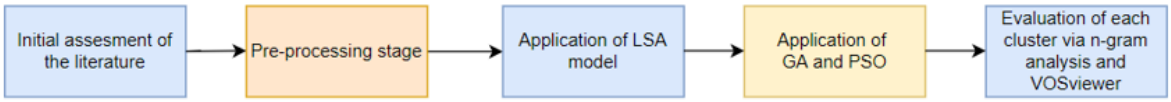


Figure 2. Flowchart of the methodology

In the first part that is 'initial assessment of the literature' is presented. In this part, papers including "metaverse" keyword in all fields in the Scopus database are analyzed on October 26, 2023. The total of 1866 documents were found, and 1843 papers were accessed among them. Documents are demonstrated according to the subject area, year, and document type. VOSviewer is chosen as analytical tool to demonstrate abstract and title keywords of all papers together with co-authors authorships, organizations, and countries. After the general analysis of all the papers, pre-processing stage is applied in order to remove stop words, URLs ((Uniform Resource Locator), papers doi numbers, and other unnecessary words. After the pre-processing stage, LSA is used to obtain semantic structure of the documents. By applying LSA method, the relationship between documents are handled. LSA gives the good performance when the corpus size is decreased and it is a stable method [22, 23]. For that reasons, LSA is considered as topic modeling. Then, GA and PSO algorithms era utilized for clustering. The reason behind applying both PSO and GA algorithms are to evaluate results of both applications. Lastly, all clusters are evaluated by using VOSviewer and n-gram analysis. The center papers of each cluster are given in detailed.

2.1 Initial Assessment of the Literature

In the proposed study, the number of 1843 documents that contains metaverse keyword is analyzed from general perspective. By using Scopus database on October 26, 2023, types, years, and subject areas of the documents are demonstrated in Figures 5, 6, and 7. After that, VOSviewer [6] (Visualizing scientific landscapes) that is a software tool to create and visualize bibliometric networks is used to provide a general overview of the abstracts of the documents (see Figure 8).

2.2 Pre-Processing Stage

Before applying the LSA, this stage is important to make accurate analysis. In this stage, stop words, punctuation, dates, URLs, doi numbers of papers, publishers, and other unnecessary parts are removed for all abstract of the 1843 documents.

2.3 Latent Semantic Analysis (LSA)

LSA is used to find the relationships between the text documents. It considers the semantic structure of text documents to enhance the identification of topical documents based on terms within queries [24]. That is, LSA is

[6] https://www.vosviewer.com/

interested in similarity of words meanings. Human-created dictionaries are not used by LSA. It only accepts raw text that has been broken down into words, pieces, or samples like paragraphs and phrases. To begin, the text is represented as a matrix, with each row representing a unique word and each column representing a document. Each cell includes the frequency with which the word in its row appears in the document denoted by its column. Following that, a preliminary transformation is applied to the cell entries [25]. For dimension reduction, LSA employs singular value decomposition (SVD). It is depicted as an information retrieval technique based on spectral analysis of the term-document matrix [26]. Let the corpus be represented as a term-by-document matrix R (m x k), with m distinct words in a collection of k documents. In Figure 3, a representational SVD is used for the dimension reduction of the term-by-document matrix.

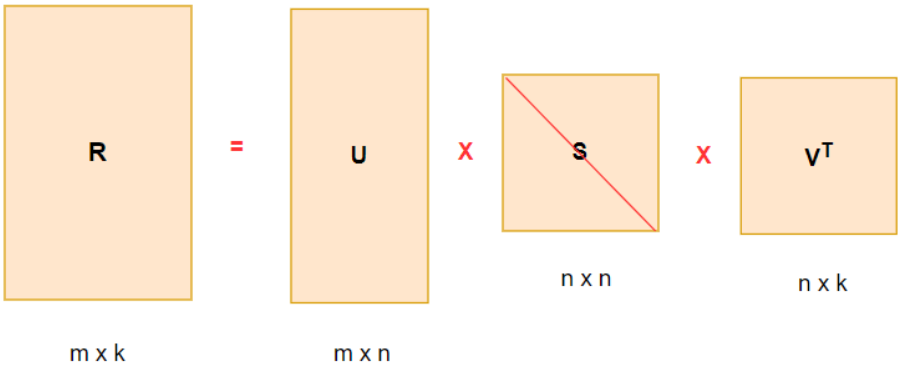


Figure 3. Schematic representation of SVD

The formulation of SVD is given by Eq. 1.

$$R = USV^T \tag{1}$$

where R refers an arbitrary real matrix with the dimension m x k, U: m x n rectangular matrix, S: n x n diagonal matrix, S=diag(S_1, …..,S_n), V: n x k transpose eigenvector matrix. R can be decomposed into a rectangular matrix, diagonal matrix, and transpose eigenvector matrix [27].

The n greatest singular values and their associated singular vectors, as given in Eq. 2, are used to approximate the initial term by document matrix [24].

$$R_n = U_n S_n V_n^T \tag{2}$$

where U_n is called as the first n columns of the matrix U, and V_n^T is covered of the first n rows of matrix V^T. S_n is the first n factors [28]. The LSA process is implemented in the proposed study using the MATLAB R2021a software [7]. It is used on pre-processed text. According to the "validation perplexity" and "number of topics (components)", and "time elapsed" graph (see Figure 4), the number of components, which is specified as a positive integer, namely data-object (features), is determined to be five.

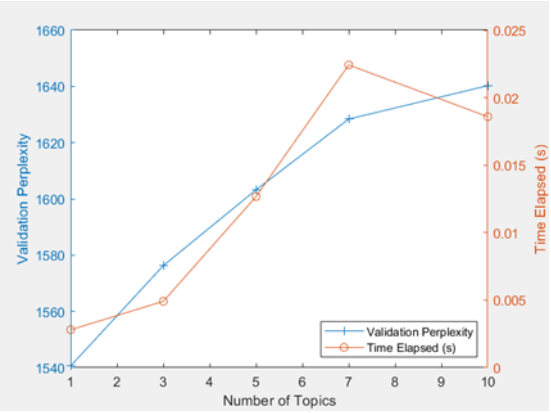


Figure 4. Relationship between validation perplexity and time elapsed

[7]MathWorks, http://www.mathworks.com/help/textanalytics/ref/ fitlsa.html

A lower validation perplexity is associated with greater fit in text analytics. Lower perplexity in a language model leads to less recognition confusion and improved speech-recognition accuracy [29]. In addition, choosing a larger number of topics can result in a better fit, but convergence takes time [30]. By considering all these criteria, the number of components are taken as five. After obtaining a document x component matrix (1843 x 5), GA and PSO algorithms are utilized in order to obtain important clusters.

2.4 Application of GA and PSO

The term GA was first used by John Holland (1992). A GA is an optimization technique that has been inspired by biological progression [32]. General formulation of GA is given as follows [33]:

```
Choose an initial population of chromosomes
while termination condition not satisfied do
repeat
   if crossover condition satisfied then
         {select parent chromosomes;
          choose crossover parameters;
           perform crossover};
    if mutation condition satisfied then
         {choose mutation points;
      perform mutation};
     evaluate fitness offspring
until sufficient offspring created;
          select new population;
          end while
```

It assumes user-specified conditions for crossover and mutation, the creation of a new population, and the termination of the entire process.

In the proposed study, the GA code which is written by Mostapha Kalami Heris [34] is used in order to obtain clusters. The objective function of the algorithm is based on minimization of sum of within-cluster distances. According to the component x document matrix obtained by LSA process, and the distance matrix is calculated by using Euclidean distance. After that, clusters are assigned and closest distances are founded. The last operation of objective function is to minimize sum of within cluster distances. It is assumed that increasing the number of topics can lead to a deviance from the points that should be focused [35]. Therefore, the cluster number is chosen as five by taking literature.

PSO is well known meta-heuristic method and it is utilized to solve optimization problems. PSO was first developed by Kennedy and Mendes (2002). It is based on the some animals' intelligent collective behaviors, such as fish schooling and bird flocking [37]. The formulation of PSO is given as follows [38]:

```
for each particle
    Initialize particle
end
do
    for each particle
        calculate fitness value
        if the fitness value is better than the best fitness value in history
            set current value as the new best fitness value
    end
    choose the particle with the best fitness value of all the particles
    for each particle
        calculate particle velocity
        update particle position
    end
while maximum iterations or minimum error criteria is not attained
```

In the proposed study, the PSO code which is written by Mostapha Kalami Heris [34] is used in order to make comparison with GA. The reason behind making comparison is to find most accurate clusters among all documents. Objective value (fitness value), and number of clusters are same with objective value of GA.

2.5 N-gram analysis

An “n-gram” is a sequence of n words [39]: a 2-gram (called a bigram) is a two-word sequence of words such as "virtual reality”, “second life”, or “augmented reality”, and a 3-gram (called a trigram) is a three-word sequence of phrases such as “green consumption value”, “virtual world platform”. In the proposed study, after the GA and PSO applications, abstracts of papers in each cluster are evaluated by using bigram analysis.

3 RESULTS AND DISCUSSIONS

In the prosed study, 1843 papers are analysed to obtain a general perspective for metaverse concept. The first research question intends to reveal types, years, and subject areas of the documents (see Figures 5, 6, and 7).

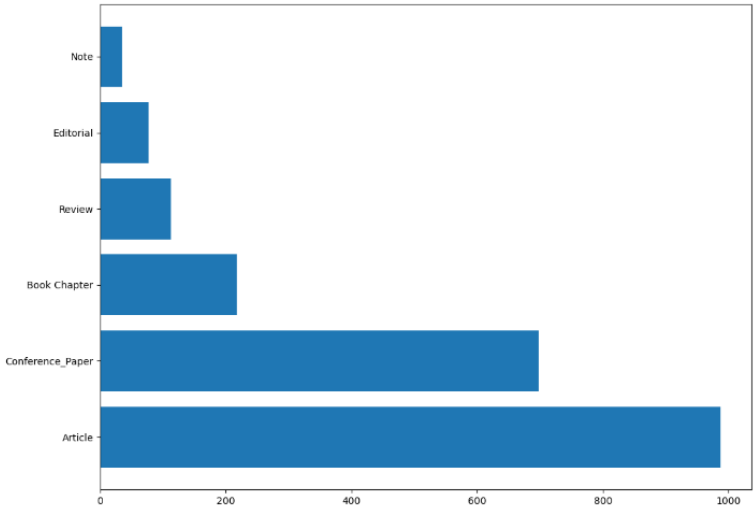


Figure 5. Document types

Figure 5 illustrates that articles outnumber other types of papers. Conference papers closely follow in number, while there is a notable scarcity of reviews, editorial papers, and notes discussing the concept of the metaverse. In addition, there are not many book chapters.

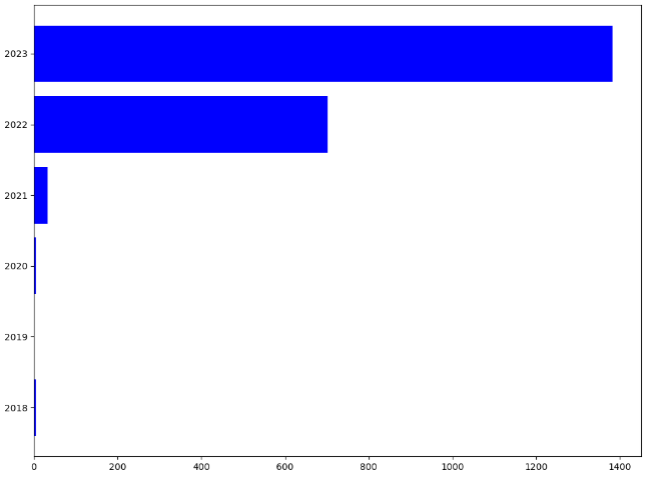


Figure 6. Years of the documents

Figure 6 represents an interesting piece of information. The documents, according to the years, demonstrate random trends. In particular, in the year 2019, there are very few documents that include metaverse keyword a decrease seems to have occurred after 2018. The reason behind that could be the COVID-19 pandemic effect. After 2019, there is an increasing trend in the number of documents. In the year 2023, a considerable number of research papers have been published relating to the metaverse concept.

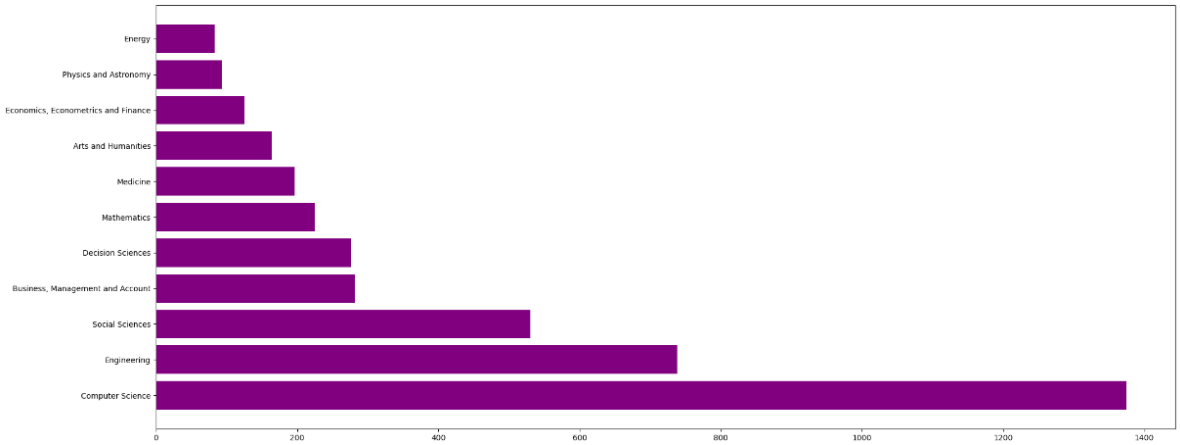


Figure 7. Subject area of the documents

Metaverse is a concern in a variety of fields. Elements of the metaverse affect people in different ways. Therefore, studies related to the metaverse are expected to cover a wide area. As seen from Figure 7, the computer science area focuses on metaverse concepts much more. The other much-focused areas are engineering, social sciences, business, management, and account, decision sciences, mathematics, medicine, arts and humanities, economics, physics and astronomy, energy, respectively.

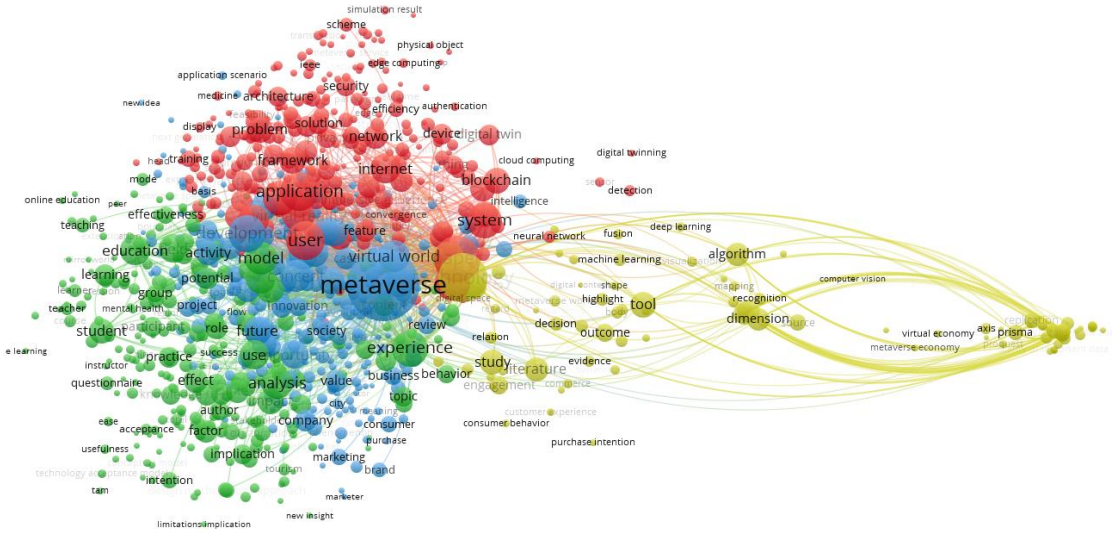


Figure 8. Social network analysis of all abstracts

In the second research question, co-occurrences of the words are analyzed through social network analysis. The number of four cluster is seen in Figure 8. The yellow cluster encompasses various data science topics, including machine learning, deep learning, neural networks, and other data-related concepts. The green cluster focuses on education. The red cluster demonstrates technology concepts such as blockchain, internet, applications, security, and digital twin. The blue cluster is related to society, business, and management. The words in the cluster are marketing, consumer, brand, society, and virtual world.

The third research question intends to find the clusters of all papers by applying GA and PSO. By considering different population sizes and iteration numbers, the GA and PSO methods are applied. The cluster number is taken as 5. Each algorithm has been run five times for different population sizes and iteration numbers. Figure 9 demonstrates various graphs, including 100 population numbers with 200 iteration numbers, 100 population numbers with 500 iteration numbers, and 200 population numbers with 200 iteration numbers, respectively for all runs. Each point over the lines demonstrates a run. In that way, the consistencies of both methods are obtained by considering the results of each run.

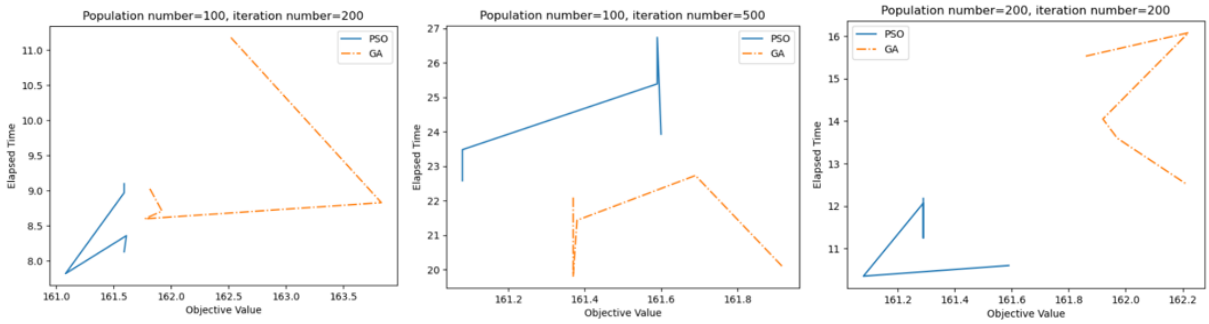


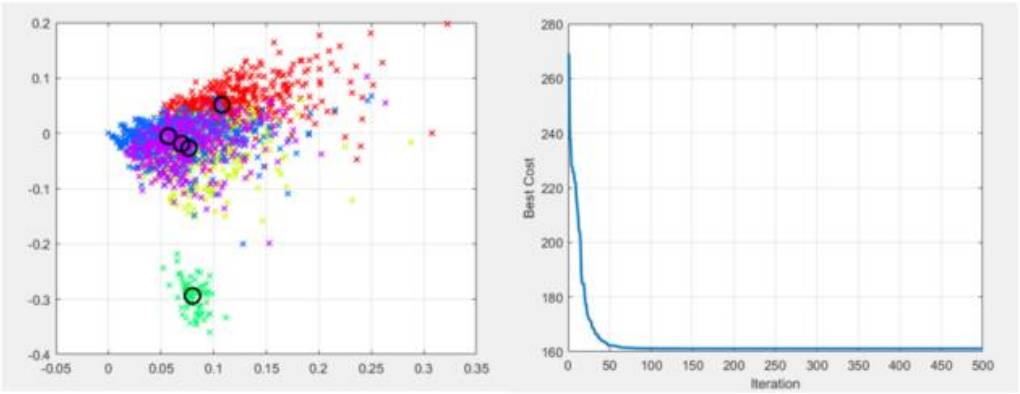
Figure 9. Results of GA and PSO for five runs

As seen from Figure 9, PSO provided the best results with a population of 100 and 200 iterations. When compared to elapsed times for GA and PSO, GA reaches the result faster than the PSO algorithm. The best objective value of PSO is found to be 161.08. The positions of clusters for the best objective value in PSO are given as follows:

Table 4. Positions of 5 clusters for PSO

[0.107910624	0.0514891074	0.0386562793	0.0176728462	0.0209881841]
[0.0694349740	-0.019046033	-0.00252348331	-0.100840444	0.00326834183]
[0.0799025022	-0.293969864	0.167685190	0.0826490254	0.0607482688]
[0.0766635942	-0.0267414348	-0.0763808781	0.0124554141	0.0352062339]
[0.0568804944	-0.00569966686	-0.0100194584	0.00434621555	-0.0264811991]

Figure 10a represents a visualization of the positions for the best objective value in PSO. In addition, changes in objective value according to the iteration number are given in Figure 10b.



a b

Figure 10. a. Positions of each cluster **b.** Objective value based on iteration number

As seen from Figure 10a, four clusters are closer to each other. However, one cluster is far from these four clusters. Both results of PSO and GA with various population sizes and iteration numbers, that cluster is found as in Figure 10a. Figure 10b indicates that the objective value is stabilized after iteration 150.

Research question 4 seeks to identify the central papers within each cluster. The present study involves the analysis of a total of 1843 papers. Following the use of clustering algorithms, the resultant outcome consists of central papers representing the entirety of the documents. Sequentially, the records present the papers in the center of attention as 1186 (cluster 1), 1649 (cluster 2), 832 (cluster 3), 968 (cluster 4), and 1204 (cluster 5).

We explain the center papers of each cluster in detail. In addition, after the explanation of each center paper, the answers to research questions 5 and 6 are sought. An analysis is conducted on the abstracts of papers in each cluster separately. In that way, the most frequently seen words in each cluster are analyzed using the n-gram analysis. In addition, the sub-clusters according to the co-occurrences of words are evaluated using the VOS viewer. Cluster 1 has 524 papers. Similarly, cluster 2 has 463 papers, cluster 3 has 67 papers, cluster 4 has 453 papers, and cluster 5 has 336 papers. Here are the center papers of each cluster and a detailed analysis of these clusters:

The center paper of cluster 1 is titled "Designing the metaverse: A study on inclusion, diversity, equity, accessibility and safety for digital immersive environments"[40]. This paper investigated several problems and

opportunities that effect the structure of the metaverse. A qualitative ethnographic study was conducted, with industry experts, to examine the social implications of the metaverse from the perspectives of inclusion, diversity, equity, accessibility, and safety. The aim of the study was to identify the necessary steps that businesses need to take in response to these issues. The findings of the study revealed the extensive scope of forthcoming research inquiries that necessitate resolution. Moreover, these findings facilitated the development of effective methodologies for constructing an all-encompassing, easily accessible, secure metaverse that ensures fairness and inclusivity. An analysis was conducted on the abstracts of 524 papers within cluster 1. Figure 11 illustrates the sub-clusters inside cluster 1, taking into account the 524 papers.

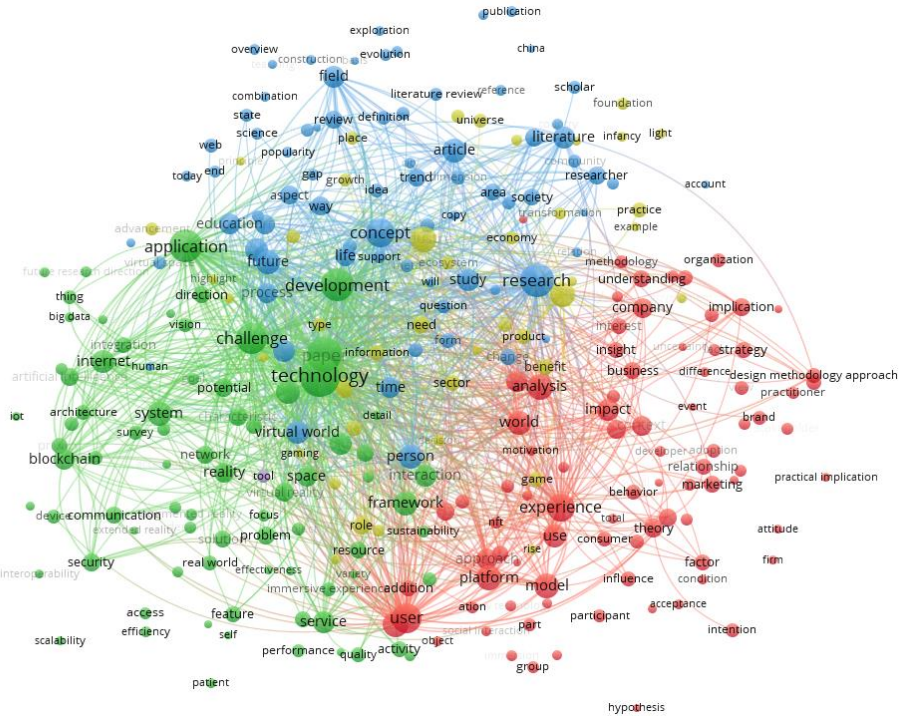


Figure 11. Network visualization of cluster 1 (minimum number co-occurrences of a term is 10)

The co-world analysis of the abstracts of cluster 1 represents four sub-clusters: the red one is focused on the words: user experience, consume, marketing, brand, design, business, organization, practical application; the yellow one: sector, product, role, universe, foundation, economy; the green one: technology, application, challenge, blockchain, internet, system, communication, sustainability, security, and finally the blue one: virtual world, society, education, life support, person, scholar, and trend. As understood from Figure 11, cluster 1 is centered on the business and management, economy, technology, and education. In Figure 12, bigram analysis for cluster 1 is demonstrated.

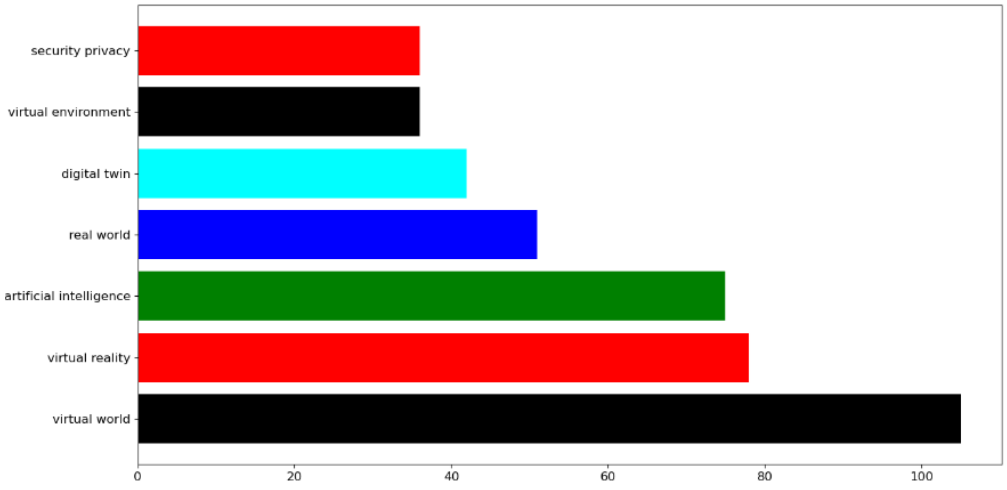


Figure 12. N-gram (bigram) analysis for cluster 1

According to the n-gram analysis results, the two most common sequential words are “virtual world”, “virtual reality”, and “artificial intelligence” which are seen together in the papers from cluster 1. This cluster focuses on the term "virtual." In addition, the other striking sequential words are “real world”, “digital twin”, “virtual environment”, and “security privacy”. These words indicate that the studies in cluster 1 emphasizes technology concept.

The center paper of cluster 2 is titled “Regulating the Metaverse, a Blueprint for the Future” [41]. In contemporary times, prominent organizations have aptly labeled the emerging concept as “the metaverse”, a term popularized by Meta and other influential platforms. These corporations are presently allocating substantial financial resources, amounting to billions of dollars, towards the development and implementation of immersive virtual environments. These environments are designed to cater to a wide range of everyday activities, including but not limited to social interactions, commercial transactions, educational pursuits, and professional endeavors. Given the potential proliferation of corporate-controlled metaverse environments in society during the next decade, it becomes imperative to contemplate the potential threats to consumers and establish comprehensive regulatory measures. This assertion holds particular validity in view of the unanticipated adverse consequences that social media platforms have exerted on society in recent times. In the paper proposed by Rosenberg, an analysis was presented that includes potential hazards associated with the metaverse as well as suggestions for implementing appropriate regulatory measures. In Figure 13, sub-clusters of cluster 2 are presented. Cluster 2 includes 463 papers.

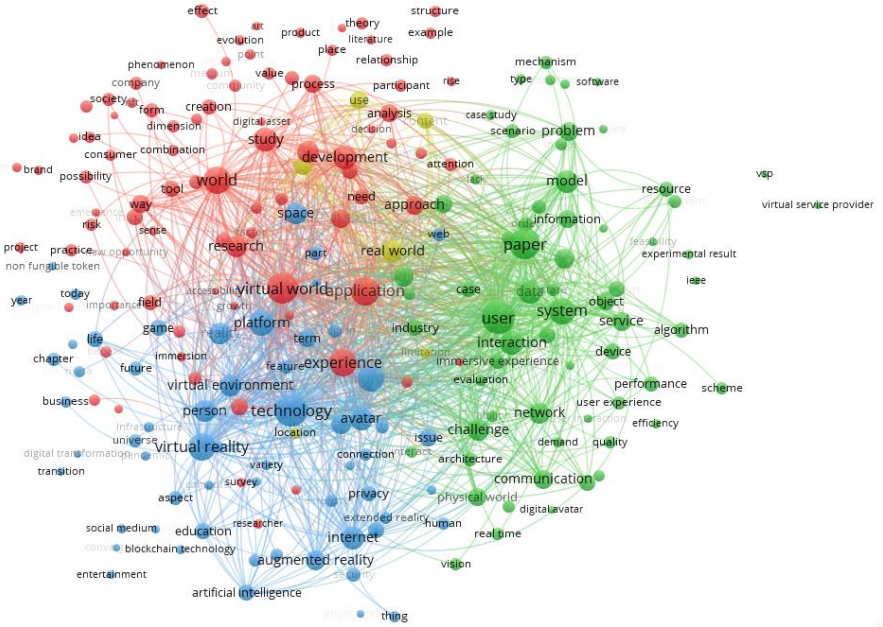


Figure 13. Network visualization of cluster 2 (minimum number co-occurrences of a term is 10)

Using the VOSviewer, the cluster 2 is divided into 4 sub-clusters. The red area covers words such as virtual world, experience, application, development, consumer, brand, product. The blue area includes words such as technology, avatar, virtual environment, virtual reality, augmented reality, social media, entertainment, blockchain technology, artificial intelligence. The green area demonstrates the words of user, system, service, interaction, challenge, communication, information, user experience, digital avatar. Finally, the yellow area focuses on the words: real world, use, and content. As seen from the sub-clusters, the second cluster focused more on technology concepts. Furthermore, cluster 2 shows the presence of concepts related to the business and entertainment sectors. Bigram analysis of cluster 2 is given in Figure 14.

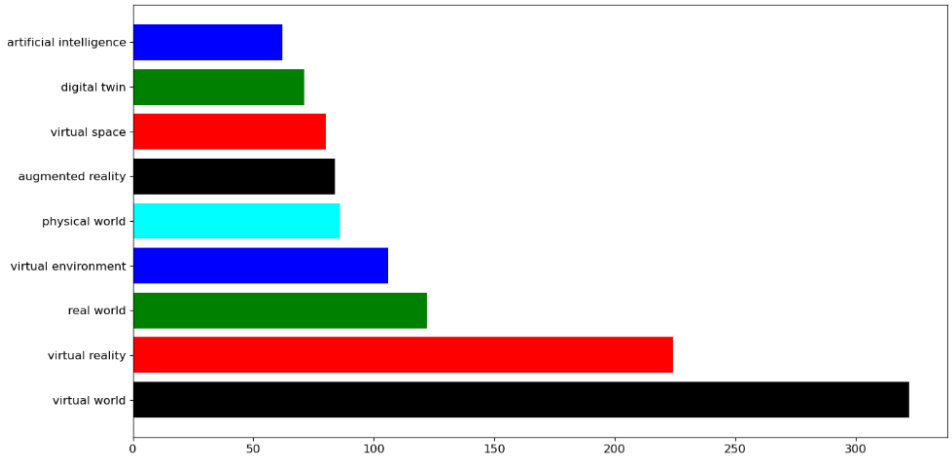


Figure 14. N-gram (bigram) analysis for cluster 2

As seen from Figure 14, "virtual world" is the most commonly used term. "Virtual reality" comes right after that. In this cluster, the sequential words "real world", "virtual environment", "physical world", "augmented reality", "virtual space", "digital twin", and "artificial intelligence" demonstrate that cluster 2 emphasizes basic principles of the metaverse.

The center paper of cluster 3 is entitled "Remote Sensing Data Fusion Techniques, Multimodal Behavioral Predictive and Mobile Location Analytics, and Spatial Cognition and Context Awareness Algorithms in the Metaverse Economy" [42]. The objective of the study was to investigate the analysis of large-scale geospatial data and user trip analytics, as well as the exploration of metaverse assets and services, and the utilization of cyber-physical cognitive and immersive visualization systems. The authors made significant contributions to the academic field of virtual modeling and immersive 3D technologies, as well as context awareness and machine vision algorithms, and sensor and actuator devices. Their research demonstrated that the development of immersive digital worlds necessitates the utilization of computer vision and cognitive decision-making algorithms, deep learning-based sensing and spatial computing technologies, and virtual navigation and data mining tools. In Figure 15, sub-clusters of cluster 3 are presented. Cluster 3 includes 67 papers.

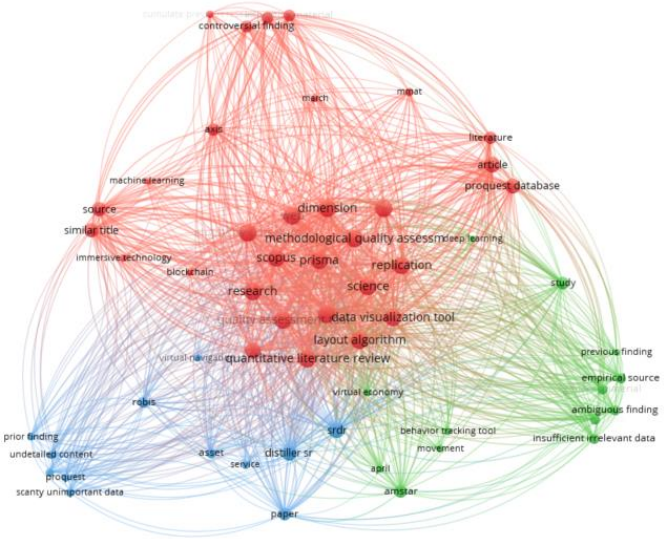


Figure 15. Network visualization of cluster 3 (minimum number co-occurrences of a term is 10)

In cluster 3, there are only sixty-seven papers, and three sub-clusters are visible. The green area includes virtual economy, empirical source, insufficient data, irrelevant data. The blue area includes service, unimportant data, asset. The red area includes prisma, data visualization, dimension, quality assessment, machine learning, blockchain, replication, database. It is seen that cluster 3 focuses on data and data related concepts. Bigram analysis of cluster 3 is demonstrated as follows (see Figure 16):

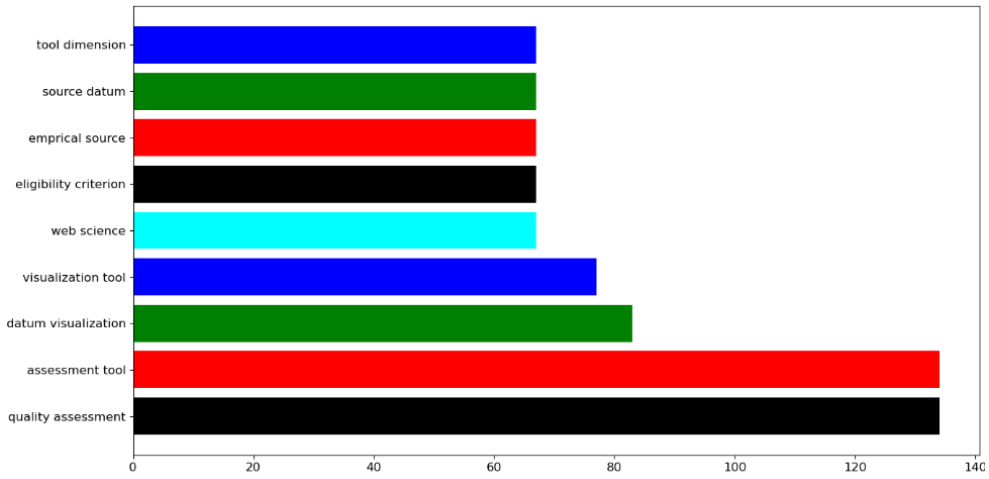


Figure 16. N-gram (bigram) analysis for cluster 3

According to the n-gram analysis, it is seen that cluster 3 is mostly related to data and visualization. The most used term is "quality assessment", and "assessment tool" follows that term. The other sequential terms are as follows: “datum visualization”, “visualization tool”, “web science”, “eligibility criterion”, “empirical source”, “source datum”, “tool dimension”.

The center paper of cluster 4 is entitled ” Optimizing Energy Efficiencies of IoT-based Wireless Sensor Network Components for Metaverse Sustainable Development using Carry Resist Adder based Booth Recoder (CRABRA)” [43]. The energy consumption of the enabling technologies of the Metaverse, such as the Internet of Things (IoT) and Wireless Sensor Networks (WSN), is widely acknowledged to be significant. To address these limitations, the researchers proposed the implementation of energy-efficient systems that incorporate algorithms characterized by high-performance and high-speed capabilities. The latency resulting from the generation of odd multiples was mitigated through the utilization of the Chinese Remainder Algorithm (CRA). The study conducted a comparative analysis between various present approaches and the proposed CRABRA methodology, focusing on power consumption, delay, and area. Due to the precise execution of CRABRA in performing addition operations, the inclusion of an error-compensation circuit became unnecessary, resulting in significant space savings. Figure 17 demonstrates sub-clusters of cluster 4. There are 453 papers in cluster 4.

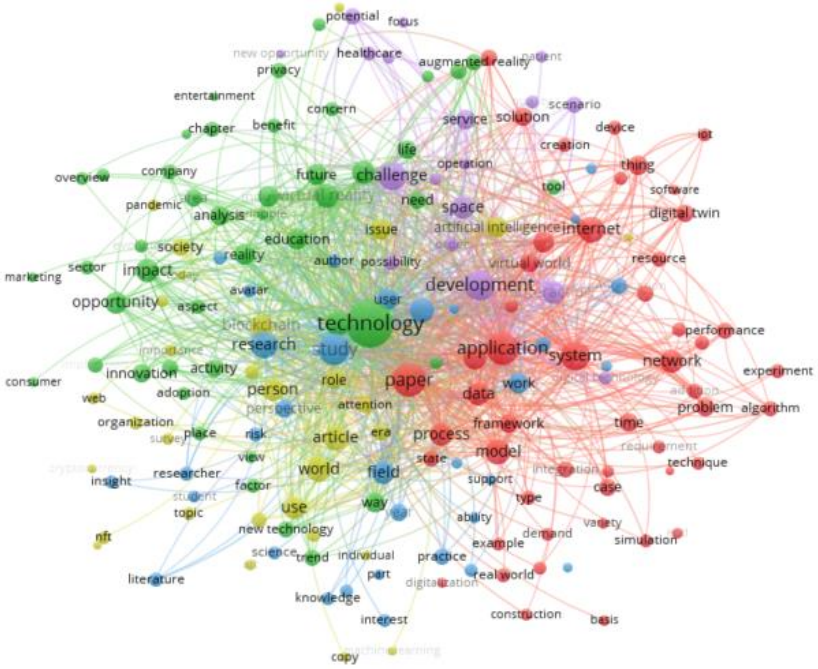


Figure 17. Network visualization of cluster 4 (minimum number co-occurrences of a term is 10)

In cluster 4, there are five sub-clusters. The purple area includes terms such as development, space, challenge, service, healthcare. The blue area focuses on study, research, science, knowledge, practice, work, and field. The green area emphasizes technology, education, innovation, opportunity, consumer, marketing, pandemic, and society. And lastly, the red area is based on model, process, problem, performance, network, system, simulation, and application. In Figure 18, bigram analysis of cluster 4 is given.

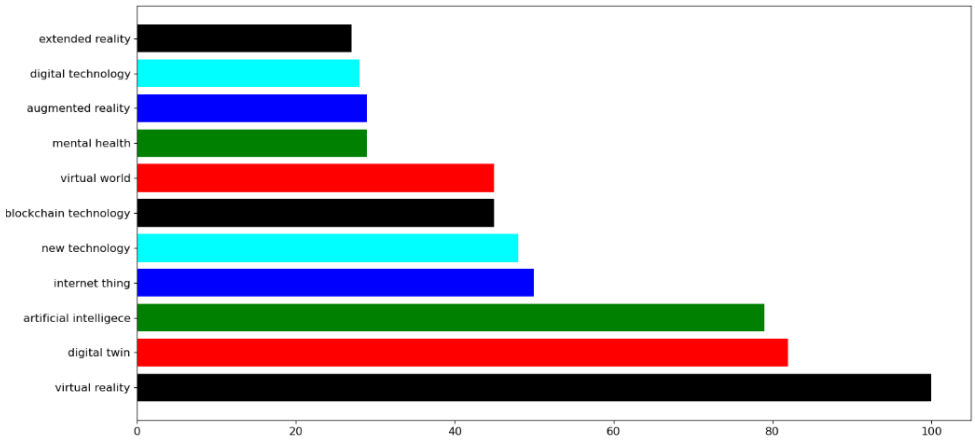


Figure 18. N-gram (bigram) analysis for cluster 4

Cluster 4 includes basic components of the metaverse that are "virtual reality", "digital twin", "artificial intelligence", and "internet thing". In addition, there are some other terms such as "new technology", "blockchain technology, "visual world", "mental health", "augmented reality, "digital technology", and "extended reality".

The center paper of cluster 5 is entitled "Evaluation of Metaverse integration of freight fluidity measurement alternatives using fuzzy Dombi EDAS model" [44]. The paper presented a proposed integrated decision-making methodology for prioritizing the choices for measuring freight fluidity. Three potential methods for assessing freight fluidity were suggested: taking no action, incorporating freight operations into the metaverse for fluidity measurement, and establishing global control of freight activities to measure fluidity using existing data. In Figure 19, sub-clusters of cluster 5 are presented. Cluster 5 includes 336 papers.

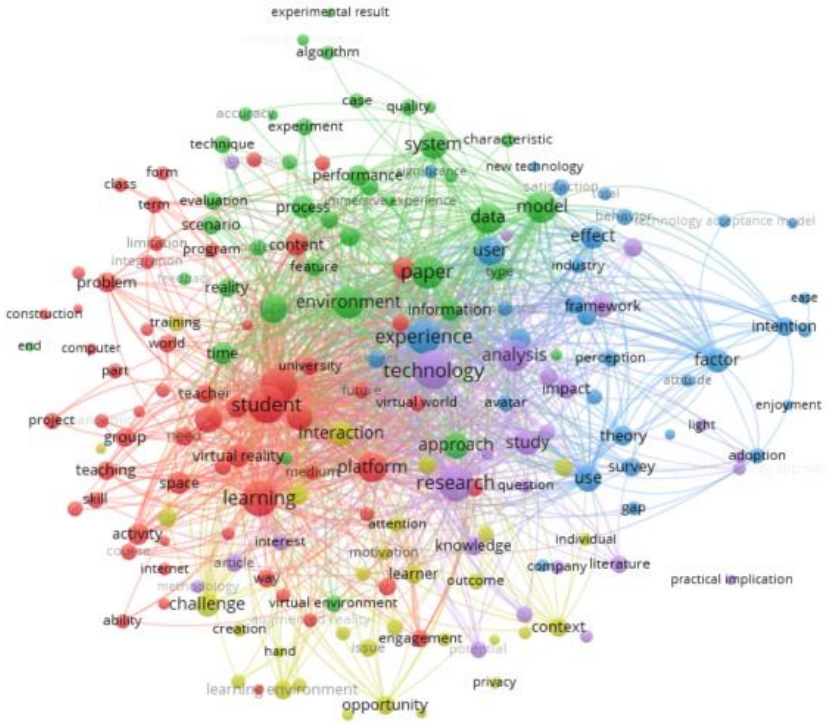


Figure 19. Network visualization of cluster 5 (minimum number co-occurrences of a term is 10)

There are 5 sub-clusters in cluster 5. The green area is mostly related to environment, system, process, data, model, technique, and information. The purple area focuses on technology, analysis, research, and knowledge. The red area includes words such as student, learning, virtual reality, teacher, teaching, and class. The blue area focuses on experience, theory, survey, industry, user, theory, avatar, and enjoyment. Lastly, the yellow area is related to interaction, creation, challenge, opportunity, privacy, training. It is seen that cluster 5 is mostly based on education and technology. Bigram analysis of cluster 5 is demonstrated as follows:

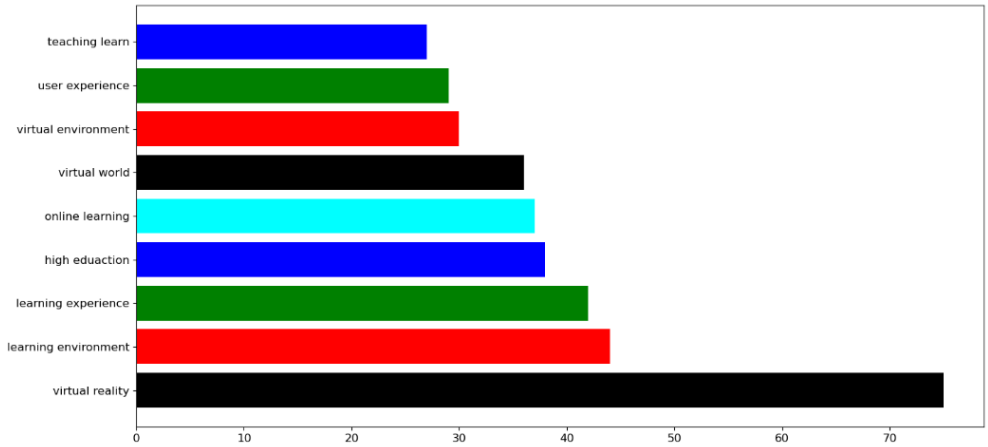


Figure 20. N-gram (bigram) analysis for cluster 5

According to Fig. 20, it can be said that, cluster 5 focuses on the education for the metaverse concept. The most common terms are “virtual reality”, “learning environment”, “learning experience”, “high education”, “online learning”, “virtual world”, “virtual environment”, “user experience”, “teaching team”.

Throughout the proposed study, five research questions are clarified. A brief summary of the answers to these questions is given below. After that, research question 6 is explained according to the first nine research questions.

- In the first research question (Q1. What are the papers’ years, types, and subject areas?), the papers that include metaverse keywords are analyzed according to their years, types, and subject areas.
- In order to explain the second research question (Q2. In which research areas are metaverse concepts studied?). VOSviewer analysis is conducted by considering the abstracts of 1843 papers.
- In order to clarify research question 3, (Q3. What are the clusters after applying GA and PSO?) GA and PSO algorithms are applied. PSO provided better results than GA. Therefore, we consider clusters obtained by applying PSO.
- After finding clusters, the center papers of each cluster are identified (Q4. What are the center papers of each cluster?).
- N-gram analysis and social network analysis are conducted by considering all the abstracts of each cluster in order to explain research question 5 (Q5. Which words are mostly seen in each cluster together?). The VOSviewer tool is applied and sub-clusters of each cluster are obtained and clarified.

The last research question aims to reveal possible gaps in the literature about the metaverse concept (Q6. What are the possible gaps in the literature about the metaverse concept?).

- The first gap in the literature is that most of the elements of the metaverse, such as “Digital Currency”, “Marketplace", “Digital Commerce”, “Device Independence”, “Digital Asset”, “Concert”, “Online Shopping”, “Workplace”, and “Natural Language Processing”, have not been considered together with the metaverse concept.
- Most of the studies include the basic components of the metaverse, such as “augmented reality”, “virtual reality”, “virtual world”. In addition, gaming, music (entertainment), and education are popular fields in the metaverse. However, more studies in these fields should be conducted as there are still so many missing. In addition, there is a need for studies related to the metaverse in some special fields, such as supply chain, war, and etc.

4 CONCLUSION

The proposed paper investigates academic studies on the metaverse concept through a combination of text mining methods, which is LSA, and clustering methods (GA, PSO), with social network analysis. The aim of the study is to provide a big-picture approach to the metaverse field. The proposed study examines papers in the Scopus database that contain the keyword "metaverse" in all categories. The following are some of the ways that the proposed study differs from existing descriptive studies: To begin with, bibliometric and social network analysis of all documents containing the metaverse keyword provides a broad perspective. Second, all documents are grouped into clusters using PSO and GA to determine each document's center papers. Topic modeling is used to conduct a cluster process by applying LSA. Finally, co-word and n-gram analysis are used to evaluate each cluster separately, and center papers are detailed. Thorough the paper, six research questions are revealed and answered according to the mentioned analyses. Some sequential steps are implemented. All documents related to the metaverse are analyzed according to their years, types, and subject areas. VOSviewer analysis is conducted by taking the abstracts of 1843 papers into account. For clustering all documents, GA and PSO are applied. PSO gives better results than GA. Therefore, clusters that are provided by the application of PSO are considered. A total of five clusters are obtained. After the clustering process, the center papers of each cluster are explained. In addition, n-gram analysis and social network analysis are conducted for each cluster by considering all the abstracts of papers within these clusters. Sub-clusters of each cluster are clarified. This study contributes significantly to the literature on the metaverse topic by identifying trends and gaps in the stated database and proposing recommendations for future research.

This descriptive analysis indicates some types of limitations. The first one is that only the Scopus database is considered. Namely, other studies that are not in the Scopus database of literature are not included. Furthermore, the proposed literature is solely available in English because of the selected database. Therefore, the final literature will be unable to cover all available research networks and recent trends.

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Scalogram Based Spoken Digit Classification via Deep Learning

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Abstract

Machines have an indispensable place in our lives. It is of great importance that many applications we commonly use to facilitate our daily lives through these machines can detect digit sounds with high accuracy. This study used the Free Spoken Digit Dataset (FSDD), which contains 3000 audio data created by people with different mother tongues vocalising the digits from 0 to 9 in English. In this database, voice recordings of each number were used as a class in the classification process. Then, scalogram images of all sounds in the database were obtained. VGG16, VGG19, Densenet201, InceptionV3 and MobileNetV2, deep learning-based classification models with proven success in the literature, were applied to these images with transfer learning. In the classification phase, 90% of all data were used in the training phase and 10% in the test phase. As a result, the classification accuracy value of the VGG16 architecture was determined as 97% as the most successful architecture among the classification methods used.

Keywords: *Sound classification, Deep learning, Signal processing*

1 INTRODUCTION

The problem of classifying speech sounds with high accuracy independent of the speaker remains popular today. The identification of speech sounds by machines is a technology in the field of natural language processing (NLP). The classification of speech sounds, especially the classification of spoken digit sounds, is necessary for many machine learning-based applications. Digit sounds are widely used in citizenship transactions, banking, telephone communication, virtual assistants, voice response systems, address descriptions and vehicle plate readings. There are a few studies on spoken digit classification in the literature. In one of these studies, 87.27% classification accuracy for English and 89.09% for Portuguese were obtained with a support vector machine classifier using a 3rd-ord polynomial kernel [1]. In another study, 98.37% classification accuracy was obtained using convolutional neural networks (CNN) to classify Bengali spoken digit sounds [2]. In classifying Pashto spoken digit sounds, a classification success of 84.17% was obtained using CNN [3]. In another study on English spoken digit sound classification, a classification model was developed using the Audio MNIST database. The developed model was tested with the Free Spoken Digit Dataset (FSDD), and a classification accuracy of 80.60% was obtained [4].

This study used FSDD [5] to classify the digit sounds spoken in English. Initially, scalogram images of all sounds in the database were obtained. The obtained images were classified by applying different CNN-based classification models by transfer learning. The dataset has been chosen randomly to split into 90% training set and 10% test set, and 20% of the training set is used for validation, based on a five-fold cross-validation method.

2 MATERIAL AND METHOD

The block diagram of the study is shown in Figure 1.

Figure 1. Block diagram of the method

2.1 Dataset

The Free Spoken Digit Dataset (FSDD) used in the study is an open and growing database containing 3000 voice recordings, each digit from 0 to 9 spoken 50 times by six different people [5]. The nationalities of these six people

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are the USA, Belgium, Germany, and Greece, but only two of them have English as their mother language. The time-amplitude representation of the spoken digit signals of a random speaker in the database is given in Figure 2.

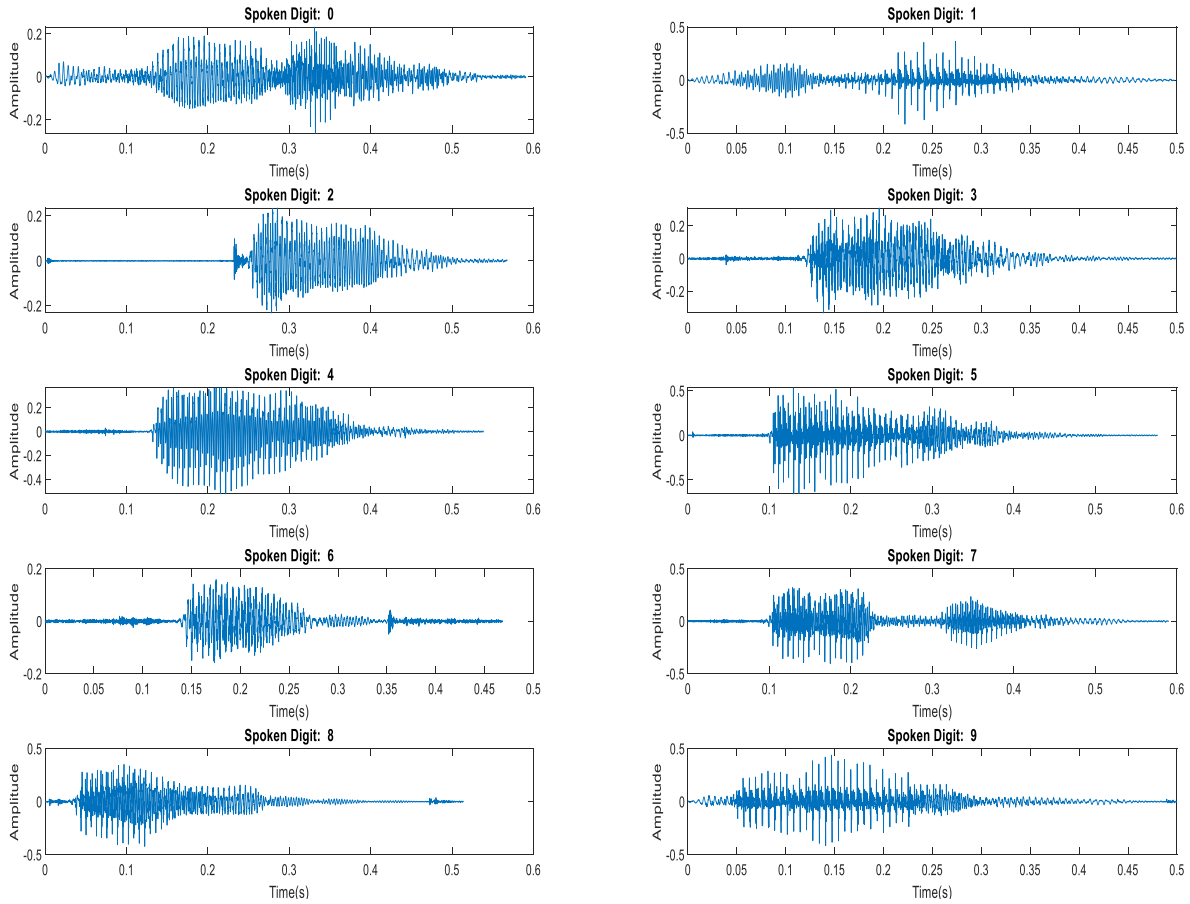

Figure 2. Time-amplitude representation of the spoken digit signals

In order to perform a CNN-based classification process containing ten classes by grouping the digit sounds spoken between 0-9, scalogram images of the sounds belonging to all classes were obtained.

2.2 Scalogram

A scalogram is created by plotting the absolute value of a digital signal's continuous time wavelet transform (CWT) as a function of time and frequency. Thus, it helps extract essential signal data thanks to analysis at different scales. In analysing real-world signals, a scalogram can provide better time localisation for short-duration, high-frequency events and better frequency localisation for low-frequency, long-duration events.

In the study, we used the Matlab cwt function to create the scalogram images and chose “bump” for the wavelet type. The scalogram representations of different spoken digits are illustrated in Figure 3.

2.3 Data Splitting

In order to ensure a blind and fair evaluation before the classification stage, the data set of scalogram images was divided so that 90% of all data was used for training and 10% for testing. In this division, the data were randomly selected. The training data were used to create the classification model, and the test data were used to measure the model’s performance. In addition, 20% of the training data used in constructing the classification model was used for validation based on the five-fold cross-validation method.

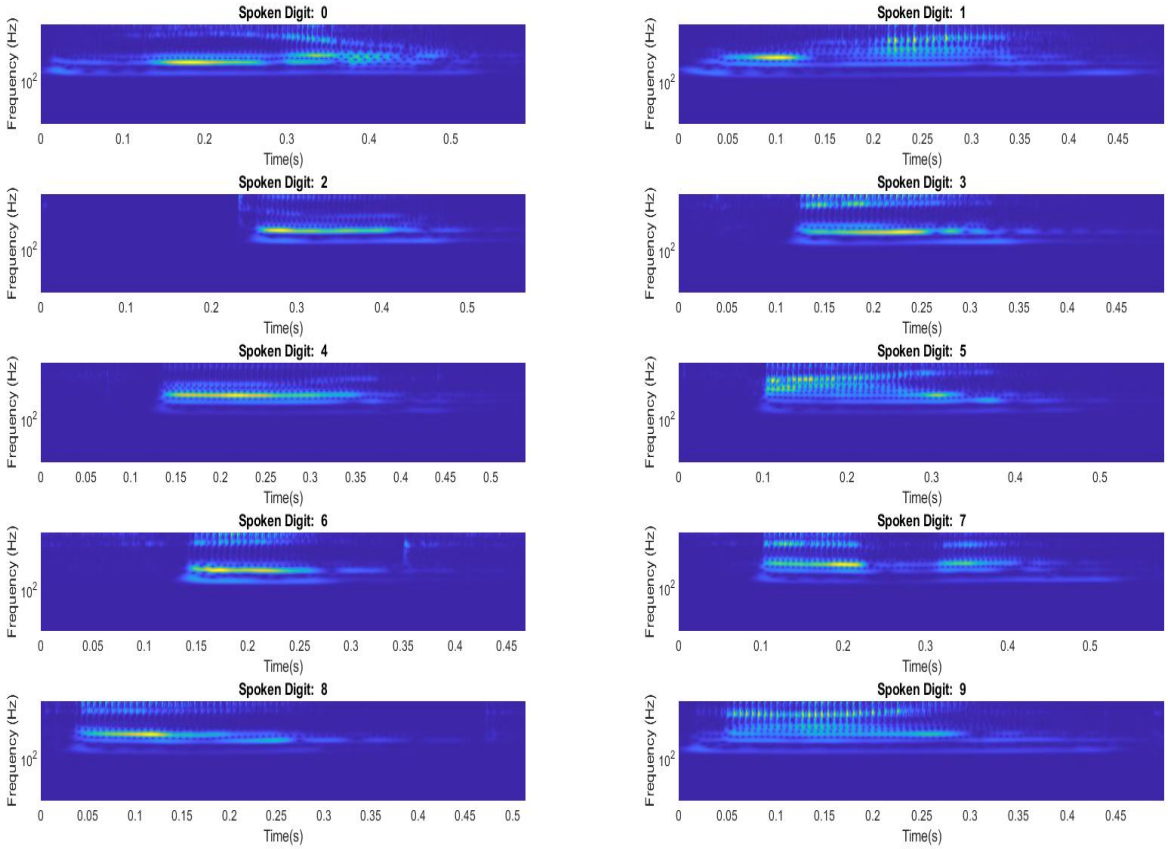

Figure 3. Time-frequency representation (scalogram) of the spoken digit signals

2.4 Classification

In the classification phase, existing CNN-based classification models with proven success were adapted to the study by transfer learning. In the study, VGG16, VGG19 [6], DenseNet201 [7], InceptionV3 [8] and MobileNetV2 [9] architectures were implemented with transfer learning. In all architectures, scalogram images containing 256x256 pixels were used as input. In addition, the batch value was 16 for all architectures, and the epoch value was 100 in creating the classification model.

2.5 Performance Metrics

This study used a confusion matrix and comparison metrics obtained from this matrix to measure the success of CNN-based architectures. The confusion matrix approach in Table 1 compares the predictions with the actual values. Table 2 shows the calculation of comparison metrics.

Table 1. Confusion matrix

Confusion Matrix		**Actual Values**	
		Positives	**Negatives**
Predicted Values	**Positive**	True Positive	False Positive
	Negative	False Negative	True Negative

Table 2. The calculation of comparison metrics

Metrics	**Formula**
Accuracy	$(TP + TN)/(TP + TN + FP + FN)$
Recall	$TP/(TP + FN)$
Precision	$TP/(TP + FP)$
F1 Score	$2 \times (Precision \times Recall)/(Precision + Recall)$

3 RESULTS

The classification accuracy results for test data of the different CNN-based methods used are given in Table 3.

Table 1. Comparison of different architectures for FSDD database

Model	Accuracy
VGG16	0.97
VGG19	0.95
DenseNet201	0.85
InceptionV3	0.89
MobileNetV2	0.92

When Table 1 is analysed, it is seen that the VGG16 architecture is the most successful method among the CNN architectures used. The confusion matrix of this architecture is given in Table 2, and the detailed results of the comparison metrics obtained from this matrix are shown in Table 3.

Table 2. Confusion Matrix of VGG16 architecture

	Zero	One	Two	Three	Four	Five	Six	Seven	Eight	Nine
Zero	30	0	0	0	0	0	0	0	0	0
One	0	29	0	0	0	0	0	0	0	1
Two	0	0	29	1	0	0	0	0	0	0
Three	0	0	1	29	0	0	0	0	0	0
Four	0	0	0	0	30	0	0	0	0	0
Five	0	0	0	1	0	27	1	1	0	0
Six	0	0	0	0	0	0	28	1	1	0
Seven	0	0	1	0	0	0	0	29	0	0
Eight	0	0	0	1	0	0	0	0	29	0
Nine	0	0	0	0	0	0	0	0	0	30

Table 3. Comparison of different architectures for FSDD database

Classes	Precision	Recall	F1 Score
Zero	1.00	1.00	1.00
One	1.00	0.97	0.98
Two	0.94	0.97	0.95
Three	0.91	0.97	0.94
Four	1.00	1.00	1.00
Five	1.00	0.90	0.95
Six	0.97	0.93	0.95
Seven	0.94	0.97	0.95
Eight	0.97	0.97	0.97
Nine	0.97	1.00	0.98

4 CONCLUSION

The confusion matrix of the VGG16 architecture, which has the highest classification accuracy among the deep learning architectures used; the diagonal from the top-left to the bottom-right (e.g., 30 for digit 0, 29 for digit 1, etc.) represents the number of correctly classified instances for each digit. Off-diagonal elements represent misclassifications. For example, the one in row 1, column 9, means that one instance of digit one was incorrectly classified as digit 9. Overall, this confusion matrix shows the performance of the spoken digit classification model, with high counts along the diagonal indicating accurate predictions and off-diagonal counts indicating

misclassifications. The metrics given in Table 3 provide a comprehensive evaluation of the classification performance for each digit in the spoken digit classification task. High precision, recall, accuracy and F1 score values indicate that the classifier performs very well for each digit class.

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Imperials vs. Rebellions: An Analogical Comparison of Fear of Missing Out and Joy of Missing Out

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Abstract

This study employs the two primary factions within the Star Wars universe and Ying-Yang as an analogical framework to clarify the challenges posed by the rapid pace of technological advancements. In contemporary society, we can observe two prevalent patterns of behaviour: one that involves a propensity to embrace and incorporate technology into daily life, and others that entails a deliberate choice to maintain a certain level of detachment from technology, opting instead for a more minimalist and simplified lifestyle or avoiding the technological products and services. The characters associated with the Imperial and Rebellion factions in the Star Wars film series exhibit resemblances to the concepts of FoMO (Fear of Missing Out), JoMO (Joy of Missing Out), and Technophobia, which are unique phenomena portrayed within the narrative. Individuals exhibit varying responses when faced with the same circumstances. This research highlights the need of addressing the literature gap around the perceived differences among these various terms, by demonstrating that they are not as distinct as previously believed, but rather represent diverse reaction patterns. This research uses bibliometric analysis to appreciate the shared aspects of these diverse ideologies. The Web of Science database is used to collect scholarly papers by using bibliometric analysis based on certain keywords and indexes. The findings indicate that anxiety, among other factors, is associated with these behaviours. However, despite the presence of similar antecedents, there are significant differences in the consequences experienced by individuals. It may be argued that people exhibit varying responses when exposed to the same situations. However, it is important to note that each person perceives the environment differently based on their own behavioural tendencies. For instance, those who display JoMO tendencies may see others who endorse FoMO behaviour as contributing to the harm of the global community or environment. These factors should be considered, since there is a lack of research that examines these three notions as a cohesive framework.

Keywords: *Fear of missing out, Joy of missing out, Technophobia, Consumer behaviour*

1 INTRODUCTION

The Imperials embody individuals who want to create and maintain complete authority and societal supremacy throughout several worlds and civilizations, motivated by a FoMO on power and control. To retain control over the galaxy, they demonstrate a willingness to implement intricate bureaucratic systems and deploy coercive tactics. Furthermore, it might be argued that people and collectives within the galaxy who oppose this kind of control are, in essence, undergoing their own manifestation of JoMO. The individuals' sense of JoMO on their personal liberties and the reinstatement of democratic governance, serves as a catalyst for their resolute bravery in opposing the Imperial troops. Within the Star Wars narrative, the Rebel Alliance serves as a manifestation of the idea known as JoMO. The individuals exhibit resolute bravery as they oppose the repressive rule of the Galactic Empire, deriving satisfaction from abstaining from the advantages of authority and dominance provided by the Imperials. The participants of the Rebellion consciously choose to disengage from the temptation of power and social hierarchy, instead prioritizing the satisfaction derived from their pursuit of liberty and democratic principles. They are satisfied with forgoing the material aspects of the Imperial system. Furthermore, a comparison may be made by examining the function of technology inside the Star Wars world. The Imperial faction utilizes sophisticated technological advancements and intricate bureaucratic systems to assert their authority and establish hegemony over the galactic domain. In contrast, the Rebel Alliance used technological means to oppose the Empire, although with a democratic and ethically driven objective. The Imperials, driven by their pursuit of power, can be observed as readily adopting technology, indicating a lack of technophobia akin to FoMO phenomenon. Conversely, the Rebel Alliance exercises caution and ethical considerations in their utilization of technology, demonstrating a certain degree of technophobia in terms of being mindful of the potential repercussions of unbridled technological prowess. The Star Wars narrative may be examined by using these terms, therefore illustrating the diverse

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experiences of various groups within the tale regarding FOMO, JoMO, and their interactions with technology as they traverse the complexities of war and power dynamics.

2 LITERATURE

2.1 FoMO

According to the definition provided by Przybylski, et al. [1], the FoMO is characterized as a widespread feeling of unease that arises from the possibility that others may be engaging in enjoyable experiences from which one is excluded, and a corresponding inclination to maintain constant connectivity with the activities of others. In broader terms, individuals may experience a persistent anxiety regarding the possibility of others enjoying themselves in their absence, or a concern that others are engaging in experiences that they themselves desire to be a part of [2]. The concept of FoMO pertains to the emotional state experienced by individuals who struggle to resist the enticement of online engagement, despite potentially having a heavy workload or commitments. Moreover, individuals may experience increased levels of anxiety pertaining to relationships when they have concerns regarding potential social exclusion [2]. According to Buglass, et al. [3], individuals experiencing anxiety may be inclined to engage in impulsive behavior by leaning to the use of internet and social networking platforms in the absence of an online connection. Chotpitayasunondh and Douglas [4] provide a description of FoMO as including individuals' anxieties, concerns, and distress regarding their level of connectedness or disconnection from ongoing events, experiences, and conversations in which they are not actively participating. The FoMO has the potential to significantly impair individuals by triggering their feelings of insecurity, subsequently resulting in excessive smartphone usage [4]. According to Przybylski, et al. [1], anxiety arising from the fear of exclusion has an impact on various aspects of an individual's well-being, including need satisfaction, life satisfaction, and mood.

FoMO is a psychological characteristic characterized by individuals being preoccupied with the activities of others. Like real-life relationships, individuals with higher levels of FoMO may find satisfaction in their relationships with influencers by fulfilling their need to stay connected and engaged in the events occurring in each influencer's life essentially [5], the engagement in parasocial interactions with influencers has the potential to fulfill the sensory needs of individual consumers who experience FoMO, thereby having an influence on their overall wellbeing including social, psychological, and financial aspects [1, 5].

In recent years, there has been an increasing body of research dedicated to investigating the phenomenon known as the FoMO. This concept refers to a pervasive sense of anxiety or unease that arises from the belief that others may be engaging in enjoyable experiences while one is not present. Przybylski et al. [1] provide a concise definition of FoMO as the apprehension that others may be engaging in satisfying activities from which one is missing out. FoMO is frequently associated with individuals' anxieties and concerns pertaining to the potential exclusion from socially interactive events and experiences [6]. The concept of envy refers to the subjective perception that one's peers are experiencing more enjoyment or possessing superior possessions compared to one's own experiences or possessions [7]. While social media platforms enhance social connectivity, individuals with a higher level of FoMO also encounter stressors and anxiety associated with their absence from events attended by their family members and friends. The events and experiences discussed occur in offline settings but are frequently shared on social media platforms. Consequently, they can have an impact on an individual's emotional well-being as well as their social well-being [8-10].

FoMO encompasses more than just the realm of social media and socialization. It is a psychological state that influences behavior, intention, and attitude towards emerging technologies, as well as the decision-making processes of individuals within organizations [11].

2.2 JoMO

JoMO, as proposed by Chan et al. [12], embodies a heightened level of awareness and purposeful endeavor in one's interaction with new technologies. JoMO, an acronym coined by [13]. encompasses the experience of experiencing positive emotions, such as joy and excitement, when confronted with a variety of choices that are incompatible yet affording the freedom to select among them.

The concept of the JoMO refers to the experience of gaining enjoyment from the ability to make a deliberate decision to stay away from participating in social activities and abstain from keeping up with them [13]. One crucial element of the JoMO concept lies in the freedom that people have to determine the focus of their attention. The concept of JoMO emerges in circumstances where individuals are presented with an abundance of options. The user possesses knowledge regarding alternative options and derives satisfaction from the ability to exercise

choice and the decisions they ultimately make. While FoMO and JoMO are commonly portrayed as contrasting and conflicting elements, they can coexist and manifest concurrently within an immersive viewing context. The user may experience a range of emotions, including concern and anxiety, when attempting to comprehend the entirety of the storyline. However, they may also concurrently feel positive emotions, such as joy and excitement, regarding the selection of content. Consequently, individuals may encounter the phenomenon of FoMO and JoMO as simultaneous and interrelated factors [14]. The JoMO lifestyle is often perceived as a deliberate rejection of the FoMO phenomenon, serving as a haven for individuals who opt to lead a minimalist and modest life [15].

JoMO is a phenomenon that can be understood as a logical and sociological response to FoMO [16]. An emerging phenomenon is observed among individuals who embrace the "JoMO lifestyle." The internet is flooded with an extensive amount of content related to the concept of JoMO, featuring advice from various sources such as experts, individuals, spiritual leaders, authors of JoMO literature, as well as multimedia resources like videos and audio recordings. However, there is a lack of research studies pertaining to the concept of JoMO that are supported by empirical evidence [15].

2.3 Blacks vs Whites: Technophobia and JoMO vs FoMO

The concept of Yin and Yang finds its origins in Chinese philosophy, wherein it clarifies the existence of opposing yet interconnected forces that sustain each other. The symbol of yin and yang is comprised of two contrasting colors, particularly black and white. The generally accepted concept of the ying-yang symbol is depicted below in Figure 1.

Figure 1. Ying-Yang symbol

There are two fundamental principles that govern the destinies of creatures and things, known as yin and yang. Yin represents negativity, darkness, and femininity, while yang embodies positivity, brightness, and masculinity. The interaction between these two principles plays a significant role in shaping the outcomes and trajectories of various entities [17].

Another significant aspect of the topic is technophobia. The concept is intricately linked to the observation and analysis of technological trends, either through active monitoring or deliberate avoidance. Technophobia is characterized as an atypical anxiety or distress concerning the consequences of sophisticated technology [18]. It impacts approximately one third of the populace, resulting in adverse health outcomes and impaired work productivity. The impact of the mobile phone on society is significant, encompassing both its design process and subsequent socioeconomic achievements [18]. Moravčíková [19] emphasize the importance of addressing technophobia, technoparanoia, and the potential negative implications of technologies that have the capacity to absorb human capabilities. It is crucial to not only view these issues as simplistic concepts, but to also recognize the complex challenges they pose within modern society. Furthermore, the trajectory of societal progress is heavily influenced by the utilization of advanced technologies.

Technophobia, a term describing fear or anxiety related to sophisticated technology, can exert influence on individuals' online behavior and overall welfare. The study that a comprehensive examination is presented regarding the phenomenon known as FoMO, along with its association with negative affectivity and the problematic utilization of technology [20]. The study examines the phenomenon of technophobia specifically among older individuals who utilize the Internet. The research reveals that technophobia has the potential to limit their engagement in online activities and subsequently impact their overall life satisfaction [21]. Brosnan and Thorpe [22] assess the efficacy of clinically derived interventions in addressing technophobia. The findings indicate that both selective desensitization and one-session treatments exhibit notable potential in reducing anxiety associated with technology. Ha, et al. [18] explores the phenomenon of technophobia within the realm of mobile device design. The research underscores the significance of inclusive product design to accommodate individuals

who experience technophobia. In general, the papers underscore the significance of comprehending and mitigating technophobia to foster favorable utilization of technology and enhance overall welfare.

3 METHODOLOGY

This study employs bibliometric analysis. The search results obtained from the Web of Science were downloaded and subsequently analyzed using the bibliometrix package [23] in R software. Table 1 presents the filters utilized for gathering data from published research across various topics, along with the corresponding number of investigations.

Table1. The search criteria utilized during the data collection procedure in Web of Science

Data No	Filter	Topic	Total Published Studies Included
1	"Fear of missing out" (Topic) or FoMO (Topic) and Article or Proceeding Paper (Document Types) and Social Sciences Citation Index (SSCI) or Emerging Sources Citation Index (ESCI) or Conference Proceedings Citation Index – Science (CPCI-S) (Web of Science Index)	FoMO	587
2	"Joy of Missing out" (Topic) or JOMO (Topic) or technophobia (Topic) and Article or Proceeding Paper (Document Types) and Social Sciences Citation Index (SSCI) or Emerging Sources Citation Index (ESCI) or Conference Proceedings Citation Index – Science (CPCI-S) (Web of Science Index)	JoMO and Technophobia	242
3	fear of missing out (Topic) or FoMO (Topic) or "Joy of Missing out" (Topic) or JOMO (Topic) or technophobia (Topic) and Article or Proceeding Paper (Document Types) and Social Sciences Citation Index (SSCI) or Emerging Sources Citation Index (ESCI) or Conference Proceedings Citation Index – Science (CPCI-S) (Web of Science Index)	FoMO, JoMO and Technophobia	822

The bibliometrix package in the R software utilized to generate a co-occurrence network and conceptual wordmap for each of the three databases. This was achieved by employing factorial analysis to examine the relationships between keywords based on data obtained from the web of science.

4 RESULTS

Bibliographic co-occurrence network analysis of data 3 which contains 822 of published study are depicted at Figure1 and list of first 20 terms according to their closeness is at Table 2.

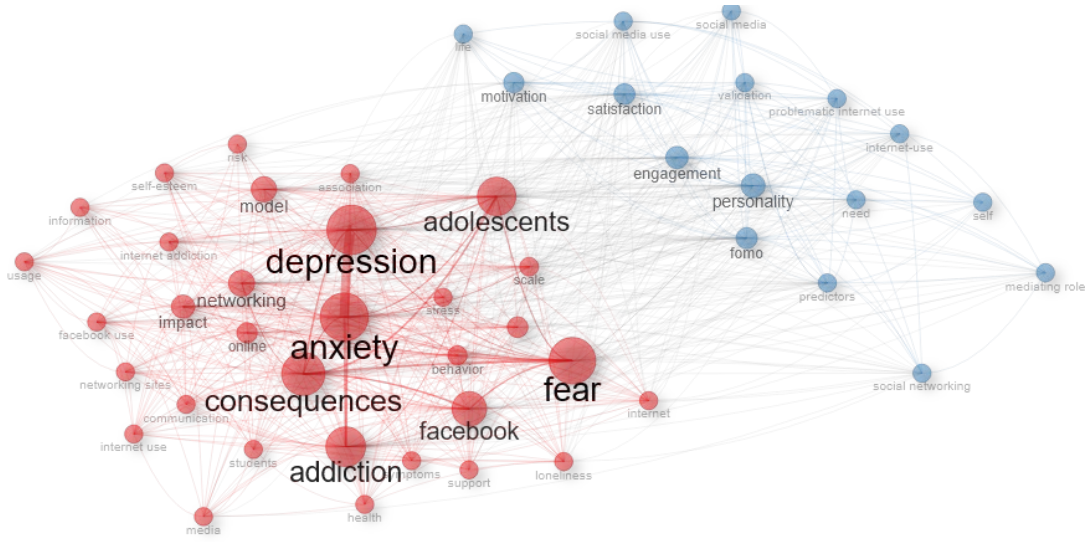

Figure1. Co-occurrence network of FoMO, JoMO, and Technophobia

Table 2. List of co-occurrence networks of FoMO, JoMO, and Technophobia

Node	Cluster	Betweenness	Closeness	PageRank
anxiety	2	83.0309	0.0213	0.0559
depression	3	43.2521	0.0192	0.0521
impact	2	36.6283	0.0192	0.0327
model	2	17.3186	0.0192	0.0270
fear	3	29.2630	0.0189	0.0442
consequences	3	21.4484	0.0185	0.0439
personality	2	20.4596	0.0185	0.0281
adolescents	3	19.8078	0.0185	0.0393
addiction	3	22.3149	0.0182	0.0404
facebook	3	15.9959	0.0182	0.0343
scale	2	8.4617	0.0179	0.0211
networking	3	7.7066	0.0175	0.0273
satisfaction	3	7.2799	0.0175	0.0216
fomo	3	3.9336	0.0172	0.0198
online	3	5.9353	0.0167	0.0198
internet	2	5.7762	0.0164	0.0170
engagement	3	4.5152	0.0164	0.0222
college-students	3	5.5670	0.0161	0.0208
behavior	2	5.2834	0.0161	0.0192

Bibliographic co-occurrence network analysis of data 2 which contains 242 of published study are depicted at Figure2 and list of first 20 terms according to their closeness is at Table 3.

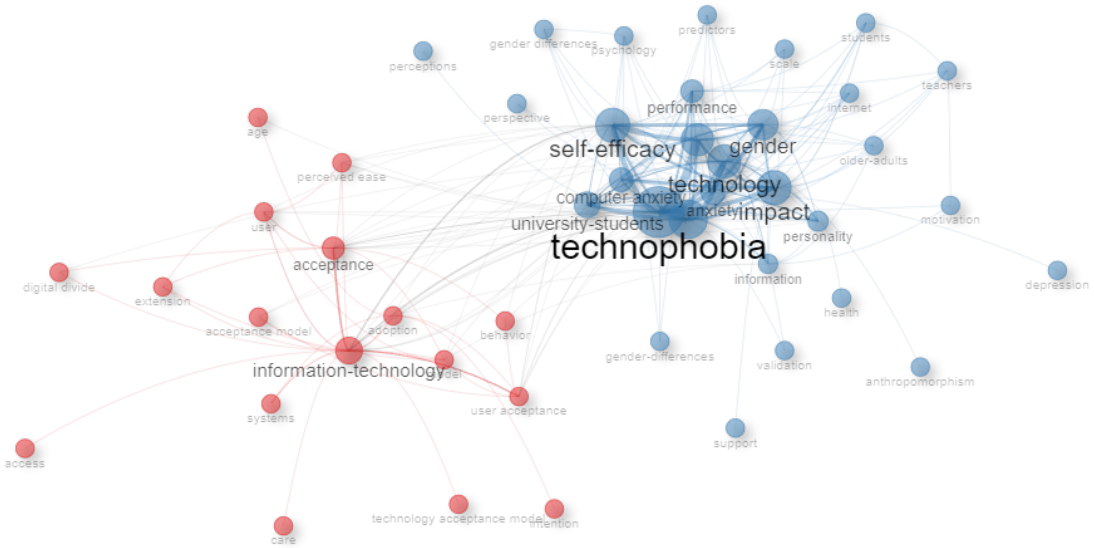

Figure2. Co-occurrence network of JoMO and Technophobia

Table 3. List of co-occurrence networks of JoMO and Technophobia

Node	Cluster	Betweenness	Closeness	PageRank
technophobia	2	248.3011	0.0159	0.0915
self-efficacy	2	90.6120	0.0152	0.0646
attitudes	2	97.7403	0.0147	0.0676
impact	2	114.0731	0.0143	0.0593
experience	2	32.9996	0.0139	0.0538
information-technology	1	214.2098	0.0139	0.0566
university-students	2	11.6484	0.0130	0.0400
acceptance	1	34.2714	0.0130	0.0325
technology	2	81.3414	0.0128	0.0512
computer anxiety	2	13.5064	0.0128	0.0358
performance	2	7.2752	0.0128	0.0324
anxiety	2	62.9933	0.0125	0.0334
gender	2	18.9195	0.0123	0.0481
information	2	13.4850	0.0119	0.0227
personality	2	47.1086	0.0118	0.0283
user acceptance	1	8.2591	0.0118	0.0211
adoption	1	57.2556	0.0114	0.0215
user	1	3.5299	0.0110	0.0159
perceived ease	1	0.3417	0.0110	0.0113

Bibliographic co-occurrence network analysis of data 1 which contains 587 of published study are depicted at Figure3 and list of first 20 terms according to their closeness is at Table 4.

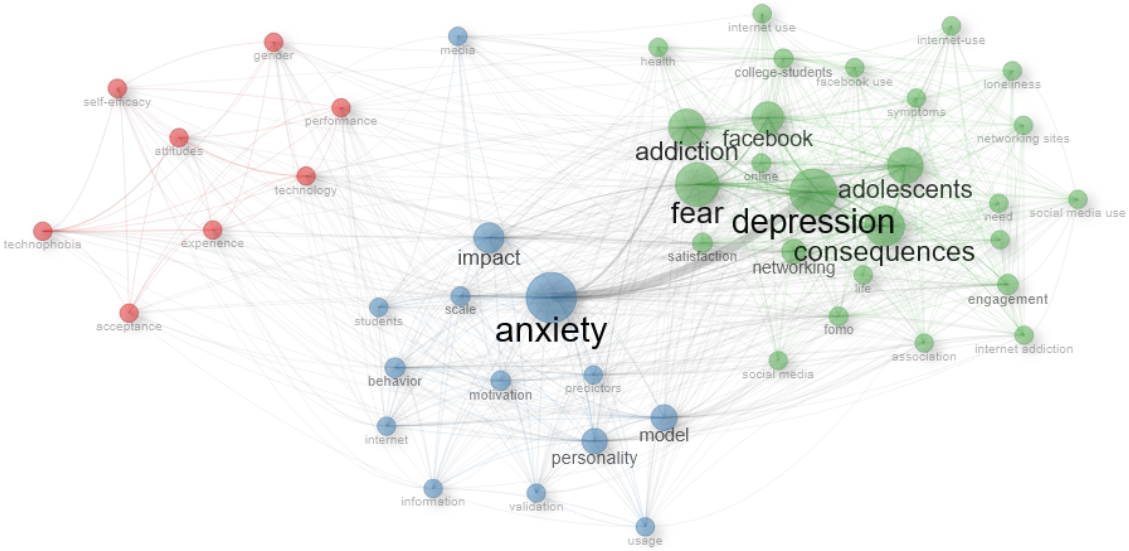

Figure3. Co-occurrence network of FoMO

Table 4. List of co-occurrence networks of FoMO

Node	Cluster	Betweenness	Closeness	PageRank
fear	1	55.8484	0.0208	0.0501
depression	1	53.9902	0.0208	0.0570
anxiety	1	49.9000	0.0208	0.0551
adolescents	1	33.8266	0.0204	0.0440
consequences	1	34.5598	0.0200	0.0491
facebook	1	34.4751	0.0196	0.0392
addiction	1	33.7018	0.0192	0.0455
fomo	2	8.8872	0.0185	0.0227
personality	2	12.4751	0.0179	0.0263
impact	1	7.7794	0.0179	0.0239
model	1	9.1260	0.0175	0.0255
networking	1	8.2051	0.0175	0.0285
engagement	2	7.3579	0.0172	0.0241
satisfaction	2	6.5541	0.0172	0.0227
college-students	1	5.5433	0.0167	0.0223
online	1	6.3432	0.0167	0.0215
scale	1	3.0898	0.0167	0.0195
predictors	2	3.6661	0.0164	0.0181
internet addiction	1	4.0383	0.0161	0.0194

Bibliometrix's factorial analysis method was used to create the wordmap that can be seen in Figure 4. This wordmap was produced using the factorial analysis method. The graphic presents information about the relative distances between the different entities as well as an illustration of the degree of relatedness that exists between them. The data that was obtained from Web of Science for all the themes (FoMO, JoMO and Technophobia) for which there were a combined total of 822 studies published was used in this analysis, and it is also presented in Table 1.

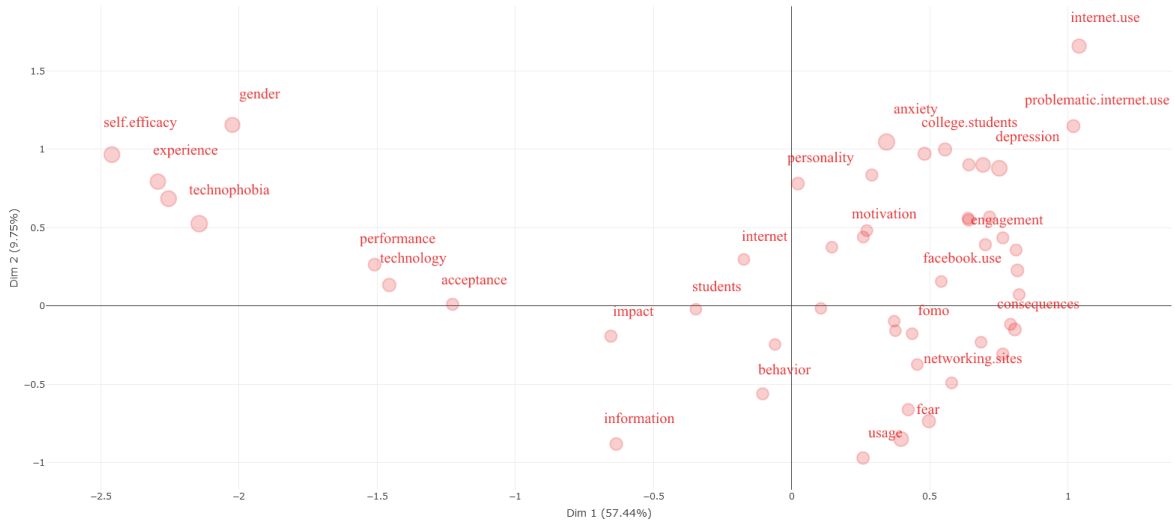

Figure 4. Wordmap

5 CONCLUSION

The findings of the study indicate that there are common elements among the terms, as evidenced by the co-occurrence network and the word map generated using factorial analysis. It is possible to posit that individuals exhibiting a higher sensitivity to the negative aspects of technological progress, sometimes referred to as JoMO, may possess a greater inclination towards such concerns compared to those who exhibit a FoMO tendency. The pessimistic mindset may not fully encompass the scope of technical advancements, since there are also indirect effects of such advancements on society and the environment. The intricate web of human emotions and behaviors often exhibits a fascinating interplay, akin to the concept of Yin and Yang. This duality extends to the modern digital age, where technophobia, the fear or aversion to technology, can significantly impact the dynamics of both FoMO and JoMO.

FoMO, is a pervasive aspect of our hyper-connected world. It's the apprehension that something exciting or essential may be happening online, and we might miss it. This FoMO on digital experiences is, in part, fueled by the rapid advancements in technology and the constant stream of information. Technophobia adds another layer to this phenomenon. Those who fear or are averse to technology may be more inclined to experience FoMO because they perceive the digital world as intimidating or inaccessible. On the flip side, there's JoMO. This behavioral pattern reflects a willingness to disconnect from the constant buzz of technology and savor moments of digital detox. It's like the Rebellion in Star Wars, opposing the unrelenting embrace of technology by the Imperial side. Individuals exhibiting JoMO behaviors are more sensitive to the consequences of rapid technological changes, opting to regulate or oppose them rather than blindly accepting progress.

It's intriguing to note that while these concepts, JoMO, FoMO, and technophobia, offer a unique lens into the human psyche, they have not received the attention they deserve in academic research. Exploring the intricate relationship between these variables could provide valuable insights into how people navigate the digital landscape. Unfortunately, there's a scarcity of comprehensive academic studies in this field. Therefore, it's imperative that future research focuses on these specific areas of study to shed more light on this complex interplay. In practice, it's crucial to present technological products and services transparently, showcasing both their advantages and disadvantages. Providing potential customers with a clear view of what they can gain, as well as what they might lose or find challenging, can help mitigate negative or opposing responses. The initial paradigms of these concepts might seem common, but they manifest differently in various individuals, making it essential to consider the intricacies of these dynamics in the digital age.

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An Intelligent Support System for Online Learners in Difficulty

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Abstract

Distance learning platforms are constantly evolving in order to improve the learning and knowledge transfer process. However, a significant number of learners still drop out, especially in the case of longer courses. This is mainly due to the social isolation felt by the learner, who sees himself interacting only with a machine without the support of a human teacher. An obvious solution would be to engage a large number of human tutors to assist learners and help them overcome any difficulties encountered. However, this would be too expensive.

We propose an intelligent system that can be integrated into learning platforms to closely trace the learner's behavior and interactions during the learning process. The information collected, known as traces, will be permanently analyzed in real time by the intelligent system, which will detect any difficulties encountered by the learner and offer the necessary and appropriate help and support.

The proposed intelligent system is based on an expert system made up of three traditional components:

- The facts base, made up of information gathered about the learner
- The rules base, which will be applied on the facts base to detect the situation of difficulty and the necessary assistance to offer
- The inference engine, which represents the program that applies the rules on the facts base

The proposed system has the advantage of replacing, even partially, the role of the human tutor through an integrated system based on expert systems. This will significantly reduce the cost of human tutors and provide instant, automatic support for learners, making the e-learning process more comfortable.

In summary, the proposed intelligent system is a cost-effective way to improve the e-learning experience by providing learners with personalized support and reducing the need for human tutors.

Keywords: *Artificial intelligence, Adaptative e-learning platforms, İntelligent tutoring system, Expert system, Personalized assistance*

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Data Augmentation Effect on Facial Expression Recognition Using Deep Learning Models

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Abstract

Facial expression recognition (FER) has grown rapidly in recent years. It is used in a variety of applications, including human-machine interaction, gaming, and healthcare. Deep learning has improved FER accuracy, but it requires large datasets. Data augmentation techniques can help address this challenge.

In this work, we investigated the effect of data augmentation on a facial expression recognition system. We used two deep learning models, VGG16 and Resnet50, to evaluate three augmentation techniques: geometric transformations, SMOTE and Cycle-GAN.

The FER2013 database was used for the training phase. It consists of a set of 35,887 images representing seven different emotions. All the images in this dataset have a size of 48 x 48 and are divided into a training set (80%) and a test set (20%).

As the following table shows, several experiments were conducted on the two models used (VGG-16 and ResNet50), with and without data augmentation. The data augmentation techniques used were geometric transformation, SMOTE, Cycle-GAN, and hybridization of data augmentation techniques. These experiments show that the absence of data augmentation or the application of a single augmentation technique may not be sufficient to avoid the problem of overfitting and improve the performance of facial expression recognition systems. On the other hand, when more than one augmentation technique is used, it is observed that overfitting gradually disappears, especially geometric transformations which are very important for overcoming overfitting and increasing accuracy.

Experimentation	Model	Accuracy
Without augmentation	ResNet50	58%
	VGG-16	65%
Augmentation with geometric transformation	ResNet50	64%
	VGG-16	60%
Augmentation with SMOTE	ResNet50	57%
	VGG-16	62%
Augmentation with SMOTE and geometric transformation	ResNet50	68%
	VGG-16	11%
Augmentation with Cycle-Gan	ResNet50	76%
Augmentation with Cycle-Gan and geometric transformation	ResNet50	74%
Augmentation with Cycle-Gan and SMOTE	ResNet50	75%
Augmentation with Cycle-Gan, SMOTE and geometric transformation	ResNet50	72%

Keywords: *Facial expression recognition, Data augmentation, Cycle-Gan, SMOTE, Geometric transformation*

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Simple Structured and Easily Realizable Triple-Band Metamaterial Absorber Design

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Abstract

In this study, a metamaterial absorber design with a structure consisting of a dielectric substrate material in the middle, a resonator structure on the top, and a ground plane at the bottom was designed. The absorber, which uses FR-4 material, which is widely used in the market and can be found cheaply, as the substrate material, has a simple structure that can be easily produced using traditional methods or a PCB prototype machine. According to the simulation studies carried out in CST Microwave Studio, the absorber suggested with the designed resonator structure shows high absorption at three frequencies, more than 0.99 at two frequency points and approximately 0.89 at one frequency point in the 1–12 GHz frequency range. It is thought that the design, which provides high absorption at three frequency points instead of a narrow bandwidth, will find a place in applications at microwave frequencies.

Keywords: *Cheap, Metamaterial, Absorber, High absorption, Triple-band*

1 INTRODUCTION

Electromagnetic wave absorbers, which can be designed in a wide range of frequencies such as microwave, terahertz, and optical frequency region, can be defined as devices that can completely (according to the design) absorb the incoming radiation at the operating frequency [1, 2]. Generally, three types of absorbers can be mentioned [3]. The first type of absorber is the wedge conical absorber used in anechoic rooms [4]. These electromagnetic absorbers are pyramid-shaped and are used in a wide frequency band, but they are not portable due to their large volume and brittleness [4]. The second type of absorbers are lossy absorbers made of composites with high electrical and magnetic permeability [5]. However, although these types of absorbers have high absorbing properties in broadband, they are expensive due to material scarcity. The third type of absorber is the metamaterial absorbers introduced to the literature by Landy et al. [6]. These absorbers have become a popular research topic in the last 15 years due to their small footprint, simple structure, and high absorption [7-12].

Electromagnetic wave absorbers based on the resonator structure as metamaterial-based are usually designed by forming from the ground plane under a dielectric substrate and from the resonator structure above it [13]. Due to this structure, resonator-structured (metamaterial-based) absorbers offer advantages such as low profile, ease of manufacturing, flexibility, and cheapness [14]. However, in addition to these advantages, metamaterial absorbers offer a narrow bandwidth [15]. To eliminate this disadvantage, metamaterial absorbers have been designed using multiple resonator structures or layers [16, 17]. In this study, a single-layer and triple-band metamaterial absorber is suggested. The suggested structure is designed as a structure that has a high absorption rate at three frequency points and can be easily manufactured (in terms of simplicity and cheapness).

2 MATERIAL AND METHOD

The suggested metamaterial absorber, designed in the electromagnetic simulation program CST Microwave Studio, is shown in Figure 1(a). In the suggested single-layer structure, FR-4 material ($\varepsilon_r = 4.3$ and $\tan\delta = 0.025$) with 1 mm (d) thickness and 20 mm length (L_1) in square shape was used as the dielectric substrate, as it is easily accessible and cheap. In order to ensure that the transmission scattering parameter (S_{21}) is zero (0) while achieving the perfect absorber, the back side of the FR-4 dielectric material is completely covered with a metallic ground surface (copper; thickness 0.035 mm (t) and $\sigma = 5.8 \times 10^7$ S/m). To create the triple-band absorber structure, the front side of the FR-4 dielectric material was formed with two square-shaped resonator structures (someone slit)

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with the same copper material on the back side, as scaled in Figure 1(b) (L_2 = 18 mm, L_3 = 14 mm, L_4 = 12 mm, L_5 = 8 mm, and g = 0.8 mm). Thus, with this resonator structure at the front, the reflection scattering parameter (S_{11}) will be ensured to be zero (0).

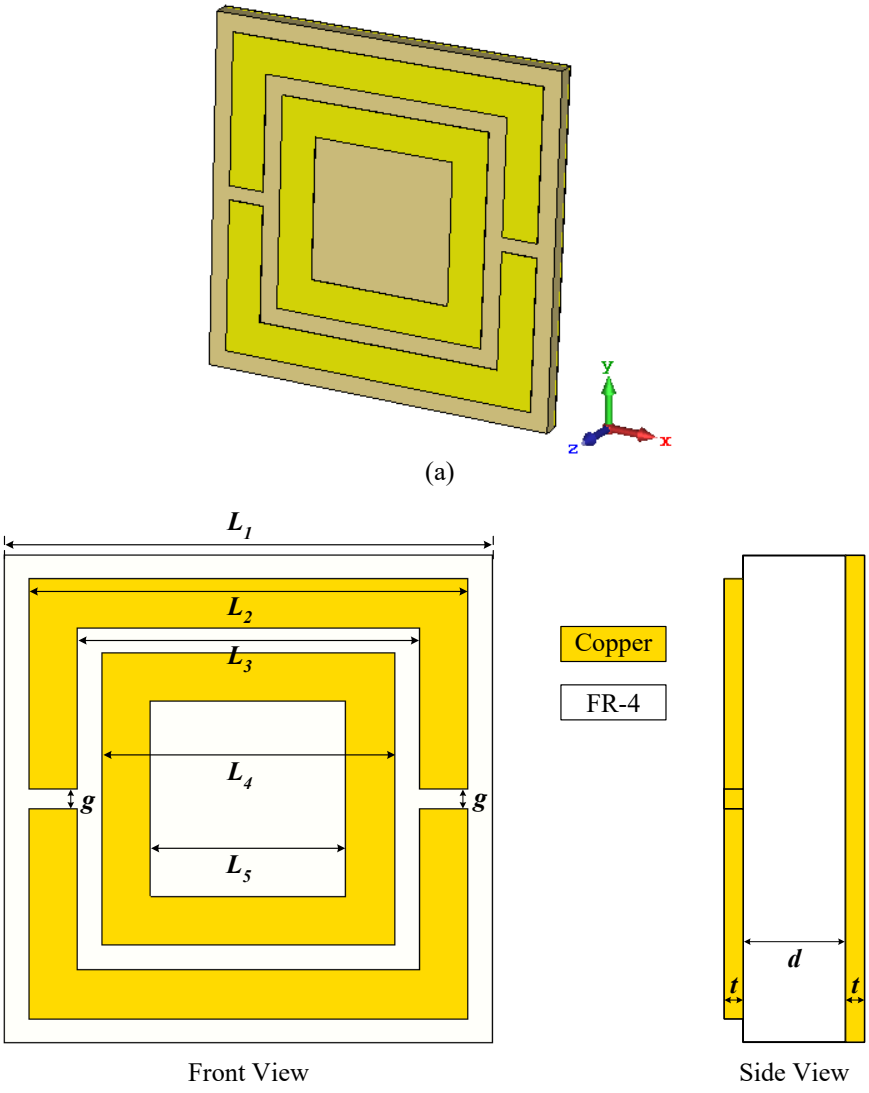

Figure 1. (a) 3D image of the metamaterial absorber structure designed in CST Microwave Studio and (b) dimensioning of the suggested absorber geometry

If the S_{11} and S_{21} parameters are zero (0) or very close to zero (0), the absorption will be perfect. In other words, in frequency regions where reflection and transmission are almost zero (0), the absorption is 100% according to the formula below [1, 3, 6-17].

$$\text{Absorption} = 1 - |S_{11}|^2 - |S_{21}|^2 \quad (1)$$

3 RESULTS

For the suggested design shown in Figure 1(a), reflected and transmitted wave amplitudes were obtained as a result of simulation studies carried out in CST Microwave Studio in the 1–12 GHz frequency range. Then, by using these quantities, the absorption amplitude is obtained through Equation (1), and these three quantities (reflection, transmission and absorption) are given in response to frequency in the same graph in Figure 2.

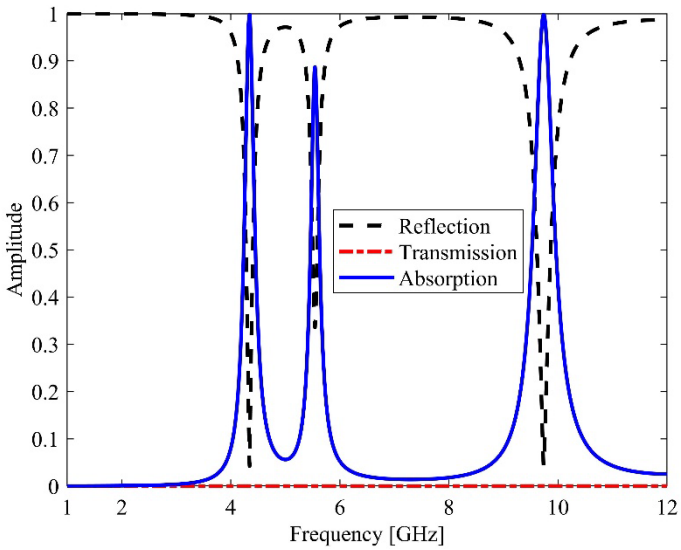

Figure 2. Reflection, transmission and absorption amplitudes simulation results for the suggested triple-band metamaterial absorber

When Figure 2 is examined, it is seen that the transmission is zero in the 1–12 GHz frequency range, the reflection approaches zero (0) at 4.34 GHz and 9.73 GHz (approximately 0.04 at both frequencies) and is 0.34 at 5.54 GHz. On the other hand, the absorption is determined to be more than 0.99 at 4.34 GHz and 9.73 GHz and approximately 0.89 at 5.54 GHz. Accordingly, the suggested design has an absorption rate of more than 99% at two frequency points (at 4.34 GHz and 9.73 GHz) and an absorption rate of around 89% at one frequency point (at 5.54 GHz).

4 CONCLUSION

In this study, a triple-band miniature metamaterial absorber was designed using resonator structures. This designed absorber shows more than 99% absorption at 4.34 GHz and 9.73 GHz frequencies, and around 89% absorption at 5.54 GHz frequency. The suggested metamaterial absorber, which stands out with its simple structure, cheapness and realizability when compared to other metamaterial absorbers in terms of both its size, resonator structure and the type of substrate used, stands out as an advantageous absorption device in 1-12 GHz microwave frequency applications.

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Comparison of Coverage Map of Different Terrain Type

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Abstract

It is very important providing a healthy communication to improve the service quality of the communication. For a qualified communication, base stations should be placed in suitable locations. In pre-deployment phase of the base station, coverage map of the nominated place should be generated by calculating the electric fields of all the direct, diffracted and reflected rays between the transmitter and the receiver. Electric fields are computed with Geometrical Optics (GO) and Uniform Theory of Diffraction (UTD) model. In this study, how the material (superconductor, soil, forest, copper and iron) and polarization types (hard, soft) of the terrain affect the coverage map will be discussed.

Keywords: *Ray tracing, Geometric optics, Uniform theory of diffraction, Coverage map, Lossy surface*

1 INTRODUCTION

Technological devices in daily life especially in wireless communication have become indispensable for people. In order to use these devices properly, improving the quality of service has a very great importance. Therefore, deployment of the base stations onto correct locations a challenging problem. In order to solve the problem, at first all the direct, diffracted and reflected rays between the transmitter and the receiver position are determined and then resulting electric fields are calculated. Finally coloured coverage map is obtained. GO and UTD models are used for electric field calculation [1]. GO model is suitable with the direct and reflected ray, unlike UTD is responsible with diffracted rays.

In this study, a three-dimensional digital data including x, y and z coordinates of a region is used to generate the coverage map in MATLAB environment. A ray tracing program is developed in MATLAB environment to determine all the direct, diffracted and reflected rays between the transmitter and the receiver [2]. Material types and polarization types affect the electric field in a point [3]. Wood, has a low conductivity and it is seemed as insulator, attenuates the electromagnetic waves less than concrete [4]. As the conductivity increased, reflected rays from the surface increased too [5]. In section 2 we go through the material and methods. Section 3 contains simulation results and then conclusions.

2 MATERIAL AND METHOD

In 3D coverage mapping, ray tracing and calculation of electric fields generated by these rays are fundamental. In order to obtain the coverage map all the direct, diffracted and reflected rays between the transmitter and receiver should be determined as shown in Figure 1.

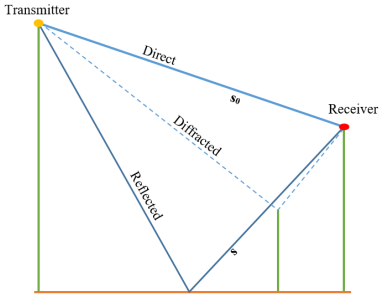

Figure 1. Diffracted, reflected and direct rays

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As shown in Figure 1, on a receiving point there can be direct, edge diffracted and surface reflected rays. Electric field of direct and reflected rays can be calculated by GO model. Electric field of a direct ray is given by,

$$E = \frac{E_0}{s_0} e^{-jks_0} \tag{1}$$

where E_0 is accepted as 1 V/m, s_0 stands for the distance shown in Figure 1 between the transmitter and the receiver and k symbolizes the wave number. Electric field of a direct ray is given by [6],

$$E = R\frac{E_0}{s} e^{-jks} \tag{2}$$

where R refers to reflection coefficient, E_0 is accepted as 1 V/m, s is total distance shown in Figure 1 between the transmitter, ground and receiver and k symbolizes the wave number. The magnitude of the reflection coefficient changes between 0 and 1. For superconductor material, the reflection coefficient is taken as 1. For lossy surfaces, the reflection coefficient for horizontal and vertical polarization is represented by [7],

$$R_s = \frac{\sin(\varphi') - \sqrt{\varepsilon_{cr} - \cos(\varphi')^2}}{\sin(\varphi') + \sqrt{\varepsilon_{cr} - \cos(\varphi')^2}} \tag{3-a}$$

$$R_h = \frac{\varepsilon_{cr}\sin(\varphi') - \sqrt{\varepsilon_{cr} - \cos(\varphi')^2}}{\varepsilon_{cr}\sin(\varphi') + \sqrt{\varepsilon_{cr} - \cos(\varphi')^2}} \tag{3-b}$$

where, ε_{cr} is the complex relative permittivity constant, φ' denotes the reflection angle. The complex relative permittivity constant is expressed by [8],

$$\varepsilon_{cr} = \varepsilon_r - j\frac{\sigma}{2\pi f \varepsilon_0} \tag{4}$$

where, σ is the conductivity, ε_{cr} is the relative complex electrical permittivity constant, f is the operational frequency, ε_0 is the electrical permittivity constant of free space. Electric field of the diffracted rays can be calculated by UTD model. Electric field of the diffracted ray is calculated by [9],

$$E = E_i DA(s) e^{-jks} \tag{5}$$

where E_i is the incident field on the obstacle, k denotes the wave number, D is the amplitude diffraction coefficient, s stands for the distance between the obstacle and the receiver and A refers to spreading factor. The amplitude diffraction coefficient is defined [10] by,

$$D(\alpha) = -\frac{e^{-\frac{j\pi}{4}}}{2\sqrt{2\pi k \cos\left(\frac{\alpha}{2}\right)}} F[x] \tag{6}$$

where, k is the wave number, α is the diffraction angle and $F[x]$ is called with the transition function changes between 0-1 is calculated by [11],

$$F(x) = 2j\sqrt{x}e^{jx}\int_{\sqrt{x}}^{\infty} e^{ju^2} \tag{7-a}$$

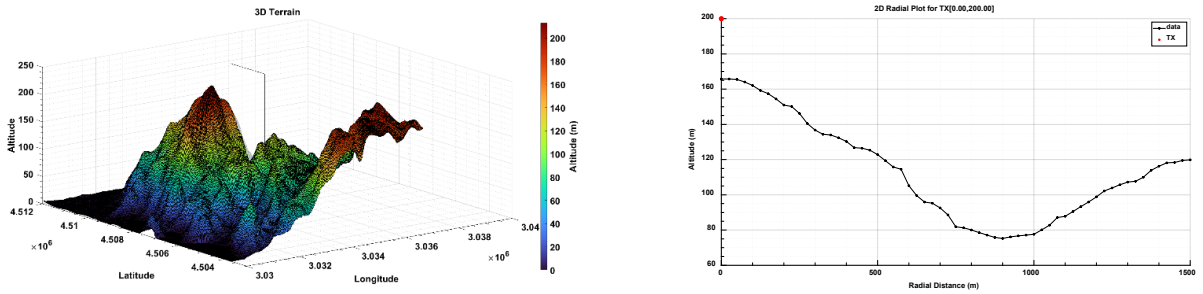
$$x = 2kL\cos\left(\frac{\alpha}{2}\right)^2 \tag{7-b}$$

where, α is the diffraction angle, L is the distance parameter for amplitude diffraction and k is the wave number.

3 SIMULATIONS AND RESULTS

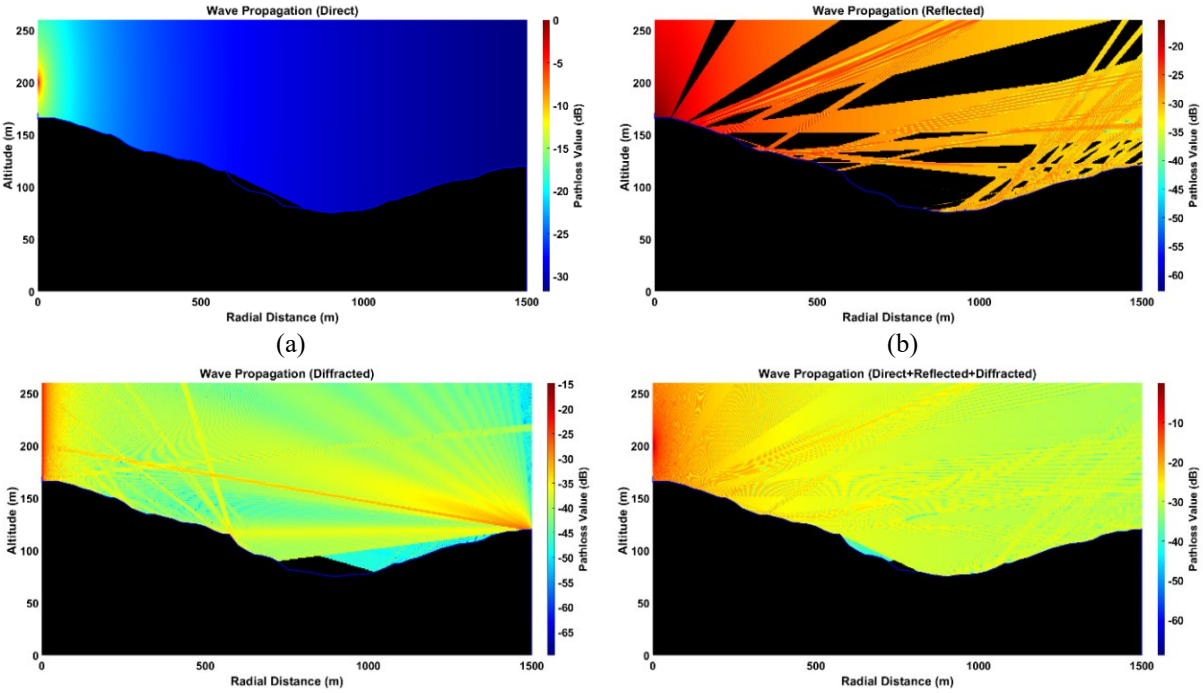
In simulations, a digital data including x, y and z components is used. Firstly 3D visual is obtained in MATLAB environment and a transformation window as it is seen in Figure 2-a. The developed ray tracing program runs for a 2D plane. For that reason, the transformation window is used to obtain 2D profile of the terrain as illustrated in Figure 2-b. A transmitting antenna is deployed on [0, 200] coordinate as it is depicted with red point in Figure 2-b. In order to obtain the coloured coverage map of the selected transformation window, all the direct, reflected and diffracted rays are determined and electric fields of these rays are calculated. For a super conducting surface with

1800 MHz operation frequency, developed program runs and electric field distribution transformation window for direct, reflected, diffracted and overall rays are demonstrated in Figure 3.



(a) (b)

Figure 2. 3D visual, transformation window, 2D terrain profile



(a) (b)

(c) (d)

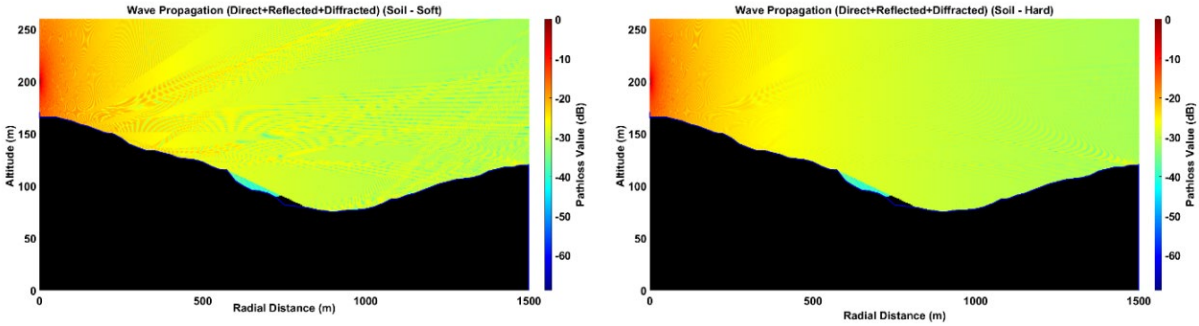
Figure 3. Electric field distribution for direct, reflected, diffracted and overall rays

In Figure 3-d, electric fields are calculated 390000 points. Average electric field is -27.73558947 dB for the super conductor surfaces. The reflection coefficient of the lossy surfaces like soil and forest is different from 1. The reflection coefficient of copper and iron is very close to 1. The reflection coefficient is related with permittivity, conductivity and frequency as defined in (3, 4). In this study electrical parameters of the surfaces are found in Table 1.

Table 1. Properties of different surface materials [8]

Surface Type	Surface Type Properties	
	Relative Permittivity(ε_r)	Electrical Conductivity (σ)
Soil	15	0.0012
Forest	12	0.03374
Copper	0.99994	59000000
Iron	0.99998	10300000

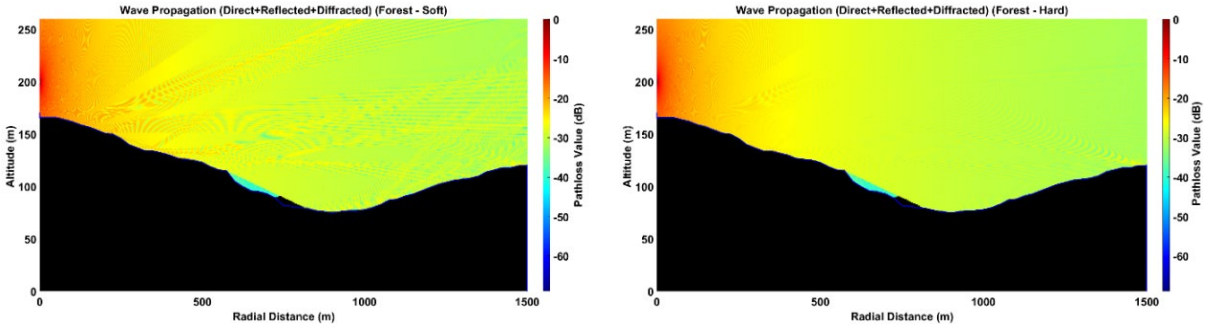
The reflection coefficients are different for both hard and soft polarization as defined in (3). For the soil surface coverage map for the profile for hard and soft polarization is shown in Figure 4.



(a) (b)

Figure 4. Coverage map of the profile for the soil

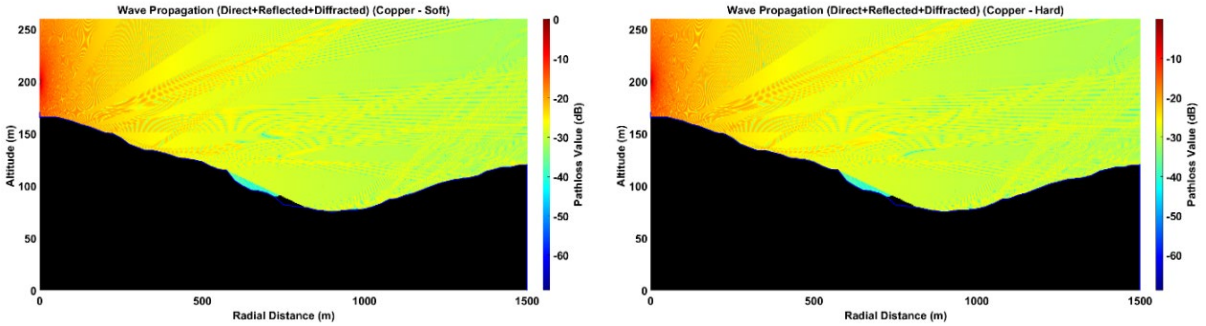
In Figure 4, electric fields are calculated 390000 points. The averages of these fields are -27.88877712 dB and -28.15873556 dB for soft and hard polarization, respectively. For the soil surface coverage map for the profile for hard and soft polarization is shown in Figure 5.



(a) (b)

Figure 5. Coverage map of the profile for the forest

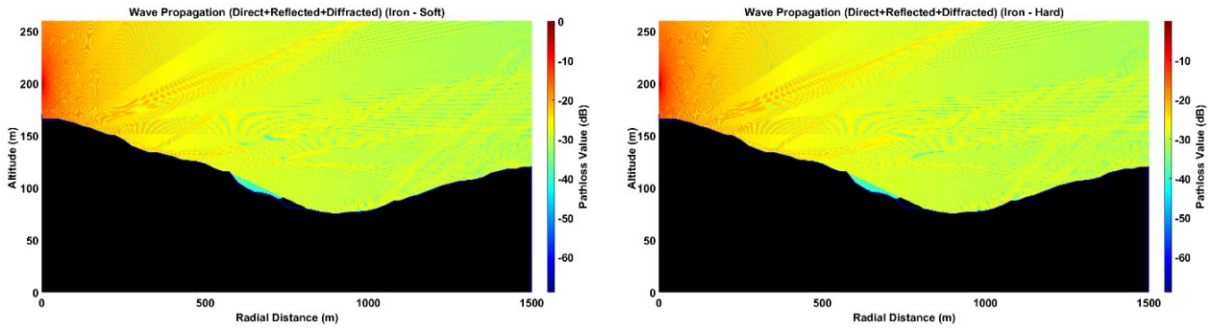
In Figure 5, electric fields are calculated 390000 points. The averages of these fields are -27.90366381 dB and -28.15973132 dB for soft and hard polarization, respectively. For the copper surface coverage map for the profile for hard and soft polarization is shown in Figure 6.



(a) (b)

Figure 6. Coverage map of the profile for the copper

In Figure 6, electric fields are calculated 390000 points. The averages of these fields are -27.73900313 dB and -27.73604432 dB for soft and hard polarization, respectively. For the iron surface coverage map for the profile for hard and soft polarization is shown in Figure 7.



(a) (b)

Figure 7. Coverage map of the profile for the iron

In Figure 7, electric fields are calculated 390000 points. The averages of these fields are -27.73898995 dB and -27.73636258 dB for soft and hard polarization, respectively.

For the lossy surfaces electric field attenuates for hard polarization more than soft polarization. Copper and iron gives almost the same results due to that reflection coefficient is very close to 1. Electric field for soil and forest is attenuated more than copper, iron and super conductor because of that the reflection coefficient is very less than 1. In soil and forest electromagnetic field penetrates more than copper, iron and super conductor.

4 CONCLUSION

Recently, the use of wireless communication devices has been increasing due to advances in communication technology and population growth. As the number of wireless devices and urbanization increases, users may suffer from service quality. Thus, there is a need to improve the service quality. In order to solve the problem, base stations should be deployed to correct places. In pre-deployment phase, firstly coverage map should be generated. Coverage map is generated by the electric fields of the direct, diffracted and reflected rays. Electric fields can be calculated with GO (direct, reflected) and UTD (diffracted) models. The surface materials affect the coverage map. Iron and copper surface gives almost the same results with super conductor surface due to high conductivity. Hard polarized rays attenuate more than soft polarized ones.

Acknowledgments

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Electromagnetic Shielding Performance of Some Bayburt Stone Based Materials

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Abstract

Electronic devices, widely used on todays, emit electromagnetic waves. These waves can be harmful both living things and electronic devices in the environment. Electromagnetic shielding mechanism can be used to reduce the harmful effects of the waves. In this study, some samples are produced by adding different materials to white Bayburt stone. The shielding performances of the produced samples are measured with Vector Network Analyzer (VNA). The shielding effectiveness of the samples including steel, manganese, iron and carbon is investigated in the frequency range between 4 and 6 GHz.

Keywords: *Shielding effectiveness, White Bayburt stone, VNA*

1 INTRODUCTION

In today's technology, many electronic devices communicating wirelessly are used. These devices produce electromagnetic radiation and cause electromagnetic pollution. The electromagnetic wave emitted from the devices should be below a certain value so as not to harm the living bodies and not to interfere electronic devices. For that reason, electronic devices are tested for electromagnetic compatibility (EMC) before they are put into use. In order to reduce the harmful effect of the devices emitting electromagnetic waves, electromagnetic shielding mechanism should be done or the radiated power of the transmitting antenna should be reduced. In this study, some samples are produced in the dimensions (22x48x5 mm) with white Bayburt stone, steel, manganese, iron and carbon at a certain ratio. S11 and S21 parameters are measured with a VNA in the frequency range of 4-6 GHz. Then, reflection, transmission, absorption values and shielding performances are determined.

2 MATERIAL AND METHOD

The VNA measures the S parameters S_{11} and S_{21} at frequencies of 4-6 GHz from two ports using a waveguide. Reflected and transmitted waves are related with S_{11} and S_{21} parameters respectively. S_{11} and S_{21} parameters are given by [1],

$$S_{11} = \frac{P_{ref}}{P_{inc}} \tag{1}$$

$$S_{21} = \frac{P_{tr}}{P_{inc}} \tag{2}$$

where P_{ref}, P_{inc} and P_{tr} is the reflected, incident and transmitted power. Total shielding effectiveness (SE) is expressed by [2]

$$SE = SER + SEA \tag{3}$$

where, Shielding Effectiveness of Reflection (SER) and Shielding Effectiveness of Absorption (SEA) is [2] defined by [2],

$$SER = -10log10(1 - R) \tag{4}$$

$$SEA = -10log10(\frac{T}{1-R}) \tag{5}$$

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where, R and T stand for reflectance and transmittance and formulated by

$$R_{dB} = 10log10\ (|S_{11}|^2) \quad (6)$$

$$T_{dB} = 10log10\ (|S_{21}|^2) \quad (7)$$

Absorption value is given by

$$A_{dB} = 10log10\ (1-|S_{11}|^2 - |S_{21}|^2) \quad (8)$$

As can be seen in the equations above, S_{11} and S_{21} values are used to calculate reflectance (R_{dB}), absorption (A_{dB}) and transmittance (T_{dB}).

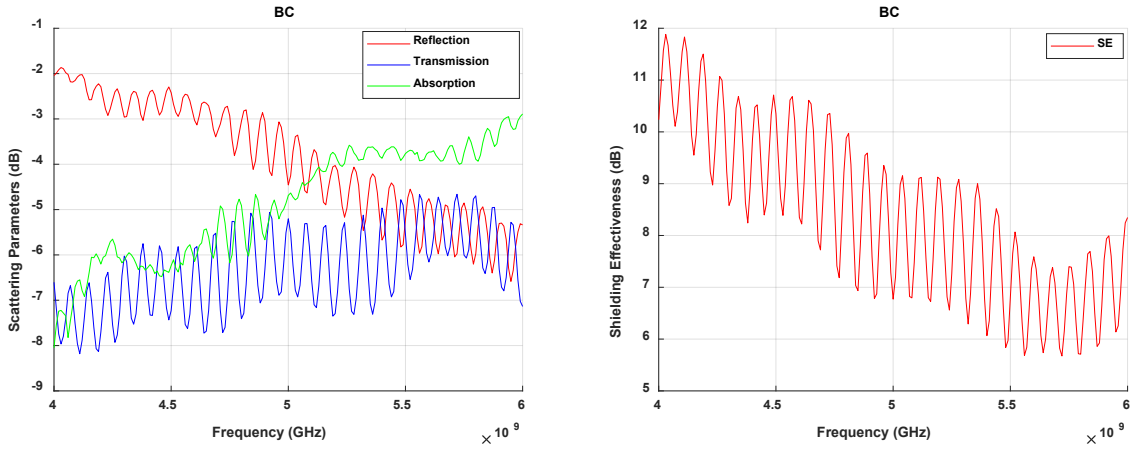
3 MEASUREMENT RESULTS

In this study, six samples are produced and coded in order to determine the shielding effectiveness as demonstrated in Table 1.

Table 1. Table of sample names and shielding performances

Symbol	Sample Name
BC	White Bayburt stone Steel
BCM3	White Bayburt stone Steel Manganese
BK	White Bayburt stone Carbon
BKC3	White Bayburt stone Carbon Steel
BKD3	White Bayburt stone Carbon Iron
BKM3	White Bayburt stone Carbon Manganese

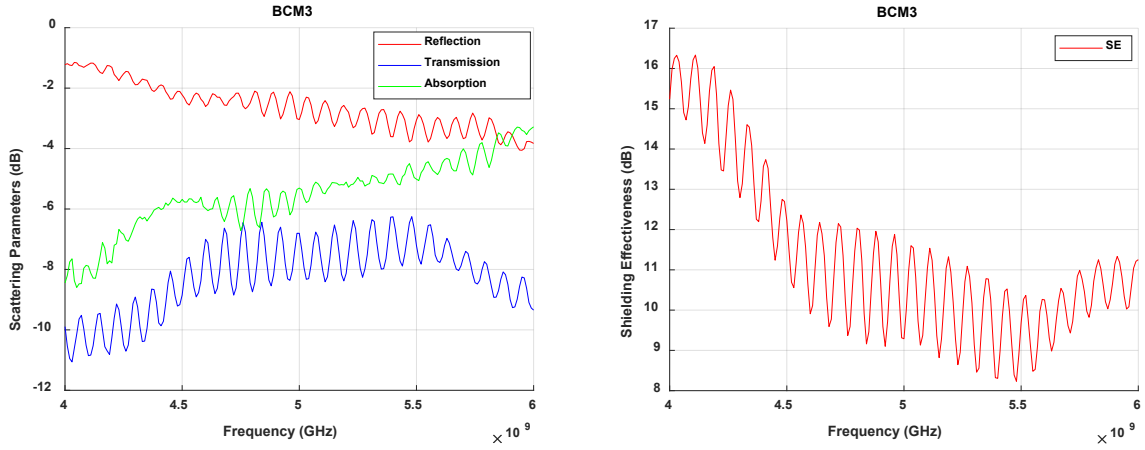
The first measurement is made for BC sample. This sample produced with white Bayburt Stone including steel fibres in it. S_{11} and S_{21} parameters BC sample is measured with VNA in the frequency range 4-6 GHz, and reflection, transmission and absorption values and shielding effectiveness are shown in Figure 1.



(a) (b)

Figure 1. Measurements for BC sample

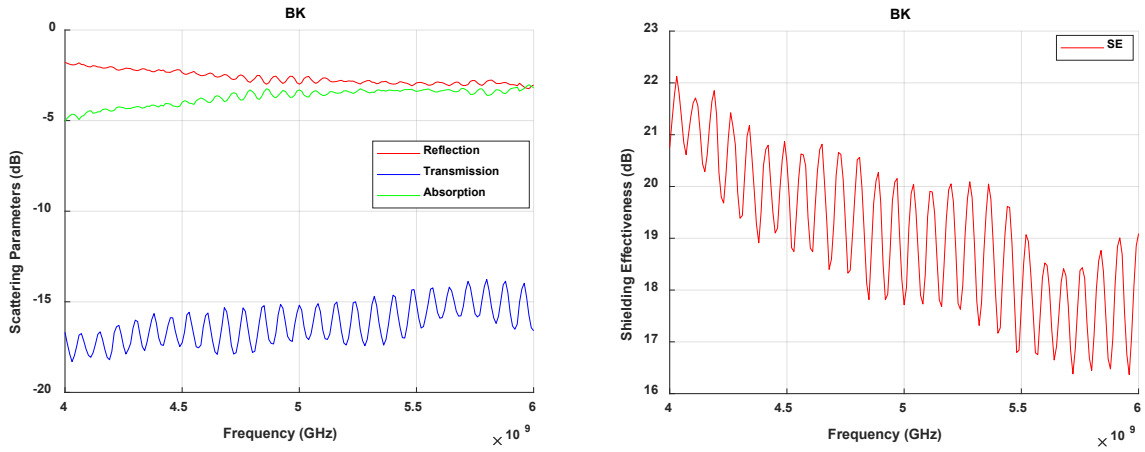
As it is seen in Figure 1a, the reflection value reaches to -2.04 dB at 4 GHz and decreases to -5.34 dB at 6 GHz. The absorption value is measured as -8.05 dB at 4 GHz and -2.89 at 6 GHz. The transmission value is between -8.2 dB and -4.7 dB. Also it is seen in Figure 1b, SE value changes between 11.88 dB (at 4.03 GHz) and 5. 56 dB (at 5.68 GHz). The second measurement is made for BCM3 sample. This sample produced with white Bayburt Stone including steel fibres and %3 manganese in it. S_{11} and S_{21} parameters BCM3 sample is measured with VNA in the frequency range 4-6 GHz, and reflection, transmission and absorption values and shielding effectiveness are demonstrated in Figure 2.



(a) (b)

Figure 2. Measurements for BCM3 sample

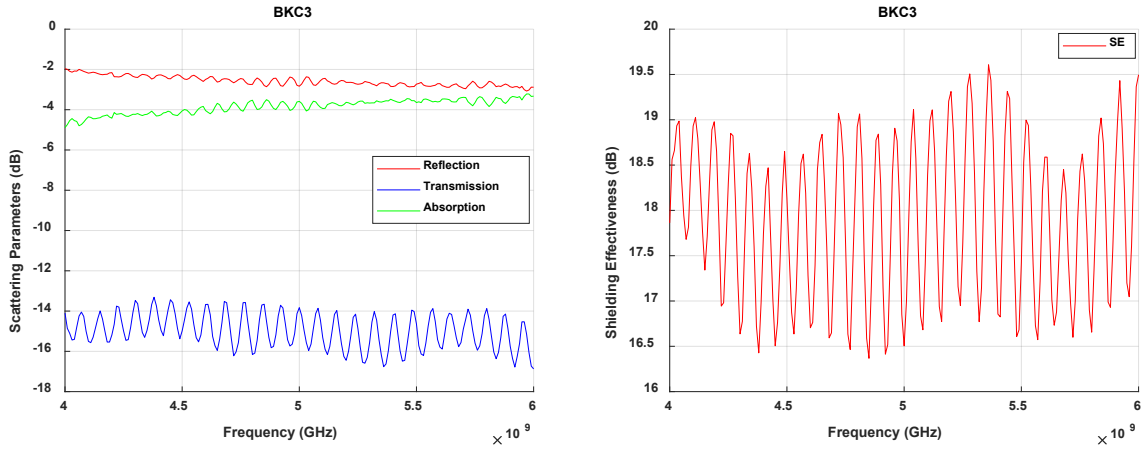
As it is demonstrated in Figure 2a, the reflection value is -1.22 dB at 4 GHz and -3.83 dB at 6 GHz. The absorption value is measured as -8.45 dB at 4 GHz and -3.28 at 6 GHz. The transmission value is between -6.5 dB and -10.8 dB. Also it is demonstrated in Figure 1b, SE value changes between 15.24 dB (at 4 GHz) and 11.25 dB (at 6 GHz). The best shielding performance is 16.33 dB at 4.11 GHz. Moreover by adding %3 manganese shielding effectiveness are increased. The third measurement is made for BK sample. This sample produced with white Bayburt Stone including carbon in it. S_{11} and S_{21} parameters BK sample is measured with VNA in the frequency range 4-6 GHz, and reflection, transmission and absorption values and shielding effectiveness are depicted in Figure 3.



(a) (b)

Figure 3. Measurements for BK sample

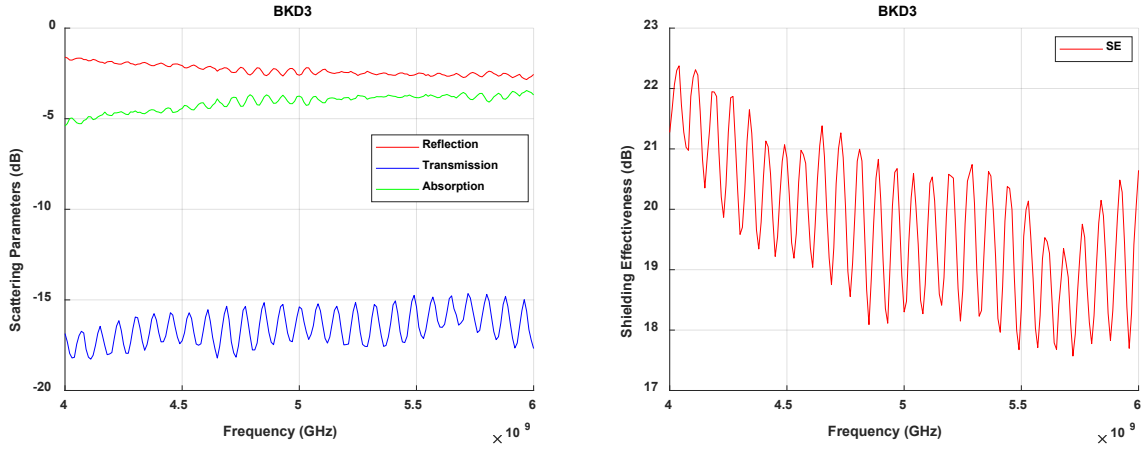
As it is depicted in Figure 3a, the reflection value is -1.78 dB at 4 GHz and -3.03 dB at 6 GHz. The absorption value is measured as -5.02 dB at 4 GHz and -3.18 at 6 GHz. The transmission value is between -14 dB and -18 dB. Also it is depicted in Figure 1b, SE value changes between 20.76 dB (at 4 GHz) and 19.09 dB (at 6 GHz). The best shielding performance is 22.12 dB at 4.03 GHz. The worst shielding performance is 16.37 dB at 5.96 GHz. The fourth measurement is made for BKC3 sample. This sample produced with white Bayburt Stone including carbon and %3 steel fibre in it. S_{11} and S_{21} parameters BKC3 sample is measured with VNA in the frequency range 4-6 GHz, and reflection, transmission and absorption values and shielding effectiveness are illustrated in Figure 4.



(a) (b)

Figure 4. Measurements for BKC3 sample

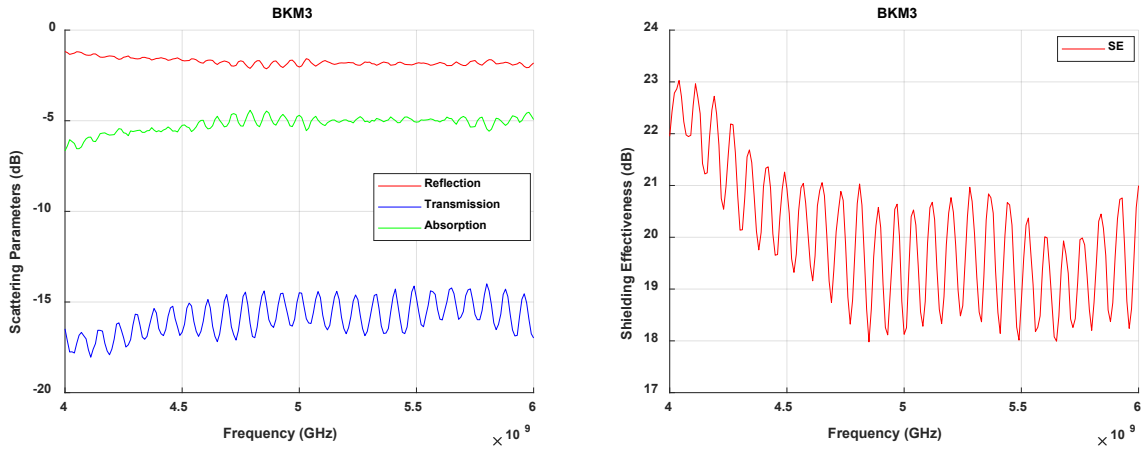
As it is illustrated in Figure 4a, the reflection value is -1.96 dB at 4 GHz and -2.88 dB at 6 GHz. The absorption value is measured as -4.89 dB at 4 GHz and -3.33 dB at 6 GHz. The transmission value is between -13.5 dB and -17 dB. Also it is illustrated in Figure 1b, SE value changes between 17.86 dB (at 4 GHz) and 19.5 dB (at 6 GHz). The best shielding performance is 19.61 dB at 5.36 GHz. The worst shielding performance is 16.37 dB at 4.85 GHz. Moreover by adding %3 steel fibers into at low frequencies the transmission values decreases and shielding effectiveness at low frequencies are increased. The fifth measurement is made for BKD3 sample. This sample produced with white Bayburt Stone including carbon and %3 iron in it. S_{11} and S_{21} parameters BKD3 sample is measured with VNA in the frequency range 4-6 GHz, and reflection, transmission and absorption values and shielding effectiveness are indicated in Figure 5.



(a) (b)

Figure 5. Measurements for BKD3 sample

As it is indicated in Figure 5a, the reflection value is -1.60 dB at 4 GHz and -2.56 dB at 6 GHz. The absorption value is measured as -5.41 dB at 4 GHz and -3.69 dB at 6 GHz. The transmission value is between -15 dB and -18 dB. Also it is indicated in Figure 1b, SE value changes between 21.27 dB (at 4 GHz) and 20.65 dB (at 6 GHz). The best shielding performance is 22.36 dB at 4.04 GHz. The worst shielding performance is 17.57 dB at 5.72 GHz. Moreover by adding %3 iron instead of steel fibers into at low frequencies the transmission values decreases and shielding effectiveness at low frequencies are increased. The last measurement is made for BKM3 sample. This sample produced with white Bayburt Stone including carbon and %3 manganese in it. S_{11} and S_{21} parameters BKM3 sample is measured with VNA in the frequency range 4-6 GHz, and reflection, transmission and absorption values and shielding effectiveness are shown in Figure 6.



(a) (b)

Figure 6. Measurements for BKM3 sample

As it is shown in Figure 6a, the reflection value is -1.18 dB at 4 GHz and -1.81 dB at 6 GHz. The absorption value is measured as -6.66 dB at 4 GHz and -4.93 dB at 6 GHz. The transmission value is between -17.5 dB and -14 dB. Also it is indicated in Figure 1b, SE value changes between 21.95 dB (at 4 GHz) and 21 dB (at 6 GHz). The best shielding performance is 23.03 dB at 4.04 GHz. The worst shielding performance is 17.98 dB at 4.85 GHz. Moreover by adding %3 manganese instead of steel fibers, the shielding effectiveness is increased. The average shielding performance of the samples is found in Table 2.

Table 2. Average shielding performance

Symbol	Sample Name	Average Shielding Performance (dB)
BC	White Bayburt stone Steel	8.4252
BCM3	White Bayburt stone Steel Manganese	11.3233
BK	White Bayburt stone Carbon	19.1409
BKC3	White Bayburt stone Carbon Steel	17.9238
BKD3	White Bayburt stone Carbon Iron	19.8132
BKM3	White Bayburt stone Carbon Manganese	20.0432

As it is found in Table 2, the average shielding performance in BKC3 is 17.9238 dB while it is 8.4252 dB in BC. Moreover, the average shielding performance in BKD3 is 19.8132 dB while it is 11.3233 dB in BCM3. Furthermore, the average shielding performance in BKM3 is 20.0432 dB while it is 19.1409 dB in BK.

4 CONCLUSION

Electromagnetic shielding can be used in order to reduce the harmful effects of the electromagnetic waves into living bodies and electronic devices. In this way interference is reduced and the devices could be worked properly. In this study, six different samples are produced with white Bayburt stone, steel fibres, manganese, iron and carbon. By means of VNA, S-parameters are calculated and it is drawn in MATLAB environment. It is observed that the shielding performance of produced samples is generally decreased by increasing of the frequency. Moreover, the shielding performance is increased with manganese addition. Furthermore carbon addition increases the shielding performance enormously, due to increasing the conductivity.

Acknowledgments

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8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023

December 1-3, 2023

Digital Twin Application in Laser Cutting Machines

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Abstract

Industrialization has started to digitalize with the developing Industry 4.0. Digital transformations have created a competitive advantage in factories. In our age, digitalization has allowed the reduction of manpower and the increase of mechanization. Technological developments have contributed greatly to the creation of smart factories. In this project, software and hardware tests were carried out in the virtual environment before the laser cutting machine with the digital twin was produced. It is expected to contribute to the shortening of production processes with the digital twin of the laser machine. The axis movements and Dynamics (acceleration, torque, speed etc.) of the Laser Cutting Machine created with the digital twin will be analyzed in the virtual environment, the risks that may occur in the Laser Cutting Machine will be determined.

Keywords: *Digital transformations, Digital twin, Laser cutting machine*

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A RCS Reduction Method Using the Air-Based Anisotropic Metasurface Polarization Converter

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Abstract

A multifunctional anisotropic metasurface polarization converter (MPC) unit cell was designed in this work to reduce Radar Cross Section (RCS). In the specifed MPC 7.2−12.8 GHz band range, conversion from linear polarization to linear polarization (LP-LP) was achieved with a polarization conversion rate (PCR) of %90 or higher. Furthermore, this design allows for conversion from linear polarization to circular polarization (LP-CP) in the band gaps of 6.55 − 6.65 GHz, 15.17−16.65 GHz, and 20.72−21.55 GHz. Moreover, the RCS reduction effect was created in this work by combining the MPC unit cell and the 90° rotated form of this cell. The study resulted in a monostatic RCS reduction of 10dBsm in the 8.96 − 12.35 GHz band range.

Keywords: *Metasurface, Polarization converter, Radar cross section, RCS reduction, Metamaterial*

1 INTRODUCTION

Radar systems are critical in both military and civilian applications today. Still, the requirement to reduce the possibility of an object being detected by radar or to improve its stealthiness implies the requirement to reduce its radar cross-sectional area (RCS). In recent years, there has been a significant focus on the study of polarization converting anisotropic metasurfaces in the context of reducing radar cross-section (RCS) [1-3]. These distinctive materials possess the capability to efficiently manipulate radar signals through the alteration of electromagnetic wave polarization and customization of reflectivity [4, 5]. There are many studies in the literature regarding the materials used and their physical properties. These studies ;coding [6], multilayer [7], transparent [6], flexible [8], Graphene Based [9], SiO2 [10], PTFE [11], Teflon [12]. In addition to these studies, it works as monostatic [13] and bistatic [14] or both monostatic and bistatic [15] at GHz [16, 17] and THz [18, 19] frequencies.

In this study, an air-based multifunctional polarization converter was designed for RCS reduction application. This polarization converter provided LP-LP polarization conversion in the 7.2 − 12.8 GHz band range, LP-LP in the 6.55 − 6.65 GHz, 15.17−16.65 GHz, and 20.72−21.55 GHz band ranges. The unit cell of the designed polarization converter and the structure obtained by rotating it by 90° provided a reduction in monostatic RCS value of 10 dBsm in the 8.96−12.35 GHz range.

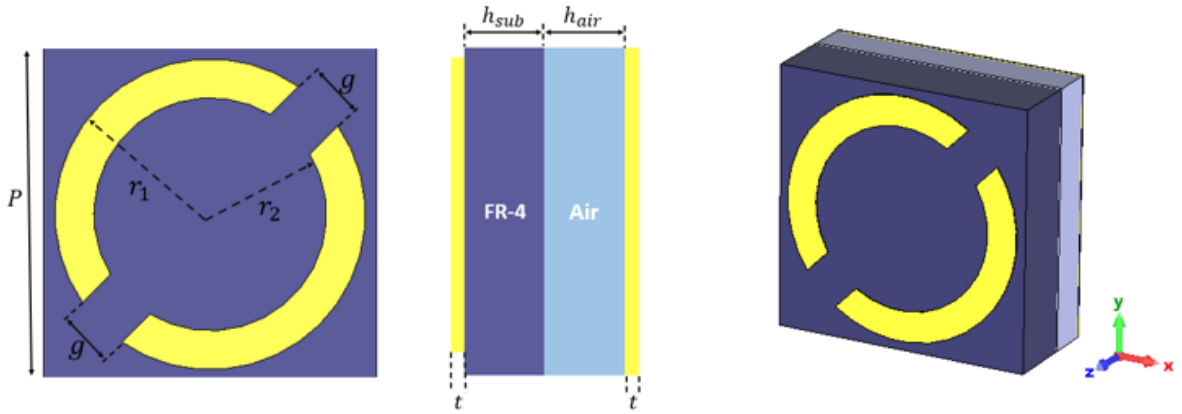

Figure 1. The structure of metasurface of unit cell and general view

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2 SIMULATION AND ANALYSIS OF METASURFACE

2.1 Unit Cell Design

Dimensioning and general view of the presented MPC structure are given in Figure 1. Unit cell dimension is P = 6mm, R1 = 2.80mm, R2 = 2.10mm, hsub = 1.60mm, hair = 1mm g = 1mm, t = 0.018mm. This structure's resonator is made up of symmetrical two-cavity ring forms. The upper and lower portions consist of copper, which has a conductivity value of σc = 5.8 × 108. In the center of the structure, these layers are two-layered; FR-4 substrate with εr = 4.3 and tan(δ) = 0.025 and air.

2.2 Simulation Results and Analysis

The simulation was conducted using the MPC CST Microwave Studio program, and the resulting data was evaluated using MATLAB® on Intel® CoreI9 13900K, 128GB RAM, RX550 GPU. The provided visual representation in Figure 1 illustrates the coordinate axes and unit cell within the simulation environment. The utilization of unit cell boundary conditions was implemented in both the (yz) and (xz) planes. Additionally, an open boundary condition was specifically established at the port plane, which corresponds to the (xy) plane. The reflection coefficients Rxy and Ryy of the simulated MPC are presented in Figure 2. The variable Ryy represents the back reflection coefficient of the incident wave that is polarized in the y direction. Similarly, the variable Rxy represents the reflection coefficient of the incident wave that is polarized in the y direction, but is measured with respect to the x direction. The reflection coefficients depicted in Figure 2 were computed within the frequency range of 6 − 22 GHz under normal incidence conditions. The graph illustrates that across the frequency range of 7.16 − 12.88 GHz, the value of Ryy is seen to be 10 dB lower than the reference level, while Rxy is found to be 0.74 dB higher. The least Ryy reflection point is seen at resonance frequencies 7.69 GHz and 11.39 GHz, with values of −26.11 dB and −32.53 dB, respectively. Additionally, the frequency regions with Rxy and Ryy reflection coefficients above −5dB are the regions where LP-CP conversion occurs. The frequency points where the LPCP transformation occurs are the points where Rxy and Ryy are approximately equal. The mathematical representation of the Ryy and Rxy polarization reflection coefficients can be expressed in Jones matrix form as follows [4]:

$$\begin{bmatrix} \vec{E}_x^r \\ \vec{E}_y^r \end{bmatrix} = \begin{bmatrix} R_{xx} & R_{xy} \\ R_{yx} & R_{yy} \end{bmatrix} \begin{bmatrix} \vec{E}_x^i \\ \vec{E}_y^i \end{bmatrix} \tag{1}$$

In this equation, the symbols Rxx and Ryy represent the co-polarization coefficient, while Rxy and Ryx represent the cross-polarization coefficient. The incident waves are represented by the symbols $\vec{}$Eix and $\vec{}$Eiy , which correspond to the x-polarized and y-polarized components, respectively. The symbols $\vec{}$Erx and $\vec{}$Ery denote the reflected waves that exhibit polarization along the x and y directions, correspondingly. In order to evaluate the effectiveness of the LP-LP polarization converter, the polarization conversion ratio (PCR) is determined by analyzing the reflection coefficients. Equation 2 presents the PCR formula [5].

$$PCR = \frac{|R_{xy}|^2}{|R_{xy}|^2 + |R_{yy}|^2} = \frac{|R_{yx}|^2}{|R_{yx}|^2 + |R_{xx}|^2}, \tag{2}$$

Figure 3 presents the change of the PCR value as determined by the frequency, as indicated by the provided formula. The graph illustrates the effective application of LP-LP polarization conversion, achieving a PCR value exceeding %90 within the frequency range of 7.2-12.8 GHz. The ellipticity value is a parameter derived from Stoke's parameters, providing insights into the polarization characteristics of electromagnetic waves. The Stoke's parameters are provided in Equation 3 [4].

$$\begin{aligned} S_0 &= E_1^2 + E_2^2, & S_1 &= E_1^2 - E_2^2, \\ S_2 &= 2E_1E_2\cos(\phi), & S_3 &= 2E_1E_2\sin(\phi), \end{aligned} \tag{3}$$

The evaluation of circular polarization conversion state can be accomplished using the Stokes parameters S0 and S3. There are two types of circular polarization. These are righthanded circular polarization (RHCP) and left-handed circular polarization (LHCP). The ellipticity value gives information about circular polarization and its types, RHCP and LHCP. It is calculated as the ratio of ellipticity=S3/S0. RHCP transformation has taken place if the ellipticity value is +1, while LHCP transformation has taken place if it is −1 [4].

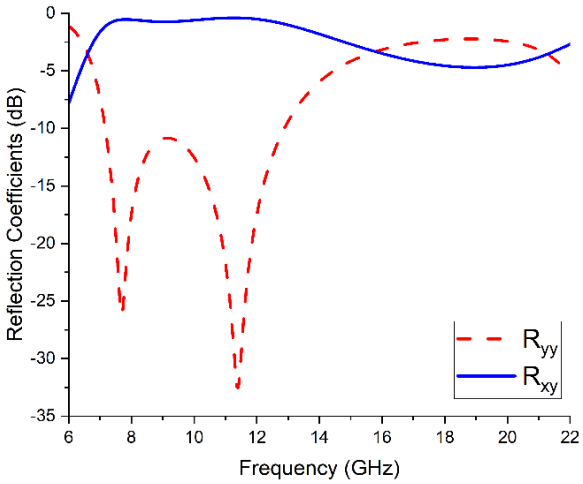

Figure 2. Simulated reflection coefficient

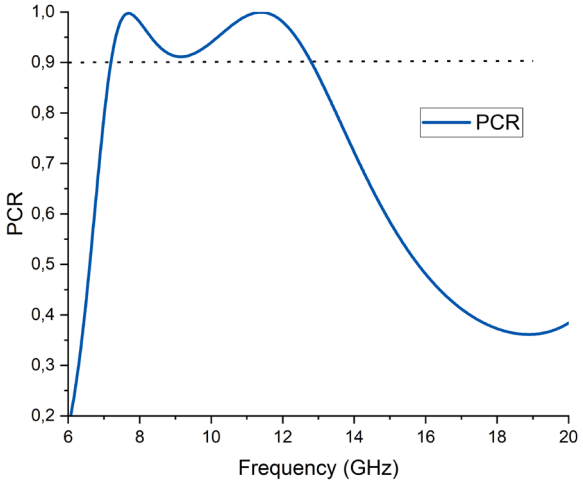

Figure 3. Polarization converter ratio (PCR)

The evaluation of circular polarization conversion state can be accomplished using the Stokes parameters S0 and S3. There are two types of circular polarization. These are righthanded circular polarization (RHCP) and left-handed circular polarization (LHCP). The ellipticity value gives information about circular polarization and its types, RHCP and LHCP. It is calculated as the ratio of ellipticity=S3/S0. RHCP transformation has taken place if the ellipticity value is +1, while LHCP transformation has taken place if it is −1 [4]. The conversion of RHCP occurred within the frequency bands of 6.55 − 6.65 GHz, 15.17 − 16.65 GHz, and 20.72 − 21.55 GHz, as depicted in Figure 4.

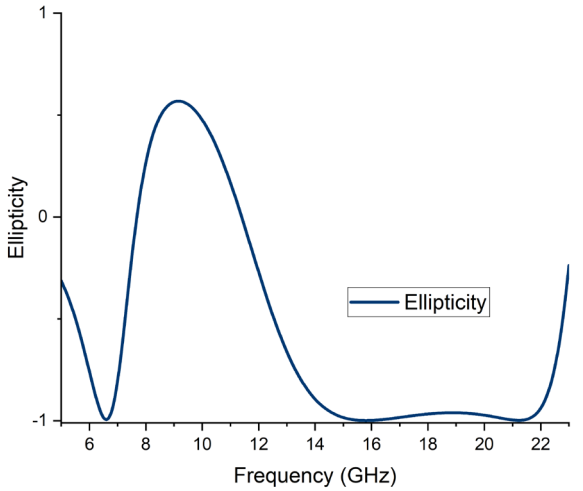

Figure 4. Ellipticity value

Figure 5 depicts the decomposition of a y−polarized incident wave $\vec{E}iy$ into u and v components to better understand the physical process of the proposed polarization converter. The y-polarized incident wave is divided into the u – v vectors, as shown in Figure 5. If the y-polarized incident wave to the polarization converter is decomposed in the u−v directions, the incident waves are as follows.

$$\vec{E}^i = (\hat{u}E^{iu} + \hat{v}E^{iv})e^{-jkz} \tag{4}$$

The mathematical representation of the electric field of the wave reflected by the polarization converter is obtained in the u − v vectors as shown below.

$$\vec{E}^r = (\hat{u}r_{uu}E^{ru} + \hat{v}r_{vv}E^{rv})e^{jkz} \tag{5}$$

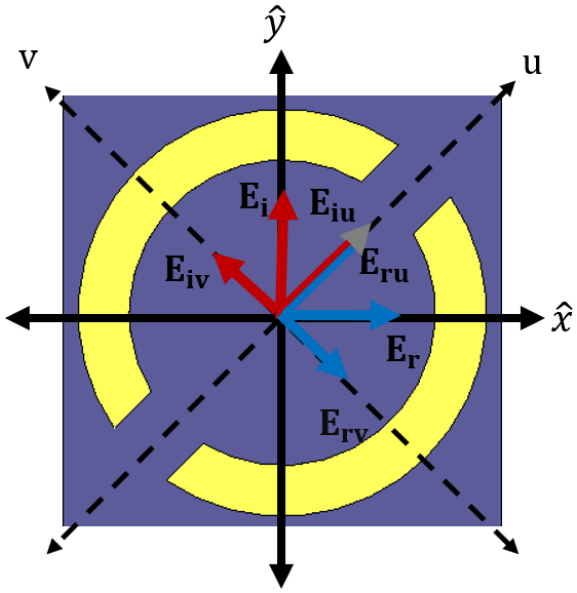

Figure 5. The proposed polarization converter is divided into u-v axes

The reflection coefficients in the u and v directions are denoted as ruu and rvv, respectively. Specifically, ruu is defined as the ratio of the reflected electric field Eru to the incident electric field Eiu, while rvv is defined as the ratio of the reflected electric field Erv to the incident electric field Eiv. In mathematical terms, the expressions for ruu and rvv may be represented as follows: ruu = Eru/Eiu As illustrated in Figure 5, in order for a vector y-polarized incident wave to be reflected back as x-polarized, the +u component must be reflected in the same +u direction and the +v component must be reflected in the same −v direction with the same amplitude. As a result, |ruu| = |ruu| = 1 and the difference of ruu and rvv phases should be Δϕ = ϕuu − ϕvv = ±180 degree.

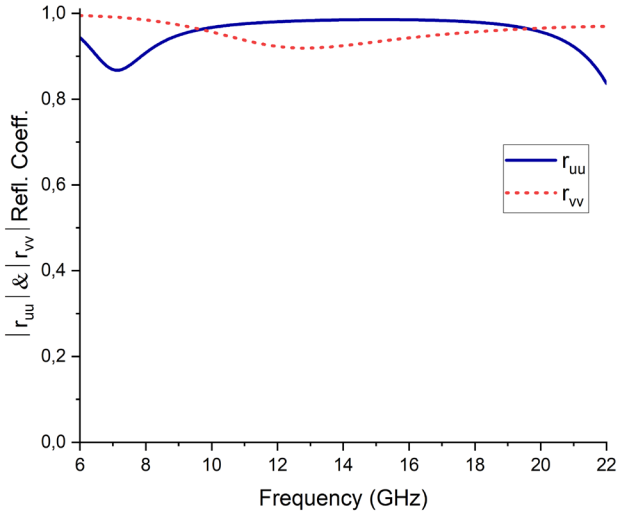

Figure 6. Amplitudes of u-v axes

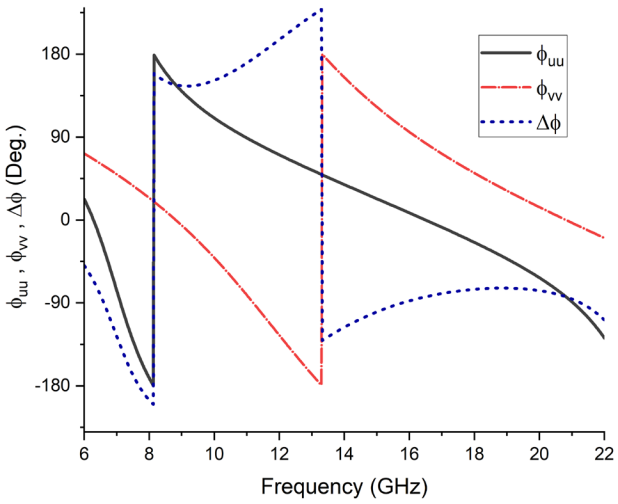

Figure 7. Phases and phase difference of u-v axes

According to the data presented in Figure 6, the reflection coefficients ruu and rvv exhibit an amplitude of approximately 1 in the frequency range of 6−22 GHz, namely in the u−v directions. This frequency range is notable for its occurrence of both linear and circular polarization. Figure 7 shows the phase difference of the reflection coefficients in the u−v directions of the MPC. Figure 7 shows that the phase difference of reflection coefficients in u − v axis amounts to about 180 degree in the frequency range 7.2 - 12.8 GHz where the conversion is conducted. In the 6.55 − 6.65 GHz, 15.17 − 16.65 GHz, and 20.72 − 21.55 GHz regions where RHCP polarization conversion occurs, it is also phase difference equivalent to ±90 degree.

2.3 RCS Reduction

When using radar cross-section (RCS) reduction techniques using a polarization converter, it is necessary to utilize two distinct unit cells [1]. In the present study, the generation of the second unit cell is achieved by a rotation of 90o, as seen in Figure 1. The reflection coefficients of both unit cells exhibit equality and correspond to the values depicted in Figure 2. There exists a correlation between RCS reduction and PCR value [1]. The metasurface array was constructed by arranging the two distinct unit cells shown in Figure 9, resulting in a total area of 180mm×180mm. The array's triangular configuration facilitates the redirection of reflected electromagnetic waves to places far away from their usual direction, resulting in the lowering of RCS [1]. The (RCS) values of the metasurface array were compared to those of a metal plate composed of a Perfect Electric Conductor (PEC) material with the same dimensions. Figure 10 illustrates the monostatic RCS values of the metasurface array and the metal plate as a function of frequency. Figure 11 compares the RCS of these two materials, as well as their differences and the RCS reduction provided. As shown in Fig. 11, the RCS value has reduced by 10dBsm or more in the 8.96 − 12.35 GHz range.

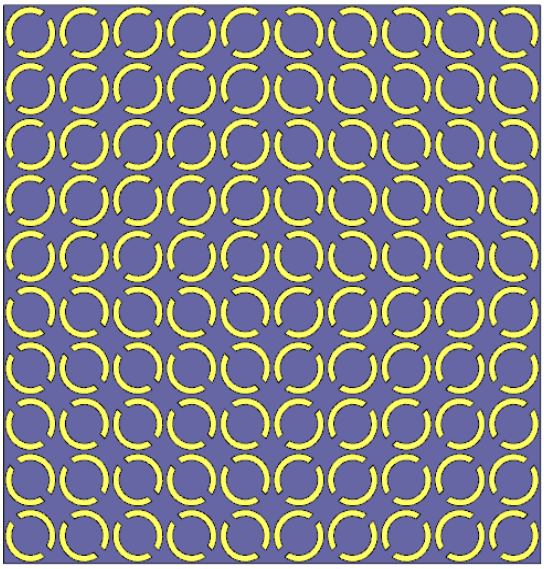

Figure 8. Metasurface designed for RCS reduction application

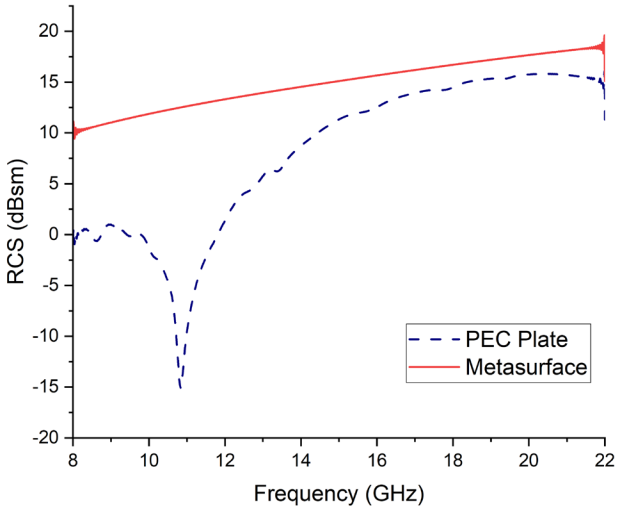

Figure 9. Simulated monostatic RCS of PEC plate and metasurface

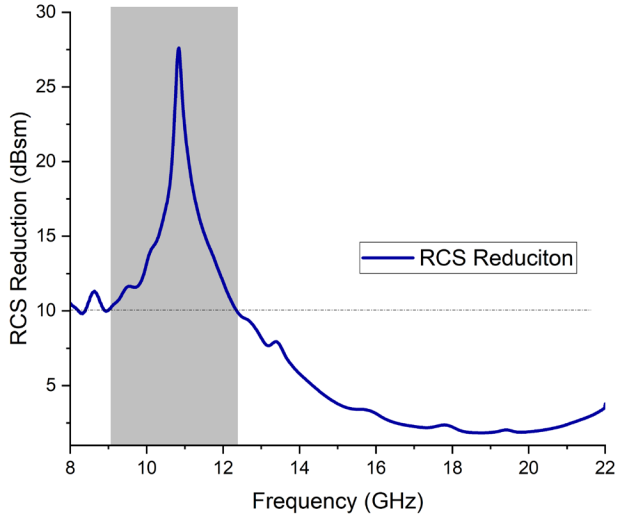

Figure 10. Simulated RCS reduction of metasurface

3 CONCLUSION

In this study, both linear and circular polarization converter metasurface design and analysis are presented. According to the results obtained, linear polarization conversion process was carried out with a polarization conversion rate of % 90 and above in the range of 7.2 − 12.8 GHz. Additionally, righthanded circular polarization conversion was achieved in the band gaps of 6.55 − 6.65 GHz, 15.17 − 16.65 GHz, and 20.72 − 21.55 GHz. Moreover, by combining the unit cell of the designed metasurface and its 90 degree rotated shape, a new metasurface array was created for the purpose of RCS reduction. This created metasurface array was compared with the PEC plate, and a 10 dBsm reduction in monostatic RCS value was achieved in the 8.96 − 12.35 GHz band range.

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The Effects of Electromagnetic Fields on Human Health and Occupational Safety

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Abstract

Electromagnetic radiation is divided into two main categories: ionizing and non-ionizing. While the effects of ionizing radiation (nuclear) are widely known, the effects of non-ionizing radiation (electromagnetic) are not yet fully understood. Electromagnetic fields, arising from the movement of electric charges and responsible for the operation of many devices, have become an integral part of our daily lives with the widespread adoption of modern technology. To describe how these fields propagate at different frequencies and wavelengths, a criterion known as the electromagnetic spectrum is used. This study provides information about a series of in-vitro and animal experiments that investigate the effects of electromagnetic fields on human health, while also addressing specific conditions such as the effects of electromagnetic fields on pregnancy and electromagnetic hypersensitivity. These experiments provide potential indications that electromagnetic fields may contribute to various health issues, including cancer, reproductive health problems, neurodegenerative diseases, and heart conditions, as well as psychological disorders. Electromagnetic fields also encompass a range of risks related to occupational safety, including the propulsion of objects due to static magnetic fields, triggering of electro-explosive devices, and the ignition of flammable atmospheres resulting in fires and explosions. The health and safety effects of electromagnetic fields depend on factors such as the frequency, intensity, duration, and frequency of exposure. When within appropriate limits, the adverse effects of electromagnetic fields are limited, and risks dissipate when exposure ceases. This study underscores the significance of electromagnetic fields in terms of human health and occupational safety and provides a foundation for future research.

Keywords: *Occupational health, Occupational safety, Radiation, Electromagnetic field, Risk*

1 INTRODUCTION

Radiation is a manifestation of energy, in the form of waves or particles, capable of penetrating matter and living organisms. Depending on its effect, it is categorized into two main types: Ionizing (nuclear) radiation and non-ionizing (electromagnetic) radiation. The effects of ionizing radiation have been fairly well understood by humans through painful experiences such as World War II and the Chernobyl disaster. However, non-ionizing radiation remains not fully comprehended due to factors such as its inability to be perceived by sensory organs, incomplete understanding of its sources, and its long-term effects. These uncertainties and gaps in knowledge have also raised concerns in society about the impact of Electromagnetic Fields (EMF) on human health. Ionizing radiation can induce the detachment of electrons from atoms and molecules, whereas non-ionizing radiation lacks sufficient energy to break atomic bonds. Nevertheless, it is acknowledged that non-ionizing radiation can lead to biological effects through mechanisms such as heating, alteration of chemical reactions, and the induction of electric currents in biological cells and tissues [1].

1.1 Sources of EMF

EMF are a prevalent environmental factor that has garnered increasing societal concerns in tandem with technological advancements, affecting various levels of exposure for all living organisms. These fields have become more pervasive and influential with the progress of technology. Electromagnetic radiation, a natural phenomenon existing since the inception of the universe, with light being its most recognized form, encompasses an energy form stemming from the motion of electric charges and involving electric and magnetic field components. Significant strides in understanding electromagnetic phenomena trace back to the 1780s when the Italian physicist Luigi Galvani discovered that muscles and nerve cells generate electricity. These advancements continued with Alessandro Volta's invention of the electric battery and other discoveries, such as Hans Christian Oersted's experiment in 1820 [2].

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Today, EMF have become an integral part of modern life, and envisioning a contemporary society without electrical devices is challenging. The industrial and residential use of electrical energy gained substantial momentum in the 20th century, similar growth occurred in areas like radio and television broadcasts, and revolutions in telecommunications transpired with wireless devices such as cell phones. EMF are also extensively utilized in advanced fields like radio navigation and medical applications.

Consequently, human-made influences beyond natural EMF have escalated. Understanding and managing the potential effects of these heightened influences on human health have become pivotal subjects of research and scientific endeavor. Research on the sources and impacts of EMF holds critical significance for health and the environment.

1.2 Electromagnetik Spectrum

Electric and magnetic fields are part of the electromagnetic radiation spectrum, which extends from static electric and magnetic fields to radio-frequency and infrared radiation, and X-rays. The electromagnetic spectrum defines electromagnetic waves, their frequencies, and wavelengths. At one end of the electromagnetic spectrum, there are high-energy gamma rays with nanometer-level wavelengths, while at the other end, there are very low-frequency waves with kilometer-level wavelengths [3] (Figure 1).

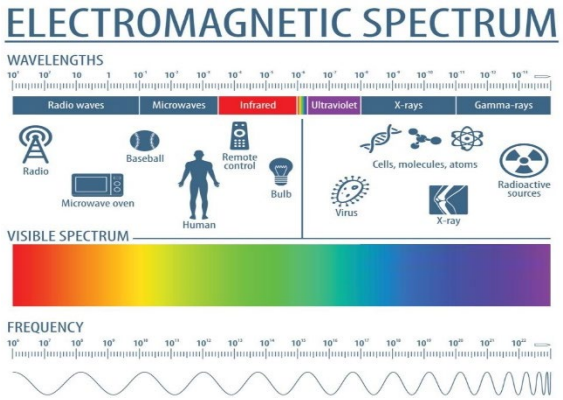

Figure 1. Electromagnetic spectrum

The generation of EMF within the scope of Directive 2013/35/EU, titled 'Directive on Minimum Health and Safety Requirements regarding the Exposure of Workers to Risks arising from Physical Agents (EMF), 'which is one of the most significant documents outlining the minimum health and safety requirements related to workers' exposure to risks originating from EMF, is a reality in the evolving world, as electricity is utilized in various domains of life. Electromagnetic radiation within the frequency range covered by the EMF Directive is not classified as ionizing radiation since it does not possess sufficient energy to remove electrons from the atoms of a material. X-rays and gamma rays, on the other hand, are high-energy electromagnetic radiations capable of dislodging orbital electrons, thus classified as ionizing radiation [5].

2 MATERIAL AND METHOD

In this study, a document analysis method was employed to examine and analyze printed and digital articles as well as printed books available in the literature regarding EMF and their impact on human health. Document analysis encompasses processes related to locating, reading, note-taking, and evaluating sources with a specific purpose [6]. In other words, document analysis is a series of activities that occur during the examination and evaluation of printed and electronic (computer-based and internet-accessible) materials [7]. This process is also defined as the examination of written materials containing information about the phenomena under investigation [8]. In summary, document analysis is acknowledged as the collection and examination of various writings, documents, creations, or artifacts produced or prepared by other individuals or institutions regarding the research topic [9].

3 RESULTS

Various research studies have been conducted on the effects of EMF on human health, with a particular focus on areas such as cancer, reproductive health, disruption of neural tissue, characterized neurodegenerative diseases, and heart diseases [10]. Several studies related to the subject are presented below.

3.1 In-Vitro Studies

In-vitro studies have been conducted using cell and tissue cultures to investigate cancer formation at various EMF levels. For instance, it has been reported that acute magnetic fields at 60 Hz can induce DNA breaks in rat brain cells, potentially affecting cellular functions and leading to cancer and neurodegenerative diseases [11]. In 2005, it was demonstrated that intermittent magnetic fields could cause chromosomal damage in cell cultures [12]. Additionally, it has been shown that a magnetic field within the range of 0.5-1 μT over 24-72 hours can lead to cell proliferation and DNA damage [13].

3.2 Animal Experiments

In animal experiments examining the health effects of EMF, it has been demonstrated that EMF can lead to increased phagocytic activity, enzyme activity, and cellular changes in macrophages [14]. Furthermore, studies conducted on chicken embryos have suggested that magnetic fields may influence embryonic development [15]. These experiments have also shown that magnetic fields can increase oxidative stress [16].

3.3 Electromagnetic Hypersensitivity

Some individuals exposed to EMF have reported a condition known as electromagnetic hypersensitivity, which has led them to quit their jobs or make lifestyle changes. Common symptoms in these individuals may include dermatological, neuroasthenic, and vegetative symptoms [17].

3.4 Cancer

Studies aiming to establish a connection between EMF and cancer have drawn particular attention to childhood leukemias and their potential relationship with EMF. Many studies have suggested that magnetic field levels above 0.4 μT may increase the risk of childhood leukemia [18]. Similarly, living near power lines has been found to be associated with childhood cancers [19].

3.5 EMF and Pregnancy

Studies on pregnant women exposed to EMF have shown a potential association between increased magnetic field exposure and the risk of miscarriage [20]. However, the relationship between congenital anomalies and diseases may be more complex, and different studies yield different results.

3.6 Other Health Effects

It has been proposed that EMF may affect melatonin levels and could be associated with conditions such as neurological diseases, brain functions, severe depression, and Alzheimer's disease. However, the results of studies on this topic are contradictory, and further research is needed.

4 CONCLUSION

Most individuals are exposed to weak electric and magnetic fields in their homes and workplaces while using electrical appliances, operating industrial equipment, or encountering sources such as power transmission, telecommunications, and radio waves. Additionally, the human body naturally generates small electric currents as part of its normal functioning. The impact of EMF on health depends not only on the duration of exposure but also on the intensity and frequency of EMF. Different frequencies interact with the body in various ways, with low-frequency fields potentially stimulating nerves and muscles, while high-frequency fields may cause tissues to heat. Occupational exposure limits are set at levels where adverse health effects are not expected to occur if these limits are adhered to. In other words, exceeding these limit values is necessary for adverse effects to manifest. The interaction of EMF with humans can be divided into four broad regions: static fields (0-1 Hz), low-frequency fields (1 Hz - 100 kHz), intermediate-frequency fields (100 kHz - 10 MHz), and radiofrequency fields (10 MHz and above). The EMF Directive anticipates that non-thermal effects are the effects on the nervous system and exposure to fields above 100 kHz may cause thermal effects related to heating. The EMF Directive establishes exposure limit values to provide protection to workers. These limit values are based on recommendations from the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and only consider short-term effects of biophysical interaction mechanisms, not long-term effects [21].

Some EMF only stimulate sensory organs, nerves, and muscles, while others can cause heating of body tissues. The EMF Directive classifies heating-related effects as thermal effects and other effects as non-thermal effects. However, it is known that exposures below a specific threshold value do not accumulate in the body and do not pose a risk. The impact is limited to the duration of exposure, and when exposure ceases, the effects also cease or diminish. Therefore, health risks disappear when exposure ends. There are two types of effects in terms of health impacts.

4.1 Direct Effects

The EMF Directive only addresses direct effects, taking into account the known effects. These direct effects are shown in Table 1 [5, 22].

Table 1. Direct effects of EMF at different frequency ranges on human health

Field	Frequency	Sensory Effects	Health Effects
Static magnetic field	0 - 1 Hz	Dizziness, nausea, metallic taste sensation	Changes in blood flow in limbs, alterations in brain and heart functions
Low-frequency fields	1 Hz - 10 MHz	Sensation of light flashes in the eyes, minor changes in brain functions in the range of 1 - 400 Hz	Tingling sensation or pain, muscle twitching, disturbances in heart rhythm
High-frequency fields	100 kHz - 6 GHz	Microwave auditory effect (individual perceiving spoken words as sounds) (200 MHz - 6.5 GHz)	Whole-body or localized heating or burns
High-frequency fields	6 - 300 GHz		Localized heat damage on the eyes or skin

4.2 Indirect Effects

Indirect effects arise as a result of the interaction between EMF and objects, which can lead to undesirable health and safety consequences. These indirect effects may include:

- Interaction of active implantable devices (e.g., pacemakers or defibrillators) with EMF.
- Interaction of medical devices implanted in the body (e.g., insulin pumps) with EMF.
- Interaction of passive implants (e.g., artificial joints, pins, or metal plates) with EMF.
- Effects on body piercings and tattoos.
- Risk of ferromagnetic objects becoming projectiles in static magnetic fields.
- Inadvertent triggering of electro-explosive devices.
- Fires or explosions due to ignition of flammable or explosive substances by EMF.
- Electric shocks or burns resulting from individuals touching a conductive object not grounded in an electromagnetic field [5, 22].

4.3 Effects on Occupational Health and Safety

EMF can also have significant implications for occupational health and safety. These effects may include the risk of ferromagnetic objects being propelled in strong static magnetic fields, the potential triggering of electro-explosive devices, and the occurrence of fires and explosions that ignite flammable atmospheres. In strong static magnetic fields, ferromagnetic objects can experience strong attractive forces depending on factors such as the magnitude of the magnetic field, the weight, shape, and material of the object. This can lead to the risk of these objects becoming projectiles, although this risk may vary under specific conditions. The potential for EMF to trigger electro-explosive devices is well-known, especially in the defense sector, and is an important consideration for both employees and employers. Additionally, EMF can induce spark discharges that have the potential to ignite flammable atmospheres under suitable conditions. Such sparks are induced within conductive structures by electromagnetic waves. However, for this effect to occur, there must be both a flammable atmosphere and sufficient field strengths to ignite it. Therefore, it may be relevant for employers in certain industries.

To mitigate all these risks and ensure occupational health and safety, technical and organizational measures should be implemented in workplaces. These measures include changing work methods, selecting equipment that produces low EMF, implementing shielding and safety interlocks using technical solutions, using signs and

barriers to restrict access, and providing training to individuals exposed to EMF. Furthermore, strict control over the use of electro-explosive devices and the identification of areas where flammable atmospheres may be present, along with restrictions on work in these areas, are crucial considerations for employers [5, 22].

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CSI Signals and Motion Analysis

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Abstract

CSI (Channel State Information) is a crucial concept playing a significant role in wireless communication systems. This term signifies the condition of communication channels and is commonly employed in Multiple Input, Multiple Output (MIMO) systems.

CSI signals are critical data used in wireless communication systems to provide information about the state of the channel. These signals, used in communication between devices equipped with multiple antennas, include essential details such as the condition of the channel, noise levels, and signal strength. CSI is utilized to understand variations in communication and ensure the effective transmission and reception of signals.

Motion analysis refers to the process of determining the location and movement of devices and objects using the information provided by CSI. Particularly in MIMO systems, CSI is used to determine the interaction and locations of devices with respect to each other. This enables obtaining detailed information about the position and movement of one device relative to another.

CSI signals and motion analysis are of great importance, especially in applications such as smart city implementations, the Internet of Things (IoT), and autonomous vehicles. For example, an autonomous vehicle can communicate with surrounding vehicles, analyze their movements, and use this information to determine driving strategies.

These technological advancements enable a better understanding of interactions between drivers, devices, and objects, enhancing communication reliability and facilitating the creation of smarter and more effective systems in various sectors.

In this paper, Channel State Information (CSI), or Kanal Durum Bilgisi in Turkish, has been utilized for motion analysis using ESP32 and NodeMCU. The software part involves the generation and analysis of CSI signals using C++ and Python, with the aim of ensuring cargo security.

Keywords: *Motion analysis, CSI signals, ESP32 NodeMCU module, Autonomous vehicles*

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An extension of the Ignite UI for Angular library for accelerating the design of web-based applications

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Abstract

In this article, we discuss the features of building a comfortable user interface for mobile, web, and desktop applications in the context of the MVC (Model-View-Controller) pattern and in particular the View layer. We present the main differences between the user interface (UI) and the user experience (UX). We also describe the main features of UI frameworks and libraries for building UI and focus on the most popular UI frameworks. The main task of our post is to offer one new component for the Ignite UI library for Angular.

Keywords: *User interface (UI), User experience (UX), Ignite UI library, Angular*

1 INTRODUCTION

The MVC (Model-View-Controller) pattern is at the heart of building modern web applications. MVC pattern [1] includes 3 layers: controller, model and view layers. Model layer implements the business logic of the application. It includes functionalities for accessing the data. Data may be stored in various databases, including integrated databases, various files, etc. It advocates abstraction, validation and authentication. View layer implements the presentation of this data to users. This includes managing the graphical user interface - forms, buttons, graphic elements, generating RSS (really simple syndication) [2] content for aggregators or Flash presentations. The view layer is directly related to the web design or templates that are used to create the user interface. This layer is responsible for presenting data on the screen and for user interaction with it. It is also responsible for collecting data from users. The main technologies used in the View layer are HTML, CSS and JavaScript. The controller manages the processing of events, which may be generated by a user or by a system process [3]. It interacts with the model to retrieve the required data and generate the view. The controller is also responsible for error handling.

View layer is of interest for our consideration. We can highlight the user interface (UI) and the user experience (UX) as a key factor in building a successful View layer. These two components work together to create a positive and seamless interaction between users and the system.

A well done definition for UI and UE is given in [4]. The dialogue between the user and the software is implemented through the user interface (UI). It allows the user to interact with the created software by giving instructions and information on the one hand and providing him with information on the other. I.e. The UI provides the efficient input/output of the software system. Basic UI components are buttons, icons, menus, forms, images, text, and any other visual elements that facilitate interaction. An efficient and easy-to-use interface is particularly important for the successful use of the software by a wide range of users.

User Experience (UX) reflects the feelings of the person interacting with the software [5]. UX describes the overall experience a user has with a product, including how easy it is to use, how intuitive navigation is, and how satisfying the interaction is. UX design covers various aspects such as user research, wireframing, prototyping, information architecture and usability testing. It is about understanding the needs of the user and ensuring that those needs are met by the product design.

Several factors can affect the user experience [4]:

- How to design a site according to the wishes or original goals.
- Site capabilities and limitations.
- Content and appearance of the site.
- Site functionality.

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UX and UI design are iterative processes. User feedback gathered during product testing and real-world use informs construction and adjustments to both UX (overall flow and functionality) and UI (visual elements and interactive components).

Both frameworks and libraries provide pre-built and well-tested code that speeds up the programming process and makes it easier for developers. The main difference is in the control over the design process and the architecture of the software created.

The developer himself determines the structure of the created software when using libraries. Their focus is on reusable functionality. Libraries provide pre-built functions, classes, or even entire tools that can be used in a wide context. The developer chooses when and where to use these ready-made components.

Frameworks often provide a higher level of abstraction. They can define the overall architecture and enforce specific design patterns by making certain decisions on behalf of the developer, and can sometimes even provide a set of design patterns. A framework can cover a wide range of functions. The developer fills in the functionalities of the framework structures. UI frameworks include a variety of tools, libraries, and templates that can be used to build visually appealing, responsive, and user-friendly application interfaces quickly and with fewer errors.

According to the statista.com [6] the most used web frameworks among developers worldwide, as of 2023 are presented in Fig. 1. We will discuss the first five of them.

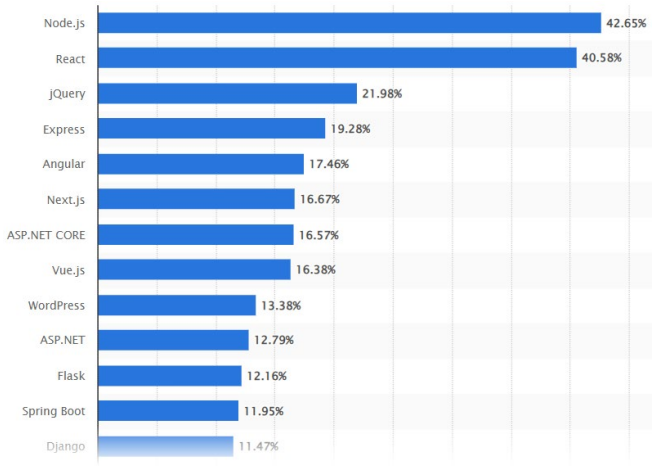

Figure 1. The most used web frameworks among developers worldwide, as of 2023, statista.com

Node.js is based on the server-side use of JavaScript to build dynamic web pages with real-time environment [7]. Node.js is an open source cross-platform environment that can run on Windows, Linux, Unix, macOS, and more. Node.js is based on a "JavaScript everywhere" paradigm and allows web application development to be built around a single programming language, as opposed to using different server-side programming languages. Node.js offers an event-driven approach to programming, a time loop mechanism, and a non-blocking I/O model [8].

React.js is an open-source framework specially designed to deal with the visualisation layer of web applications [9] - single-page, mobile, or server-rendered. It works with DOM (Document Object Model). React is a JavaScript library, based on components, for building user interfaces. React updates and renders just the right components when the data changes. It also offers developers access to powerful third-party tools and plugins. In many of the sources, React is only seen as a library.

jQuery is an open-source JavaScript library, which in some sources is also interpreted as a framework [10]. It is most often used with AJAX technology and using multi-layer architecture, in which factory pattern, dependency injection and reflection mechanism are applied in the multi-layer architecture. jQuery works with the Document Object Model (DOM) and allows simplified interactions between HTML/CSS documents [11]. jQuery enables successful integration with the business process processing framework [12].
Express is a minimalist web framework for Node.js [13]. It provides a robust set of features for web and mobile applications. It offers robust routing, high performance, content negotiation and quickly generating the applications.

Angular is an open-source JavaScript framework based on TypeScript (an extension of JS developed by Microsoft) [14, 15]. It was developed by Google with the main purpose of developing single-page applications. The main advantages of Angular are the standard framework for work and easy maintenance. It offers a successful implementation of the model-driven development concept. Angular is based on Components, Templates, Directives and Dependency injection. Angular is an application framework and includes a collection of well-integrated libraries that cover a wide variety of features, such as routing, forms management, client-server communication, and more [16]. Angular encourages developers to develop open-source libraries for public use. Publicly available instructions for Angular library developers have been created [17].

2 IGNITE UI LIBRARY FOR ANGULAR

The Ignite UI for Angular library is a complete set of Material-based components and support directives for Angular from Infragistics. It enables developers to build modern, enterprise-ready, high-performance HTML5 and JavaScript mobile, web, and desktop applications targeting the Angular front-end web framework [18].

The Ignite UI for Angular library consists of a set of ready-made components. This library can make the layout of an application much simpler, faster, and easier, and eliminate the need to build much of it from scratch [19].

UI/UX components can be grouped in many ways, but usually fall into one of the following categories:

- Input components - Allows users to enter information into the system.
- Navigational components - Help users navigate a product or website.
- Informational components - Share information with users.
- Containers - Keep related content together.
- Grids (Tables of Data) - Provide a means of displaying and interacting with large amounts of data structured in tabular form.

3 BUILDING A NEW COMPONENT

We notice the absence of a timer component in the group of offered in Ignite UI for Angular library components. This component can allow the page to display the remaining time to complete a certain operation. Our ambition is to expand the library by creating such a component that is easy to embed and creates a positive user experience. We stuck to two main aspects when building the timer component: vision and functionality.

The visual structure of the component that includes colours, layout, fonts, etc. are contained in the timer.component.scss file. We have adhered to the principle of obtaining a good user experience in selecting these features. The classes count-down-timer, description, and times describe the basic appearance of the component, while the classes timer-warning, timer-end and the keyframes pulse-red rule are responsible for the appearance of the component when the remaining time reaches a certain value or when it ends. Developing the vision of the component is presented in Figs. 2.a and 2.b.

The overall behaviour of the component is described in the timer.component.ts file. This includes - how the hours, minutes and seconds values are set, when and how the values should be changed, and provides an event to indicate when the timer has finished counting down.

The idea is that the user can set the time that the timer will count down and this happens by setting values to the hours, minutes and seconds properties. The Angular framework's @Input decorator is used to achieve this functionality. Values are set via get/set access modifiers to control the validity of passed values.

The timerEnded event is used to notify that the timer has finished counting time. This is useful in some scenarios, for example, a modal window with information needs to be displayed after the timer has finished, and a follow-up action is required, for example, pressing a button. The Angular framework's @Output decorator, which allows data to be sent from one component to another, is used to achieve this functionality.

```scss
$dark-purple: #641e41;
$light-white: #eaeaea;
$inactive-color: #cbcaca;

.count-down-timer {
  box-shadow: 2px 6px 9px 2px rgb(0 0 0 / 10%);
  text-align: center;
  background-color: $dark-purple;
  max-width: 400px;
  margin: 20px auto;
  color: $light-white;
  border-radius: 6px;
  padding: 10px;
  font-family: sans-serif;
  > p {
    margin: 5px 0 15px 0;
  }
}

.description,
.times {
  display: flex;
  justify-content: space-around;
  align-items: center;
}

.description {
  > p {
    margin: 0;
    font: normal 14px sans-serif;
  }
}
```

a)

```scss
.times {
  p {
    letter-spacing: -5px;
    position: relative;
    margin: 0;
    font: normal 40px courier, sans-serif;
  }
}

.timer-end {
  background-color: $inactive-color;
}

.timer-warning {
  transform: scale(1);
  animation: pulse-red 2s infinite;
  background-color: #d2042d !important;
}

@keyframes pulse-red {
  0% {
    transform: scale(0.95);
    box-shadow: 0 0 0 0 rgba(255, 82, 82, 0.7);
  }

  70% {
    transform: scale(1);
    box-shadow: 0 0 0 10px rgba(255, 82, 82, 0);
  }

  100% {
    transform: scale(0.95);
    box-shadow: 0 0 0 0 rgba(255, 82, 82, 0);
  }
}
```

b)

Figure 2. New component vision development

The setTime method is responsible for counting down the remaining time and providing those values to the hours, minutes, and seconds properties that are rendered in the html file.

The functionality development of the component is presented in Figs. 3.a and 3.b.

```ts
export class TimerComponent implements AfterViewInit {
  private _hours: number = 0;
  private _minutes: number = 0;
  private _seconds: number = 0;

  public warning: boolean = false;
  public end: boolean = false;

  @Input()
  get hours(): number {
    return this._hours;
  }
  set hours(value: number) {
    if (value < 0 || value > 23) return;
    this._hours = value;
  }

  @Input()
  get minutes(): number {
    return this._minutes;
  }
  set minutes(value: number) {
    if (value < 0 || value > 59) return;
    this._minutes = value;
  }

  @Input()
  get seconds(): number {
    return this._seconds;
  }
  set seconds(value: number) {
    if (value < 0 || value > 59) return;
    this._seconds = value;
  }
```

a)

```ts
private setTime(hours: number, minutes: number, seconds: number) {
  let totalTime = hours * 60 * 60 + minutes * 60 + seconds;
  if (!totalTime) return;

  let secondsValue: any = '0';
  const timer = setInterval(() => {
    totalTime--;
    if (seconds != 0) seconds--;
    else seconds = 59;

    if (seconds < 1 && !totalTime) {
      secondsValue = '0';
    } else if (seconds < 10) {
      secondsValue = '0' + seconds;
    } else {
      secondsValue = seconds;
    }

    let hoursValue = Math.floor(totalTime / (60 * 60));
    let minutesValue = Math.floor((totalTime / 60) % 60 | 0);

    this.hours = hoursValue;
    this.minutes = minutesValue;
    this.seconds = secondsValue;

    if (totalTime === 30) {
      this.warning = true;
    }
    if (totalTime === 0) {
      this.warning = false;
      this.end = true;
      this.timerEnded.emit(true);
      clearInterval(timer);
    }
  }, 1000);
}
```

b)

Figure 3. New component functionality development

4 TESTING A NEW COMPONENT

Jasmine and Karma [21] tools were used to test the functionality of the component. Jasmine is a JavaScript testing framework that supports a software development practice called Behaviour-Driven Development, or BDD for short. Jasmine and BDD in general try to describe tests in a human-readable format so that they can understand what is being tested without the need for technical knowledge. Karma is a tool that allows creating browsers and running Jasmine tests in all of them from the command line. Test results are also displayed on the command line. Karma can also monitor files for changes and rerun tests automatically.

When the new component is created, the necessary configurations are automatically added to the test file, as well as an example "should create" test. We will demonstrate only one new test "should set 'hours', 'minutes', 'seconds' properties properly", which tests whether the hours, minutes and seconds properties are set properly and whether these values are rendered in the html file. The set test values are hours = 2, minutes = 30 and seconds = 15 and the expect function marks the beginning of the expression with the expected result. The overall configuration is demonstrated in Figure 4.a-b.

```
import { ComponentFixture, TestBed } from '@angular/core/testing';
import { TimerComponent } from './timer.component';

describe('TimerComponent', () => {
  let component: TimerComponent;
  let fixture: ComponentFixture<TimerComponent>;

  beforeEach(async () => {
    await TestBed.configureTestingModule({
      declarations: [TimerComponent],
    }).compileComponents();

    fixture = TestBed.createComponent(TimerComponent);
    component = fixture.componentInstance;
    fixture.detectChanges();
  });

  it('should create', () => {
    expect(component).toBeTruthy();
  });
```

a)

```
import { ComponentFixture, TestBed } from '@angular/core/testing';
import { TimerComponent } from './timer.component';

describe('TimerComponent', () => {
  let component: TimerComponent;
  let fixture: ComponentFixture<TimerComponent>;

  beforeEach(async () => {
    await TestBed.configureTestingModule({
      declarations: [TimerComponent],
    }).compileComponents();

    fixture = TestBed.createComponent(TimerComponent);
    component = fixture.componentInstance;
    fixture.detectChanges();
  });

  it('should create', () => {
    expect(component).toBeTruthy();
  });
```

b)

Figure 4. New component testing

5 EMBEDDING A NEW COMPONENT

A default configuration is automatically generated when the component is created in the timer.component.ts file (Fig. 5). The parameter selector identifies the component and triggers its instantiation in the HTML file. It can be taken as the unique identifier by which components can be defined.

```
@Component({
  selector: 'my-timer',
  templateUrl: './timer.component.html',
  styleUrls: ['./timer.component.scss'],
})
```

Figure 5. The default configuration

The unique identifier of the new component is set to be my-timer in this case. The definition of the component is done through it (Fig. 6). For this component, the values of the time that should count down are set using the hours, minutes and seconds properties. The timerEnded event is used to define the event to perform some action in the timerEndedHandler method after the time has expired. This method is implemented in the ts (TypeScript) file and the name is only an example, it can be called anything as it is defined by the developer who will use the my-timer component when developing an application.

```
<my-timer
  [hours]="2"
  [minutes]="30"
  [seconds]="15"
  (timerEnded)="timerEndedHandler($event)">
</my-timer>
```

Figure 6. Define the component

6 CONCLUSION

The main advantage of the presented component is its uniqueness. The timer component was developed in sync with the requirements of the Ignite UI for Angular library. It is easy to embed and provides a good user experience. In order to become part of the library, it has to go through the relevant approval procedure.
The component could be improved in the following areas:
Flexibility. The ability to add the option to show only parts of the remaining time, for example, if only minutes and seconds are set for the countdown, not to display the part showing the remaining hours.
Changing styles. The component offers to change the styles by overriding the CSS classes. The module is about to be improved by giving the ability to change the default styles, which will ease the work of front-end developers.
Enrichment of events. The component has one event - timerEnded. In the process of operation, it may be necessary to add more events that are executed in different situations.

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Main Features of the Digital Transformation of Higher Education

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Abstract

The implementation of digital technologies and the global network impacts virtually all areas of life in the modern world. Higher education is no exception, and this requires an analysis of the entry of new technologies into education, as well as a review of existing strategic documents at the national and European level. The current study aims to review the process of digitalization of tertiary education and analyse the main factors that influence the process of digital transformation of higher education.

Keywords: *Digital transformation, Higher education, Factors*

1 INTRODUCTION

The growing use of digital technologies by young people is seen as a major topic in the 21st century and raises a number of questions related to the place of these technologies in modern life and their impact on the future. The introduction of multimodal and digital technologies in the learning process is constantly increasing. These forms of knowledge transfer and modes of communication are becoming common practice in university halls, combined with traditional educational technologies, such as lectures and the use of textbooks.

The concept of digitization is gaining popularity in modern society. Attempts to define digitalization and related concepts confirm the growth of scientific interest and the large-scale penetration of information and communication technologies in modern society.

The upheaval caused by the global health crisis was sudden and unexpected, and the subsequent economic and social measures have led to enormous change. The pandemic situation and the measures introduced had a huge impact on education. In a very short time, educational systems worldwide had to completely transform their conventional way of functioning and switch to e-learning. According to UNESCO, "higher education institutions closed their doors entirely in 185 countries in April 2020, affecting more than 1 billion students worldwide" [1].

The new reality foresees a radical change in education and training, and one of the sectors experiencing rapid digital development is higher education. The sudden forced termination of face-to-face learning has placed teachers and students in completely unfamiliar territory due to the need for timely adaptation to e-learning. This unexpected change was the reason for a rapid transition to e-learning, the implementation and adaptation of available technological resources and the inclusion of teachers and researchers who did not have the necessary technological training.

2 MATERIAL AND METHOD

The aim of this paper is to review the theoretical concepts related to the digital transformation of higher education, to identify the main factors influencing the process of digitalization and to mark the progress of the EU member states in this field. Descriptive and comparative analysis have been used in the study, applying qualitative data review.

2.1 Definition

The terms "digitization", "digitalization" and "digital transformation" are used interchangeably and it is necessary to distinguish between them (Fig. 1). The term "digitization" is defined as "the process of changing from analogue to digital format" [2] and is a purely technical process. "Digitalization" describes a distinct process (societal, operational or economic) and could be defined as "the process of using digital technologies and information to transform business operations" [2]. This definition could also be related to higher education.

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Figure 1. Concepts of digitization, digitalization and digital transformation (Source: Massachusetts Institute of Technology (MIT))

"Digital transformation" could be defined as the set of necessary digital processes aimed at strategic change in an individual organization. The important thing here is that digital transformation is about more than just digital processes. Bloomberg summarizes the three concepts as follows: "We digitize information, digitize processes and roles that define business operations, and digitally transform business and its strategy" [3].

Digitization can be seen as part of digital transformation, and additional components include the right strategic planning, trust building, organizational learning, etc. [4].

Therefore, digital transformation is understood as the set of digital processes necessary to bring about a change that will allow higher education institutions to successfully introduce the use of digital technologies.

2.2 Importance and Role of the Digital Transformation of Higher Education

Digitalization of education includes its modernization, reform and transformation, as well as solving problems and making decisions with the help of digital technologies [5]. According to researchers, digital technologies should be introduced in all areas of education, teacher training, educational infrastructure, methodology, teaching materials, as well as management at all levels and all sectors of the education system [6].

Digital technologies offer possibility for optimizing the learning process and improve the level of knowledge acquiring. Interactive tools support educators in introducing innovative approaches, including case studies, experimental and research work, simulation games, and more. The use of the listed methods leads to more efficient assimilation of information, development of "appropriate skills and work in an emotionally comfortable environment that stimulates motivation to learn, the birth of new ideas and creativity" [7].

The digital transformation of higher education is closely related to acquiring and improving the digital competence of both, students and teachers. Digital competence is an extensive holistic concept that encompasses technological skills in a broader perspective.

According to the European Commission "digital competence" refers to "effectively and critically use information and technology for training, self-development and active participation in society" [8]. The conceptual reference model of the digital competence is presented in Fig. 2.

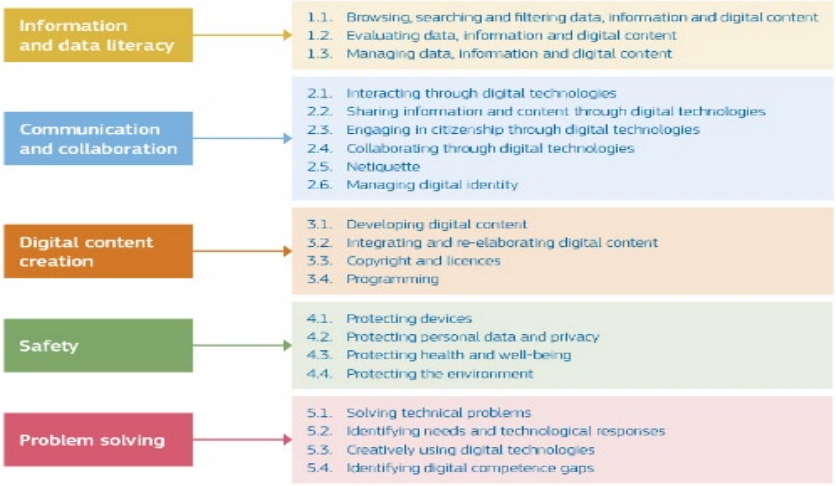

Figure 2. The DigComp conceptual reference model [11]

The DigComp framework 2.2. encompasses 5 different areas:

- Information and data literacy,
- Communication and collaboration,
- Digital content creation,
- Safety,
- Problem solving.

The set goal of the European Commission is that by 2030 at least 80% of all adults will have basic digital skills and that there will be 20 million specialists in the field of information and communication technologies in the European Union.

In the current pandemic situation, as well as with the trend of increasing internationalization of higher education, the introduction of e-learning will become more and more common practice. In view of the need for digital transformation of higher education, it is necessary to review the factors related to this process.

2.3 Main Factors for Digital Transformation of Higher Education

The main factors related to the digital transformation of higher education could be categorized in five groups:

➢ Political factors

Digital technologies have enormous potential to help increase the quality, equity and effectiveness of higher education. Realizing the full potential of digitization requires a rethinking of the policy framework, including ways of funding, additional training and quality assurance. An adequate strategic framework of digitization, monitoring and ensuring quality education is needed.

The EU Digital Education Action Plan 2021-2027 [9] has two main priority areas - promoting the development of a highly effective digital education ecosystem and improving the digital skills and competences needed for digital transformation.

Digital transformation affects every aspect of people's lives, providing enormous possibilities for “a better quality of life, innovation, economic growth and sustainability, but it also creates new challenges for the structure, security and stability of societies and economies” [10]. As the digital transformation accelerates, the European Union outlines “how its values and fundamental rights should be applied online in the recently adopted European Declaration on Digital Rights and Principles for the Digital Decade” [10].

➢ Socio-economic factors

- Competition between higher education institutions;
- Education costs;
- Generational differences;
- Social inclusion.

➢ Organizational factors

- Organizational culture;
- Organizational effectiveness.

➢ Educational factors

- Digital competence of teachers;
- Digital competence of students.

➢ Technological factors

- Diffusion of technologies;
- Infrastructure;
- Learning platforms;
- Information Security.

The digital age affects all participants in the educational process: both individuals and higher education institutions could not avoid the radical changes that technology initiated. Stakeholders are not even presented with a choice - it is inevitable to adopt and implement new, completely different approaches to digital practices that were considered unthinkable for most institutions in the recent past.

2.4 The Process of Digital Transformation of Higher Education

"Digital transformation" refers to the set of digital processes required to bring about the change that will enable organizations to successfully adopt the use of digital technologies.

The digitization of education includes "its modernization, reform and transformation, as well as solving problems and making decisions with the help of digital technologies" [12]. According to the researchers, digital technologies should be introduced in all areas of education, teacher training, educational infrastructure, methodology, teaching materials, as well as management at all levels and all sectors of the education system [12].

An adequate and modern management vision implies massive use of all new trends and technological renewal of educational institutions, which is able to qualitatively change the process of education development.

Technological developments also require the creation and updating of an appropriate legal framework, including on digital learning content and digital competence. Regarding the digital skills of teachers at all levels of education, the European Commission's Digital Competence Framework for Teachers (DigCompEdu) defines and describes the skills that teachers should acquire in order to teach and introduce innovations through the use of digital technologies.

In order to move to more sustainable model of e-learning, educational institutions need to utilize the existing technologies to reinvent learning processes, transform the roles of the traditional faculties and focus on quality through reinvention and the self-renewal of the educational service model and teaching methods. Fostering such digital transformation requires building a culture of active participation by students, faculty, and administrators to support the change. A number of educational institutions in the EU also face additional challenges, including financial and technological constraints. Public higher education institutions will also need to function in the situation of reduced state funding, while experiencing a drop in the number of students due to the recent and ongoing financial crisis. Investments will also be needed to improve the technical capabilities of European higher education institutions. Despite all these challenges, educational institutions in the EU are rather optimistic regarding the digital transformation. In a recent survey of institutions from all countries of the European Higher Education Area, most universities confirm that they "plan to explore new ways of teaching (92%) and improve its digital capacity (75%) after the crisis" [13].

2.5 Challenges in the Process of Digital Transformation

The introduction of digital technologies in higher education globally started already decades ago and differs significantly among individual higher education systems, as evidenced by the large amplitudes in the indicators of online learners in the higher education systems of OECD countries [14]. When digital technologies were first introduced, their use was still limited. Many of higher education faculty used existing systems only to publish syllabi, distribute course materials and assignments, and maintain semester grade information, and students accessed course materials, announcements, or grade information.

The pandemic situation has led to a sudden need for timely digitization of higher education, forcing educational institutions to make a rapid transition to online learning. E-learning platform providers have had to respond to a fundamental shift in the demands of educators and students. The use of virtual classrooms increased by 3600% in the month of March 2020 and by 9000% at the end of the month of September 2020 [15]. This process has been largely driven by the shift to online learning courses, but the use of e-learning platforms and students' use of alternative learning content formats has also increased dramatically.

The sudden shift to virtual learning in different countries is being accepted patiently and flexibly by teachers and students, although neither has perceived the experience as satisfactory. Educators are frustrated by the lack of guidance consultation when moving to distance learning, as well as the increased workload in developing online learning materials and students' need for more support in the virtual learning process.

A study conducted by the European Student Union shows that students prefer face-to-face interaction with professors [16]. As a result of the extraordinary and rapid transition to distance learning, many students perceived

it as incomplete and unsatisfactory. Lectures and seminars have not always been replaced by an online equivalent. Other challenges were related to a significant increase in workload and assignments, lack of a good internet connection, appropriate learning space and adequate learning materials.

Considering the challenges faced by institutions and individuals, it would be necessary to take the necessary measures and provide an opportunity to go smoothly through the process of digital transformation.

2.6 Digital Transformation "In Progress"

Among the goals of the European Commission, by 2030, all households in the EU will have broadband connectivity, and all populated areas will be covered by 5G.

Access to a reliable Internet connection significantly increases the chances of inclusion both in the learning process and in social and economic life. Existing technological limitations hinder the inclusion and participation of individuals in every sphere of activity in modern society.

From the given data, the rapid technological development and its importance for better connectivity and inclusion are evident. Broadband internet connection was used by 90% of EU households in 2021, almost 30% more than in 2011 (65%).

It is a positive fact that in the recent years, many households in Bulgaria have gained access to high-speed Internet and our country has largely approached the EU average indicators (Table 1).

Table 1. Household internet connection type: Broadband (percentage of households) – 2011-2021

TIME	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
GEO (Labels)											
European Union – 27 countries (from 2020)	65	71	74	77	78	82	83	85	88	89	90
Belgium	74	75	79	81	79	82	84	84	88	91	92
Bulgaria	40	51	54	56	59	63	67	71	75	79	84
Czechia	63	69	69	76	76	80	83	86	87	88	89
Denmark	84	85	87	85	84	92	92	90	93	93	92
Germany	78	82	85	87	88	90	92	90	94	95	89
Estonia	65	73	78	81	87	85	87	89	90	89	91
Ireland	65	65	67	80	83	86	88	88	90	92	93
Greece	45	51	55	65	67	68	71	76	78	80	85
Spain	61	65	69	73	78	81	83	86	91	95	96
France	70	77	78	77	76	79	79	81	83	:	88
Croatia	56	60	64	68	76	77	76	81	81	85	86
Italy	52	55	68	71	74	77	79	83	84	87	:
Cyprus	56	62	64	69	71	74	79	86	89	92	93
Latvia	59	67	70	73	74	75	76	79	83	88	89
Lithuania	56	60	64	65	67	71	75	78	81	82	86
Luxembourg	68	68	70	93	95	97	97	93	95	94	97
Hungary	59	66	69	73	75	78	82	83	86	87	91
Malta	75	77	78	80	81	81	85	84	86	90	91
Netherlands	83	84	87	94	94	95	98	97	98	97	99
Austria	72	77	80	79	81	85	88	88	89	89	91
Poland	61	67	69	71	71	76	78	79	83	90	92
Portugal	57	60	62	63	69	73	76	77	78	82	84
Romania	31	50	56	58	65	70	74	79	82	84	88
Slovenia	67	73	74	75	78	78	82	87	89	90	93
Slovakia	55	72	70	76	78	78	79	79	80	85	90
Finland	81	85	88	89	90	91	93	93	93	95	95
Sweden	86	87	:	87	83	89	93	91	95	91	91

The possibility of using broadband internet significantly influences the building of good digital competence and successful participation in the process of digital transformation.
Another important aspect is the level of digital skills. With regard to higher education, it is emphasized that the digital competence of teachers significantly affects digitalization in educational institutions and is related to the synchronization of students' educational needs, their personality traits, curricula, learning process management and digital competence. With a view to introducing effective digital integrated training, it is necessary to prioritize the development of the academic staff and the increase of their technological competence.

The digital competence of students also significantly influences the introduction of new technologies in education by harmonizing digital learning methods, intercultural interaction and equal access to higher education. Considering the critical importance of students' digital competence, it is necessary to make decisions at the political level and take the necessary measures to increase it, with a view to successful technological adaptation. This applies with particular force to Bulgaria, bearing in mind the data on the digital skills of Bulgarian citizens (Table 2).

Table 2. Individuals' level of digital skills (from 2021 onwards) (percentage of individuals)

INDIC_IS (Labels)	Individuals with basic or above basic overall digital skills	Individuals with above basic overall digital skills
GEO (Labels)		
European Union - 27 countries (from 2020)	53.92	26.46
Belgium	54.23	26.34
Bulgaria	31.18	7.82
Czechia	59.69	24.06
Denmark	68.65	37.37
Germany	48.92	18.84
Estonia	56.37	27.68
Ireland	70.49	39.69
Greece	52.48	21.70
Spain	64.16	38.06
France	61.96	31.25
Croatia	63.37	31.18
Italy	45.60	22.52
Cyprus	50.21	20.95
Latvia	50.80	23.79
Lithuania	48.84	23.01
Luxembourg	63.79	31.81
Hungary	49.09	21.54
Malta	61.23	35.49
Netherlands	78.94	51.77
Austria	63.33	33.28
Poland	42.93	20.64
Portugal	55.31	28.54
Romania	27.82	8.73
Slovenia	49.67	19.72
Slovakia	55.18	20.83
Finland	79.18	48.13
Sweden	66.52	35.68

It is noteworthy that the digital competence in Bulgaria is at a low level and this can be seen from the presented data and the comparison with other European countries and the average level for the European Union. It is necessary to take urgent measures to increase the technological competence in Bulgaria.

3 RESULTS

The process of digital transformation requires radical change at system level. The digital transformation of higher education is understood as the set of digital processes necessary to bring about a change that will allow higher education institutions to successfully introduce the use of digital technologies.

Higher education systems are expected to undergo a process of strengthening digitization in the planning of the educational process, the teaching and learning process, assessment and educational statistics. An adequate response to the need for more effective and widespread use of digital technologies will require higher schools to create a new generation educational environment.

The digital educational environment of the near future must be adapted for the use of mobile devices, offer conditions for better group work during the learning process and support interactive classrooms. Educators will have more complete access to student statistics and will be able to better identify their educational needs and difficulties they encounter; will have better assessment opportunities and advanced models for continuing professional development when using the digital educational environment.

The challenges facing the digitalization of higher education worldwide include the need for significant investments in hardware and software and sufficient time to train academic staff in applying new technologies. Educational institutions do not take full advantage of the opportunities of information and communication technologies to create a more flexible and rich educational process. Higher education institutions need to guide the digitalization process, so as to ensure that the services provided by educational technology providers meet the needs of teachers and students.

The digital transformation of higher education is closely related to acquiring and improving the digital competence of both, students and teachers. More efforts should be made in improving the digital competence of the academic staff and achieve the goals set by the European Commission.

Increasing digital competence is a priority at both European and national level, and its importance for digital transformation and higher education is crucial. Investments in human resources development and capacity building, as well as in improving their digital skills, will be repaid many times over, and the whole society will benefit from the positive effects.

Along with access to high-speed Internet, digital competence is the other condition for active participation and inclusion in the learning process, the labour market or public life in general.

In conclusion, we can point out that there is a significant difference between the development of the educational ecosystem and the ecosystem of digital technologies. Like any other ecosystem in nature, the educational ecosystem needs balance to be sustainable. The pandemic situation has shifted the focus on digital technologies behind e-learning, with too little attention being paid to people and learning methods. Data and technology are just tools, but the focus should be on the people in the system. If we limit ourselves to using technology to copy traditional pedagogical approaches, it will not serve the students well. A complete revision of the used training methods and the possibilities of new technologies should be done.

4 CONCLUSION

The recent global health crisis and the faster introduction of new technologies has led to a sudden digitalization that has made it difficult for a number of students to participate in the learning process and for teachers to deliver classes. It should be ensured that all students, teachers and staff will be supported with adequate training and inclusive measures on the one hand, and on the other - will have the opportunity to continue to carry out their activities in an analogue mode, using hybrid forms of education.

The significant impact of the recent global health crisis, combined with the possibility to use digital technologies to deliver online learning, represents an unprecedented opportunity to transform higher education in Europe and globally. We are all part of the digital world and the phenomenon of online learning will continue to exist. The expectation is to build a sustainable model that will continue to be implemented in the future.

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Basic Systematization of Nuances (Aspects) for Understanding Human Factors Pressure in Workplace Differences

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Abstract

The publication highlights a study in the scientific literature, where it was found that there is no established predominance of the nuances (aspects) for understanding the human factors pressure in workplace differences, because not only in a theoretical plan, but also in a practical environment, they are difficult to identify and depend on the normative approach of the authors, their research and conceptual views. This often makes it difficult to understand the concept of human factors pressure in workplace, because individual differences give rise to complex perceptions of behavioral actions, varying widely and in frequency of manifestation. The problem with terminology boils down to the conflation of etymological meanings, which creates confusion in the understanding, manifestation and intensity of behavioral workplace pressure. It is a palette of causes and effects (consequences) that are mixed in three accepted and academically established concepts ("mobbing", "bullying", and "harassment"), giving rise to peculiar interpretations in scientific research, object of consensus or controversial discussions in most of it.

Keywords: *Human factors, Work environment, Bullying, Mobbing, Harassment*

1 INTRODUCTION

The different treatment of the individual in the workplace creates conditions for discriminatory signs that reflect the individual behaviour and work potential of the human factors. In the scientific literature [1] a perception has emerged that the premises that lead to discrimination in the workplace are a major source of pressure for people when their rights are violated or conditions for a deteriorated organizational climate are created through personal attacks, insults and social exclusion. In the presence of discrimination in the labour process (both in terms of professional competences and in a personal plan for the individual), discriminatory signs arise that make the working climate problematic for the person and his relationships with others (the group).

In social management and workplace relationships, it is difficult to give a single explanation because people react in a certain way when they commit violence or pressure against others, and most importantly - what provokes them! There may be various causes arising from the character and behaviour of individuals, environmental factors and the type (specificity) of the situation. In the general context of the issue, workplace pressure is a catalyst for conscious and unconscious human behaviour, whether or not there is intent in it.

Sometimes a person can be kind, responsive and well-intentioned without having any characterological features of behaviour that make them aggressive, but a situation can send them out of control and give rise to a moment of violence. Is it then possible to claim that the person is predisposed to pressure - and yes and no?! Yes, because pressure can be a fact in a situation (be real), even though the person is not naturally inclined to it (unless they have the necessary tools and don't aim for it). Still, pressure does exist, and no one is safe from experiencing it or being a victim of it.

On the other hand, there are people who are permanently (by nature) aggressive, prone to violence in the workplace. These are individuals who have problems of a different nature, are complex, self-centered or simply enjoy watching (without direct intervention) others suffer. But there is an option for them not to react maliciously (to bully others) in a particular situation, no matter what the motives and considerations are for doing so. Here, too, the presumption is that bad guys are aggressive by definition, but the situation is such that in this particular case there is no human factors pressure in workplace. Why, since the aggressive person is capable of this? Because environmental and situational factors affect his consciousness, and hence his behaviour.

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2 SYSTEMATIZATION OF NUANCES (ASPECTS) FOR UNDERSTANDING HUMAN FACTORS PRESSURE IN WORKPLACE DIFFERENCES

The understanding of human factors pressure in workplace differences in the scientific literature is a complex component of conceptual views characteristic of specific time periods, linguistic features of the national identity of different countries, author positions and scientific interpretations. For the more precise identification of the theoretical positions in the scientific literature, three nuances (aspects) are examined for understanding the human factors pressure in workplace differences – "mobbing", "bullying", and "harassment".

In theory, there are some differences between the individual concepts, which, according to a group of authors, are not so noticeable in practice and it is difficult to determine their distinguishing characteristics, because the effects that occur are similar or identical [2-4]. A similar thesis is also advocated here, because in theory the concepts of human factors pressure in workplace differences have symptoms that give rise to different interpretations depending on the terminology that is used, but in a practical environment, the scientific research of the authors and the tools for their implementation follow a common context. It is about harmful, negative or inappropriate behaviour for the individual and/or group of people - negative effects and consequences of the manifestation of the human factors pressure in workplace differences, i.e. in a work environment.

As a result of the three nuances (aspects) for understanding the human factors pressure in workplace differences, characteristic features of the terminology are distinguished, which require systematization. The aim is to reveal key nuances of individual perceptions of people (caused by their differences), which depend on the subsequent determination of the form, degree, factors, intensity and effects of the manifestation of pressure in a working environment, i.e. its typology and conceptual model.

Of course, this is a difficult undertaking because the margin of distinction (and deviation) is very minimal, as some of them have similar characteristics or overlap (especially in practice). Usually, violence is associated with conceptual views of human factors pressure in workplace, but there are peculiarities - it is an introductory fragment to consequence depending on the context of the situation. The point is that violence is examined from the position of the abuser, who has a certain form of behaviour, visible and decipherable to others (mostly from the object of violence) – his behaviour is aggressive with different variations. Research in this direction is focused on the causes of this behaviour and the environmental factors affecting aggressive behaviour.

As for the human factors pressure in workplace differences, it can be part of the process of violence (pressure occurs without violent behaviour), and research focuses both on the "victim" (the target of workplace pressure) and their experiences, and on the bully provoking the pressure. From this point of view, the different shades of human factors pressure in workplace focus on the same phenomenon, but viewed from a different angle of victim and bully, i.e. prerequisites, causes and consequences of violent behaviour and victim in the situation [5-8].

For this reason, the review of the scientific literature gives reason to systematize basic theoretical statements for understanding the human factors pressure in workplace differences and to reflect their adequate application for research in practice, in relation to its accompanying nuances (aspects) - Table 1.

From Table 1, it is appropriate to make the following scientific findings to systematize the main theoretical propositions for understanding the human factors pressure in workplace differences, namely:

2.1 "Mobbing"

There is systemic mobbing that has a constant and negative impact on the behaviour of human factors in the workplace, there are no organizational mechanisms for counteraction, people are afraid to share, the subject of harassment is empowered or acts with machinations. Part of the group is surrounded by the one in power or under his tutelage, but its members act for their own sake. Even if informed about the group's (bullying) behaviour, the power subject remains passive or protects group cohesion (the group remains highly cohesive).

Because bullying permeates all levels of the organization (or unit), it affects groups and a person's personal identity. The groups that affect the target of bullying are more involved and to a limited extent personal "person-to-person" relationships are involved.

The manifestation of harassment is in an aggressive form, which gives rise to an attitude of constant and purposeful actions to discredit the person and search for an occasion for retribution. This creates a strong discomfort for the

individual with high levels of stress that affect their emotional and health status. Employees of a company are highly stressed, prone to harassment, often apathetic towards goals and objectives and demotivated to work.

The presence of "Mobbing" in the workplace creates a harmful environment for the individual, which is determined by the personal perceptions, preferences and attitudes projected on the consciousness and behaviour of the human factor - the object of harassment. An indicative effect of this process is the poor organizational culture, the bad organizational climate and the ignoring of reports and complaints of employees about harassment. As a result, an unregulated normative base is created with an ineffective departmental policy towards the action and behaviour of people in the work environment. Although there are signals and complaints from employees, they are ignored or remain in the background.

Table 1. Systematization of nuances (aspects) for understanding human factors pressure in workplace differences

Terminology / ***Key nuances***	***"Mobbing"***	***"Bullying"***	***"Harassment"***
Frequency (intensity) of pressure in working environment	Systemic (continuous) mobbing affecting the behaviour and action of the individual (personal and group) in a work environment	Regular (intermittent) bullying affecting a person's behaviour and action (personal and group) in a work environment	Discriminatory harassment (regardless of the frequency of occurrence) towards individual characteristics and behaviour of the person (personal and group) in a work environment
Personal and group manifestation of pressure in a work environment	Less often "Human-human" and more often "group-man"	More often "Man-to-Man" and less often "group-man"	Usually a mix of "Human-to-Human and Group-to-human"
Degree (level) of manifestation of pressure in a work environment	Aggressive attitude towards the behaviour and action of the personality (personal and group) in a work environment	Negative attitude towards the behaviour and action of the personality (personal and group) in a work environment	Inappropriate or offensive attitude to personal characteristics and behaviour of the person (personal and group) in a working environment
Organizational environment and opportunities for impact in the context of corporate culture	Toxic work environment, poor organizational climate and disregard for employee whistleblowing and complaints	Deteriorated social relationships, lack of adequate communication and conflicts when registering employee signals and complaints	Reaction after receiving a report of unethical or discriminatory behaviour in the case of employee reports and complaints
Context in which workplace pressure occurs	Abuse of a person's power, influence or dominant position in the organization over another or a group when the latter have no tools or mechanisms to protect against workplace pressure	Striving to prove superiority over another/s, looking for opportunities to discredit at work, personal influence over the psyche and behaviour of the individual or group, so as to harm the individual to achieve the intended results.	Interpersonal relations based on antisemitism and discriminatory signs towards the person (personal and group), including taking advantage of dominant positions in the organizational hierarchy
Opportunities for legislative initiatives (measures) against pressure in working environment	Lack of clear regulation in the legislative aspect, blurring the boundaries between professional (official) commitments, hidden motives and hard-to-prove subtext for pressure of the person (personal and group) at the workplace		Legislative regulation against antisemitic or discriminatory treatment of individuals (personal and group) in the workplace
Human factors impact tools for workplace pressure	Force, threat, coercion and compromise to perform a certain act	Psychological attack and negative influence to gain advantage in a specific situation	Extorting, inducing, provoking or taking advantage of the situation for personal interests and goals
According to the human factors intent degree for workplace pressure	Systematic/regular intentional or unintentional human factors behaviour and action, i.e. conscious or unconscious (subconscious) conviction to achieve interests goals in the workplace		

At the core of “Mobbing” pressure is power, struggle and the desire to redistribute positions of power based on personal and professional interests for goals, influence and supremacy. Less importance is given to the personality characteristics of the individual and he is seen more as a competitor in a work environment. Mobbing is accelerated by the lack of legislative regulation (unlike discrimination) that takes into account its framework and the influence of the primary source. Usually, the pressure effect is noticed at the expense of the approach, because much of the group's (or individual's) actions remain hidden and the motives and sources unclear. The person assumes where the pressure comes from (if there is no direct impact), but cannot always blame or expose the subject of mobbing, because it is the work of the group or part of it, i.e. responsibility is blurred.

Main tools for impact in "Mobbing" pressure are force, threat, coercion and compromising. They are a means of power that provides opportunities to influence the action and behaviour of others, i.e. to be mobbed for personal or organizational purposes.

Examples of mobbing:

- A head of a unit in the organization systematically mobbed the person “X”, because he is afraid of not taking his position;
- A group in the organization systematically mobbed the person “Y”, because it feels threatened by the sympathy of a part of the management towards him;
- A group from the financial and accounting department of the organization is systematically mobbed the person “Z”, because they found out about unregulated practices of intra-departmental allocation of amounts for performed activities.

2.2 “Bullying”

Bullying is not as intense as in the previous shade, but with a negative effect on the action and behaviour of the person. In contrast to "Mobbing", bullying, this one is carried out at certain intervals of time, so that it slowly and methodically affects the psyche and working capacity of the individual. He is gradually discredited on a personal and professional basis, efficiency in the labour process decreases, which destabilizes his behavior and confidence to cope with goals and tasks, i.e. affects productivity and quality of work.

“Bullying” takes place on an individual basis and partly affects the group aspect of the process, because it is a personal context of dissatisfaction and/or lack of personal potential. Prerequisites are created for a subject to bully another subject or to tune people to him so as to psychologically influence his consciousness.

The attitude towards the human factors is negative, although it does not cross the border into aggressive, but enough to traumatize people to not take initiatives and decisions in the workplace. When an individual is pressured with criticism, negative comments or pressure, it is difficult to stay focused and achieve high results.

Obviously, "Bullying" has a personal contrast to relationships - they do not escalate to a peak level, but lead to destabilization of communication in the workplace. The victim of bullying feels pressured by circumstances, ashamed, embarrassed, or blamed for outcomes that are not their responsibility. An environment of worsened social relations and conflicts is created, reports and complaints of employees are registered, but often without effect - there are usually no culprits or it is difficult to prove the wrongdoing of bullying.

At the core of “Bullying” is a desire for supremacy over another/s, opportunities to discredit at work, personal influence over the psyche and behavior of the person or group, so as to harm the individual not to achieve the desired results.

“Bullying” is manifested and developed by the lack of legislative regulation (unlike discrimination), which takes into account the limit of acceptable behaviour, because it is subjective to the specific situation and is a matter of argumentation - for example, when evaluating employees by their supervisors quality criteria.

The main tools for impact in “Bullying” are psychological attack and negative influence to achieve an advantage in a specific situation. They also relate to power, but are also applied at a lower level to equal positions in the organization or the ability of one person to negatively influence another/s.

Examples of bullying:

- A colleague in the organization does not like the style and way of working of person "X" and finds reasons for criticism, which affects his psyche, reduces motivation and work productivity;
- A project team leader dislikes person "Y", because a colleague gives him personal attention and underrates him for his work on the project for no reason;
- Person "Z" does not provide information to a colleague or sabotages the work under the pretext that it is missing or partial, which prevents the individual from performing the work well and on time.

2.3 "Harassment"

Harassment is about discrimination against a person, no matter where, how or by whom it is applied. Discrimination gives rise to harassment as a result of prejudice and unfair treatment (judgment, opinion and action) to the human factors in the organization because his dignity and status in society is affected. Oppressed subjects show discriminatory signs through negative attitudes towards individual characteristics and behaviour of the person in basic human characteristics – race, religion, gender, age and disability (disability). In recent years, discrimination has been perceived as a global problem in the workplace, is not subject to compromise and is regulated through normative acts.

Discrimination occurs at the individual and group level – the subject of harassment is discriminated against when his psyche and behaviour are negatively affected. There is discomfort affecting the socialization of the individual, reducing work productivity and leading to chronic stress. Symptoms affecting a person's emotional and physical health appear and reflect in the workplace - anger, irritation, aggression, apathy, alienation, lack of concentration, etc.

The basis of discrimination is an inappropriate or offensive attitude towards the individual or a group of people at the workplace, from which conflict situations and contradictions arise. This creates conditions for social differences in the workplace, neglect of human rights, equality and opportunities for self-expression.

Unlike the other shades of workplace pressure ("Mobbing", "Bullying"), the presence of "Harassmen" is regulated by legal acts, obliging the management of the organization to react to employee reports and complaints. Although discrimination governs the protection of natural persons only (legal entities do not fall into this category), organizations are obliged to take measures to verify and establish whether harassment has occurred (or not) and not to apply it to their employees. In most cases, it is about interpersonal relations through antisemitism and discrimination against the person (personal and group), including taking advantage of dominant positions in the organizational hierarchy.

The main tools for influencing "Harassment" are bothering, extorting, persuading, provoking or taking advantage of the situation for personal interests and goals. The latter are related to the perception and attitude of the individual, his desire to take advantage of the situation and obtain satisfaction of personal needs.

Examples of harassment:

- Senior managers do not allow a junior manager to eat at their table;
- A manager allows himself obscene compliments with sexual undertones to a subordinate, sends invitations to intimate meetings and sexual hints;
- Employees make fun of a colleague for being bisexual, having a strange gait, habits and manner of communication;
- An employer refuses to hire a woman for work if he finds out that she intends to give birth to children and go into maternity, when the applicant has health problems or is disadvantaged.

3 CONCLUSION

All three nuances of human factors pressure in workplace differences are associated with the degree of intent for the committed act. It is subject to systematic/regular intentional or unintentional behaviour and action i.e. conscious or unconscious (subconscious) conviction to achieve interests and goals in the workplace. This process could range from rude behaviour in the workplace to physical violence, abuse with trauma or death.

From what has been said so far, it can be concluded that in practice different aspects of the manifestation of human factors pressure in workplace differences are formed, and the nuances have a mixture of factors and specifics between them. This makes them difficult to distinguish in the context of their individualization, which aims to mainly underline the scientific contribution and effect in theoretical terms. As for the practice of the organizations,

the processes of human factors pressure in workplace differences are investigated, nuances, regularities and trends regarding the typology of manifestation are established.

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Impact of Cyberbullying on the Behavior and Performance of Employees: An Empirical Study in Telecommunication Services Companies in Republic of Bulgaria

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Abstract

The publication is oriented to a significant problem of digitalization in the workplace, where the benefits of information and communication technologies are often exceeded and their negative impact on the behaviour and work of human resources is highlighted. The emphasis of the publication is placed on the cyberbullying experienced by employees when the organization overdoes both the official authority and the personal time and interests of the human factor. In addition to a literature review on the issue, a study was also conducted into the practice of cyberbullying of employees and the impact on their behaviour in telecommunication service companies in Republic of Bulgaria.

Keywords: *Human factors, Behaviour, Work, Cyberbullying, Telecommunications*

1 INTRODUCTION

In recent years, the development of digital technologies and mobile devices has created a new approach in communication between people at the corporate and personal level - the electronic network and related components for electronic communication and exchange of data and information. Undoubtedly, today it is perhaps one of the greatest discoveries of our time, because it creates unprecedented conveniences to communicate anywhere and anytime with a click or minimal impact on the technical device. People can now talk and send messages anywhere on the planet as long as there is an Internet connection and an entity to communicate with. This social interaction in an electronic environment allows for the inclusion of heterogeneous social groups that can create communities in a digital environment and conduct communication without the need to be physically in the same place. This development of communication and the ability to communicate unrestrictedly in an online environment creates enormous advantages through the use of modern information and communication technologies, but they can be compromised when used for malicious purposes and interests.

One of the great advantages of the digitalization of communication processes in business and society is the fast and feedback relationship between the participating entities, the immediate sharing of data and information, as well as real-time conversations through the Internet and mobile communications. In modern society, e-mail, mobile communications and social media (Instagram, Facebook, Twitter, etc.) provide convenience in this regard, which help participating entities to communicate with each other in a timely manner, create groups and virtual communities, search for people by professional and personal interests, to create friendships and partner relationships [1-3]. However, this is only one side of a two-sided process that can also have negative consequences on human factor behaviour and performance.

As the Internet grows, the application of social media and mobile communications increases, so does the risk of malicious and harmful acts in the online environment, which can lead to cyberbullying and cybercrime, both in the workplace and reflect on people's personal lives. In this way, conditions and prerequisites are created for unregulated actions of a certain entity (person) or group of people in the online space, to harm another (others) through the use of modern information technologies and mobile communications. Thus, their application from a positive can turn into a negative when ethical practices and standards for work and interaction in an online environment are violated. This process is extremely dangerous in cyberspace, because unlike, for example, conventional harassment, which is visible to the victim (the object of harassment), in an online environment, the initiator of harassment can remain anonymous or cover up his tracks and actions [4-7] if the organization does not have the necessary cyber protection and control systems in place to successfully prevent cyberbullying in the workplace.

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2 CYBERBULLYING IN THE WORKPLACE

In recent years, the phenomenon of cyberbullying has grown at full speed, and according to data from Google Trends (Fig. 1.) from 2004 to 2020, cyberbullying has grown nearly three times, which is due to the development of information and communication technologies and the use of mobile telephones in all spheres of society and business. Globally, this has significantly changed the type of communication and the ways people communicate, who have started to communicate more often digitally. The Covid-19 pandemic has accelerated the process and forced digital technologies and mobile devices as a priority in the communication policy of modern companies and human communication in general.

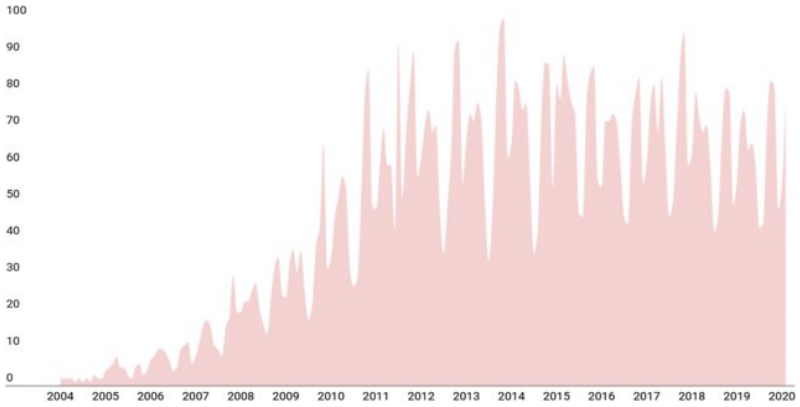

Figure 1. Source: Google trends

In the scientific literature [8, 9] cyberbullying in the workplace is defined as unwanted behaviour in an online environment, through which one or several subjects (the bully) perform unregulated actions by using electronic devices to bother (targetfully bully) a certain object (victim), based on unethical and harmful online content. It can have a different context, depending on the form through which it is used (social media platforms, sending offensive or inappropriate messages via e-mail and mobile devices, as well as disclosing inappropriate information in an online environment), thereby creating stress and tension in the affected side. From what has been said, a parallel can be drawn to the traditional way of bullying in the workplace in terms of their common characteristics and differences with cyberbullying.

Conceptually, traditional bullying and cyberbullying are similar in the following more important characteristics [10, 11]:

‣ *Tendency of behaviour by the subject of bullying (the bully) with the aim of harming the object of bullying (the victim)*. In both conventional and cyberbullying, there is a definite intention of a person or a group of people who have different psychological attitudes and motives to harm someone, as a result of personal dissatisfaction, unrealized ambitions, professional incompetence or use of a power resource for personal goals and machinations. These people (bullies) have a different type of behaviour, regardless of the type of bullying carried out, ranging from psychopathy to malicious actions to achieve specific goals and priorities.

‣ *Degree of intent to negatively impact the behaviour and performance of the human factors in the organization*. Both types of bullying are intended to harm the victim by disparaging them, based on compromised data or data that will affect them in the workplace.

‣ *Effect of negative behaviour on the victim*. Both types of bullying can create emotional-psychological and physical effects in the mind and behavior of the victim that reflect negatively on productivity and relationships in the workplace.

Conceptually, traditional bullying and cyberbullying differ in the following more important characteristics [12-14]:

‣ *IT technologies and connectivity of countries*. Unlike traditional bullying, which is face-to-face and requires the direct physical intervention (in real time) of two or more people, IT technologies allow bullying in an online environment to take place at any time and place where the bully and the victim are involved computer or mobile devices. This makes cyberbullying particularly dangerous, because by means of IT technologies it can be carried out and distributed comprehensively and without restrictions to any point on the planet with the necessary technical

characteristics and devices. Since people can no longer do without computers and mobile phones (or at least depend on them in their social environment or in their profession) they cannot protect themselves from targeted cyberbullying or cybercrime behaviour in the various forms and aspects of digital technology.

‣ *Opportunities to anonymously impact the abuser*. Modern information and communication technologies allow bullies (the subject of bullying) to remain anonymous, covering their tracks in the online space. Unlike conventional bullying, where people cannot escape the confrontation and it affects both parties (regardless of whether one has the upper hand through power or other attributes of professional and behavioral dominance), in cyberbullying encounters are completely absent or limited to communication in technological platforms. This creates confidence for the abuser to not only be assertive, but to abuse the acceptable boundaries of ethical behaviour, even going beyond normal online communication practices. To a large extent, the anonymity of the abuser manifests itself in the victim's personal contacts on social platforms and unsecured digital communications, but this can also transfer to the workplace, where robust protections and systems are needed to improve corporate cyber security.

‣ *Digital skills of the abuser*. While traditional bullying can take place on the spot and does not require some form of intelligent communication, ie. it is enough only to be bully by the object, in the case of cyberbullying it is necessary for the bully to have at least basic knowledge in the field of digital communication. When he needs to skillfully cover his tracks or remain undetected, this knowledge can grow into appropriate digital skills (even hacking) so that he constantly bullies the victim online. The digital skills of the abuser can make him a skilled online manipulator who constantly and everywhere stalks the targeted victim online, even if he is recognized and blocked, he can create new accounts to continue bullying the person.

‣ *Larger audience of unethical and harmful online content*. Communication online is usually seen and read by a larger audience, which means that online bullying can be widespread and reach more people. Of course, there are also corporate groups within the organization with quite a few managers and employees who can witness online bullying that can denigrate the victim. Therefore, most organizations seek to curb this type of unregulated behavior through systems to control and censor inappropriate content and online behaviour.

The following are the main forms (types) of cyberbullying:

- messages with bully online content;
- malicious and defamatory offensive messages on social platforms;
- electronic and SMS messages violating the privacy of the individual;
- messages sent at a time specified for rest or leave for the individual;
- photo or video material threatening the security, psychological (emotional) stability and physiology of the individual;
- mobile calls or SMS messages with an indecent context;
- hindering normal work with digital technology: viruses, phishing attacks, etc.

Both traditional and cyberbullying create various effects on the behaviour and performance of human factors in the organization related to:

- technostress from unethical and harmful online content;
- psychological problems and cognitive negative perceptions;
- lack of motivation and alienation from work;
- physiological problems and prerequisites for health problems, etc.

For the organization, cyberbullying creates various effects related to:

- complaints and filed cases for cyberbullying;
- demotivated employees;
- drop in labor productivity;
- limited human factor initiatives in a cyber environment;
- problems with cyber security and protection systems, etc.

To deal with cyberbullying in the workplace, organizations can implement a targeted and adequate policy to prevent it or reduce it to acceptable limits, as follows [15-17]:

‣ *Cybersecurity Strategy and Policy*. These include an organizational culture adequate to cyberbullying and a policy to deal with it, including regulating a framework for countering and responding to complaints and complaints from the organization's human resources.

‣ *Rules and regulations to prevent cyberbullying in the workplace*. Having clear zero-tolerance rules and regulations for cyberbullying and subsequent punitive effects for offenders can deter bullies from bullying victims. This requires not only the development of normative documentation to regulate signs of cyberbullying in the organization, but also to stimulate the human factors to share about any situation of unethical practices in an online environment.

‣ *Training to deal with cyberbullying in the workplace*. In order to be able to understand cyberbullying and react to its negative impact, the human resources of the organization must be trained on how to act in such situations. This necessitates the development of training modules that set the parameters and determine the guidelines for the prevention and management of cyberbullying situations.

‣ *Diagnosis and monitoring of cyberbullying*. In order to prevent cyberbullying and limit it within acceptable limits, it is necessary to carry out diagnostics of online communication and the actions of the human factors in an organizational cyber environment. In addition, monitoring is required through the implementation of modern security and cyber protection systems to filter the content of information and communication in the online environment and intercept malicious acts of cyberbullying in the workplace.

In order to ensure the sustainability of management in a cyber environment, the organization must take not only adequate, but also timely measures to oppose cyberbullying and provide the necessary conditions for human resources to work safely and effectively in the conditions of digitalization of business activity.

3 FEASİBİLİTY STUDY FOR CYBERBULLYİNG ON THE BEHAVİOR AND PERFORMANCE OF EMPLOYEES İN TELECOMMUNİCATİON SERVİCES COMPANİES İN REPUBLİC OF BULGARİA

Telecommunications is an important industry that continues to grow and provide new opportunities for connectivity and innovation. Undoubtedly, technological development in this sector is one of the most dynamic, which presents organizations in the sector with a number of challenges. One of the most important of which is a continuous and proactive offering of services to organizations from other sectors of the economy that are ready to experiment in order to be competitive in the conditions of rapidly advancing digitization.

This need on the part of organizations became tangible during the Covid-19 pandemic, when they had to go completely digital.

This, in turn, necessitated a change in business models, not only in a technological but also in an organizational management aspect [18]. It led to a change in work processes, communication between employees, an increase in the use of digital tools, etc [19].

All these changes to one degree or another affect all sectors of the economy, but the special thing about organizations from the telecommunications sector is that it is thanks to them that all processes are carried out in a digital environment. This requires a constant focus on improving existing and offering new services, which in turn requires continuity, creativity, flexibility on the part of employees of telecommunication companies to the growing demands of users of telecommunication services.

For a long time, the workplace is no longer just a physical space that employees occupy during their working hours [20].

As the boundaries between work and personal life are gradually erased, the workplace becomes truly digital, and employees communicate and collaborate in unprecedented ways. [18] All this leads to the so-called constant connectivity, which often gives rise to cyberbullying, knowingly or not.

Being responsible for enabling the work processes of organizations to take place in a digital environment, employees in telecommunication services organizations seem to be the most affected by all this. From such a point of view, the authors of the present paper are conducting a pilot study based on which to establish the presence / absence of cyberbullying in telecommunication service organizations, and the degree and form in which it manifests itself.

For this purpose, employees from 12 organizations (small and medium-sized enterprises according to the number of employees up to 50 people and medium-sized enterprises from 50 to 250 people)[1] for telecommunication services (total 96 employees) were studied. The authors do not claim representativeness of the sample, since this study is a pilot study and aims to lay the foundations for the subsequent development of a methodological toolkit for diagnosing the typology of the manifestation of bullying and opportunities for its management in large companies for telecommunication services in the Republic of Bulgaria.

Due to the limited scope of the publication, only part of the results of the conducted research are presented. For the purposes of the study, a survey method was used.

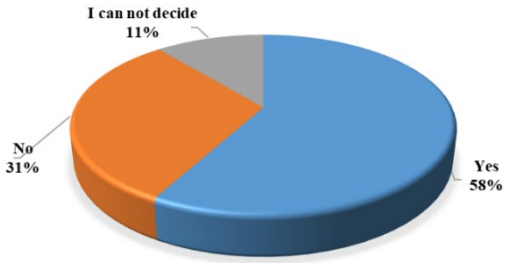

Figure 2. Existence of cyberbullying in the surveyed telecommunications companies

As can we seen from Figure 2, over half of those surveyed (58%) believe that there is cyberbullying in the surveyed organizations. This fact is not accidental, precisely because of the need for continuous communication between employees and a quick response in work processes.

The results in the next figure are indicative of this. The first two places are occupied by professional calls from managers, outside regular working hours (92%) and professional messages from managers, outside regular working hours (88%). Unfortunately, the percentage of cyberbullying is not small, which is expressed in offensive messages and malicious attacks on social platforms, which answer was indicated by 65% of the respondents.

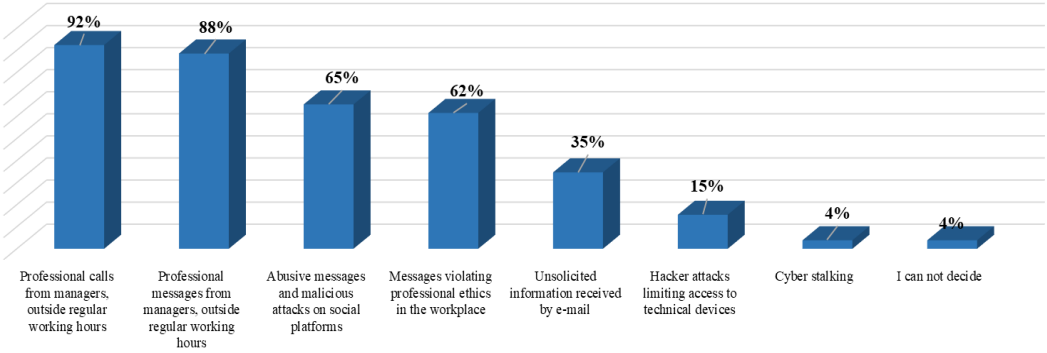

Figure 3. Type of cyberbullying in research telecommunications companies[2]

Regardless of the form and extent of cyberbullying, it can have different effects on employees. The following figure shows how cyberbullying affects the behavior and performance of the surveyed employees in the telecommunications companies.

[1]This classification is based on the Law on Small and Medium Enterprises in the Republic of Bulgaria, https://lex.bg/laws/

[2]In Figs. 3 and 4 The surveyed employees have the opportunity to indicate more than one possible answer.

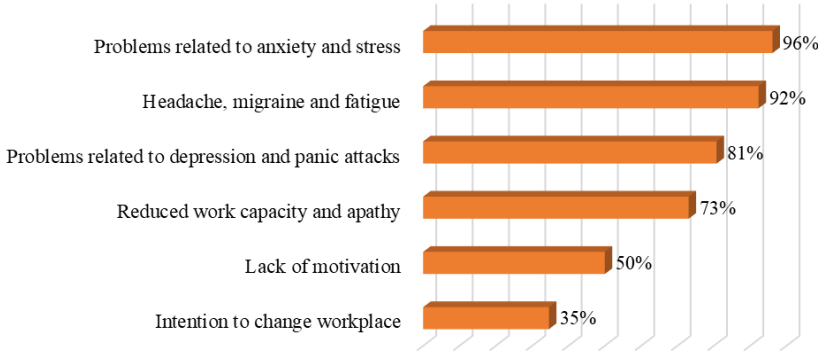

Figure 4. Effects of cyberbullying on employee behavior and performance in telecommunications companies

What is striking about the figure are the overwhelming responses regarding problems related to anxiety and stress (96%), headaches, migraines and fatigue (92%) and problems related to depression and panic attacks (81%). Although the negative consequences of cyberbullying, both physical and mental, are more prevalent, only 35% of employees surveyed are ready to leave their workplace and replace it with a new one.

4 CONCLUSION

The digitalization of business processes in organizations, as well as the wide application of social platforms as a way of personal and professional communication in the workplace, have created undeniable conveniences for connectivity between people, regardless of their geographical location. However, this also led to some negative trends, mainly related to compromising the security of data and information and called into question the inviolability of the person in the online environment. Thus, the development of digital technologies became a prerequisite to facilitate the communication processes between people and to optimize not a small part of the work processes, but it put to the test the personal identification of the person in a cyber environment and his vulnerability to cyber attacks and cyber bullying.

Through this publication, theoretical aspects of cyberbullying in the workplace have been explored, touching on some important highlights in the specialized literature. In the general context of the issue, it was established that cyberbullying is harmful (unwanted) behaviour at the workplace that can disrupt the personal and professional rhythm of any person subjected to stressful and harmful factors and situations in the online space. On the other hand, the publication examines some characteristics of traditional versus cyberbullying in the workplace, identifying the main forms (type) of cyberbullying and their corresponding manifestations - in a personal context for the individual and in an organizational aspect. Basic guidelines for dealing with cyberbullying in the workplace have been systematized with research in a real business environment in the field of telecommunications sector in the Republic of Bulgaria. Based on what was said through the post, the following was achieved:

- A theoretical overview of the conceptual aspects of bullying and cyberbullying in the workplace was made, justifying their specificity, similarities and distinguishing characteristics;
- The main forms (type) of cyberbullying in the workplace are identified, reflecting the effect on the behaviour of the human factors and the effect on the organization - in a negative context;
- A framework is outlined for organizations to deal with cyberbullying in the workplace based on strategic activities to manage it or reduce it to acceptable limits;
- A pilot study of the manifestation of cyberbullying was carried out in several organizations from the telecommunications sector in the Republic of Bulgaria, and the presence of cyberbullying against employees was established, which was categorized by degree of manifestation and corresponding effects.

Acknowledgments

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Improving the Email Software Security by Identifying the Attacker Tools and Techniques

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Abstract

Due to the current revolution of multimedia technologies and the widespread use of internet, the attackers did their best to improve their tools and techniques to attack different systems and networks as well. As a result, software developers should duplicate their efforts to face such a rapid improvement in cyber security attacker techniques. The benefit of this paper is to shed light on the attacker's techniques and the tools used in the process of attacking. This paper is answering questions for instance, how the effect of cyber-attacks could be avoided or minimized?, what are the tools and techniques the attacker is using to exploit the faults in email software product?, how the vulnerability concepts can help us to determine the product vulnerabilities?. This paper intended to offer a complement knowledge about representing the faults and the errors that occurred in email software products that usually happened within different stages of the producing products before the process of releasing them in markets, and accessible to everyone. Hence, this paper is an attempt to improve the future of software products in addition to minimize or avoid the errors completely.

Keywords: *Software faults, Software development life cycle, Software vulnerabilities, Cyber security attacks*

1 INTRODUCTION

The tremendous spread of email communication services led to emergence of a new effective set of complementing standards and solutions aimed to raise security rates and privacy issues. However, practically these improved methods and technologies proved its failure to provide the required protection. As a result, global email communications remained primarily open to security and privacy concerns since, email communications are no longer remained as an adequate safeguarded in general. According to the findings of the research we found out that most global email communications pose major privacy and security threats. Three parties can intercept email content; placing the conditional, integrity, and availability of the information shared, in the message's text and any attachments that are vulnerable to risk. Standards, protocols, and procedures have the potential to improve the security of email conversations, but they are not always used or even applied correctly in reality. Technological countermeasures, such as SMIME and OpenPGP (e.g., PGP/GPG), that have been demonstrated considered as not enough active tools that stand in the way of all security and privacy risks, they are rarely used in practice because they are not supported by commercial providers, who do not integrate them into their web-based email clients and mobile applications. Due to the lack of both support and integration the current use of end-to-end security solutions has usability concerns and necessitates IT skills that the common person lacks.

Vulnerability represents a flaw in the software that may be utilized and used by a hacker to get direct access to the system or network, [1, 2]. Vulnerability refers to a flaw or fault in system security processes, design, implementation, or internal controls that can lead to a security breach or destruction of the system's security policy. Vulnerabilities has been defined by MITRE Corporation in CVE database. Software vulnerability represented in form of CVE entry or node in the properties: CVE-ID, Description, and references, while the last property is ignored in this study. The properties Component, Product Vendor, Root-Cause, Attacker, Impact, and Vectors are obtained from CVE description property. In this study ontology is used to represent the email software product vulnerabilities with their properties. The sample data are extracted from MITRE Corporation website [3].

Weakness is a mistake or condition that, if left unaddressed, could under the proper conditions contribute to a cyber-enabled capability being vulnerable to attack, allowing an adversary to make items function in unintended ways. While vulnerability is an occurrence of a kind of weakness (or multiple weaknesses) within software, in which that weakness can be used by a party to cause the software to modify or access unintended data, interrupt

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proper execution, or perform incorrect actions that were not specifically granted to the party who uses the weakness.

In this paper the software vulnerabilities with their properties were representing using ontology. Ontology is described as a data model that represents a collection of concepts within a domain and the connections among those concepts [4]. It is employed for reasoning about the items in that domain. It enables the information to be shared and reused. It is a study of the conceptions of reality [5]. Ontologies make up of three main elements Classes, Properties and Individuals.

1.1 Literature Reviews

Products vulnerabilities have been studied by many researchers for instance A. Tripathi and Umesh Kumar Singh in [6] and [7] stated that Software vulnerabilities represent one of the key factors that endangers software product; it is considered as a vital issue for producing hardener and robust product towards the variant attacks.
In 2016, Umesh Kumar Singh and Chanchala Joshi in [8] proposed a risk estimation model that uses vulnerability database at the National Institute of Standards and Technology (NIST), National Vulnerability Database (NVD), and the Common Vulnerability Scoring System (CVSS).

Irena Bojanova, Paul E. Black, Yaacov Yesha and Yan Wu in [9] used BF, but this time it included rigorous definitions and (static) attributes of bug classes, along with their related dynamic properties, such as proximate, secondary, tertiary causes, consequences, and sites. Their study discussed the buffer overflow class, the injection class, and the control of interaction frequency class, and provided examples of applying their BF taxonomy to describe particular vulnerabilities.

All studies that dealt with software product vulnerabilities didn't take into account the product vulnerabilities without studying and being familiar with their properties and the way that enable attackers to attack the software products.

1.2 The Work Ontology Description

Ontology is known as data model that represents a collection of concepts within a domain and the connections among those concepts [10]. It is used for reasoning about the items of that domain. It provides definitions for the terminology that used to characterize and depict the mentioned field of study. In other words, it is a collection of ideas and classifications within a certain field that serves to illustrate their characteristics and connections [11]. People, databases, and apps utilize ontologies to exchange knowledge within a domain [12].

Ontologies make up of Classes, properties, and relationships among class members. Classes are groups of things, objects, or even instances that share the same descriptions. OWL properties have binary relationships on the individuals, [11], which aims to describe the individual membership in a class through constructing several restrictions in order to link an individual from class to an individual from of another class. While the individuals in ontology may include particular objects, such as people, animals, tables, automobiles, molecules, and planets. Individuals are the other important elements in ontology components; they represent objects in the domain in which we are interested in, [13]. The following two main elements should be prepared first before starting to create the work ontology:

1. Email CWE Entries: The weakness properties are represented in each entry involving ID, Name, Abstraction, Description, Extended Description and Relationships. All these properties are interpreted according to the ontology fundamentals of the design of ontology.
2. Email CVE Entries: Common Vulnerabilities and Exposures (CVE). Entry possesses have three main properties, they are the CVE identifier (CVE-ID), Description, and References. Each CVE entry has properties CVE-ID, Description, Component, ProductVendor, Version, Attacker, RootCause, Impact, and Vector.

Classes are CVEEntries that contains all CVE entry individuals. CWEEntries contains all CWE entry individuals in the work domain. It has subclasses: Classes, Bases, Variants, and Views. All the individuals in this class have ID and Name datatype properties. Classes: involves the class abstraction level instances. Bases: subclass includes the base abstraction level instances. Variants includes the variant abstraction level instances. Views: includes the view instances.

Properties can be shown in two types, object properties and datatype properties. Object Properties are linking an individual from a class to an individual in other class, for instance VulnType is linking the/a CVE individual

(entry) to the/a CWE individual (entry), hasMember is linking an individual from views class to an individual from Classes class, hasChild is correlating an individual from Classes class with an individual from Classes, Bases, or Variant class, hasBaseChild linking an individual from Bases class to an individual from Bases, or Variant class, hasVariantChild is correlating an individual from Variants class with an individual from Variant class.

While datatype Properties are linking represents that an individual from a class with a data type (integer, string, Boolean, and others) [14, 15]. For example, ID property with integer, Name property with string. The CWE entry datatype properties, for instance ID datatype property represents CWE entry identifier, Name is the datatype property representing the name CWE entry with a string data type, and Description is datatype property representing CWE entry description.

In addition, CVEID datatype property expresses the vulnerability entry identifier, CVEDescription datatype property represents the CVE entry definition and explanation, Component clarifies the part that is exactly affected, ProductVendor represents the name of the product or Vendor, Version datatype property represents the version(s) of the affected product, Attacker datatype property clarifies the attacker type remote attacker, users, or others. RootCause datatype property represents any additional information about the techniques and tools for the CVE entry. Impact datatype property represents the effects of the software product. Vector datatype property represents the used tools and techniques in attaching.

The third important element in the work ontology is Individuals therefore, there are CWE individuals for instance, CWE-20 which should be created with a roper name then determining its type class (Views, Classes, Bases, or Variants). In addition to CVE entries that should be created for instance, CVE-2005-3287 and all CVE datatype properties should be assigned.

2 THE KNOELEDGE BASE AND APPLICABLE CASE

Through the following usable cases, the benefit of the ontology can more effective:

Case 1: The following query is used for testing the infected email products with the attacker tools by checking the effected email product vulnerabilities that exploited be the attacker. The query is checking the email vulnerabilities on the base of: mail “keyword to involve all email software products.

```
PREFIX : <http://www.semanticweb.org/falak/ontologies/2018/0/20/untitled-ontology-337#>
        SELECT DISTINCT *
        WHERE { ?CVEID  :CVEDescription ?CVEDescription;
                        :Component ?Component;
                        :ProductVendor ?ProductVendor;
                        :Version ?Version;
                        :RootCause ?RootCause;
                        :Impact ?Impact;
                        :Vector ?Vector;
                        :VulnType ?VulnType.
              ?VulnType :Name ?CWEName;
             filter( regex(?Vector, "mail")) } ORDER BY  ?VulnType
```

This query is find knowledge about the email product vulnerabilities using “Vector” property on the base of “mail” keyword organized by the Product CWE entry through the property VulnType.

The result of this query is shown in Table 1 which demonstrates the effected email weaknesses products and its related vulnerabilities. Additionally, Vectors column shows the tools and the techniques that the attacker is using when attacking. It contains a sample of email product infected declaring the CVE vulnerability and the related CWE entry. Table 1 show the sample of tools and techniques that attacker is using when attacking these email products.

Table 1. Sample of email products that shows infected by attacker tools

CVEID	ProductVector	Vectors	VulnType (Infected CWE)
CVE-2017-7440	Kerio Connect for Windows and Mac	via a crafted e-mail message.	CWE-1021
CVE-2003-0307	Poster version.two	by appending the “field separator and an “admin” value into the email address field.”	CWE-141
CVE-2002-0542	OpenBSD	via calls to mail in cron.	CWE-150
CVE-2003-1015	Multiple content security gateway and antivirus products	via MIME messages that use whitespace in an unusual fashion, which may be interpreted differently by mail clients.	CWE-156
CVE-2005-2933	mail.c for Washington’s IMAP Server (UW-IMAP)	via a mailbox name containing a single double-quote () character without a closing quote, which causes bytes after the double-quote to be copied into a buffer indefinitely.”	CWE-157
CVE-2005-4155	ATutor	via an e-mail address that ends in a NULL character, which bypasses the PHP regular expression check.	CWE-158
CVE-2005-4155	ATutor	via an e-mail address that ends in a NULL character, which bypasses the PHP regular expression check.	CWE-185
CVE-2002-0485	Norton Anti-Virus (NAV)	via attachments which Content-Type and Content-Disposition headers are mixed upper and lower case, which is ignored by some mail clients.	CWE-436
CVE-2002-0108	Allaire Forums and Forums!	by modifying the hidden form fields for the name and e-mail address.	CWE-472
CVE-2005-1784	Hosting Controller	via a modified email address parameter in an update profile action for UserProfile.asp.	CWE-472
CVE-2005-1652	message.htm for Woppoware PostMaster	by modifying the email parameter.	CWE-472
CVE-2005-4155	ATutor	via an e-mail address that ends in a NULL character, which bypasses the PHP regular expression check.	CWE-626
CVE-2008-5734	IceWarp Software Merak Mail Server	via an IMG element in an HTML e-mail message.	CWE-79
CVE-2002-1495	JAWmail	via (1) attached file names in the Read Mail feature, (2) text/html mails that are displayed in a pop-up window, and (3) certain malicious attributes within otherwise safe tags, such as onMouseOver.	CWE-80
CVE-2005-2276	Novell Groupwise WebAccess	via an e-mail message with an encoded javascript URI (e.g. j&#X41vascript” in an IMG tag.”	CWE-84
CVE-2005-0563	Exchange Server	via an email message with an encoded javascript: URL (jav&#X41sc
ript:”) in an IMG tag.”	CWE-84

The attacker tools and techniques are showed in column “Vector”, the affected Product is in column Product Vender, the affected product vulnerability is seen in column “CVEID”, and column “VulnType is showing the product weakness that the product vulnerability is belong to in CVEID column.

3 RESULTS

In Table 1, it seems that the attacker has used different tools when they attack software Products. There are 16 CWE entry related to 12 CVE entries. It is shown that there is one for instance CWE-84 is attacked by the attacker through different components using different CVEs, in addition CWE-472 is attacked through different components exploiting different CVEs using different attack tools and vectors.

4 CONCLUSION

The findings of this research come to conclusion that the attacker exploit the product vulnerabilities that make a base of his session to attack the email products. The same weakness entry could be exploited by an attacker to threat more than one software product through different CVEs. The attacker uses different tools to inbox mail, the message body, the file attachments, and the headers. To improve the software security these vulnerability entries should be eliminated, minimize their effects as possible or they should be fixed at least.

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Brief Analysis of Key Aspects of the Digital Workplace

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Abstract

The article deals with the concept of the digital workplace and its role in the current global situation. The fast development of the information and communication technologies, as well as the restrictions due to the pandemic situation has brought new challenges for the public institutions, the business and the individuals. The application of the new technologies opened a new perspective for the effective work re-organization and market competitiveness. The digital transformation includes natural integration of the processes and services while using digital technologies. The remote working and the flexible working time are becoming more and more popular worldwide. These forms of work could boost organizations' productivity and at the same time are preferred for the employees. Some of the advantages and disadvantages of the digital workplaces have been analysed and listed and a brief summary of the development perspectives has been proposed.

Keywords: *Digital transformation, Digital workplace, Remote working, Flexible work, Information and communication technologies*

1 INTRODUCTION

The term "digital transformation" is increasingly coming into practice with the rapid development of new technologies, and enterprises around the world are embracing the digital workplace as the new market reality. The digital workplace consists of a natural integration of processes or services in the company, where everyone uses digital technologies, such as applications, large databases or the Internet of Things.

Modern technological progress offers many new opportunities, but also poses many challenges: customers demand to be served faster and better, and employees prefer flexible working hours and remote work options. At the same time, the diversity of technologies creates difficulties in finding a balance between coordination and interaction between these two groups.

Businesses are changing the way they perceive the role of technology. The solution is in the digital workplace, which brings customers and HR departments closer together and changes the traditional way of working. In this sense, the classic processes in the company should be abandoned and a more dynamic and fast communication strategy should be introduced. Processes that until recently were performed in analogue mode must be performed online, i.e. in cloud space.

Digital transformation is becoming a critical organizational strategy for survival and achieving competitiveness in today's market. The use of ICT's is becoming more and more common in people's personal and professional lives. The organizations need to change urgently in order to succeed and compete with companies that were born digital. The workspace nowadays as a digitally connected workforce that can work and communicate from anywhere at any time.

In the last three years, remote work has become increasingly popular as a form of employment. The reasons for this are the conditions of a pandemic situation in which public administration, higher education, business and citizens function, as well as the progress in technology and the use of modern technical achievements. The fulfilment of work duties through computer networks and systems would support the participation in the labour market of persons who are in some way excluded, due to a certain illness, caring for young children or family members who require the presence and physical care of specific people.

Recently, the European Commission has also encouraged research on telework as a means of developing economic activity and creating job opportunities in rural and economically backward areas.

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At the same time, the challenges and the insufficient regulatory framework of teleworking in Bulgaria are becoming more and more obvious.

2 MATERIAL AND METHOD

The aim of this paper is to review the theoretical basis of the digital workplace, to define briefly some of the advantages and disadvantages of the remote work and to analyse the status quo in the European countries. Descriptive and comparative analysis have been used in the study, applying qualitative data review.

2.1 Definition

There are different definitions of remote work, which at the same time unite around common aspects of this form of employment.

According to the Cambridge Dictionary, telecommuting is defined as “the practice of an employee working from home or from another location other than the usual location of the organization” [1].

Remote work (also known as work from home [WFH] or telecommuting) is “a type of flexible working arrangement that allows an employee to work from remote location outside of corporate offices. For employees who can complete work offsite, this arrangement can help ensure work-life balance, access to career opportunities or reduced commutation costs” [2].

Remote working, also called telecommuting, telework, work from home, mobile work, or work from anywhere, is an employment arrangement in which employees do not travel to a central location for work, such as an office building, factory, or store. It is facilitated by technology, such as software, local area networks, virtual private networks, conference calls, video-telephone connection, Internet access, cloud space, VoIP, mobile telecommunication technologies, such as laptop or tablet, smartphones and desktop computers.

Remote work arrangements can be temporary or permanent, part-time or full-time, occasional or frequent.

The legal definition of the term “remote work” is given in Art. 107z, para. 1 of the Labor Code. It is “a form of organizing work moved outside the employer's premises, carried out under an employment relationship through the use of information technology, which before its relocation was or could be carried out on the employer's premises” [3].

The digital workplace can be described as an organization that provides its employees with technology and an environment for communication, innovation, collaboration and effective collaboration to achieve business results. Currently, the digital workplace is becoming a competitive advantage that can greatly improve the day-to-day processes of an organization. In 2018, 41% of companies still use the traditional workplace, but 22% have already taken steps to introduce digital technologies [4].

The concept of a digital workplace implies the use of digital transformation to harmonize technology, employees and business processes to improve operational efficiency and achieve organizational goals. As a virtual complement to the physical workplace, the digital space includes any facility, software or platform that employees use in their work. This conceptual idea, understood as the virtual equivalent of the physical workspace, requires careful planning and management due to its key role in productivity, engagement and healthy working conditions. Important aspects for a digital workplace are related to communication tools, cloud-based solutions, video conferencing platforms, online project management tools, work calendars, document storage capabilities and customer service tools.

2.2 Development in the EU Member States

In response to social distancing measures introduced as a result of the pandemic situation, more and more people have started working from home. In 2020, 12% of the working population in the EU habitually work from home, and over the past 10 years this percentage has remained stable within 5-6%.

The region in the EU with the highest percentage of people working from home in 2020 is the Finnish capital Helsinki - 37%, followed by two Belgian regions - Brabant Walloon province - 27% and Brussels Capital Region - 26%.

At the same time, working from home is less common in many of the eastern and southern regions of the EU. Again in 2020, less than 5% of the workforce works from home in Croatia, Cyprus, Latvia and Bulgaria, as well as in most regions of Hungary, Romania and Greece.

Among the EU regions (Fig.1), the largest increase in the share of employed people who work from home was registered in:

- Brussels – the capital region of Belgium;
- Province of Brabant Walloon – again in Belgium;
- Helsinki – the capital region of Finland;
- Eastern and Central - the capital region of Ireland.

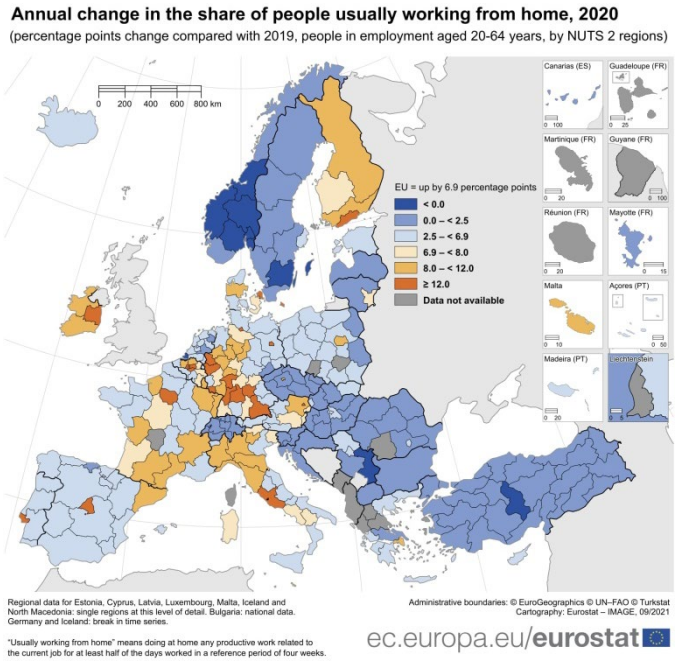

Figure 1. Annual change in the share of people usually working from home, 2020 (Source: www.ec.europa.eu/eurostat)

These regions are followed by the capital regions of Denmark, Germany, Spain, France, Italy, Austria and Portugal. The benefits of telecommuting include optimizing resources, increasing employee motivation and productivity.

2.3. Development in Bulgaria

Bulgaria ranks one of the last places in terms of working from home, with a strengthening of the trend to increase the percentage of remote workers in 2021. Before the COVID-19 regime, working from home was not a common practice in Bulgaria. The reasons for this are rooted in the strict rules of the Labor Code and the need for additional technological resources. The Bulgarian Labor Code requires the written consent of the employee for switching to work from home and imposes various obligations on the employer related to monitoring the process of remote work in connection with ensuring safe working conditions, as well as sharing the costs of the necessary work equipment and observance of working hours and holidays [3].

During the pandemic situation, working from home has become an adequate solution for business, but at the same time it has raised new questions that require their answer.

During the state of emergency, working from home was a recommended, if not mandatory, form of employment. Employers were even allowed to use this form as an emergency measure.

Some problems related to working from home became apparent:

- Compliance with the requirements for safe and healthy working conditions - for some employers this has become a challenge, due to the need to find creative solutions/for example, self-assessment tools/ to reduce the risk of administrative fines and work accidents;

- Cyber security and data protection – in view of the strict regulatory provisions on cyber security and personal data protection, enterprises have had to invest in additional measures to protect information and data in the context of remote work and strengthen the rules for employees related to the protection of the information;
- Disciplinary control - the lack of possibility of direct monitoring, accompanied by the need to protect employees' personal data, created a potential risk of violation of labor legislation, which is difficult to prove in a remote form of work;
- Flexibility – employees are increasingly demanding the freedom to work from anywhere /not just from their homes/. This exposes enterprises to the risk of non-compliance with the norms for safe and healthy working conditions.

Telecommuting varies significantly across sectors and occupations and is particularly high in the information and communication technology sector, as well as in knowledge-intensive sectors (including information services, science, higher education), and also among highly qualified specialists. The industrial structure, the distribution of employment among enterprises of different size and subject of activity, the share of self-employed persons and the digital skills of workers are some of the factors explaining the differences and variations in the frequency of remote work [5].

Bulgaria continues to note an increase in offers for work from home and their share in October 2021 was 13.5%. The observed increase compared to the previous month is 7% and in the last four months this growth is 29%.

In perspective, taking into account the pandemic situation, it can be assumed that working from home will continue to be used as a form of employment and changes in labor legislation are needed. Working from home has emerged as a useful tool to respond to the COVID-19 crisis, but at the same time it has posed new challenges for employers and employees. Changes to the Labor Code are needed to provide for more flexible remote work models. Otherwise, working from home will remain a good alternative, but it will not completely replace working in the office.

At the beginning of 2019, a survey was conducted among more than 15,000 entrepreneurs from 100 countries [6]. The subject of the study is the key reasons for flexible working, how it is used by international business and what challenges there are to its introduction. The results show that there is a power shift in the direction of the employee - now he has more influence in determining the way and place of work. And organizations that understand this see higher productivity, talent retention and higher engagement. It's no surprise then that 62% of businesses worldwide now have a flexible workspace policy.

Businesses that have understood the importance of providing more flexibility to their staff have seen positive results in more successful staff retention, greater engagement and increased productivity compared to companies that do not have a flexible work culture. For example, 65% of the respondents in a Regus survey believe that businesses that adapt to the work environment to meet employees' job roles are more productive [7].

Table 1. Enterprises that have increased the percentage of employees who have remote access to e-mail systems (percentage) 2021 (Source: www.ec.europa.eu/eurostat)

TIME	2021
GEO (Labels)	Percentage
Belgium	40
Bulgaria	17
Germany	42
Italy	31
Cyprus	36
Latvia	21
Lithuania	12
Luxembourg	33
Hungary	17
Malta	55
Netherlands	n/a
Austria	38
Poland	18
Portugal	30
Slovenia	24
Slovakia	25
Finland	31
Sweden	25
Norway	21

Bulgaria ranks one of the last places in terms of the number of companies that have increased the percentage of their employees with remote access to the company's email systems (Table 1). Awareness of the need and advantages of moving to more flexible forms of employment would create advantages for Bulgarian enterprises and their employees. There are also many different forms of remote work that Bulgarian organizations can take advantage of.

In most cases, experts need to work on more than one project, and the digital environment allows avoiding the interruptions and flexibility needed to work on large-scale projects. Work flexibility is preferred by employees – 76% of employees say they would stay with their current employer if flexible working hours were available. According to surveys, 40% of employees say that flexibility is one of the biggest advantages of working remotely According to 86% of the Bulgarian companies that participated in the survey, flexible work solutions stimulate employee productivity. The global survey shows that 74% of the Bulgarian participants believe that flexible working hours are the key to attracting and retaining women specialists at work [6].

At the same time, according to Eurobarometer data, Bulgaria ranks last in Europe in terms of flexible work schemes. Only 39% of the employed in our country have access to non-fixed working hours, half-day work or work from home [8].

2.3. Benefits of the Digital Workplace

Benefits for the company include increased employee satisfaction and retention, increased productivity and cost savings on physical resources. According to Forbes magazine, the benefits of the digital workplace for employees are related to the speed of decision-making (16% increase), collaboration with colleagues (increased by 16%) and increased productivity (a fivefold increase) [9]. There are certain additional benefits of the digital workplace for the business and the employees. Among them we could mention:

- Reduced costs for consumables and transportation;
- Increased revenue for the company – increased productivity;
- Attracting and retaining talents;
- Increased engagement – motivation and commitment;
- Improved communication – enhance effective communication through different channels;
- Social inclusion;
- Cultural diversity;
- Employee benefits;
- Universal access – digital workplaces facilitate work from anywhere in the world and through a variety of devices;
- Collaboration – teamwork is encouraged, and digital technologies make it easier to communicate and work simultaneously on the same project;
- Intuitive and easy tools for work;
- Flexibility;
- Achieving a good balance between personal life and work;
- Environmental protection – decrease in pollution; reducing harmful emissions.

2.4. Disadvantages of the Digital Workplace

Research on working in a digital environment shows that there are various problems and disadvantages for which solutions have not yet been found. We could highlight the following disadvantages of the digital workplace:

- Lack of social interaction;
- Distraction;
- Equipment and maintenance costs;
- Security and support issues;
- Customer relations;
- Loss of interpersonal communication skills;
- Dependence on technology;
- Legal and administrative issues;
- Managing cultural differences.

3 RESULTS

The digital age and changes in the business world brought to the fore two leading values - the quality of work and human resources. The balance between work and private life is also changing, and new forms of employment are being sought to combine them.

The development of increasingly new technologies also leads to changes in the understanding of the working space and working conditions; new solutions are being sought for the location of the offices. The spread of flexible working is not only due to the increasing demand from workers, but also to the increased awareness among business leaders of its leading role in achieving success. Successful managers try to stimulate and retain talent, and employees themselves begin to prefer more flexible forms of work.

The need for greater flexibility in the labor market gives rise to increasingly different contractual forms of employment. Flexible work presupposes above all the use of information and communication technologies for remote work [10].

The recent COVID-19 crisis and the faster introduction of remote work technologies has led to a sudden digitization that makes it difficult for a number of workers with lower education or one that does not include digital competences to perform on the labor market. It should be ensured that such workers and employees will be supported with adequate training and inclusive measures, providing the possibility to continue to fulfil their work commitments “on paper”.

Organizations should choose the most suitable communication channel according to the specifics of their activity, sector and employees. It is also necessary to develop a strategy that offers a combination of the digital and the conventional way of communication, finding the intersection between them.

Managing organizations and personnel in a digital environment requires specific management skills, flexibility, resilience and innovative ways of organizing work, as well as results-oriented management. Targeted training needs to be provided for both employees and managers to more effectively manage work in a digital environment.

4 CONCLUSION

The digital solutions could accompany human interaction and facilitate integration and communication between employees. The digital workplace allows employees to have more effective control over their work-life balance. Organizations with greater flexibility, effective communication channels and a balanced organizational culture have better opportunities to engage human resources, increase productivity and realize significant profits.

The modern dynamic environment requires the introduction of new, more flexible forms of work, in order to reduce costs, increase productivity and achieve a better work-life balance. The rapid development of technologies and the pandemic situation on a national and global level have contributed to the ever-widening spread of remote work, which has become an alternative to the present form. Combining effective change in the way of activity and processes in organizations with the skilful use of appropriate technological means will ensure their survival and competitiveness in the global market.

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Navigating the Legal Landscape of Rapid AI Development in European Union

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Abstract

In the dynamic realm of the era, the European Union (EU) has long been at the leading edge of crafting policies to navigate the complex landscape of Artificial Intelligence (AI) and Machine Learning (ML). The distinction between AI and ML is not simply dependent on academic precision; it holds profound felony implications. This section delves into the history and purpose behind the vital significance of distinguishing between AI and ML from a legal angle within the EU. The fast proliferation of AI and ML technologies has touched nearly every aspect of cutting-edge life, from self-sufficient cars and healthcare diagnostics to algorithmic selection-making and economic forecasting. This technological ubiquity has propelled governments, policymakers, and felony pupils into a movement to make sure that the transformative electricity of AI and ML is harnessed responsibly and ethically.

The EU has taken proactive steps to adjust AI and ML (The EU's Commitment to AI Regulation), spotting their potential benefits and the risks they pose. In April 2021, the European Commission unveiled its proposed "Artificial Intelligence Act" "As part of its digital strategy, the EU wants to regulate artificial intelligence (AI) to ensure better conditions for the development and use of this innovative technology. AI can create many benefits, such as better healthcare; safer and cleaner transport; more efficient manufacturing; and cheaper and more sustainable energy.", a landmark piece of rules designed to set up a legal framework for AI, especially in CURIA.

***Keywords:**, AI and ML, EU law, CURIA, AI act*

1 INTRODUCTION

The case observed, Navigating the Legal Landscape of Rapid AI Development in Europe: Challenges and Strategies for Effective Risk Prevention, explores the complex felony terrain surrounding the fast proliferation of artificial intelligence (AI) technologies within the European Union (EU). It investigates the demanding situations posed via AI improvement and deployment, as well as the strategies needed to mitigate dangers and make sure accountable AI is used in the EU.

Policy Recommendations for Effective Risk Prevention in AI Development inside the EU and the fast advancement of Artificial Intelligence (AI) technologies have ushered in a new technology of innovation and transformation throughout industries. However, the proliferation of AI additionally brings forth moral, criminal, and societal demanding situations, especially within the European Union (EU), in which values that include privateness, transparency, and accountability hold substantial importance. To ensure accountable AI development, effective threat prevention strategies and rules are imperative. This section outlines key policy suggestions for the EU to successfully save you dangers related to AI improvement [1].

EU policymakers must maintain complete threat tests for AI structures earlier than deployment. These tests must embody ability biases, privacy violations, security vulnerabilities, and other ethical and criminal worries. Implementing standardized risk evaluation protocols ensures that AI builders very well understand and cope with capacity dangers. The next step is to develop clean ethical pointers and technical requirements that AI structures need to adhere to. These hints need to emphasize fairness, transparency, accountability, and human oversight in AI decision-making techniques. Creating a unified moral framework enables the improvement of AI systems that could inadvertently propose harm or discriminate towards positive groups. Enhance information privacy and safety regulations to safeguard personal facts utilized in AI schooling and operation. Strengthen the General Data Protection Regulation (GDPR) to encompass provisions specific to AI structures, making sure that records used for education are obtained and processed responsibly, and that AI outputs appreciate individuals' privacy rights.

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2 AI HARMONIZATION OVER EU LAWS RECOMMENDATION VS RATIONALE

The advent of Artificial Intelligence (AI) has revolutionized industries and economies, promising innovation, and increase. However, the European Union (EU) recognizes that AI also poses ability dangers, particularly in phrases of information privacy and safety. Addressing those issues requires focused rules and techniques to ensure accountable AI development. This section presents unique policy hints that emphasize data privacy and security as crucial additives of AI chance prevention inside the EU [2].

a) Strengthening Data Privacy Regulations:
Recommendation: Enhance the General Data Protection Regulation (GDPR) to encompass provisions especially addressing data used in AI systems.
Rationale: AI structures rely heavily on statistics for training and decision-making. Strengthening statistics privacy rules ensures that private facts used in AI tactics are amassed, saved, and processed transparently, with the consent of the individuals concerned.

b) Encouraging Differential Privacy:
Recommendation: Promote the use of differential privateness techniques to shield personal data whilst retaining the software of AI models.
Rationale: Differential privacy provides noise to the dataset, making it harder to become aware of specific people. This safeguards information privacy without compromising the effectiveness of AI systems.

c) Implementing Privacy via Design:
Recommendation: Mandate the mixing of privacy by using layout concepts in AI machine development.
Rationale: Privacy by using design guarantees that records safety measures are embedded into the AI improvement process from the outset, minimizing dangers associated with records breaches or unauthorized entry.

d) Federated Learning for Privacy:
Recommendation: Encourage the adoption of federated studying strategies to teach AI fashions on decentralized information assets.
Rationale: Federated studying allows AI fashions to be taught across more than one gadget without the want to centralize touchy statistics. This reduces the risk of statistics publicity even as still enhances AI device accuracy.

e) Transparent Data Usage:
Recommendation: Require AI developers to provide clean explanations approximately how facts are used within their structures.
Rationale: Transparent statistics usage explanations promote user trust and understanding, making sure individuals are privy to how their records contribute to AI decision-making approaches.

f) Regular Security Audits:
Recommendation: Mandate normal security audits of AI systems to discover vulnerabilities and ability facts breaches.
Rationale: Regular audits help AI developers identify and rectify safety weaknesses before they may be exploited, preventing unauthorized admission to and information leaks.

g) Encrypted Data Transmission:
Recommendation: Enforce encrypted information transmission among AI systems and their information resources.
Rationale: Encrypting information transmission prevents eavesdropping and information interception, making sure that sensitive statistics stay protected at some point in their journey.

h) Data Minimization Principle:
Recommendation: Advocate for the precept of statistics minimization, wherein AI builders most effectively acquire and use the information vital for a selected motive.
Rationale: Limiting the number of statistics gathered reduces the ability risks associated with information breaches, exposure, and unauthorized use.

i) Ethical Data Sharing:

Recommendation: Develop pointers for ethical information sharing that make sure records are shared responsibly and in compliance with information safety laws.
Rationale: Ethical records sharing practices allow for the development of sturdy AI fashions even as respecting individuals' rights and privacy.

j) Collaboration and Information Sharing:
Recommendation: Encourage pass-border collaboration and data sharing among EU member states concerning facts privateness and security fine practices.
Rationale: Collaborative efforts enable member states to learn from each other's reports, selling an extra cohesive and powerful method for data privacy and safety in AI regulation.

The development and deployment of AI within the EU must be guided via effective hazard prevention strategies. Policymakers play an essential role in ensuring that AI technology aligns with ethical ideas, criminal standards, and societal values. By imposing comprehensive threat exams, moral tips, obvious decision-making practices, and strong information protection measures, the EU can foster an environment of responsible AI innovation that advantages society while minimizing capacity dangers [3]. Through considerate policy hints and collaborative efforts, the EU can pave the manner for a future wherein AI's transformative potential is harnessed responsibly and sustainably.

3 CHALLENGES WITHIN THE MODERN LEGAL LANDSCAPE

Challenges within the Legal Landscape are not so easy to understand either from a legal or from a technical perspective [4]. Some of the frames and challenges are presented in the list below, including short explanations.

- Regulatory Fragmentation - The EU's criminal framework for AI is characterized by fragmentation, with more than one guideline and directives addressing AI in diverse sectors. This fragmentation poses demanding situations in developing a unified and regular regulatory method.
- Ethical Dilemmas - Rapid AI development brings ethical dilemmas related to bias, discrimination, and transparency. Balancing innovation with moral considerations is a pressing mission.
- Data Privacy and Security - AI heavily relies on records and making sure facts are privateness and security while adhering to the General Data Protection Regulation (GDPR) is a massive task.
- Accountability and Liability - Defining duty and liability in cases of AI-associated damage or mistakes remains a complicated issue, particularly in multi-stakeholder AI ecosystems.
- Transparency and Explainability - Achieving transparency and explainability in AI decision-making methods is critical for ensuring equity and belief but stays technically difficult.
- Strategies for Effective Risk Prevention
- Unified AI Regulation - The EU needs to strive for a unified regulatory framework for AI to reduce fragmentation and ensure steady requirements throughout member states.
- Ethical Guidelines - Ethical pointers for AI improvement need to be set up, emphasizing principles inclusive of fairness, responsibility, and non-discrimination.
- Data Governance - Robust information governance measures should be implemented to guard statistics privateness at the same time as permitting AI innovation.
- Accountability Mechanisms - Clear mechanisms for establishing accountability and legal responsibility in AI systems should be developed, thinking about the roles of developers, users, and regulators.
- Transparency Tools - Tools for enhancing transparency and explainability in AI selection-making processes need to be recommended and incorporated into AI structures.

The landscape of fast AI development in Europe is marked by both challenges and possibilities. While regulatory fragmentation and moral dilemmas pose complicated hurdles, the EU can steer accountable AI development by embracing unified law, ethical suggestions, robust data governance, accountability mechanisms, and transparency tools [5]. By navigating those challenges effectively and adopting forward-searching techniques, Europe can harness the blessings of AI whilst safeguarding essential rights and values, in the long run shaping the destiny of AI development in an accountable and ethical way, examples presented on Tab. 1.

Table 1. Legal aspects and landscape challenges

Legal aspect	Actions and suggestions
Ethical and Legal Compliance	Involve legal specialists and ethicists within the AI improvement procedure.
Data Governance and Privacy	Implement a "facts safety by means of design" technique, where privacy and statistics protection are necessary for AI machine improvement
Fairness and Non-Discrimination	Integrate bias detection gear into the ML pipeline to discover and mitigate biases in schooling statistics. Regularly check the fairness of AI choices, and make modifications as wished.
Transparency and Explainability	Use interpretable ML models and strategies to enhance transparency. Develop strategies for producing reasons for AI selections, particularly in instances wherein they affect people's rights or criminal outcomes.
Human Oversight and Control	Incorporate a human-in-the-loop technique, in particular in excessive-stakes programs like legal choice-making. Ensure that AI systems augment human decision-makers rather than update them entirely.
Accountability and Liability	Define clean traces of duty inside the AI development and deployment pipeline. Establish duties for AI builders, operators, and customers
Continuous Monitoring and Evaluation	Conduct everyday audits and checks of AI structures to ensure ongoing compliance with EU laws and moral standards. Make important changes based totally on the consequences of these audits.
User Education and Awareness	Training and Education: Educate customers, stakeholders, and the general public approximately the abilities and boundaries of AI systems. Promote cognizance of data rights and the way AI affects individuals' lives

4 LEGAL FRAMEWORK AND ROLE OF AI

By following recommendation steps and maintaining a nicely described statistics classification framework, organizations can correctly control information sensitivity levels, reduce the threat of facts breaches, and align their practices with felony and ethical standards in the European legal panorama. Regular updates and ongoing schooling are important to make sure the framework stays effective and applicable.
Segmentation of data and a very interesting and popular part of big-data analysis is who can read and access them. This is the critical decision-maker policy to complete the full landscape and make sure that the information is in safe hands [6].

Analysis and proposals for access levels:

4.1 Public Data Access

Policies: Public information must be available to all users without regulations. However, usage guidelines ought to dictate responsible and ethical use.
Examples: Open datasets, publicly available research statistics, and non-sensitive statistics.

4.2 Limited Access

Policies: Limited admission must be granted to legal users based totally on their roles and duties. Users must go through authentication and authorization tactics.
Examples: Internal business records, patron information, and research records shared inside a particular group.

4.3 Restricted Access

Policies: Highly sensitive facts need to have strict access control policies. Access ought to be constrained to a pick out few individuals with a valid want.
Examples: Financial facts, personal fitness records (PHI), and felony documents.

4.4 Highest Security Access

Policies: Critical and exclusive data should be available best to a handful of individuals with the highest stage of clearance. Strict tracking and auditing needs to be in the vicinity.
Examples: National safety facts, categorized files, and alternate secrets and techniques.

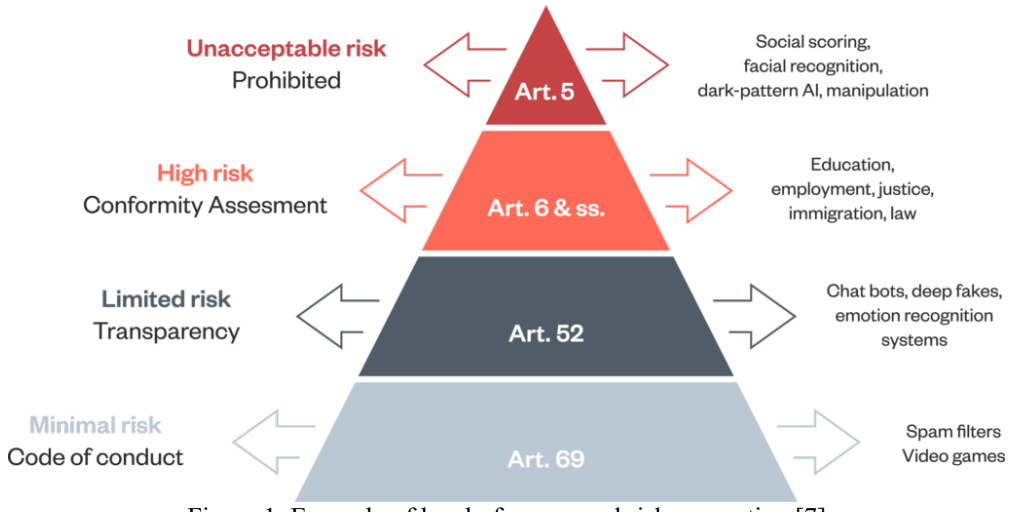

Figure 1. Example of level of access and risk prevention [7]

The corporation of AI Laws and Access Levels, alongside recommendations for better implementation, are related to the items below:

AI Laws Organization:

- Centralized Repository: Create a centralized repository or database in which all applicable AI legal guidelines, guidelines, and guidelines are documented and easily accessible. This should be maintained and frequently updated via a dedicated authority.
- Categorization: Categorize AI laws and rules based on exclusive aspects, including statistics privateness, transparency, responsibility, and quarter-unique guidelines (e.g., healthcare, finance). This categorization will resource customers in locating relevant records more efficiently.
- Search and Navigation: Implement a consumer-friendly search and navigation gadget in the repository, permitting customers to look for precise AI-associated subjects or legal guidelines via keywords, sectors, or dates of enactment.
- Regular Updates: Commit to an agenda for reviewing and updating AI legal guidelines to keep them aligned with technological advancements and evolving ethical and criminal standards.

Access Levels:

Public Data Access:
- Suggestion 1 - Usage Policies: Alongside unrestricted get entry, put into effect clear usage policies for public information. These rules should emphasize responsible and moral use, such as recommendations on information sharing, attribution, and ability restrictions on industrial use.
- Suggestion 2 - Data Catalog: Maintain a publicly handy facts catalog that offers specific facts about to-be-had public datasets. This catalog must consist of metadata, information formats, and information on the resources and functions of the data.

Limited Access:
- Suggestion 1 - Role-Based Access Control: Implement a position-based get right of entry to manipulate (RBAC) system that offers users entry based on their roles and duties within the organization. Different roles should have various tiers of getting admission to.
- Suggestion 2 - Authentication and Authorization: Require users to undergo authentication and authorization approaches to get admission to restricted information. Implement - issue authentication (2FA) for brought security.
- Suggestion 3 - Data Classification Labels: Label facts assets with their category level (e.g., “exclusive” or “touchy”) to provide clean visible cues to users approximately the level of sensitivity of the records.

Restricted Access:
- Suggestion 1 - Need-to-Know Basis: Enforce a strict “need-to-understand” precept for accessing touchy facts. Access ought to be granted most effectively to people with a valid and documented need for such statistics.
- Suggestion 2 - Encryption: Implement encryption for facts in transit and at rest for confined entry to data. Use strong encryption protocols to shield facts from the unauthorized right of entry.

- Suggestion 3 - Data Access Logs: Maintain targeted get right of entry to logs for confined information, which includes timestamps, consumer IDs, and the purpose of access. Regularly audit those logs for any suspicious activities.

Highest Security Access:
- Suggestion 1 - Multi-Level Authentication: Implement multi-level authentication (MLA) for individuals with the highest safety clearance. MLA consists of biometric authentication, clever cards, and token-based total access manipulation.
- Suggestion 2 - Real-Time Monitoring: Employ real-time tracking and alert systems for the best safety access information. Any uncommon activities should cause instant alerts for research.
- Suggestion three - Regular Security Audits: Conduct periodic security audits for structures handling the most important statistics. These audits need to be thorough and contain 0.33 safety professionals to ensure the highest degree of safety.

5 CONCLUSION

The future directions for criminal frameworks governing AI in Europe are marked by using a dedication to accountable innovation, moral issues, and a holistic method that considers societal and financial effects. Regulatory tasks just like the AI Act offer a basis for addressing rising demand situations in AI improvement and usage. Ethical standards manual the development of AI technology, ensuring fairness, transparency, and responsibility.

Socio-financial impact tests might be essential in addressing the broader consequences of AI adoption, from activity displacement to monetary inequality. Public-private partnerships and guides for innovation and entrepreneurship will drive AI's superb impact on society and the economy.

Data privacy and safety stays paramount, and criminal frameworks must evolve to guard personal facts in the AI era. Europe's future AI guidelines ought to be dynamic, flexible, and responsive to the fast advancements in AI technology, ensuring that AI blessings all residents whilst upholding European values and principles. In doing so, Europe can maintain to guide the manner in shaping the responsible development and utilization of AI in the twenty-first century.

With the implementation and maintenance of a properly based AI laws agency and get right of entry to degree policies, the EU can enhance transparency, accountability, and protection in AI improvement and utilization while respecting information privacy and law requirements. Regular schooling and awareness programs should additionally be part of the strategy to make certain that each stakeholder recognizes and adheres to these regulations effectively.

Acknowledgments

This paper is related to the bigger master thesis of the author dedicated to EU laws and AI integration from the legal point of view. The future works include extensions and focus to the regulation part introducing virtual ID and the impact of the models in the virtual world regarding the laws and legal landscape.

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Agile Automation: Enhancing Telecommunication Management through AI-Driven Strategies

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Abstract

This paper delves into the dynamic landscape of the telecommunication industry, emphasizing the pivotal role of Artificial Intelligence (AI) and Agile methodologies (AgM) in helping management projects. In a generation marked by swiftly evolving consumer demands and fierce marketplace competition, telecommunication businesses are compelled to optimize their operations and service high quality. This observation explores the fusion of AI and Agile methodologies as a promising solution for addressing those demanding situations.

The research investigates how Agile practices can be correctly integrated into telecommunication control, providing flexibility, adaptability, and improved assignment shipping. Furthermore, AI's transformative skills, which include statistics analytics, predictive maintenance, and system automation, are explored inside the context of telecommunication management. The paper emphasizes the synergy between Agile concepts and AI technology to acquire strategic objectives, decorate purchaser reviews, and gain operational excellence inside the telecommunication zone.

This interdisciplinary research provides valuable insights for telecommunication professionals, venture managers, and managers in search of modern solutions to manage projects extra correctly in an ever-evolving enterprise. It highlights realistic use cases, case studies, and real-world programs of Agile and AI, offering a complete guide for telecommunication businesses seeking to live competitively within the digital age.

Keywords: *Agile, Telcos, AI, Telecommunication management*

1 INTRODUCTION

The telecommunications industry is undergoing a paradigm shift, driven by relentless technological advances. This paper sets the stage by highlighting the challenges facing telecommunications management, including the need for rapid adaptation, resource efficiency, and network robustness It establishes that the combination of agile methods and AI-powered automation is a transformational solution to address these challenges [1]. Based on existing modern technologies that provide a high level of project management in Telcos with the integration of plug-ins and AI-driven models rapidly developed in the last year, managing has become an easy approach to preventing and avoiding problems and risks.

2 AGILE METHODOLOGIES IN TELECOMMUNICATION MANAGEMENT

Originally designed for software development, the principles of speed have been adapted to the dynamic nature of the telecommunications industry. Topics covered include iterative development, cross-functional teams, and customer centricity, illustrating the adaptability and responsiveness of these principles at its core, the Agile approach follows a set of principles that prioritize flexibility and customer satisfaction. In the case of telecommunications design, these principles holistically manifest themselves and are repeated continually in problem-solving and service development. Iterative development, a key principle of agility, allows for continuous improvements in network design, functionality, and customer experience, and ensures that the telecommunications ecosystem continues to meet evolving roles. One of the key principles of Agile methodologies is iterative improvement, where solutions are developed incrementally with a focus on continuous improvement. Applying this approach to telecommunications design allows the industry to quickly respond to emerging technologies and consumer demands. By prioritizing customer focus, agile processes ensure that end-user experience is at the forefront of decision-making processes, resulting in outstanding telecommunications services and convenience for users to come.

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Agile methodologies emphasize the importance of cross-functional teams, breaking down traditional silos within organizations. In telecommunications design, where continuous communication between network engineers, software developers, and customer service representatives is essential, this approach provides seamless communication and shared understanding throughout the telecommunications process leading to improved problem-solving ability and effective decision-making. The telecommunications industry is dynamic, with rapid technological developments and market changes. Agile methods by their very nature prioritize flexibility and flexibility, enabling a telecommunications manager to actively manage change. By embracing flexibility as a core principle, organizations can move with speed to the industry's challenges, rapidly deploy new information, and produce high-quality products Real-world examples and case studies are a powerful illustration of the success of incorporating agile methods into telecommunications infrastructure. This model demonstrates tangible benefits such as reduced time to market for new projects, improved customer satisfaction and increased operational efficiency Ability to evolve quickly in response to market demand by telephone does agile communication establish itself as a strategic advantage in an industry where innovation is critical.

Figure 1. Agile principles

2.1 Kanban

Kanban proves useful in telecommunications management by providing more visibility and transparency. It provides a visual representation of work elements, enabling stakeholders to make informed decisions and ensuring clear communication between team members. In a dynamic telecommunications environment, Kanban's adaptability is critical, allowing teams to quickly respond to changing priorities and market demands. They simplify work prioritization, allowing teams to better focus on important activities. Continuous improvement has incorporated Kanban, which fosters a culture of flexibility and efficiency, ultimately increasing productivity and reducing downtime. Challenges to Kanban implementation include the risk of overemphasizing immediate performance improvements at the expense of strategic planning. The potential for information overload comes from the large number of tasks represented in the Kanban board, which likely causes confusion and reduced concentration If visual processing is relied upon, creates challenges for geographically dispersed groups and can hinder effective communication. [7].

2.2 Scrum / SAFe

Scrum provides a framework that encourages flexibility and collaboration in telecommunications management. Its iterative approach facilitates rapid response to changing requirements, providing greater flexibility. Regular sprint reviews ensure continuous improvement, while the transparency of roles and responsibilities in Scrum provides a structured way of managing tasks and projects. SAFe (Scaled Agile Framework) on the other side extends Scrum principles to large projects typical of telecommunications infrastructure. It introduces new layers such as Release Trains and Program Increments, providing a structured way for multiple teams to organize and collaborate. SAFe's emphasis on consistency, collaboration, and monitoring consistently and effectively is beneficial for managing complex projects in telecommunications. The lack of detailed project planning in Scrum can be a challenge for a telecommunications project that requires extensive planning. The structure of Scrum teams themselves can pose challenges for teams that lack sufficient experience or expertise. Failure to run timed runs can result in some incomplete results if not handled properly. The complexity of SAFe can be excessive for small groups or businesses, resulting in premiums.

3 AI-DRIVEN AUTOMATION IN TELECOMMUNICATIONS

The telecommunications industry is leading the way in harnessing sophisticated technologies to meet the demands of an ever-evolving digital environment. One such revolutionary force is the integration of artificial intelligence (AI) in AI-driven automation. AI-powered automation in telecom represents a paradigm shift in how networks are managed, delivering services, and improving customer experience. Advances in machine learning, natural language processing, and predictive analytics have enabled telecom companies to process large amounts of data developed on their networks used to make more intelligent decisions. A key area is network optimization, where AI algorithms analyze network performance data in real-time, identify bottlenecks, and dynamically adjust policies for efficiency. Predictive maintenance performing predictive maintenance is another important application, where AI requires historical data to identify potential equipment failures and proactive interventions are allowed to prevent service disruptions. Regarding customer service, AI-powered chatbots, and virtual assistants have helped solve frequently asked questions, provide instant feedback, and improve overall customer satisfaction. Not only does this reduce the workload on human agents but also ensures 24/7 availability and answers to customer queries AI is used. The integration of AI-powered automation offers many benefits to the telecommunications industry. One of the most important benefits is increased productivity [1]. Through routine tasks such as network management, maintenance, and customer support, telecommunications companies can improve resource efficiency, reduce manual errors, and provide human expertise for challenges it is more intense. AI-powered automation allows for streamlined scheduling and resource allocation, reducing operational costs. Additionally, AI's predictive capabilities contribute to more efficient logistics, reducing unnecessary costs. Improved customer experience stands out as a key benefit. The use of AI-powered chatbots and virtual assistants ensures fast and accurate responses to customer queries, increasing satisfaction. Additionally, the dynamic nature of AI-powered predictive maintenance reduces service disruption and increases overall reliability and trust in telecommunications services with the ever-increasing volume of data and users, scalability is a key consideration in the telecommunications industry.

4 SYNERGY BETWEEN AGILE AND AI

This chapter explores the mechanisms between agility and AI-driven automation. It explores how the iterative and collaborative nature of agile processes complements AI capabilities related to prediction and data manipulation. Case studies and real-world examples are used to show how organizations can use this collaboration to increase the flexibility and efficiency of telecommunications management systems Benefits and challenges associated with Agile and AI-driven approaches a balanced analysis of automation integration is needed. A major goal is to explore how this hybrid approach can improve time-to-market, cost-effectiveness, and customer satisfaction [6]. At the same time, it addresses potential challenges such as data security, ethical considerations, and the need for professional development. The intersection of agile methodologies and artificial intelligence (AI) has emerged as a dynamic collaboration in today's fast-paced business environment, driving organizations towards increased scalability and efficiency Known for its techniques of iteration and collaboration, Agile finds a natural partner in AI, implementing data-driven insights automation at the heart of this interaction is the iterative nature of Agile methodologies. Agile's emphasis on continuous feedback loops and incremental improvement fits well with the limited and variable AI capabilities based on data analytics Iterative cycles in Agile provide a framework for refining AI models, incorporating user feedback, and ensuring that AI is aligned with evolving business needs. Agile methodologies for collaboration support the power of AI to improve human capabilities. Agile cross-functional teams with different skill sets can collaborate effectively on AI-driven tasks. This collaboration ensures that the implementation of AI solutions is not only technically sound but also an integration of business needs, user experience, and ethical considerations AI's predictive and analytical capabilities, too, underscore Agile's decision-making processes. AI algorithms can analyze large data sets, providing valuable insights into user behavior, market trends, and potential risks. This data-driven decision-making makes Agile teams more accurate, allowing them to better prioritize projects and react faster to changing circumstances. Furthermore, the combination of Agile and AI fosters a culture of continuous improvement. Agile methodologies encourage teams to brainstorm strategies and make iterative improvements. AI's ability to analyze operational data helps create this culture by providing usable insights into areas for improvement. The result is a dynamic feedback loop that drives both pathways to optimal performance. While the interface between Agile and AI is powerful, it is not without its challenges. Integrating AI into an Agile business process requires careful consideration of data security, ethical implications, and the need to upgrade the skills of the employees.

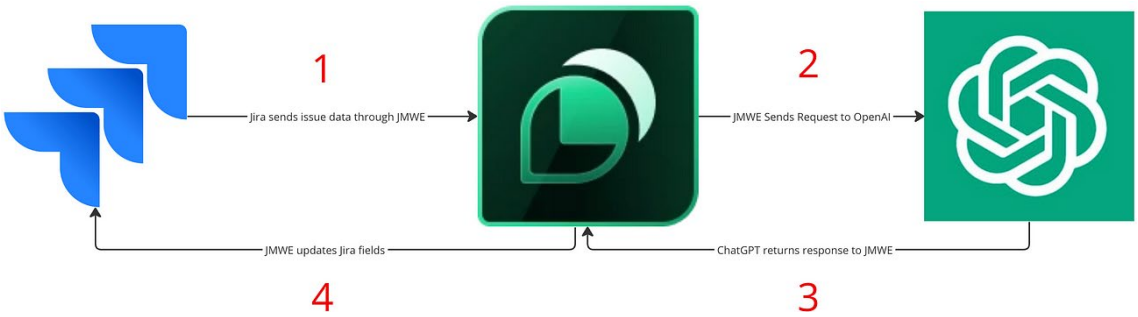

Figure 2. Integration between JIRA and OpenAI [4]

Figure 2 above presents the most popular project management tool used in almost all telecommunication projects and integration with the most famous AI toll – the ChatGPT / OpenAI. Jira Misc Workflow Extensions stands as a vital utility that enhances the capability of Jira workflows. Offering customizable conditions, validations, and submit functions, along with the functionality to craft personalized scripts, this app gives administrators a versatile toolkit. Such adaptability empowers administrators to finely tailor workflows to necessities, contributing to Jira's accelerated adaptability and operational efficiency [4]. During the lifecycle of one project number of the requirements or tickets (IssueTypes in the JIRA language [5]) can increase up to 100K. Most of them will be dummies, irrelevant, or simply closed, but the majority are the real ones who need to take care and attention. Managing such a large number even with the tool as JIRA requires creating a decent number of Automation rules, which are OOTB (out-of-the-box) solutions within the tool, but this is taking a huge amount of time for investigation and creation [4]. Thus, the direction of integration with the AI tools will provide a clearer view of the analyses, decision-making based on previous experience including and risk prevention. The flow is basic, and the integration is not so complicated.

Table 1 presents the movement of the real numbers of the tickets that are monitored and managed in real telecommunication projects. The duration of the monitoring is for the period of around one year (May 2022 – Sep 2023) for a big Telecommunication company while moving to digital transition. The project is focused on changing the methodology of software delivery introducing Agile, DevOps, and Cloud migration. The overall number of tickets and investigation cut-off is 86940.

Table 1. Use cases and impact of AI integration.

Use Case	Before AI Integration	After AI Integration
Ghost tickets	9023	149*
Escalated tickets	234	4001
Automatically closed	0	7426
Risk prevention	574	3477
Retested	199	27895

The results present a serious number of ticket iterations after the system is connected and integrated with the AI. The reason is related to reducing the manual work including the end-user testing for the quality of the code and ticket resolution. In the beginning lot of the tickets around 10% were pure placeholders or empty ones used for notes or not completed, which are clear cases that the statistic is deviated, and after integration, the number was reduced to 149. * The reason behind this is simply that further clarification is needed as some of the tickets are bridges (linked) between two real and existing working ones. The AI also based on the triggers escalated and increased the number of the tickets to 4001 as most of them are past due date, approaching commitment, and no movement or no one is working on them. The interesting number is 7426 closed tickets, all of them are simply commented as Done, but the status is not updated. In some cases, even the linked issues are not closed when the parent is done. Based on the AI learning the importance of the 3477 ticket is increased with upper priority so it can be brought to the attention of the reports. And maybe the most important part is the testing one. The JIRA has a lot of plug-ins like Zephyr and Xray dedicated to the testing, and both have very nice flow and rules for testing and retesting of the use-cases and issues. The involvement of the AI integration here is focused on the pure customer experience and the prediction that around 27895 users will hit the problems instead of manual testers. The conclusion from the investigation is clear and AI helps the project to handle and clean the mess with the dummies tickets and focus more on those who need real attention by escalating and moving to higher priority.

5 LANDSCAPE AND CAPABILITIES OF JIRA AND AI

Artificial intelligence (AI) capabilities can be incorporated into JIRA (a popular project management tool [2]) to increase productivity, automate routine tasks, and provide valuable insights example here are a variety of useful examples of how AI can be used in JIRA.

Table 2. Examples and needs of JIRA integration with AI

Areas of Interest	Directions
Automated journal function	AI algorithms can analyze historical data on issue assignments to identify patterns. JIRA can use AI to automatically provide updates to the most qualified team member based on their historical performance, skills, and hard work.
Critical Forecasting Issue	AI algorithms can analyze past data, considering factors such as urgency, importance, and historical decision time. JIRA can then predict and suggest issue priorities, helping teams focus on the most important tasks first.
Smart Content Classification	AI-powered natural language processing (NLP) can analyze details and categorize them accurately. This feature helps simplify tagging, organizing, and searching operations for content with relevant automatic labels.
Smart Race Planning	AI can analyze historical race statistics, team speed, and the ability of individual team members. JIRA can use this information to propose realistic sprint schedules, optimize work distribution, and ensure achievable goals.
Automated Documentation	AI-powered tools can create documents based on data stored in JIRA. It includes project summaries, progress reports, and releases, saving team time and ensuring accuracy.
Sentiment analysis for the storyline	AI-driven sentiment analysis can be incorporated into JIRA to measure the sentiment of comments. This helps teams quickly identify and address potential conflicts or issues affecting the business unit.
Auto-tagging and labeling	AI algorithms can analyze the content of the article and issue orders or apply relevant tags and labels automatically. This improves classification accuracy and facilitates filtering and analysis.
Dynamic management	AI can analyze historical project data, skill sets of team members, and current work products. JIRA can then dynamically recommend or adjust resource allocations to ensure optimal implementation and eliminate complexity.
Predictive analytics for forecasting conclusions	AI algorithms can analyze historical data on transaction completion times and factors affecting delays. JIRA can use this information to provide more accurate estimates for project completion, helping to optimize project management.
Continuous pursuit of improvement	AI analytics can assess team performance, identify challenges, and suggest JIRA workflow enhancements. This continuous feedback loop facilitates agile precedents and supports the refinement of teams' processes.

Implementing these AI-driven features in JIRA not only automates routine tasks but also adds internal intelligence, empowering teams to perform efficiently, make informed decisions, and continuously improve their management processes. However, here are some plugins that were known for combining AI capabilities with Jira:

- **Zephyr and Xray for Jira** (Test Management). AI Integration: Zephyr integrates Jira with advanced testing tools that use AI for test automation and analysis. Increases testing efficiency and provides insight into testing strategies;
- **Mindville Insight (**Property Management). AI integration: Although not an AI plugin specifically, Insight provides comprehensive reporting and analytics. Users can use external AI tools to perform data analysis and gain insights into asset management systems;
- **IntegrateCloud AI** (Submit entry). AI Integration: This plugin integrates AI to manage emails in JIRA. It uses AI algorithms to create intelligent email classification, prioritization, and reply to recommendations;
- **Jira Assistant** (AI Integration): JIRA Assistant is an AI-powered virtual assistant for JIRA. It uses natural language processing to understand user input and help Jira navigate around town, search for information, and act;
- **nFeed** (Data from any source). AI integration: While primarily a data integration tool, nFeed can be used to import external data, including data generated by AI applications. It enables users to connect JIRA with AI-powered tools for enhanced insights;
- **Botron** (Configuration Manager). AI Integration: Although not directly focused on AI, Configuration Manager by Botron supports the definition and migration of Jira systems, which can be useful if AI tools may need configuration changes in the integration process;

- **DeepDesk AI for JIRA (**AI Integration): This plugin aims to bring AI capabilities to JIRA process management. It has features like automatic ticket classification, sentiment analysis, and intelligent ticket routing.

It is important to check the Atlassian Marketplace or the official websites of these plugins for the most up-to-date information on features, compatibility, and user reviews Moreover, as technology evolves, new plugins and updates are introduced and JIRA itself is also upgrading own capabilities in the mood of the technology development and progress pure example is JIRA Software Management stream.

6 CONCLUSION

Looking ahead, this section explores the future development possibilities of integrating agile automation and AI in telecommunications. It discusses implications for the industry, including evolving business activities, regulatory considerations, and emerging business model innovations. In conclusion, the paper synthesizes key findings, highlighting the transformative impact of agile automation through AI-driven processes in telecommunications management. It emphasizes the importance of taking a holistic and collaborative approach to harnessing the full potential of this technology in a dynamic telecommunications environment. The insights presented in this paper provide a road map for industry stakeholders to leverage the synergies between agility and AI to navigate the evolving landscape.

AI-powered automation is a transformative force in the telecommunications industry, reshaping how networks are managed and services delivered. Advances in AI technology, including applications, offer significant benefits in terms of efficiency, cost savings, customer satisfaction, and scalability but challenges such as data security, ethical considerations, and importance must be met aside from the availability of skilled labor. As telecommunications continues to evolve in the digital age, the process of integrating AI-powered automation remains key in shaping the future landscape of the industry.

Acknowledgments

This paper is the first part of the real project management development and provides intro information for the project itself including a couple of real examples and results. The following papers will include the configuration and integration code with various tools and products.

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Ensuring and Improving Communications During Crises Caused by Natural Disasters or Mass Events

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Abstract

Technologies related to communications ensure the transmission of data and in the modern world they are everywhere. The exchange of information during a crisis is naturally of greater interest for study because it is precisely in situations of instability that ensuring connectivity can be crucial and there is often a need for guaranteed channels of communication. There are various connectivity solutions for problems with conventional communication channels. The most popular is the emergency call system 112. Another solution is the BG-Alert system, which is an additional channel to the National Early Warning System or siren system. A third possibility is through the use of the radio frequency spectrum for the construction of terrestrial networks, allowing the provision of electronic communication services after the issuance of a permit to the municipalities in our country. During the measurements in the flooded villages of Bogdan and Slatina in the municipality of Karlovo, as well as during the assembly near the village of Gela, Smolyan region, in these locations were registered various significantly lower indicators of voice transmission via GSM technology or of Internet access via UMTS, LTE and 5G, according to reports from the Communications Regulation Commission (CRC). The reasons are that during disasters and mass events, public communication networks cannot provide the necessary connectivity and this creates the conditions for a crisis and the impossibility of providing a reliable connection to an emergency aid or other specialized public service. The conclusions give us reason to make a recommendation for the development and implementation of alternative channels for connection in case of crises, using the radio frequency spectrum for the construction of local terrestrial networks with a single center for the needs of the municipalities in the Republic of Bulgaria after the issuance of a permit by the CRC.

Keywords: *Crisis, Telecommunications, Radio frequency networks*

1 INTRODUCTION

The transmission of messages has remained one of the most important processes for the formation and development of human civilization for thousands of years. The information that is exchanged during communication has different value and importance depending on the situation in which it happens. Sending data in a crisis is naturally of greater interest for research because it is precisely in situations of instability that ensuring connectivity and information exchange can be crucial. But what do we take to be a crisis? According to the authoritative Oxford English Dictionary, a crisis is "a vital or decisive stage in the development of anything", especially characteristic of a period of uncertainty or difficulty [1] and without necessarily having the meaning of a moment of decision. In general, a crisis is a situation inherent in "complex systems" (organizations, economy, society) when the systems are functioning badly and an immediate solution is needed to stop its further disintegration, but the causes of the dysfunction are not immediately identified because they are so many, or unknown, that it is impossible to make a rational, informed decision to reverse the situation [2]. Crises, according to Seeger, Sellnow, and Ulmer [3], have three defining characteristics, which are "specific, unexpected, and non-routine events or series of events that create high levels of uncertainty and threat, or are perceived as such, to the organization's high-priority goals." Thus, the first three characteristics are that the event is - unexpected, creates uncertainty, and is seen as a threat to important goals. Venette [4] argues that "a crisis is a process of transformation in which the old system can no longer be maintained." Therefore, the fourth defining quality is the need for change. This work presents a study and analysis of measurements of the coverage and quality of mobile terrestrial networks in the villages of Bogdan and Slatina, Karlovo municipality during the floods there in September 2022 and on the Ilinden meadows near the village of Gela, Smolyan district during at the council in August 2023. The reasons leading to the deterioration of the signal in the areas of crisis, the prerequisites for its occurrence and the recommendations for solving them were also examined.

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2 TRANSFERRING DATA STREAMS IN CRISES

Natural crises are often destructive, such as earthquakes, volcanic eruptions, floods, and cause effective problems in communications, and precisely in situations where they are urgent and extremely necessary. According to the general requirements for the implementation of public electronic communications of the Communications Regulation Commission, enterprises providing public electronic communications networks or services in the Republic of Bulgaria immediately notify the commission of any incident related to security or violation of the integrity of the networks, which has significantly impact on the functioning of networks and services.

Depending on the main reasons for the occurrence of incidents in communications, they are divided into five categories: human error, failures in technical and software security, malicious attacks for physical or logical access to publicly important networks, external causes and natural disasters. The duration of the impact is also important, as in the regulations it is categorized from 1 to 8 hours, and in terms of affected users - from 1,000 to 150,000. Communication in crises also has two main models - disclosure, which is one-way, and the second, with feedback, is two-way. For the mass dissemination of information about the state of people and public infrastructure, radio and television broadcasts are usually used, and in recent years, social networks using wireless or optical Internet connectivity. It is also possible in case of crises to use the local radio nodes to the town halls, as well as local wireless internet networks. Cell phone networks are most often used for two-way communication, but base stations are particularly vulnerable to power problems. Another way is the transmission of short text messages, which are much more economical in terms of bandwidth used and can be delivered even with a partial breakdown in the GSM system. It is also possible to connect to landlines, as well as connect via text or voice over the Internet. Also, in emergency situations, amateur radio stations can be used for two-way communication and transmission of information from the affected areas. In crises, just when connectivity is most needed, problems with securing communications often arise. For example, in severe winter conditions and power outages, base stations may be left without backup power or it may be stolen [5-7].

3 REGULATIONS AND OPPORTUNITIES

There are various solutions at the institutional level that provide connectivity for problems with conventional communication channels. The most popular is the single European emergency number 112, which however requires a working mobile or landline to connect. Another is the BG-Alert system, which is an additional channel to the National Early Warning System or siren system. This is a one-way communication and can be received by devices that support Cell Broadcast technology, which, like the 112 connection, can also be made without a SIM card. Commissioning trials began on November 7, 2023 [8, 9]. A third possibility is through the use of the radio frequency spectrum after the issuance of a permit by the CRC to the municipalities in our country. The frequency ranges are described in 9 appendices to Article 3 of the Rules for the use of the radio frequency spectrum for terrestrial networks, allowing the provision of electronic communication services after the issuance of a permit, issued by CRC and are for nine channels from 700 MHz to 26 GHz [10]. So far, according to CRC data, only 28 out of 265 municipalities have implemented this system. They follow a series of EC decisions from 2008 to 2020 that regulate the bandwidth for terrestrial systems in the provision of electronic communications services in the community.

4 MEASUREMENTS

Indicative of how communications are implemented during a crisis are the data from the coverage and quality measurements of mobile terrestrial networks carried out by CRC experts on September 8, 2022 for the frequency bands 900 MHz, 1800 MHz and 2100 MHz. For different networks, there is a different standard for the minimum signal level to ensure coverage - and the following norms are accepted for lack of coverage - GSM below -100dBm, UMTS below -105dBm, LTE below -110dBm and 5G below -110dBm. For visualization of the measurement routes, color codes are used on the maps - white for no coverage, green for satisfactory coverage, yellow for good coverage and red for very good coverage.

4.1 Flood in Bogdan Village, Karlovo Municipality

The village of Bogdan, Karlovo municipality suffered very seriously from the flood in the summer of 2022, and this caused a lot of media interest in the disaster site, and many volunteers got involved in clearing the area [11]. The results of the telephony measurements of operator “A1” show [12] that when using GSM (2G) technology, the indicators “received signal level”, “received signal quality” and call statistics are not good, which indicates in the data from the CRC measurements. For telephony using UMTS technology (3G) with the same operator along

the measurement route, normal parameters were achieved - the average signal measurement level is -94.65 dBm, the quality of the received signal is 3.14 MOS, and we have 100 percent successful calls. Thus in fig. 1 with a color diagram shows the levels of the received signal for telephony when using UMTS (3G) technology along the measurement route. The graphs clearly show that in 3 areas with 7 percent coverage of the route, telephony through the operator's UMTS network was poor.

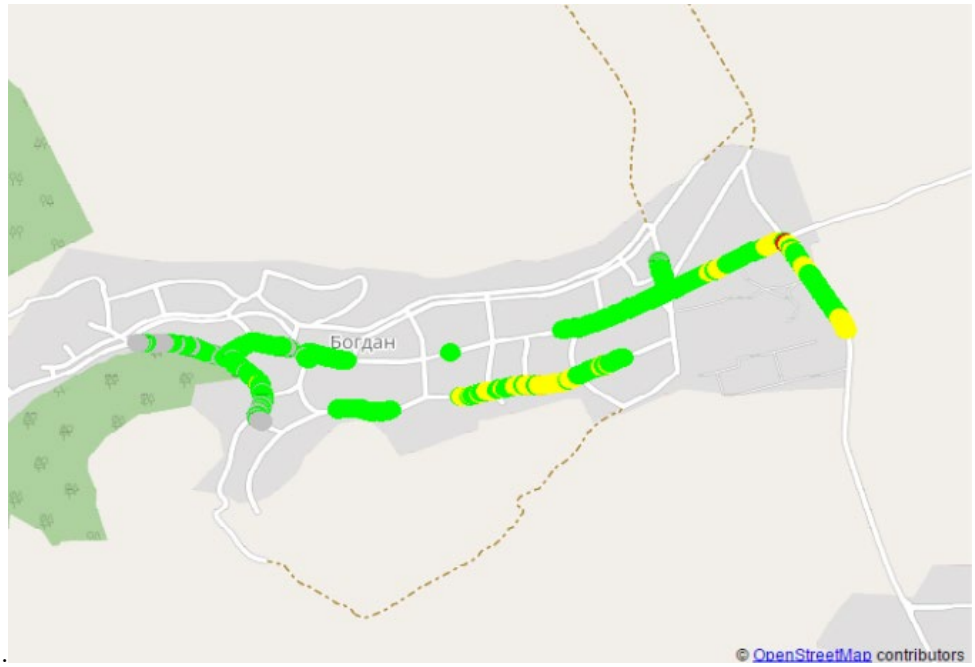

Figure 1. "A1" measurements for GSM and UMTS

In the measurements for the possibility of using UMTS technology for Internet access also carried out on September 8, the parameters "measured signal level", "average speed during data transfer", "average time for two-way time delay", all measurements show that no no signal is available (N/A). When accessing the Internet via LTE technology on the same route, -105.92 dBm for the level of the received signal, 5115 Kbps average data transfer speed and 47 ms average time for two-way time delay were measured. The measurements also include a map with the route and signal levels for Internet access (fig.2), where in 6 areas, which are 7.1 percent of the route, there is a bad signal.

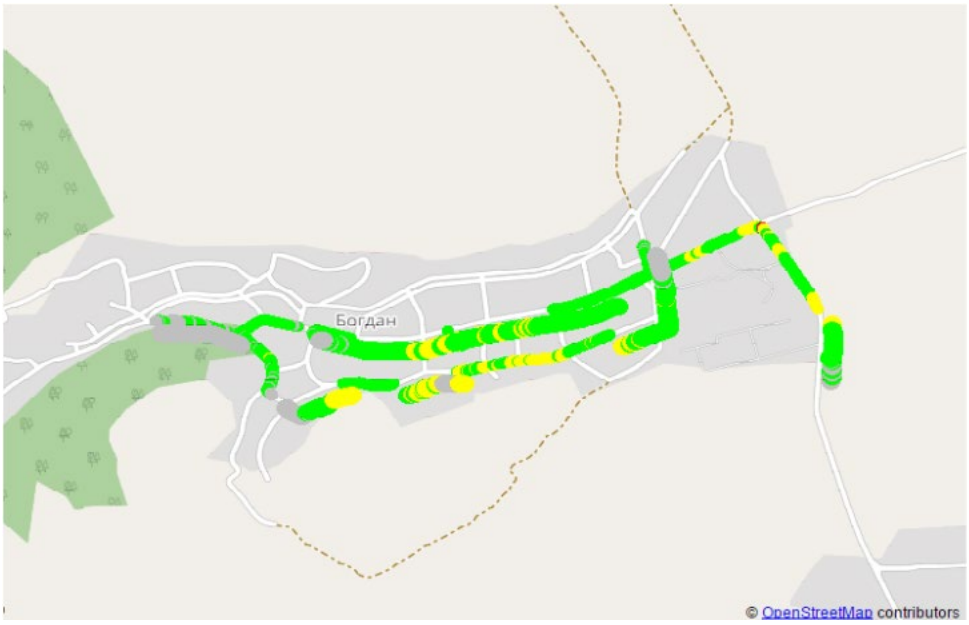

Figure 2. "A1" measurements for UMTS and LTE

With the operator “Vivacom”, the measurements made at the same time show the following results – “level of the received signal”, “quality of the received signal” and the statistics for the calls made using GSM technology are N/A (i.e. no available signal) [13]. For telephony using UMTS technology, the following data were measured: -87.95 dBm for the level of the received signal, 3.82 MOS and 100% successful calls according to the statistics for their implementation. Figure 3 shows a small area of 2.68 percent with poor signal in telephony measurements, which is shaded gray.

Figure 3. “Vivacom” measurements for GSM and UMTS

Internet access through this operator’s network using UMTS technology also shows N/A (ie no signal available) for all tracked parameters. The use of LTE technology for Internet access shows the following results in the measurements made: -108.02 dBm for the level of the received signal, 18451 kbps for the average speed of data transfer and 57 ms for the average time for two-way time delay.

Figure 4. “Vivacom” measurements for LTE and UMTS

In the upper Fig.4, the areas that were registered with poor Internet access along the measurement route are indicated, with up to 43 percent using LTE and 2.68% using UMTS technology.

The network of the operator “Yettel” in measurements for telephony using GSM technology show similar results for the level and quality of the received signal, as well as for the first two operators - N/A (i.e. no signal is available) [14] . When using the UMTS technology for telephony, -90.02 dBm for the level of the received signal, 3.60 MOS for its quality were measured and, accordingly, 100 percent completed calls were registered.

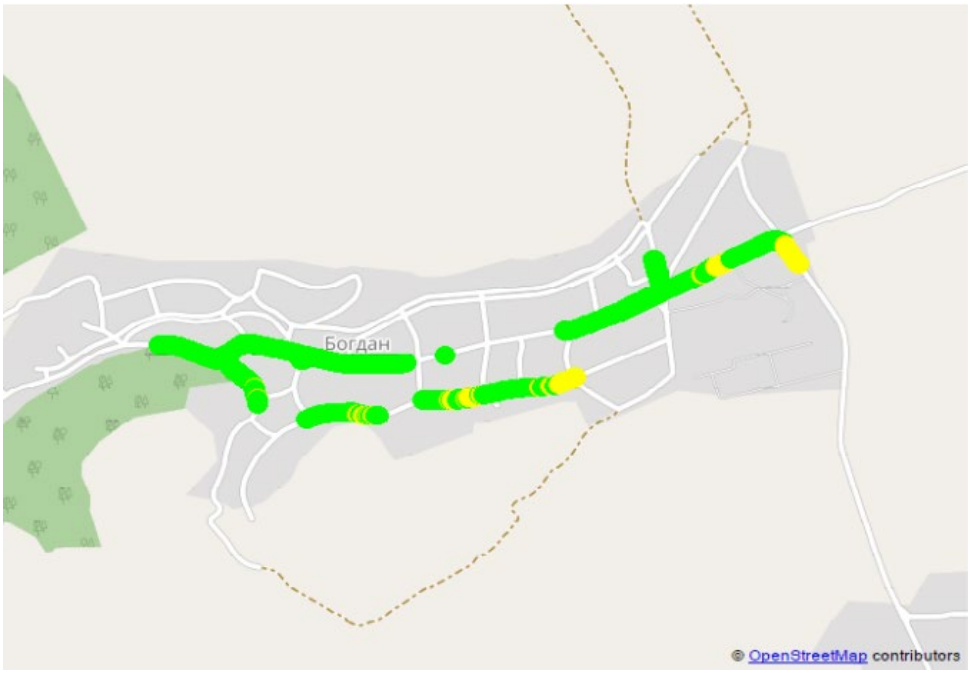

Figure 5. “Yettel” measurements for GSM and UMTS

The level of the received signal for Internet access was measured on the same date, September 8, 2022, and when using UMTS technology it was only N/A (i.e. no signal available) and for surfing when using LTE technology were the following parameters were measured: -102.08 dBm for received signal level, 10169 kbps for average data transfer rate and 172 ms for average round-trip delay time. In Fig. 6 below, the route of the measurements can be followed and the areas with a bad signal are marked in gray, which reach up to 20 percent when using the LTE technology.

Figure 6. “Yettel” measurements for UMTS and LTE

4.2 Flood in Slatina Village, Karlovo Municipality

Measurements of the frequency ranges of 900 MHz, 1800 MHz and 2100 MHz. during the disaster caused by the flood in the municipality of Karlovo on September 8, 2022, they were also held in the village of Slatina[15].

The network of the telecommunications operator "A1" for GSM standard telephony and at this measurement point shows results N/A (no signal available) [16]. With the UMTS telephony technology, 83.29 dBm for the level of the received signal, 3.75 MOS for its quality were measured, and accordingly 100 percent of calls were made. When detecting the indicators of Internet access in the area via UMTS in the network of the first operator, the data is again: N/A (ie no signal is available). Access to the worldwide network via LTE technology was also measured with the following parameters: -101.29 dBm for received signal level, 51057 kbps for average data transfer rate and 47 ms for average round-trip delay time. The accompanying graphs (Fig. 7) show minor sectors between 0.4 and 2.4% of bad signal areas along the route of the inspection performed by the experts.

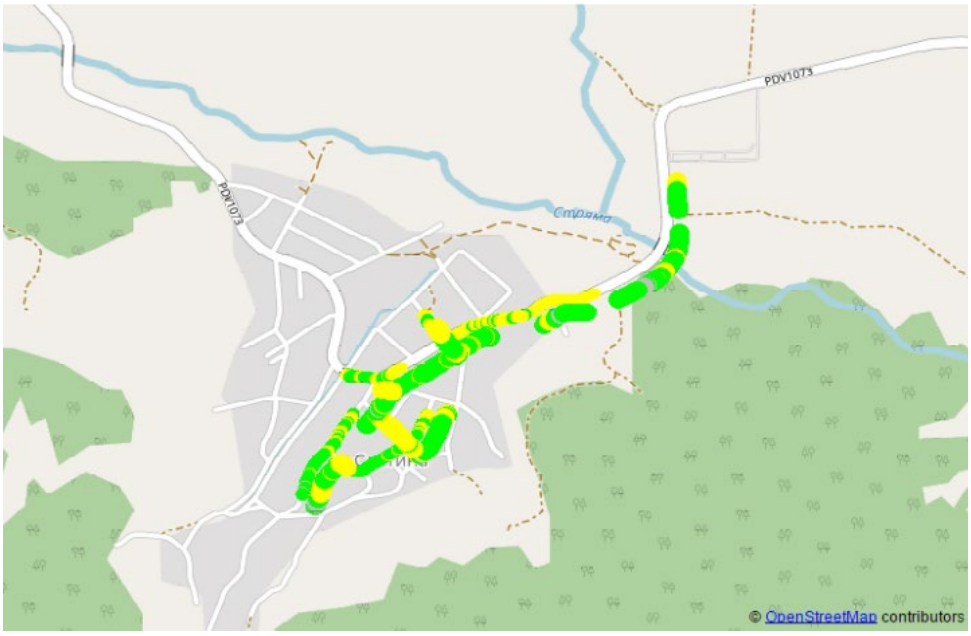

Figure 7. "A1" measurements for UMTS and LTE

Measurements in the network of the telecommunications operator "Vivacom" for GSM standard telephony give the same results for this area caught in the flood - N/A (no signal available) [17]. With the UMTS technology for telephony, -90.18 dBm for the level of the received signal, 3.78 MOS for its quality were measured and, accordingly, there were 100 percent completed calls. UMTS Internet access indicators are again: N/A (no signal available). Access to the network via LTE technology has measured the following parameters as normal: -103.12 dBm for received signal level, 21,832 kbps for average data transfer speed and 33 ms for average round trip time. The graphs of the measurements show only up to 1.5 percent areas with poor telephony signal and lack of measurements in certain parts of the route. When creating a measurement map (fig. 8) for Internet access, up to 19 percent of areas with a bad signal were detected.

Figure 8. "Vivacom" measurements for UMTS and LTE

In the flooded village of Slatina, they also measured the possibilities for calls in the GSM network of the third telecommunications operator "Yettel", and the results for all parameters are the same as for the first two operators - N/A (no signal available) [18]. At the same time, with the UMTS technology for telephony, -83.18 dBm for the level of the received signal, 3.63 MOS for its quality were measured, and accordingly 100 percent of calls were made. Internet access measurements using UMTS give the same results as with the other two licensed operators - N/A (no signal available). Surfing using LTE technology, the following parameters were measured as normal: -102.69 dBm for the level of the received signal, 7821 kbps for the average speed during data transfer and 35 ms for the average time for two-way time delay. The graphs for the areas in the village of Slatina with this operator show that 1.27% have a poor signal reception for telephony, and about 7.7% for Internet access. (Fig.9)

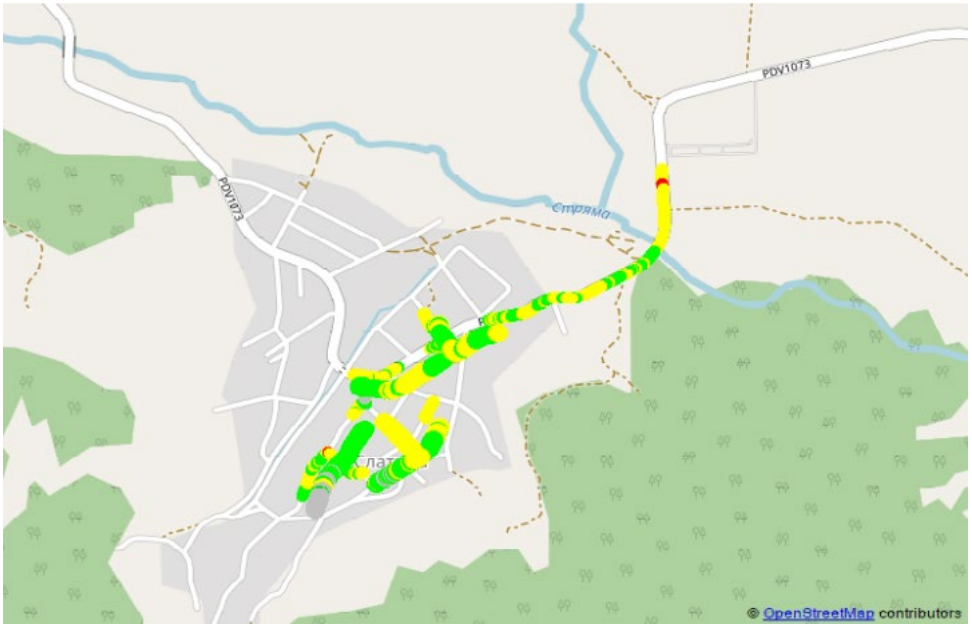

Figure 9. "Yettel" measurements for UMTS and LTE

4.3 Meeting Near the Village of Gela, Smolyan Region

The gathering of large numbers of people in one place is a prerequisite for the emergence of a crisis, and therefore the measurements of the CRC experts during the meeting near the village of Gela in the Rhodopes provide important information that can be used for subsequent analysis and conclusions [19]. The measurements were carried out during the two days of the event on August 5 and 6 in Ilindenski meadows at

an altitude of 1473 meters. The frequency ranges tested are 900 MHz, 1800 MHz, 2100 MHz, 2600 MHz, 3600 MHz. On August 5, the measurements carried out in the "A1" network for voice transmission for GSM technology show: the level of the received signal is -77.34 dBm; the quality of the received signal is 0.09; calls made are 100%.[20] The data for voice transmission via UMTS are: the received signal level is -80.22 dBm; the quality of the received signal is 1.62; calls made are 100%. During data transfer via UMTS - no signal, via LTE (received signal level: -106.40 dBm, download: 58.35 Mbps, two-way time delay: 61 ms), via 5G - no signal (Fig. 10).

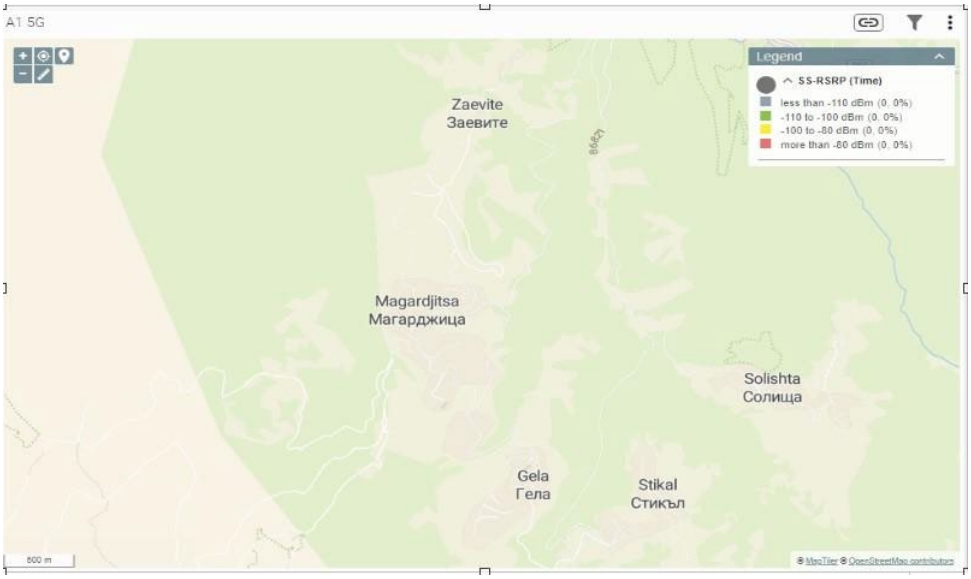

Figure 10. "A1" measurements for 5G

On the same date, during the meeting, the following results were obtained in the network of the operator "Vivacom" for voice transmission via GSM technology: the level of the received signal was -88.38 dBm; the quality of the received signal is 0.19; made calls are 97.66%.[21] The data for voice transmission via UMTS are: the received signal level is -94.60 dBm; the quality of the received signal is 0.8; calls made are 100%. During data transfer via UMTS - no signal (fig.11), via LTE (received signal level: -108.60 dBm, download: 0.904 Mbps, two-way time delay: 141 ms), via 5G - no signal.

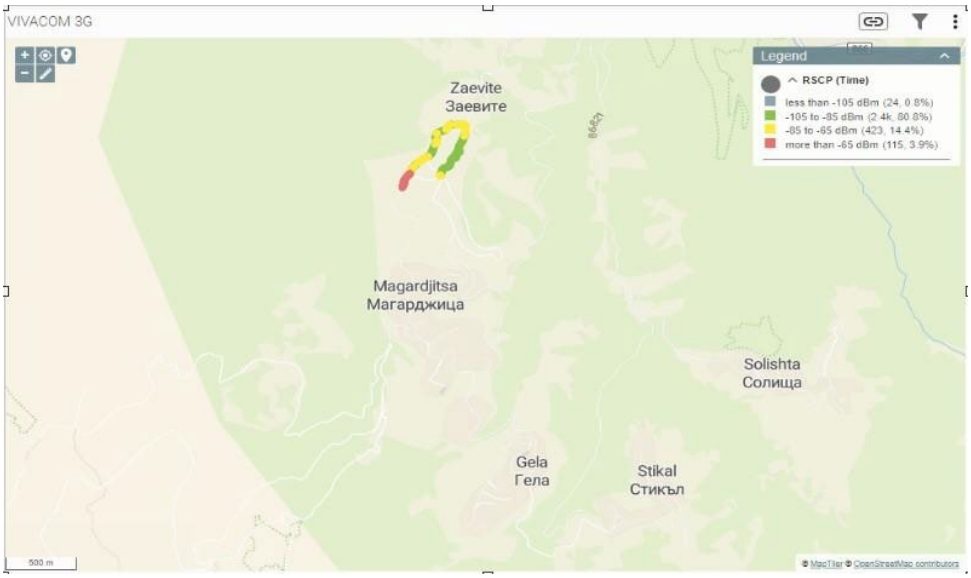

Figure 11. "Vivacom" measurements for UMTS

The third operator "Yettel" and the network built by it had the following indicators on the first day of measurement by CRC experts. [22] When transmitting voice via GSM technology: the level of the received signal is -78.05 dBm; the quality of the received signal is 0.16; calls made are 100%. The data for voice transmission via UMTS are: the level of the received signal is -99.01 dBm; the quality of the received signal is 0.47; calls made are 100%. During data transfer via UMTS - no signal, via LTE (received signal level: -103.20 dBm, download: 27.36 Mbps,

two-way time delay: 107 ms), via 5G (received signal level: -104.20 dBm, download: 8.384 Mbps , two-way time delay: 1405 ms) A 19 percent bad signal was detected (see Fig.12).

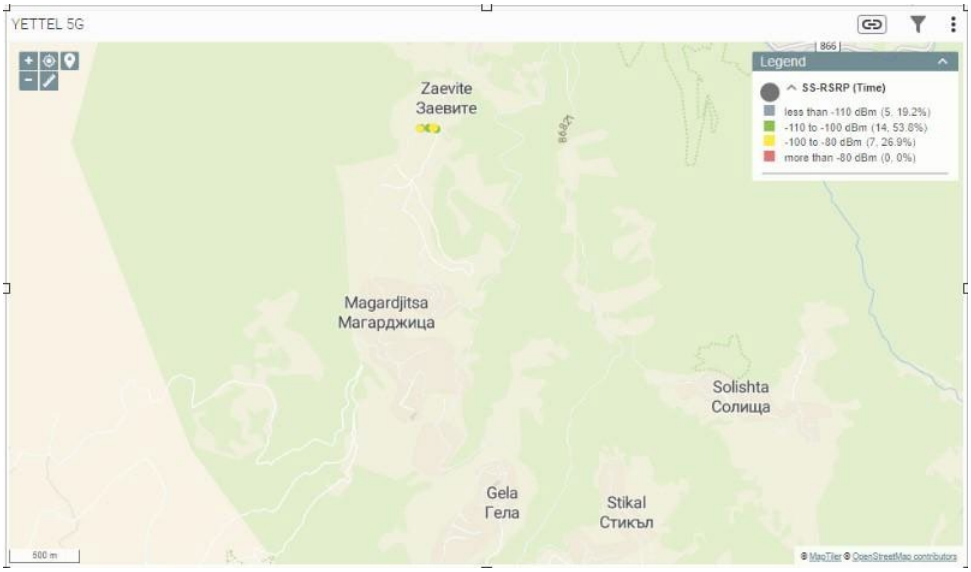

Figure 12. "Yetell" measurements for 5G

On the second day of measurements, August 6, 2023, the experts determined the following parameters for operator "A1" [23]. When transmitting voice via GSM technology: the level of the received signal is -81.94 dBm; the received signal quality is 0.1; calls made are 100%. The data for voice transmission via UMTS are: the received signal level is -88.05 dBm; the quality of the received signal is 0.41; calls made are 100%. When transferring data via UMTS - no signal, via LTE (received signal level: -106.70 dBm, download: 53.297 Mbps, two-way time delay: 67 ms), via 5G - no signal. With LTE technology, 18 percent of the measured areas show a bad signal (Fig. 13).

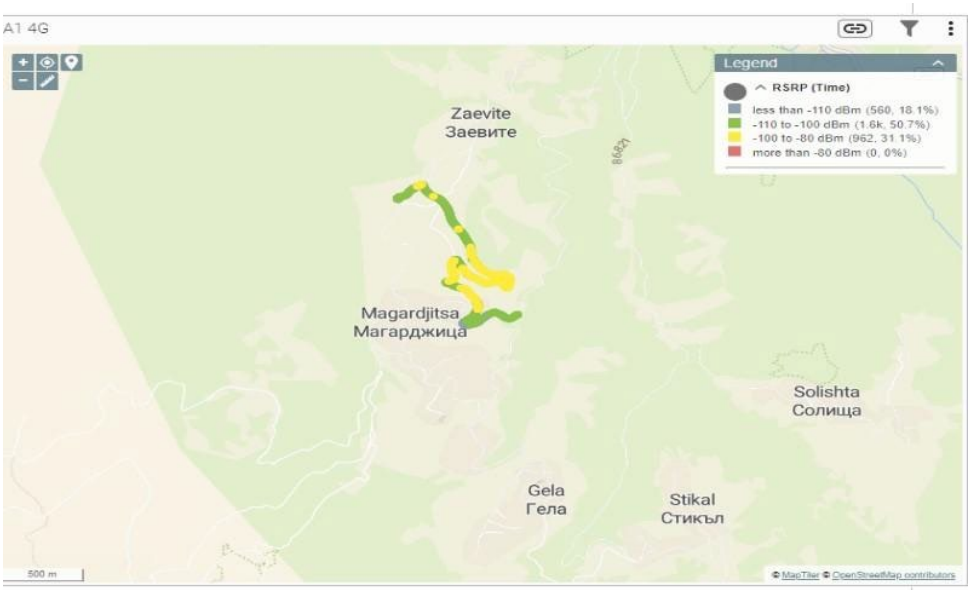

Figure 13. "A1" measurements for 4G

The "Vivacom" network shows the following results for voice transmission via GSM technology: the level of the received signal is -78.50 dBm; the quality of the received signal is 0.27; calls made are 100%. [24] The data for voice transmission via UMTS are: the received signal level is -83.25 dBm; the quality of the received signal is 0.81; calls made are 100%. During data transfer via UMTS - no signal, via LTE (received signal level: -99.20 dBm, download: 29.064 Mbps, two-way time delay: 45 ms), via 5G - no signal (Fig. 14).

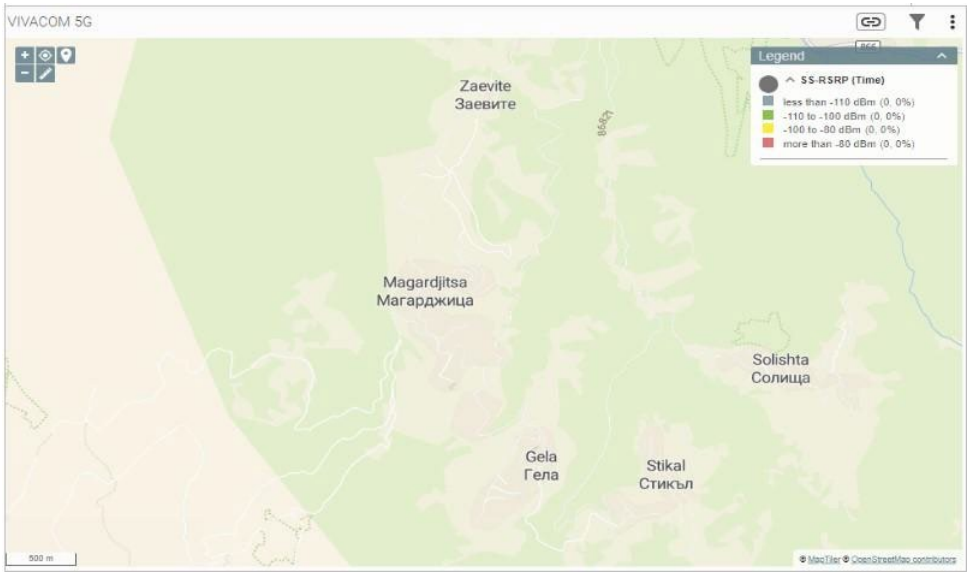

Figure 14. "Vivacom" measurements for 5G

The third operator "Yettel" gives the following results when measuring its network when transmitting voice via GSM technology: the level of the received signal is -86.04 dBm; the quality of the received signal is 0.27; calls made are 100%. [25] The data for voice transmission via UMTS are: the received signal level is -91.90 dBm; the quality of the received signal is 1.68; calls made are 100%. During data transfer via UMTS - no signal, via LTE (received signal level: -102.20 dBm, download: 6.067 Mbps, two-way time delay: 51 ms), via 5G (received signal level: -105.20 dBm, download: 179.861 Mbps , round-trip time delay: 1405 ms). 37 percent of the measured areas have a degraded 4G signal (Fig. 15)

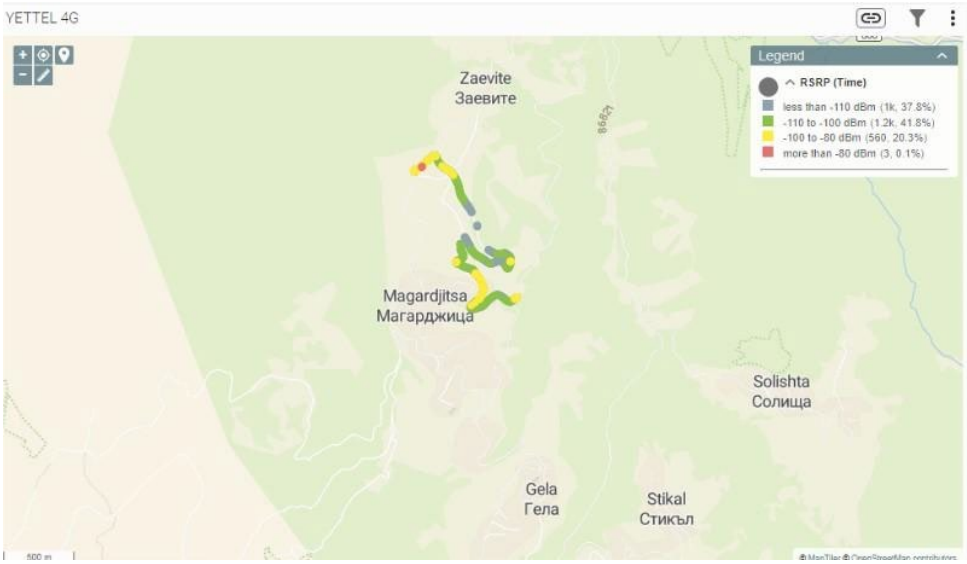

Figure 15. "Yettel" measurements for 4G

5 ANALYSIS AND RECOMMENDATIONS

The comparison between the measurements in the flooded villages of Bogdan and Slatina, as well as during the assembly near the village of Gela, gives us the opportunity to analyze the provision of communications in crises caused by natural disasters or mass events, where there is a gathering of large groups of people using mobile communications. It is also appropriate to identify certain measures for their improvement.

In the first settlement there are significantly more areas with a bad GSM signal, and the difference with the second flooded village is that the larger number of volunteers and the higher media interest, i.e. this leads to more intensive communication and load on the base stations far beyond their planned throughput. Experts explain the deteriorating signal for telephony and mobile internet (LTE) also with the fact that in recent times TV teams carry out their live broadcasts using mobile networks, due to the significantly lower costs of the technology, where a dedicated

transmission channel is provided for example through using a satellite connection. Also, the base stations get the extra load due to the increased number of calls from the volunteers who come to help with the cleanup, as well as from other people in the area. Thus, during a crisis, the absurd situation can be reached, in which, in the desire to help in real terms, including and by publicizing the extent of the disaster to prevent business communications or specific communications being prioritized at these times.

The analysis of the data collected during the measurements near the village of Gela during the assembly held at the beginning of August 2023, proves that when large masses of people gather in one place, communications cannot provide the necessary connectivity, and with the available prerequisites for a crisis is created risk of not being able to provide a reliable connection to emergency services or other necessary response in the event of a problem.

On the first day of the assembly in the village of Gela, which was more visited, there was no GSM connection and 5G connectivity, and on the second day, when there were fewer people at the event, problems were registered only with the fifth generation mobile Internet.

In view of the extraordinary load in crises where the popular channels for the distribution of voice and data via GSM, UMTS, 4G and/or 5G technologies need potential communication capabilities far in excess of the planned ones, which on the other hand is not justified from the point of view commercial goals and the economic interest of companies, it is necessary to ensure reliable channels for the transmission of information. The conclusions from the data presented so far give reason to make a justified recommendation to actively develop and implement alternative channels for connecting in crises of a different nature, and the recommendations are to develop the use of the radio frequency spectrum for the construction of local terrestrial networks for the needs of municipalities in a republic Bulgaria, allowing the provision of electronic communication services after the issuance of a permit by the CRC, to be used by voluntary or departmental formations to respond to crises or other emergency situations in the respective municipality. Building a single center for coordination between them can also be suggested as a recommendation. This will ensure a secure, easy to maintain and relatively cheap to build communication system throughout the country. The construction of local area networks in municipalities can also replace local emergency notification systems, using connectivity through the social networks of affected communities. Also as an alternative to connectivity in areas with suitable topography, connections can be made using amateur radio stations. In emergency situations and lack of other options, transmission of the necessary data and messages through the established networks of radio amateurs in the country can also be used.

6 CONCLUSION

The analysis and conclusions made presuppose the need to deepen the studies on the topic, as well as the expansion of the scope of observations. Given that the topic is related to crisis situations or potential ones, it is also imperative to define adequate general and specific measures for their resolution.

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Challenges and Solutions for Resilient Transport in the Era of New Environmental Requirements

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Abstract

According to the research of ITF, one of the big challenges for the environment is that the transportation sector is responsible for approximately 23% of energy-related CO2 emissions, which are expected to increase to 40% by 2030 and to 60% by 2050. This negative tendency requires for multimodal freight transport models in international economic relations, represented by land mode of transport (road and rail), inland waterways, short-sea shipping, and even airborne transport at short distances, while domestic transport policy should stimulate non-road transportation solutions. Usually, logistics providers offer logistics solutions, combining several modes, led by stakeholders' expectations for reduced time and costs of transferring of goods, reliability, and frequency of services. The difficulties arise from the already existing share distribution between the different modes of transport, due to political, economic, and technological issues. The biggest challenge is to design a resilient transport network, where the users can easily switch between transport modes in real time.

Keywords: *Combined transport, "Green" international logistics, Transport policy, Strategic analysis*

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Individual Time in the Context of Artificial Intelligence

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Abstract

In this work we analyse the problem of the formation of perceptual time in order to answer the question, if AI could have inner time. For this purpose, the process of signal perception is studied including an emotional response related to determining the significance of the information, characterized by a sense of one's own time. As we take into account that cybernetic approach to data processing doesn't consider the signal significance we justify the necessity the necessity to mean one additional channel to proceed the incoming data. This channel determinate data pragmatic value. A quantitative method is proposed for this evaluation by means of a scalar quantity, interpretable as an emotional amplitude, that is the basis of the formation of individual time. This gives grounds for defining a new criterion for comparing human mental activity with the capabilities and specificity of AI.

Keywords: *Perception, Memory, Emotion, Artificial intelligence, Individual time*

1 INTRODUCTION

The discussions about the place and possibilities of artificial intelligence (AI) have been ongoing for a long time, and they tend to intensify with each new breakthrough in the field. The emergence of AI and cybernetics has sparked debates that go beyond scientific arguments, often delving into ethical, social, and even existential considerations. We are in a similar ascending peak now, as a result of the literally daily achievements flooding us on the basis of constructed artificial neural networks in the field of recognition, entering new and new spheres of life, of human activity [1]. The new situation requires revision of the understanding of the goals and capabilities of AI based on a more detailed analysis of the specifics of human recognition and comparison with AI algorithms. The aim of the present work is to analyze one of the specific features of the human recognition process - the formation of perceptual time and connected with it individual characteristics of the recipient of data such as motivation, needs and requirements, desires and opportunities, manifested through the emotional saturation of the recognition experiences with a duration estimate. This connection is very important for our purpose – to describe such a personal subjective element as man's construction of the world with all the one's experience, thoughts and feelings. On this basis, it is possible to determine to what extent the specific characteristics of human cognition are inherent in AI and to mark the methods for its development. This is relevant because so far it is not sufficiently realizes that it is pragmatics that transforms data into information, which in human perception also manifests itself through emotional reaction [2-8]. Considering the importance of data in algorithms of AI [9] requires expanding the methodical approach and grouping the processing schemes around a core determining the value of inputs based on an assessment of how they affect the achievement of one's own goals [10-12]. Because of that in the present work we will analyze how data is evaluated in the course of human perception, how own time is formed and the way it can be integrated into AI.

2 RESULTS

2.1 Sense of Time

One of the first results of the phenomenological philosophy that analyzed human as a source of knowledge was identifying the influence of the subjective sense of time, which differs from physical time. In Bergson's philosophy, a person's experience of duration has become the organizing factor that determines the subject's life processes. According to Schachter and Gross not physical, but individual time, also designated as perceptual time, the psychological time of the individual, recorded by internal feelings, affects the content of memory, perception and biological processes [13]. Wittmann and Wassenhove point that personal time „is not 'isomorphic' to physical time and many factors including attention, memory, arousal and emotional states are all potential modulators of time perception [14]. One can recognize this personal time as something manifested through the perception and assessment of duration [1].

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2.2 Cybernetic Approach

Individual time is redundant in the cybernetic approach to signal recognition because the result is identified in the concept of physical time. This approach emphasizes the study of the information that is necessary to decipher the signal, the complete transmission of the message, while the effect of its pragmatic value is not considered. See Figure 1 to have an idea of simplified illustration of this model.

The signal received by the organ of perception (in this case vision) is transmitted to a neural network, that processes the data and produces a result - in this case the word "tree". The external signals come continuously as a stream and the result of the processing has continuous character. The scientific researches show that human perception doesn't work exactly that way. In the scheme, discussed above, different "objects" (each leaf, part of it, group of twigs, etc.) could be identified as units in the incoming signal. The human income is that an artificial neural network is constructed to recognize a particular "tree" as a tree. Through this activity, a pragmatics is implicitly introduced into "correct recognition". If we try to set a complete recognition task, no matter how powerful the capacity of the processing organ is, it will quickly become overloaded. The cybernetic model does not take into account that the purpose of perception is not only to form an image of an object. Perception basic task is to evaluate the need of reaction to the received information, which depends on its significance and the possibilities for action. It means that defining the outlook for the development of AI must begin with the question - what potential targets and responses it can form. A set of possible objects of AI perception should be formed as a function of these possible objects.

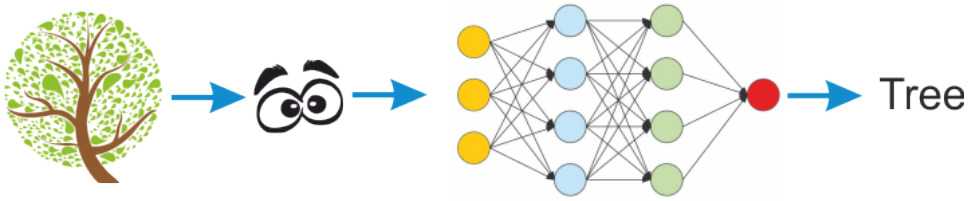

Figure 1. Linear cybernetic signal processing

2.3 Two Information Channels

According to the scientific researches, once there is the information channel described above where the input data is processed and the result is consciously perceived image of an object, in the course of the human perception process, another information channel is formed related to the same input data. This channel does not determine the specific object associated with the signal, but determines the degree of significance of the received message, that is accomplished by determining the availability of a significant characteristic associated with it. In the neural network should be the set of embedded features by the involvement of which the signal is tested. In this case, the set of features plays the role of the AI memory. Genetic memory is the principle part of the AI memory, where the results of the experience are accumulated through the connection - signal - significant characteristic, connected with needs and motivation, a certain type of purposeful action, with a specific reaction of the signal recipient.

An important element of human memory is a scalar quantity indicating the degree of importance of each of the features in it. As this process is automatic, it remains unconscious; we fill its result indirectly. In particular, the degree of significance is experienced as an emotional feeling on the pleasant-unpleasant scale, activates the autonomic nervous system [15], affects the endocrine and neurohumoral systems by changing the mode of operation of neural circuits. Neurobiological studies have shown that upon admission the signal to the projection cortex, a circular movement of impulses is formed with the activation of memory centers [16]. Like this this mechanism provides the ability to compare and synthesize information about physical properties and information about its significance, which is implemented 100 - 150 ms after the arrival of input data. Schematically, the considered process of signal significance processing and the synthesis of the two channels is illustrated in Figure 2. The input data, shown by the picture on the left side of the figure, contains information about multiple objects. The signal from them is transmitted to two channels, depicted by arrows. One of them, indicated by a dotted line, holds the input signal until its significance is determined, and the second, denoted by a semicircle, defines the characteristics of the signal related to its pragmatic value. The dominant characteristic, depending on the current needs, can be love or hunger, which activates a certain emotional state associated with the signal. (For more in detail about connection between the perception and emotion: see Ref. [17]). The processing data from this channel is synthesized with the input signal on the other channel, with the first element being a decision as to whether the signal processing process should continue or not. In the Figure 2, this is conventionally indicated by a barrier. If the signal is determined not to be significant, through the small amplitude of the emotional memory associated with the feature, the "barrier" is lowered and processing of the signal is terminated. If the signal leads to a large

amplitude of emotion, the "barrier" is raised and it continues processing. Depending on the dominant feature and associated emotion, at subsequent stages of processing the signal may be recognized differently as an object, for example, in this case, as "daughter" or "roasted chicken." If, on the other hand, a danger is noticed during the determination of the signal characteristics, a reaction can occur even before the synthesis of the two information channels and before the danger is fully identified as an object, in the case of a “bandit”. The information channel allows the individual to quickly respond to such information (and run away, for example).

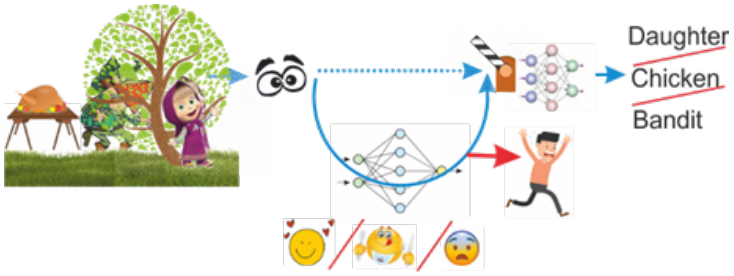

Figure 2. Illustration of the two information channels of data processing

2.4 Emotional Magnitudes

Signal processing at this stage, namely selection according to a set of characteristics, is much faster and more economical than detailed recognition of data as an object. Characteristics of the perceived object and associated to it emotional magnitudes are dynamic, the perceived benefits of signal processing at subsequent levels through feedback change them. In this way, successful evolutionary adaptation is also ensured, as the act of selective recognition is enhanced [18]. An emotional response related to determining the significance of the message, characterized by a sense of one's own time, an internal experience of duration. This time is not the physical time of objects, it is not based on their spatial characteristics and their dynamics, i.e. it is to a certain extent autonomous in relation to four-dimensional space. On the one hand, a person’s internal sense of time is associated with changes in the characteristics of incoming data, and with changes in emotional intensity. It, however, correlates with the presence of goals, motives and needs. On the other hand, however, it correlates with the goals, motives and needs, as the center of the sense of temporality basis, of one’s own Self [15]. So, if the signal is emotional or new one, the two information channels transmit their data to determine the object. This takes place on two interdependent levels. Initially, the signal is filtered at the level of available memory. It is a memory for objects perceived in the past (not signal characteristics).

At this stage, the significance of the message is already consciously specified and the subject creates imaginary scenarios of possible changes may result from knowledge of the information of incoming data. So, the subject tries to determine the best strategy for his behavior in order to reach his goals. The intense of inner time is changed as e new component of self-awareness. An analysis of the two-channel model of message processing shows that human intellectual processes are inseparable from individual information-related pragmatics. It manifests itself in terms of two different classifications of signals – features and objects. Each object or feature is associated with a possible action to achieve a desired goal. The significance of what is communicated on both processing channels is expressed by a quantity that we interpret as emotional saturation. It guides all stages of signal processing, and its dynamics are the basis of the formation of individual time and the related sense of individuality, of the Self. This gives grounds for defining a new criterion for comparing human mental activity with the capabilities and specificity of AI.

3 CONCLUSION

The Turing test to check whether an AI has intelligence in the human sense of the word should be replaced by a test of having its own time.AI is currently capable of solving a large set of recognition tasks using memory - of features, of objects, even can construct imaginary reaction scenarios. With each of these processes, with each possible object or characteristic, a quantity can be associated, which can be interpreted as a significance [10] and called an emotion. AI successfully analyzes imaginary scenarios. In Reinforcement Learning programs (e.g., the AlphaGo program) the reward when approaching the goal is a measure of significance and therefore relevant to the increase in emotional support. All these elements can be combined into a single structure that forms responses to the recognized signal. The intensity of network activity and response may be related to the manifestation of emotional magnitudes. However, this is not enough for the formation of proper time, that can be possible when AI starts to change the set of possible features and objects based on the experience of the reactions. This will be self-education, which will form its own "world", based on the construction of objects, characteristics (in which, in a

hidden form, the formation of its own goals is also embedded). If there is an element of randomness (mutation) in behavior (such as a sequence of reactions or processing), there are Fuzzy Sets, then individuality will gradually form in AI and the related own time and individual significance of messages. The future will show whether the development of AI will continue in this direction and what will be the result of this.

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Evaluating the Machine Learning Techniques for Classification of Rice Variety

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Abstract

Machine learning (ML) have been obtaining much interest due to their developments. With the recent faster ML algorithms, the classification task can be handled in an efficient manner. Such classification process includes a sufficient a number of images to be trained and tested. Rice is one of the significant products in human life and a lot of attempts have focused on its classification to provide better and effective production process. The direction of this study is to examine state-of-the-art ML-based approaches and underline the advantages. A conclusion is provided along with a future potential research direction.

Keywords: *Machine learning, Classification, Rice*

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Image Segmentation of Satellite Imagery with U-Net Convolutional Neural Network for Floods Detection

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Abstract

Within the scope of this study is presented a potential in using U-Net CNN (Convolutional Neural Network) for image segmentation in disaster management. The usage of image segmentation with combination of detailed spectral imagery could potentially be used for monitoring and analysis of flooded areas and could show to have potential in other further processing as for example change detection. The scope of this paper is to provide example of image segmentation of satellite imagery Airbus Pléiades with U-Net CNN and the resulting segmented result that could potentially be used in area of interest change detection.

Keywords: *Remote sensing, U-Net, Convolutional neural network, Satellite imagery*

1 INTRODUCTION

The usage of high-resolution spectral satellite images increased for many purposes including: agricultural, disaster management, military and more. With the increase in resolution of satellite imagery the side effect of increasing data size and time for computation has increased proportionally. Convolutional Neural Network could potentially solve the issue of increasing raw computation as they are faster in generating result in extraction of areas of interest that the conventional algorithms, like for example NDVI (Normalized difference vegetation index) or NDWI (Normalized Difference Water Index), after initial training of the CNN. The use if U-net CNN is useful in training the neural network faster as it increases the training speed providing weights from previous layers and giving the forward layers context information. As a result of using high-resolution spectral images from Airbus Pléiades the given product is segmented image with highlighted areas indicating water bodies. This result could be used in further processing with change detection to filter permanent water bodies as rivers and lakes to give clearer picture of newly formed water bodies that could potentially indicate flooded areas.

2 AREA OF STUDY

The area of study is Gölbaşı, Adıyaman Turkey, after the earthquake on 6 February 2023. The area has flooded territory bordering a permanent water body The Gölbaşı Lake. The bordering water body is perfect obstacle for image segmentation and localization of flooded areas near the lake.

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Figure 1. View of Gölbaşı lake. Image source: Aurbus Pléiades on 12 February 2023

3 DATA

The data used in this paper is Airbus Pléiades with high-resolution multispectral imagery, satellites images which are acquired by ITU Implementation and Research Center for Satellite Communications and Remote Sensing (ITU – UHUZAM/CSCRS)[1]. The satellite image provides resolution of 50x50cm per pixel. The image data is collected on 12 February 2023 roughly one week after the earthquake. The spectral images contain 4 bands of data including red (600-720 nm), green (490-610 nm), blue (430-550 nm) and near infrared (750-950 nm). Given that the raw data is being further processed for preparation of training and validation of U-Net CNN. The data is first split in 2 sets of data, training and test sets. For increase of the training set the training data set is randomly transformed with operations flip and rotation to increase the training set and to prevent the data of overfitting during training. The validation data is prepared with automation and by hand. The automatic process of preparing validation data is being derived from NDWI [2] shown in formula (1) and further process and cleared by hand.

$$NDWI = \frac{(Xgreen - Xnir)}{(Xgreen + Xnir)} \quad (1)$$

4 METHOD

The used methods of preparation of the U-Net CNN was to split the image in sectors of 128x128 pixels to train the neural network for increase image sample and reduce load on the processing hardware [3]. The images could be increased in size depending on available hardware. The basis of the U-Net CNN [4] architecture is feeding copying data from previous layers and cropping the data to reduce the training speed and increase relative context data. In Figure 2 is presented the architecture of the neural network. Main problem with training the CNN was to prepare balance dataset for training. Given the nature of remote sensing data many of the resulting cropped sectors were discarded as the ratio of lant mass to water bodies was close to 95% of the total image size.

Table 1. Evaluation metrics from best trained model of U-Net CNN

Metric	Score
Accuracy	0.9995
Precision	0.9982
Recall	0.9989
F1 Score	0.9986

The used dataset for training was selected to contain four to one ratio of mand mass to water bodies [5]. This selection prevented the neural network from overfitting on similar data. In are presented evaluation metrics from the best iteration of the trained model. The results from the image segmentation are 2 classes separated as land mass and water body. The confusion matrix for the two classes is shown it Table 2. Potentially this method could be further improved with implementation of unsupervised learning method as oppose to supervised learning as the latter requires validation data and could potentially be limited to a specific geographic region. Giving the high evaluation results it is safe to assume its related to the fact that the data is strongly grouped on small geographic area. Assumed that fact it is possible the evaluation metrics might drop if the provided training data contains more largely separated geographic areas. This prediction model falls short on several problematic areas. With images containing heavy cloud coverage it is impossible to extract meaningful information based on the input data. As the model depends only on multispectral optical imagery dense cloud cover would obscure the sensors. This will prevent the model from finding any water located under the cloud cover. Given this it is also known challenge analysing areas with dense vegetation as for example dense forests. The dense vegetation could cover areas with floods and prevent the CNN from segmenting the area as the model would assume the area of interest is land mass. Further experimentation with different geographical areas of interest is needed for concluding better solutions for previously stated problems.

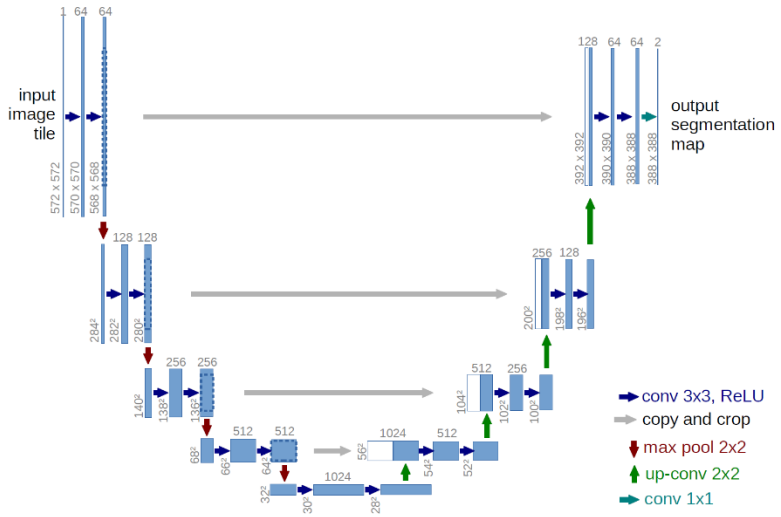

Figure 2. U-Net CNN architecture image [2]

Table 2. Confusion Matrix from best trained model of U-Net CNN

	Predicted land mass	Predicted water body
Actual Land mass	23400469	6064
Actual water body	6736	5127659

5 RESULTS

Resulting segmented images show area with containing water. Shown in Figure 3 and Figure 4 is the resulting segmentation and indicated land mass and water bodies. Excluding the training cost of the CNN the time to perform computation on the full raster is greater than applying several costly operation to extract the same data with conventonal methots.

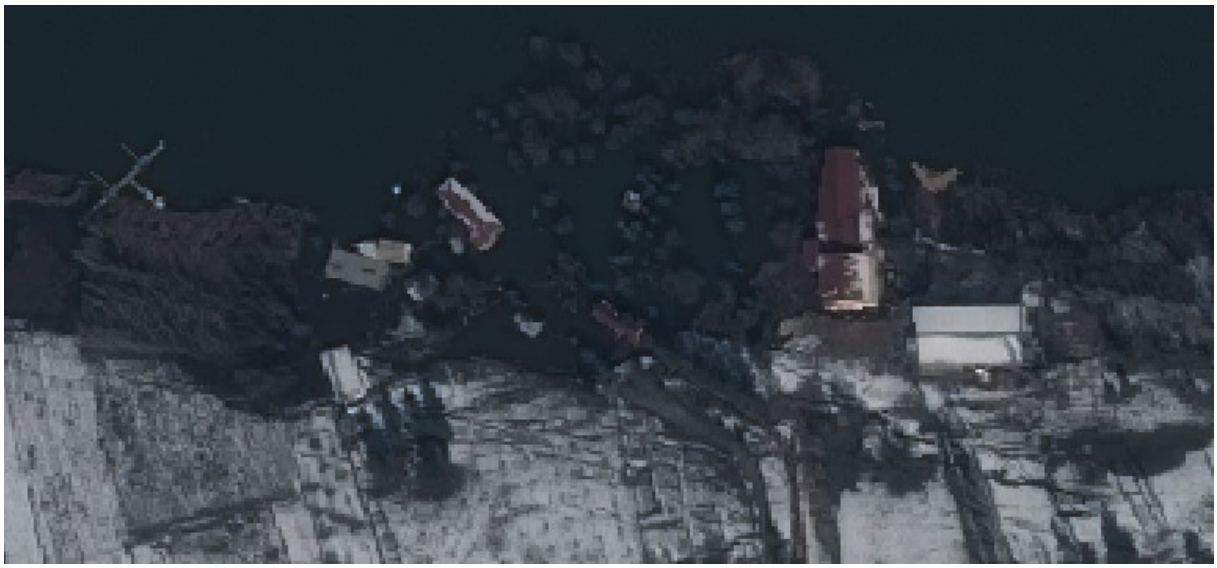

Figure 3. Flooded area as base layer

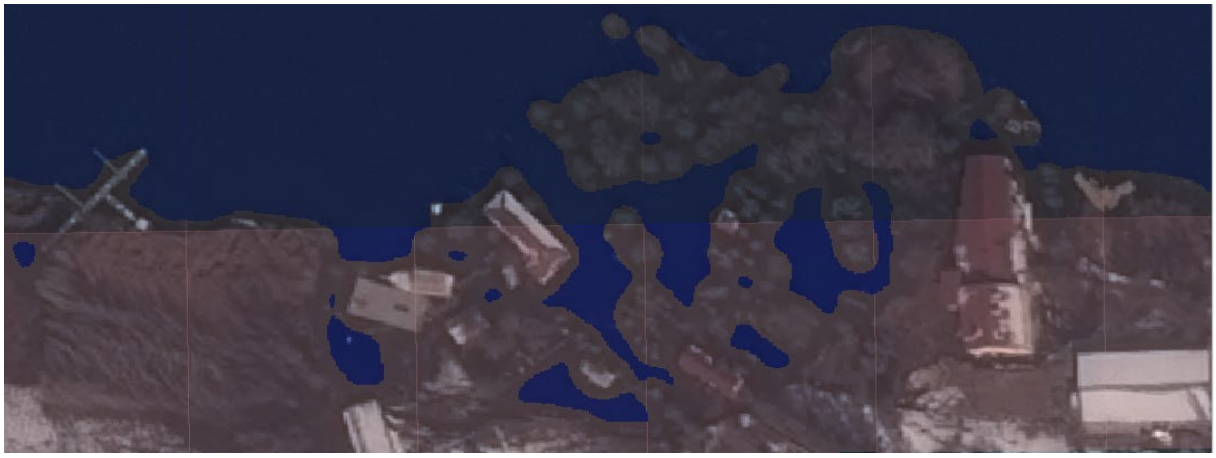

Figure 4. Flooded area with overlaped result of image segmentation.

6 CONCLUSION

Given the high performance and high accuracy of the trained U-Net CNN it shows great potential in use of preparing data for further processing. The results of this paper provide great base for analysing floods and other disasters with algorithms such as change detection. Change detection algorithm could extract the water bodies areas and intersect previous and following image to detect increasing or decreasing areas of water bodies which could be used to alert experts to review the data provided from the system. Other types of improvements on the current design of the system could include image segmentation of several segments. This could potentially decrease the false positive results of change detection in areas with increased water bodies from rain. This paper shows the potential in further developing system for disaster management and analysis with CNN and specifically U-Net type architecture to decrease training times and required data as well as the time for preparation of validation datasets. Further increase in accuracy and full data picture would be addition of other data information about the geographical location as for example DEM [6] or additions of SAR data. The resulting approach falls short on resolving the problem with cloud coverage as it is reliant mainly on spectral imagery and it is hardly applicable on areas with heavy forest as the vegetation of the dense forestry would obscure the information of floods in the area. Because of this it is safe to assume that for the specific problems of heavy cloud coverage or areas with dense vegetation another approach may be more viable and could provide better results. Implementation of U-Net++ [7] is also considered in further research in finding optimal architecture for image segmentation

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Short Overview of Software Architectural Models

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Abstract

The architecture of microservices in the development of software applications is one of the most current methods of creating software that reflects the development of hardware, communication technologies and challenges of today. The main trends related to increasing reusability, scalability, reliability and high performance of software applications are fully reflected in the architecture of microservices. This article analyses the main architectural models for software development. The main characteristics of Structural, Object-Oriented, Client-Server, Component-Based architectural models, Service-Oriented Architecture (SOA) and Microservice Architecture (MSA) are discussed. The main principles of building microservices are covered. Some architectural patterns for microservice design are shortly presented.

Keywords: *Software architecture, Microservices*

1 INTRODUCTION

Software application development follows a certain architectural model. The purpose of this article is to analyze the architectural models for software development - monolithic and distributed, with a focus on Microservice Architecture.

Architectural programming models can be mainly divided into monolithic and distributed. Structural, Object-oriented and Client-Server styles fall into monolithic architectures. Component-based architectures, service-oriented architectures, and microservices architectures belong to the distributed software architecture model [1].

The structural architecture model can be considered the oldest model for creating software applications [2]. Its key characteristics are as follows:

1. Top-down design [3]. The main problem is broken down into smaller problems, which in turn are broken down into even smaller ones, until the tasks are small enough and can be easily addressed using basic programming constructs.
2. Usage of Modules. The most basic building units are modules, which are relatively self-contained pieces of code with a single input and, in most cases, a single output. Only emergency outputs can be allowed as additional ones. Modules allow:
   a. Code reusability;
   b. Different developers to work on specific modules (thanks to the module's relative independence from the rest of the code);
   c. Improves the readability of the code and makes it easier to debug.
   d. Allows easier expandability of the code.

Object-oriented architecture is an upgrade of the structural model [4]. Modules are now objects with a much more complex anatomy. Its main characteristics are:

1. Granularity becomes coarser. The main building block are the objects which aim to reflect the real world as much as possible. They combine data and the code to process it. The level of abstraction is increased.
2. Thanks to inheritance, a higher degree of reusability is achieved.
3. Transmission of messages. Objects communicate with each other through messages.
4. Delayed connection. The selection of an appropriate method is deferred until runtime, resulting in great code flexibility.

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5. Relative independence between objects, allowing multiple developers to work together. However, due to inheritance, this independence is limited and it is recommended to use low depth inheritance and without multiple inheritance.

The client-server architectural model is a result of the development of the Internet [5]. This is the first architecture with elements of a distributed model. In this model, the business logic and data are centralized on the server. The client is responsible for sending requests to the server and presenting the results to the user. Main characteristics:

1. Communication over the network is carried out based on the communication protocols from the TCP/IP protocol stack.
2. This model allows resource sharing. Resources are centralized on the server and can be used by multiple clients.
3. The principle of operation is request-response. The client sends a request that is processed by the server and the server returns a response that is interpreted by the client.
4. Processing is decentralized. The server is responsible for data storage, data processing and business logic. The client is responsible for the interface and the primary processing of the data, such as its verification.
5. This model allows for easy scalability. Multiple users can easily be added without significantly impacting the server's performance.
6. Increase the software's power without it affecting the user hardware requirements. The main powerful calculations are performed on the server machine that satisfies the relevant hardware requirements. The client machine only interprets the results.
7. Platform independence. Client applications are developed independently of the server side. This way they can be designed for machines with different operating systems and hardware platform.
8. Sharing of Resources. Different clients can update the database and the results of this can be used by other clients.
9. Centralized data management. The server is responsible for the storage, consistency and integrity of the data.
10. Reliability and fault tolerance are increased. The organization of the server's work provides for regular backups and spare hardware that can promptly take over the work of a failed hardware component.
11. Security is both the bottleneck and a major focus in the operation of this architecture. As data is transferred over a public transport medium, there is an emphasis on authorization and encryption.
12. This architecture enables high performance. The server part can run on multiple machines for load balancing between them to ensure high performance.

Component-based architecture marks the next stage in the development of software architectures [6, 7]. A software system is built using relatively independent software components that are reusable. Components communicate with each other through well-defined interfaces. The main characteristics of this architectural model are expressed in the following:

1. Modularity and reusability, which continues the trend outlined by the models discussed above.
2. The application is built as a composition of individual components, and their inclusion can happen at different levels: during the creation of the application or during the execution.
3. Scale and Scalability. Each component can be developed in a different programming language and by different teams. This allows easy integration of different technologies, easy expansion of the component base with which applications are built, and the creation of a wide variety of components.
4. Interoperability. Thanks to communication through interfaces, individual components can successfully communicate with each other.
5. Reduced dependency between components. Components are encapsulated and hide the processing code. Interfaces are the only means of accessing them. This makes the components independent of each other.
6. Easy maintenance. When detecting defects, only the problematic components are tested. If new functionality is needed, new components can be added to the application or components already included in the application can be replaced.
7. Component Version Support. The different versions of the components are numbered, which helps to move from one version to another.
8. Standards. In order to support the successful interworking of components, industry standards are relied upon to communicate and define interfaces.

Service-oriented architecture (SOA) extends the concept of reusability and independence of the building blocks of the application being developed [8, 9]. Software applications are built as a collection of loosely coupled and interoperable services. Services are the basic structural unit. Services can be distributed over a network. The main characteristics of this architectural model are expressed in the following:

1. The principles of modularity, encapsulation, reusability and platform independence are preserved and deepened.
2. Loose coupling. Services in SOA are much more independent entities than components. Like them, they are developed and progress independently of each other. This allows flexibility and scalability (development by multiple independent teams) to be fostered.
3. Interoperability. Like components, services communicate with each other using standard protocols and data formats, such as SOAP (Simple Object Access Protocol) and REST (Representational State Transfer), enabling seamless collaboration.
4. Composition of services. Applications can be very large and complex due to being built by composing or orchestrating multiple services to achieve specific business processes. The composition can be built dynamically by combining services in real time.
5. Service Lifecycle Management. Services have a well-defined lifecycle that includes creation, deployment, and version control.
6. Lack of condition. Services in SOA are most often designed to fulfill a fully submitted request. The request contains all the necessary data for its execution by the service. After its execution, the state of the service is not saved for follow-up actions.
7. High level of security. Security is managed at the service level through authentication and authorization mechanisms.
8. Management Mechanisms. SOA often includes governance mechanisms to ensure that services adhere to organizational standards, policies, and best practices.

Microservice Architecture (MSA) builds on SOA by adding some new features [10-13]. The most significant of them are:

1. The basic unit is the microservice.
2. Decentralized data management. Microservices typically maintain and manage their own databases. In this way, external dependencies are reduced and greater autonomy is achieved.
3. Dynamic discovery of microservices and support for load balancing is accomplished by maintaining service registries.
4. Containerization is one of the main characteristics of microservices. Microservices are most often deployed in containers, such as Docker containers. Containerization helps ensure consistency and deployment.
5. Distributed management. Microservices architecture works with both local and distributed management. The goal is to ensure consistency in areas such as security, data management, and API (Application Programming Interface) design.

2 MICROSERVICE ARCHITECTURE

In microservice architecture, an application is built as a collection of small, autonomous microservices. Each microservice performs a specific business task. In fig. 1 shows a diagram of an application built with a microservices architecture. Application interfaces installed as client software on user devices communicate with the Gateway, which performs the Load Balancer function and calls the corresponding microservices. They, in turn, can solve the specific business problem and return a result or call on other microservices to perform their subtasks.

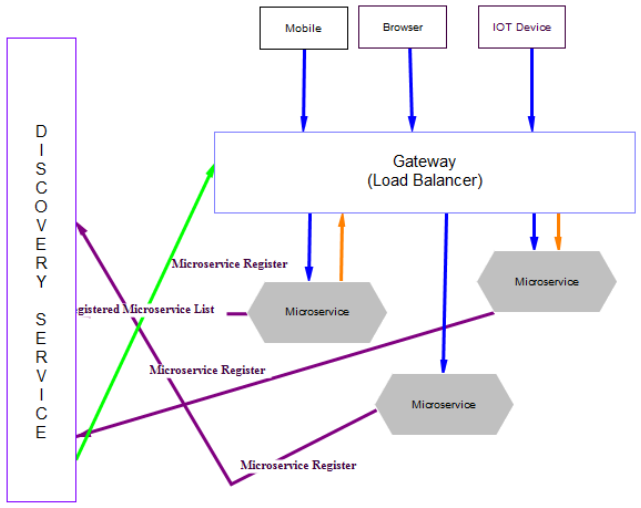

Figure 1. MSA model [14]

The main principles that must be observed when building microservices can be systematized in the following aspects [15-18]:

1. Componentization via services. This means that microservices should be developed as a black box that hides the content and allows the application to be built by "assembling" these black boxes without knowing either their structure or the language in which they were developed.
2. Focus on business tasks. Each microservice must execute a specific business logic without caring about the overall business logic of the application.
3. Decentralized governance. Microservice development is not managed centrally. There are no clearly defined rules for building all microservices. Each of them can be developed by a different team, with independent management.
4. Infrastructure automation. When building microservices, automation of deployment and testing processes must be ensured, as well as support for different versions of the microservice.
5. Design for failure. If one microservice in the application fails, all other microservices must function successfully. This ensures fault tolerance of the system. When deploying microservices in containers like Docker, monitoring tools like Grafanam Heapster and Prometheus can be used to automatically restart the microservices that are down.
6. Products not projects. Microservices are viewed as finished product, not as part of some larger project. Microservices are developed by teams responsible for the entire cycle of creating the final software product: design, development and testing of the microservice.
7. Smart endpoints and dumb pipes. Microservices should not be too "heavy" and should use lightweight asynchronous communication mechanisms such as HTTP with REST.
8. Decentralized data management. Each microservice manages its own data repository and that microservice alone has direct access to it. If another microservice needs this data, it must contact the microservice responsible for the repository and obtain the required data extract.
9. Evolutionary design. Each microservice is autonomous and independent. This means that it can undergo an evolution in its internal design, or even have its design replaced with a brand new one. If a microservice is found to be unused, it can be painlessly removed from the application.
10. Independently deployable. Each microservice can be developed independently, supporting different versions. Several versions can be in use at the same time, for as long as it is necessary.
11. Highly observable. For the stable operation of microservices, continuous monitoring of their operation is required. In the process of working, microservices can become overloaded and this can lead to errors. Developers should continuously monitor the performance of the service and take timely measures when problems appear or when reporting inefficient behavior in certain cases.

3 ARCHITECTURAL PATTERNS FOR MICROSERVICES

At this point, we will present some of the most popular patterns for creating microservices [19].

API-Gateway represents a Service Composition Pattern [20]. An application developed with MSA consists of multiple (sometimes hundreds and thousands) microservices that communicate with each other via APIs. The API gateway acts as a single entry point for all client requests, providing clients with a unified API. API gateway is responsible for request routing, protocol transformation, authentication, monitoring, response aggregation, etc. It can also act as a load balancer. The main disadvantage of this pattern is that it represents a single point of failure and requires precise work in order not to become a development bottleneck.

Client-side Discovery Pattern is responsible for selecting services from the service registry, applies a load balancing algorithm, and selects an instance and makes a request to it. The main advantage is the ease of development. A major drawback is the strong coupling between the client and the service registry.

Server-side Discovery allows the client to communicate directly with the microservice. The client makes a request to the load balancer. It in turn makes a request to the registry, which selects an instance and forwards the request to it. This model has a number of advantages: increased maintainability, ease of communication, health management, failure safety, software understandability, ease of development. ease of migration. The model has the following disadvantages: service registry complexity, the registry could be the main bottleneck of the system, distributed system complexity.

Hyrbid Pattern combines Service Registry and API-Gateway, replacing the API-gateway with a message bus. The idea of the message bus is borrowed from the Enterprise Service Bus used in SOA architectures.

Multiple Service per Host Pattern allows multiple services to run on a single node. The main advantages of this pattern are scalability and performance.

Database-per-Service Pattern governs the creation of microservices, where each microservice has its own database. Advantages: scalability, independent development and security mechanism.

Database Cluster Pattern allows the data to be stored in a single cluster. Microservices use the data from this cluster. The advantage of this approach is in improved scalability and is recommended for applications with intensive data traffic. Disadvantages: increased complexity and risk of failure.

Shared Database Server Pattern allows data to be stored in a common database for multiple microservices. This pattern is suitable for use when migrating from a monolithic to a microservice architecture.

4 CONCLUSION

The evolution of architectural models for software development has led to the replacement of monolithic architectures with distributed architectures. One typical representative of distributed architectures is the Microservice Architecture. The main advantages of this model are distributed management, a high degree of encapsulation, decentralized data management, the possibility of building applications as a structure of microservices developed by different teams, the possibility of polyglot programming, containerization and scalability. Microservice Architecture, as the name suggests, is based on Microservices. The main requirements that must be met when building microservices can be summarized in componentization via services, focus on business tasks, decentralized governance, infrastructure automation, design for failure, products not projects, smart endpoints and dumb pipes, decentralized data management, evolutionary design, independently deployable, highly observable.

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Vulnerabilities Testing in Real-Time Wi-Fi Network

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Abstract

Nowadays, people own various devices such as tablets, phones, laptops, and IoT products connected to wireless networks. Many businesses use wireless networks for the convenience of their employees, but they are not always well-configured and secured. Since the dawn of wireless networks, cyber professionals have struggled with their proven vulnerabilities. As information technology advances, so do changes in wireless security standards and protocols. Although the IEEE (Institute of Electrical and Electronics Engineers) strives to keep the 802.11i standard secure, there are still users who neglect or forget to provide a secure wireless network. This article aims to show the vulnerability in a wireless network, as well as to remind us about their removal and securing. There are numerous instruments for detecting vulnerabilities. In our case, the analysis and evaluation are done with the Airgeddon instrument. The operating system that we used is Kali Linux, Alfa omni antenna AWUS036NHA using 802.11 b/g/n standard, Airgeddon tool.

Keywords: *IEEE, WiFi, Kali Linux, Airgeddon, MITM*

1 INTRODUCTION

The flow of information nowadays is overwhelming. Almost everyone on the planet owns an electronic device that connects him to the rest of the world via the Internet. According to Statista.com [1], as of July 2023, there are 5.19 billion Internet users worldwide who frequently use a WiFi network, whether private or public, for this connection.

Since the dawn of their creation, wireless networks have been the target of cyber specialists who have struggled with their vulnerabilities. The creation of the 802.11i standard for wireless networks is due to the IEEE. It has evolved over the years, with the latest version 802.11be or WiFi 7 being developed and expected to be completed in 2024 [2]. The standard will operate at 4 times higher data rates (~40 Gbit/s) and have twice the bandwidth (320 MHz channels vs. 160 MHz channels for WiFi 6) [2]. Improvements to MIMO protocols and refinements to WiFi capabilities are also included. Advanced WPA3 and AES cryptographic techniques encrypt and secure the wireless connection. This will ensure that the data and information transmitted over the WiFi network remains secure and confidential. WiFi works with radio waves, with the antenna picking up and receiving signals. The built-in MIMO (multiple-input and multiple-output) technology is used.

WEP "Wired Equivalency Privacy", introduced just a few years ago, is susceptible to brute force attacks. Actually, cyber experts don't recommend its utilization. The next generation is WPA, but it turns out that it has a weak cryptographic hash and is not a good solution for open infrastructure radio networks for Internet access.

Despite today's 802.11ax or WiFi6 standard and WPA2 encryption method, wireless networks remain a challenge for cyber professionals and hackers alike. A type of network protocol established by IEEE 802.11i is 4-way wpa/wpa2 handshake (Fig. 1) [3].

1. The AP (Access Point) send a nonce-value to the client (ANonce).
2. The client now has all the attributes to construct PTK (Pairwise Transient Key). The client sends its nonce-value (SNonce) to the AP together with a Message Integrity Code (MIC) including authentication.
3. The AP constructs and sends the GTK (Group terminal key) which is used to decrypt (multicast and broadcast) and a sequence number together with another MIC.
4. Finally the client sends a confirmation to the AP [4].

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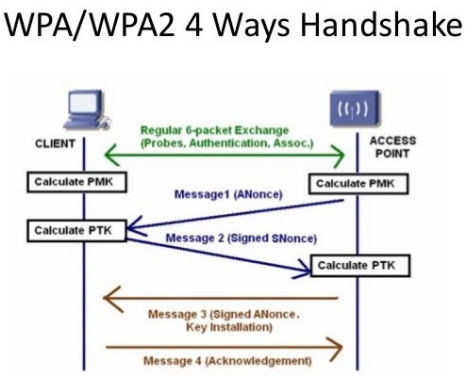

Figure 1. WPA/WPA2 4Way handshake (Soure: https://www.secpod.com/blog/the-krack-attack-wi-fi-at-risk/)

In the 4-way handshake, the client and access point independently prove to each other that they know PMK (Pairwise Master Key), without revealing it. The process doesn't send this key to the web and contributes to strengthening security.

The threats from the Ewil Twin, password cracked, and man in the middle remain. Uneducated and careless users and organisations would not notice a man in the middle until their data appears on the dark web.

In his article "Wireless Network Vulnerabilities Estimation" Ass. Proff. Linko G. Nikolov shows a table of different passwords and proves that the password length is of great importance [5]. Andrés Javier Pulido Bernal, Octavio José Salcedo Parra, and Alberto Acosta López build fake access point in their article "Vulnerabilities and Attacks on WiFi Network" [3]. In our experiment, we will show the automated tool Airgeddon, which makes testing easier for both professionals and hackers. Experiments are carried out in a real environment to make with Evil Twin MITM attack.

2 TOOL USED

Airgeddon is an automated tool with more features. It is also an open-source and auditable WiFi network. This multipurpose bash script is designed for Linux operating systems [6]. It includes several tools: aircrack-ng, hashcat, bettercap and Beef-xss. Working with the tool is extremely easy since at each step a menu appears from which we choose what we will do. Even users who don't have much pen-testing experience can handle it [7].

3 EXPERIMENTS

Used Kali Linux, Alfa omni antenna AWUS036NHA and Airgeddon tool, we work in local home WiFi network in real-time.

The purpose of our experiment is to build an MITM attack, get the password of the router and build a connection in the MITM attack from HTTPS to HTTP for the client. As we know the connection is encrypted in HTTPS, unlike the connection in the HTTP protocol. We are constantly monitoring traffic and listening to the client's connections (Fig. 2). It relies on the fact that everyone nowadays wants to be connected to the Internet at any cost.

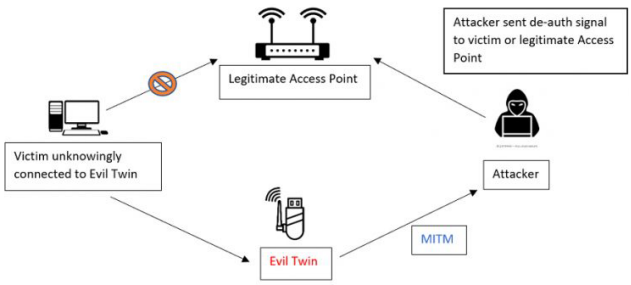

Figure 2. Evil Twin attack (Source: https://cyberartspro.com/en/evil-twin-attack/)

First, we installed the Airgeddon tool, as it is not being installed by default in Kali Linux. Then, the following command line is typed: sudo Airggedon.(the instrument work only sudo privilege).

When we started Airgeddon, tool, we saw that the tool was getting revised on a library (Fig. 3).

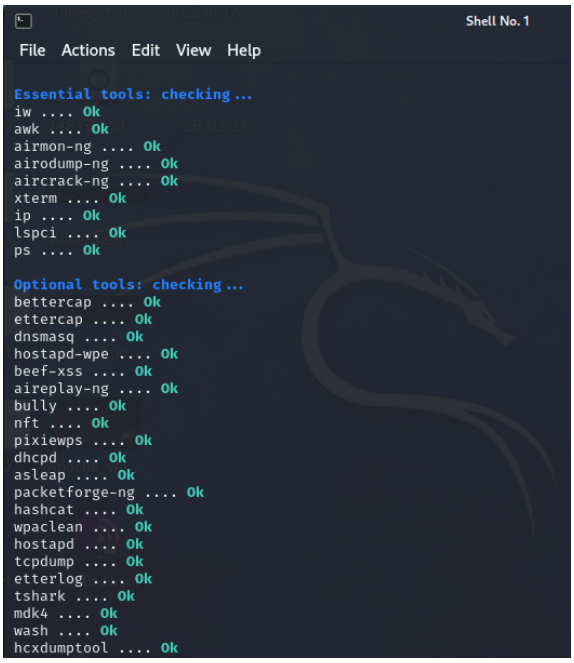

Figure 3. Airgeddon get revision on library

Our antenna is in management mode by default. Or, it must be switched to monitor mode to start working (Fig. 4 and Fig. 5).

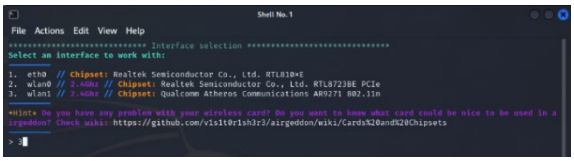

Figure 4. WLANs in our computer

Figure 5. Our antenna is in monitor mode

Ready for monitoring we started discovering WiFi networks (Fig. 6).

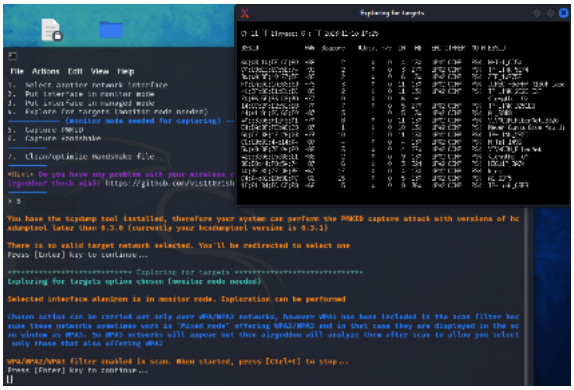

Figure 6. Discover WiFi networks

When see our WiFi network, we stop the process by pressing ctrl+C. All detected networks are displayed (Fig. 7).

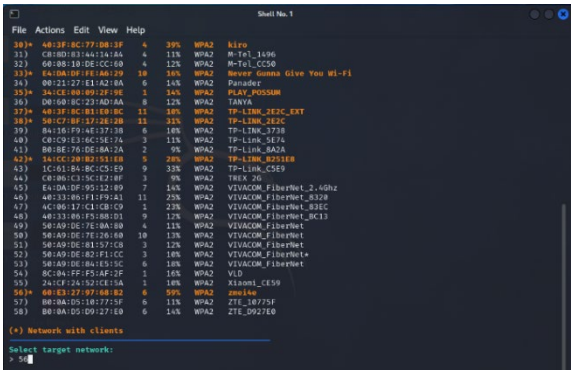

Figure 7. All detected network

The coloured ones show that there are working users in them. This is important for our experiment because we can intercept the 4-way handshake and find out the password to access the router. We see the MAC address, the channel it's on, and what cryptographic method it uses, name the network or name the router.

Finding the victim's network, in our case our local WiFi network, through the 4-way handshake, we establish a connection with the router. From the resulting text file is in /root/handshake-00:00:00:00:00:00cap. We can extract its password using hachcat or aircrack-ng. We choose aircrack-ng + Dictionary because we have performed social engineering and included a learned password in our wordlist. Nowadays passwords are quite and it was considered that it's better to use social engineering that waste time in a brute force attack (Fig. 8).

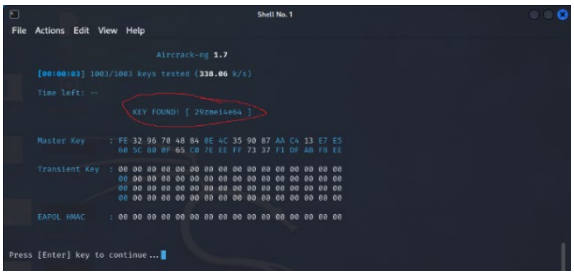

Figure 8. Finding password

We found the password of the router in 3 sec. If we had chosen a brute force attack, we would have lost days or even months in cracking this 10-character password containing lowercase letters and numbers, since the combinations of them are 3 656 158 440 062 976 [8]. We would need a supercomputer.

In the next phase, we choose to use the HTTPS to HTTP transfer option in addition to sniff and spoof to build the Evil Twin attack. That way the link goes through and should, if possible, intercept the password if the victim decides to use the relevant page.

During the attack, 5 windows are opened, which show:

access point AP (top left);
the DHCP server window, with the IP addresses and what exactly the device is, (left in the middle);
deauthentication, (bottom left);
in the upper right is the window of the evil twin with the connected devices to the fake access point, in our case these are a computer and mobile phone;
the Bettercap window (bottom right);
In the Bettercap window, we take the commands:

net.probe on;

set arp.spoof.target 192.169.1.33;

arp.spoof on;

net.sniff on (fig.9).

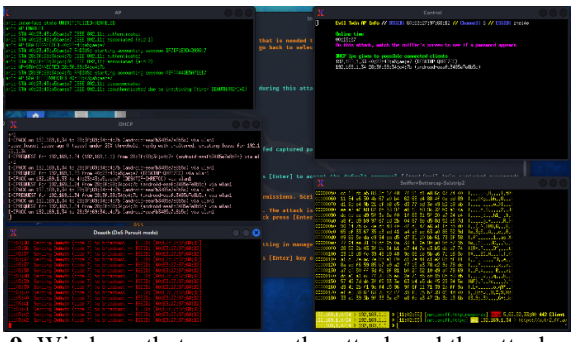

Figure 9. Windows that opens on the attack and the attack working

Throughout the attack, each page opened by the client triggers a wave of packet captures that, after the attack is complete, will be examined.

4 RESULTS

After reviewing the results of the attack, it was found that the HTTPS to HTTP doesn't work because the page we built as HTTP is not visited by the victim. The page he enters is mail.bg and for this reason, we intercept neither the user nor the password. It would be better to use another approach and clone the mail.bg page through another social engineering tool built into Kali Linux. Mail.bg logging in is not secured so the victim must remain vigilant (Fig. 10).

Figure 10. Connection is not secured

The experiment of the attack is not insignificant, as the traffic passes through us and gives us an idea of which site is visited most often by the victim, which allows us to have better results in the next attempt.

5 CONCLUSION

The man-in-the-middle attack remains one of the most dangerous attacks in WiFi networks. As we've seen, traffic monitoring opens up unlimited options for follow-up. We can steal a session and impersonate someone else, we can get sensitive information if the connection is unsecured, and we can clone the victim's most visited pages and whatever else we need.

Users must be especially careful when using an Internet connection via WiFi, especially through open access point. It is highly recommended to use anti-virus programs that warn about entering unprotected pages, some of which are particularly aggressive and prevent the user from accessing them, using a VPN connection to transfer sensitive information. Nowadays, there are opportunities for better technology protection, which helps social engineering development.

In conclusion, no matter how well technology is protected, man is the biggest threat to himself**.**

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Classification of Fire-Affected Areas with Satellite Data and a Multi-Layered Neural Network

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Abstract

The classification of forest fire-burned regions of the earth's surface and their correlation with the same areas before fire, is essential to model preventive actions. The purpose of this research is to use satellite images to make classification of different regions of the earth's surface burned by forest fire, according to the carbon monoxide parameter of the same areas before the fires. An adaptive approach with machine learning of a multilayer neural network was applied, which was trained with different carbon monoxide values for four different geographical regions in Greece. For the purposes of the study, freely accessible images of burned areas obtained by the Sentinel 2 satellite were used. Based on the obtained database and the recognition results in the test phase, it becomes possible to classify them as areas of burning and to find the correspondence with similar such areas before the occurrence of the fires. The results of the research are presented and analysed. Some steps are suggested for future development of the method when testing with a larger volume of data.

Keywords: *satellite data, fire-affected areas, neural networks, classification.*

1 INTRODUCTION

In recent years, forest fires have been increasing for various social reasons, as well as due to climate change. Due to the severe damage and sometimes irreversible consequences, it is imperative that they be classified and, based on the result, create a database with both appropriate prevention measures and prescriptions for correct actions in extinguishing such fires. Thanks to the free access to satellite images and related databases provided by the European Space Agency (ESA), as well as the large number of freely available software tools for accessing and processing these images, it is possible to realize a number of ideas for effective containment of harmful consequences of various natural disasters [1].

The purpose of this research is to use satellite images to make classification of different regions of the earth's surface burned by forest fire, according to the carbon monoxide parameter of the same areas before the fires. An adaptive approach with machine learning of a multilayer neural network was applied, which was trained with different carbon monoxide values for four different geographical regions in Greece. For the purposes of the study, freely accessible images of burned areas obtained by the *Sentinel 2* satellite were used. Based on the obtained database and the recognition results in the test phase, it becomes possible to classify them as areas of burning and to find the correspondence with similar such areas before the occurrence of the fires. The results of the research are presented and analysed. Some steps are suggested for future development of the method when testing with a larger volume of data.

2 PROPOSED METHOD

For the purposes of this study, images from four different regions with fire damage, which took place in year 2023, were used. The images, their processing and the extraction of the NBR graphics were obtained by means of software tool Earth Observation Browser [2]. Classification of burned areas is made, for 2023 Wildfires in Greece with satellite data before and after the fire applying the measured values of CO (carbon monoxide) – concentration in the atmosphere around the place of fire before and after it. The target method is to make classification of burned areas in Greece – Rhodes Island, Athens, Alexandropulis and Corfu Island in 2023. Many NBR graphs of the obtained by satellite Sentinel 2 images, for four burned areas were used as input data to a MLP neural network. The MLP was trained to classify the graphs in eight different categories/classes, according to their different mean CO values. In the test phase, different test data samples with standard deviation and not included in the train set, were used to generalize the classification. The obtained classification results in the test stage are given in a table

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and discussed according to the four investigated burned areas. The values of CO for the region by dates is exported in csv file format to prepare train and test files.

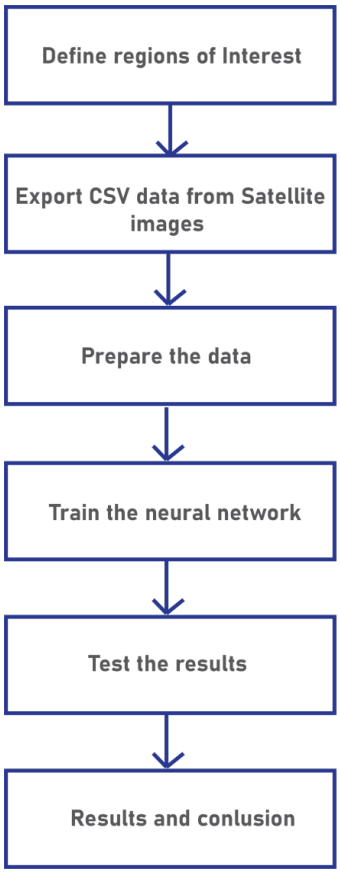


Figure 1. Workflow of the tasks

2.1 Description of Input Parameters

Normalized Burned Ratio Index is used to estimate burn severity. This index uses near-infrared and shortwave-infrared wavelengths. Healthy vegetation has a high reflectance in the near infrared part of the light spectrum, and low short-wave infrared reflectance. Burned areas, on the other hand, have a high shortwave infrared reflectance but low reflectance in the near infrared darker pixels indicate burned areas.

Wildfires releases large amounts of toxic gases including carbon monoxide, nitrogen oxides and non-methane organic compounds into the atmosphere. This contribute significantly to global warming and this is also the second pollution cause in the world. Special sensors are needed to observe these gases and they are on board of Sentinel satellites. They measured increased concentration of CO as a consequence of the wildfire. The NBR index measures the concentration of CO in the atmosphere around the place of fire. For this research median CO value which is result from P10 CO and P90 CO values for the regions of interest, is used. P10 is also called Proved, this is the lowest figure. It means that 90% of the calculated estimates will be equal or exceed P90 estimate. Possible (P10): The highest figure, it means that 10% of the calculated estimates will be equal or exceed P10 estimate. For the research median value – P50 is used. These values provide the best possible evaluation of CO concentration in the concrete regions. This provides the neural net with the precise data for the train and test operations [3].

For the purpose of this study, the values of CO for the region by dates is exported in csv file format to prepare train and test files. From the csv files are used only P10, P90 values for CO concentration and precisely the median value for a time period of 6 months before and after the fires.

2.2 Investigated Fired Regions

The target method is to make classification of burned area in Greece – Rhodes Island, Athens, Alexandropulis and Corfu Island 2023. The relevant NBRs are reported for a 6-month summer period of 2023, during which fires

raged in the indicated regions. The data was obtained from the Sentinel 2A satellite. CO/P10 and CO/P90 were used as training and testing data according to the parameters described above. Burned areas and NBRs for areas a/ Rhodes Island, b/ Athens, c/ Corfu Island d/ Alexandropulis are represented in Figure 2. the data is distributed in 8 classes. The first 4 classes contain the CO data for the four areas before the fire, and classes 5 to 8 - contain the CO data for the affected four areas after the fire.

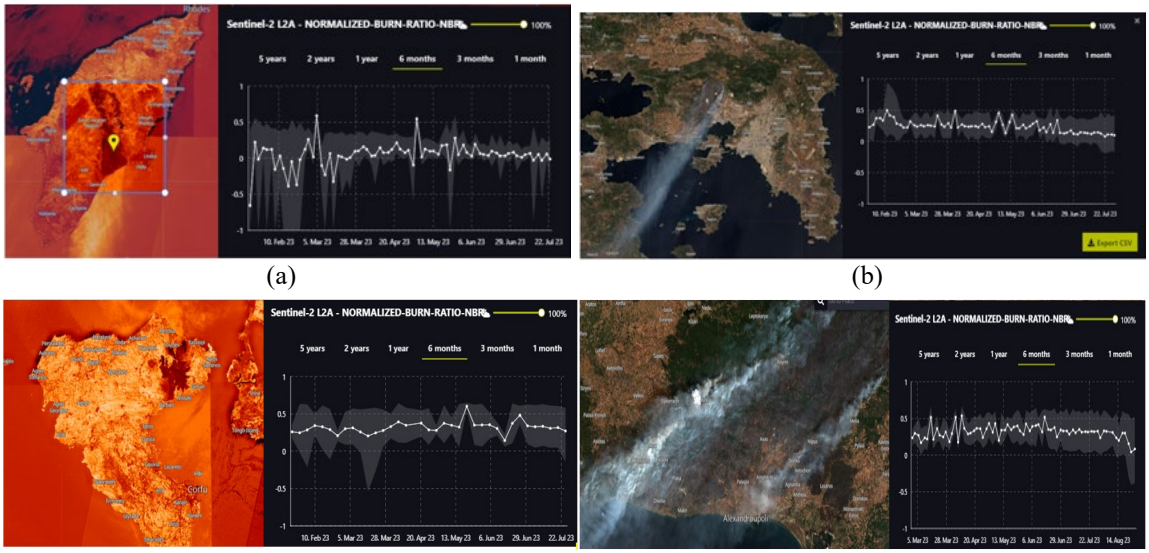


Figure 2. Burned areas and NBRs for areas (a) Rhodes Island, (b) Athens, (c) Corfu Island, (d) Alexandropulis

2.3 Train and Test Data for the Proposed MLP NN

The training and testing inputs are prepared in a normalized format in the range [-1 1] and applied to the inputs of the neural network in the training and testing stages, respectively. The test sample was not involved in the training of the neural network. The data are presented for the 8 classes defined in item 2.2

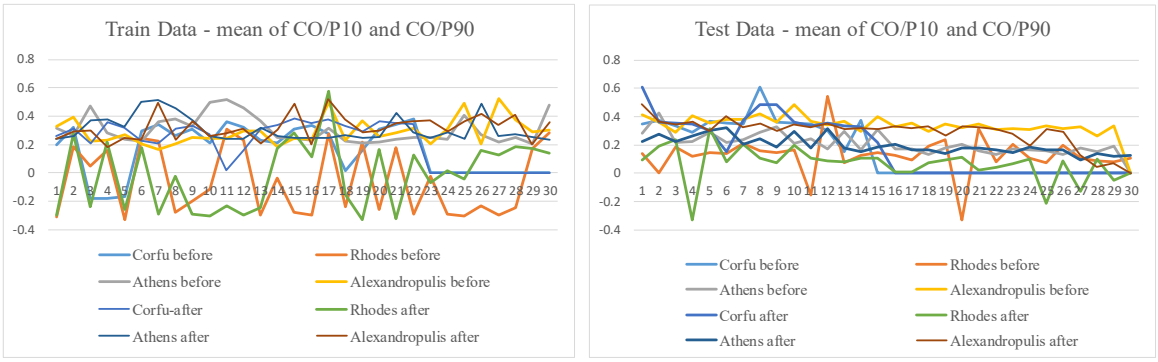


Figure 3. Train (a) and test (b) data applied to the inputs of the neural network

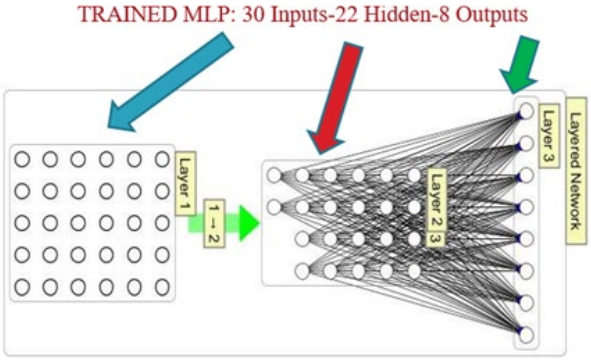
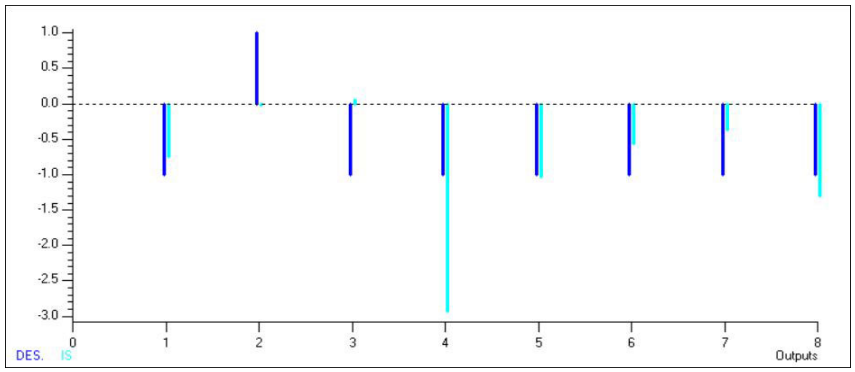
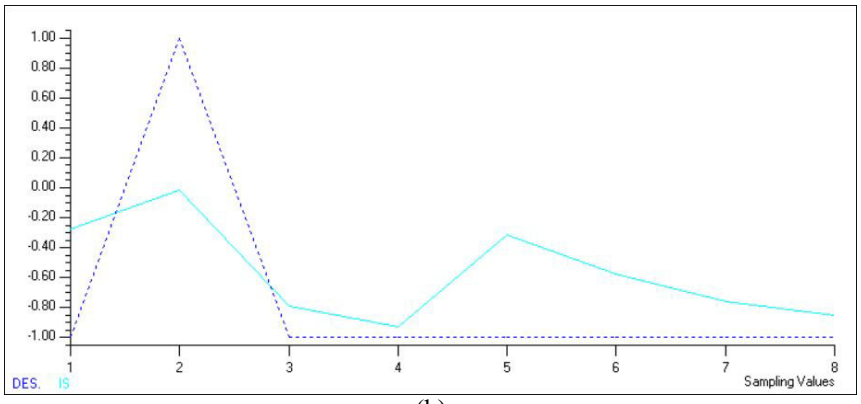


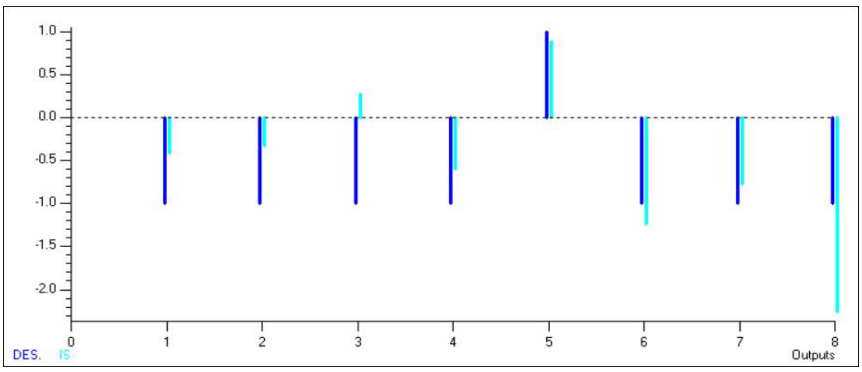
Figure 4. Applied MLP NN structure 30-22-8



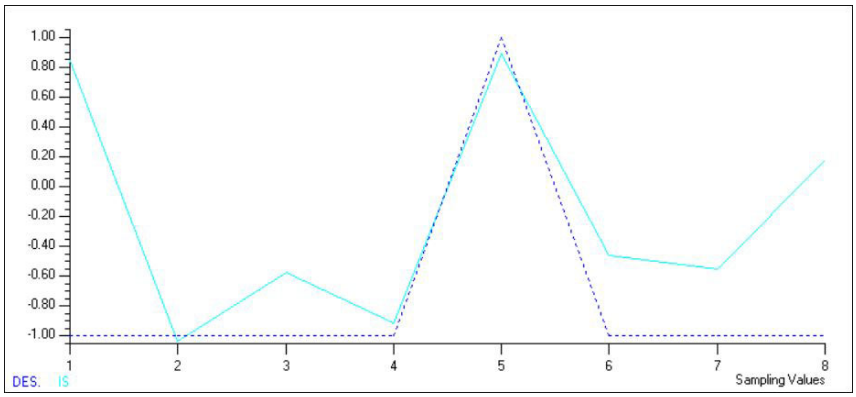
(a)



(b)



(c)



(d)

Figure 5. Test results for output 2 – "Rhodes-before fire" – (a) vector presentation; (b) signal presentation. Test results for output 5 – "Corfu-after fire" – (c) vector presentation; (d) signal presentation

The structure of the trained MLP neural network, that showed the best accuracy in the testing stage with samples that are not part of the training sample, is shown in Figure 4. It consists of 30 input neurons, 22 neurons in the hidden layer, and 8 neurons in the output layer, corresponding to the set 8 trained and recognized classes. It was

trained reaching 0.1% MSE (Mean Square Error) with 2361 iterations. Tangent hyperbolic as activation function and BPG train algorithm were applied. Neuro System was used as software tool [4, 5].

As shown in Figure 5 a) and b) the results for Rhodes before fire is classified as Athens before fire region. The output was predicted as 2 – Rhodes before fire, but the result output was 3 – Athens before fire. The difference is clearly shown with the blue and red dots – predicted and real result. As can be seen from the data in Figure 5 c) and d) – the vector and signal representations of the results for Corfu Island the predicted and the real results are the same. The blue and red dots are really close to each other.

2 RESULTS

Table 1 shows the overview of the results. What is interesting in this data is that the predicted and real classified regions are the same, except the results for Rhodes Island. This region was classified like Athens before fire – output 3 and like Corfu Island after fires, according to output5 of the network. In every other occasion the regions were classified from the neural network exactly like the prediction. These results suggest that carbon monoxide values in Athens region and Rhodes Island before fire was the same, but the values of carbon monoxide after fires was different for these two regions but the values of carbon monoxide after fire in Rhodes Island was as much as the values in Corfu Island. In summary, these results show that the data from satellite images could be used for classification of different areas before and after wildfires.

Table 1. Predicted and real classified regions

Predicted	Real classified-before fire				Real classified-after fire			
	1 Corfu	2 Rhodes	3 Athens	4 Alexandropulis	5 Corfu	6 Rhodes	7 Athens	8 Alexandropulis
1 Corfu-before fire	OK							
2 Rhodes-before fire			X					
3 Athens-before fire			OK					
4 Alexandr.-before fire				OK				
5 Corfu-after fire					OK			
6 Rhodes-after fire					X			
7 Athens-after fire							OK	
8 Alexandr.-after fire								OK

3 CONCLUSION

The prevention and detection of the wildfires is really significant nowadays, but also the recovery management after the disasters is also important.

The results from classification clearly show that the areas are different, they were classified in different classes. The results also show that the damages after wildfires in two islands are the same but clearly distinct from the other two continental regions, which are different between each other. This conclusions and results are really important for the recovery management after fires – the recovery procedure will be different for each region. The repair from the disasters will take different time for each area.

Classification of the fire-affected areas after and before fires with satellite data and neural network is a good tool for the recovery strategies after wildfires. It is essential after big disasters to asset the damages and stabilize environment. Using satellite images, makes it is possible to evaluate the damages, analyse burn severity and determination of long-term environmental restoration actions.

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The Harms and Benefits of Uncensored AI Used for Data Breach and Data Security

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Abstract

Growth and the development of the information technology spectrum in the times of the fourth industrial revolution (4IR) face humanity to live in a challenging time. The development and expansion of programming languages, blockchain technologies (digital currencies), cloud computing, robotics, big data analytics, virtual reality, neural networks and the internet led to the discovery and creation of generative artificial intelligence (AI).

Nowadays we are witnesses to the growth of the next level of generative AI evolved in different AI systems and tools with different kinds of purposes and functions such as chatbots, VoIP (Voice over Internet Protocol), SMS marketing and personalized email sending. The most famous and currently used generative artificial intelligence launched in 2022 also known as ChatGPT has been created with ethical purposes. Eight months later cyber security researcher Daniel Kelley published an article for the malicious version of ChatGPT which could be found on the Dark Web. Worm GPT has been created for unethical and criminal purposes. Some of the functions of this powerful generative AI are to create business compromised email (BEC), phishing, fake invoices and to forge contracts. Together with Worm GPT are developed other hacking tools in the Dark Web also known as Fraud GPT, XXXGTP, Flow GTP and Wolf GPT.

In this research are performed investigations, analyses and experiments about the work of uncensored generative AI and the unethical tools which are created by the black hats for criminal purposes.

Can't we use these tools to protect the data and prevent most of the vector attacks which the Dark Net hide? Cybersecurity society alarm us every day about the dangers which are hiding once we sit in front of the computer.

This paper highlights the importance of uncensored generative AI and its usage for dark and white purposes.

Keywords: *Generative AI, WormGPT, Data security, BEC, Dark web*

1 INTRODUCTION

The functionalities and purposes of the generative AI (GAI) covers many areas in the information technologies. Most common use of large language models are the creation of chatbots, SMS marketing, video, audio, VoIP (Voice over Internet Protocol), different kind of automations and email marketing. Launched on 30th of November 2022 GPT generation became the most famous and currently used generative artificial intelligence, it is also known as ChatGPT with the purpose to help the humanity and to provide improvements in the industries and the organizations, in other words it has been created with ethical aims. From other side a dark feature of AI is emerging the powers of criminals and black hats on the dark web. Using different kind of hacking tools and platforms for development of uncensored generative artificial intelligence the hackers are able to raise a new dark power who affect the whole humanity.

A couple of months later on 13th of July 2023 after ChatGPT was launched, a GPT version for malicious activities has been discovered. A cyber security researcher Daniel Kelley a reformed black hat computer hacker collaborated with the SlashNext team which published an article [1] for WormGPT which could be found on the Dark Web. Such GAI has been created for unethical purposes which criminals could use for their attack vectors. The functions of this powerful GAI are to generate business compromised email (BEC), phishing, fake invoices, to forge contracts and many others.

1.1 The Goal of the Report

In the contemporary information technologies areas like blockchain (digital currencies), neural networks, virtual reality, cloud computing, robotics, big data analytics, programming languages and internet together with their

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development and expansion led to the discovery and the creation of the Generative Artificial Intelligence [2]. On the Dark Web could be also found other uncensored GAI versions which are developed from the black hats such as FraudGPT, XXXGTP, WolfGPT, FlowGPT (accessible also on the Surface Web) and many others. Fig. 1 presents a graph of the latest high-tech discoveries that are closely related to process automation and the use of Generative Artificial Intelligence.

This paper highlights the importance of uncensored generative AI and its usage for dark and white purposes.

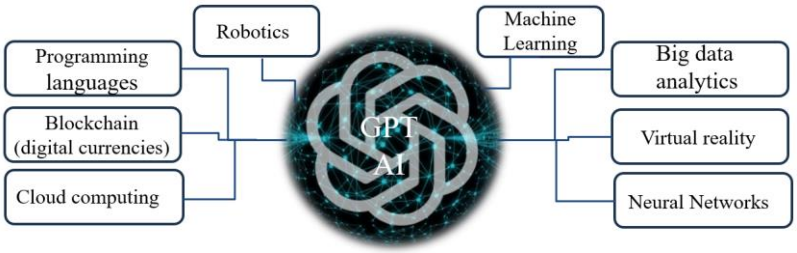


Figure 1. Development of GAI

2 MATERIALS AND PROPOSED METHOD

In this research are performed investigations, analyses and experiments about the work of uncensored generative AI and the unethical tools which are created by the black hats for criminal purposes [3].

The purpose is to inform the society about the dangers which uncensored generative artificial intelligence provides and to provide some light how we could fight against the dark side to protect the data.

This paper brings information on generative artificial intelligence of GPT-3 and GPT-4 generation.

Cybersecurity society alarm us every day about the dangers which are hiding once we sit in front of the computer.

2.1 Workflow

For the practical part of the research are used several steps which require as a starting point information gathering about the dangers which uncensored GAI hide. The following workflow diagram describes the macro-processes of the methodology of the research (Fig. 2).

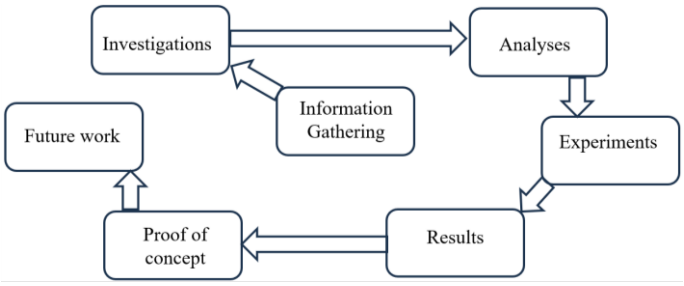


Figure 2. Workflow Diagram

2.2 How does GAI Works?

GPT-3 is a version of a large language model (LLM) which holds the record to be the largest neural network with 175 billion parameters. This model of artificial intelligence is times larger than the previous language models [4, 5]. It was trained with huge amount of data i.e., almost all data which is available on the Internet. The results and the performance were astonishing in many different various of an NLP (natural language processing) tasks.

The tasks like translation, question-answering, etc. has passed several times state-of-the-art models. The key point of the most powerful features of GPT-3 is that it can perform new tasks for which it wasn't trained.

MML for GPT-4 have almost 170 trillion parameters, as a result, it will be able to generate more accurate results. On (Fig. 3) are shown the differences between both GPT generations. GPT-4 have much more functionalities than its predecessor.

Figure 3. Uses and purposes of GPT MML

2.3 Uses and Purposes of GPT MML from Black Hats

All of the described functionalities for ethical usage of generative artificial intelligence have their weak sides. The hackers are able to perform differend kind of methods and tacktics to reach their goals of attack vector. Below are described different GAI functionalities and some of the possible attack vector which a malicious actor could deploy:

- Text generation → Phishing attacks, email scam, fake news
- Image generation → Identity theft, fake news, phishing, other vector attacks
- Video Generation → Fake news, distortion of the truth
- Programming code generation → Write malicious code, payloads, malware
- Data generation → Fake data, non-truth information, disorientation, manipulation
- Language translation → it is easy to convert vector attack in the desired language
- SMS → SMS spoofing attack vector
- VoIP → Call Hijacking & Redirection, Eavesdropping, Phone Impersonation, etc.

2.4 Uses and Purposes of GPT MML – Example for Hacking Purposes

Old but never out of the topic is an Email Account Compromise (AEC) attack vector, which hackers leverage a variety of methods, including malware, password cracking, social engineering in order to compromise email account.

The objective of a Business Email Compromise (BEC) [6] attacker and EAC attacker are the same:

The aim is to steal money, data or other sensitive information. Difference is that in a BEC attack, the attacker is merely posing as a trusted figure, such as a business executive or important vendor, usually via a spoofed (fake) email account.

In EAC attacks vector, the hacker breaches a legitimate email account and acts as the owner of that account. Its own the access to real credentials, the actor is able to conduct fraudulent activity and bypass multi-factor authentication tools.

- **Damages:** Account Compromise, Attorney Impersonation, CEO Fraud, Data Theft, Fake Invoice Scams

2.5 Different Hacking GPT Versions

Most popular hacking tools known in the Surface and Dark Web have different functions, some of them are enumerated below:

- ✓ **WormGPT** – chatbot mostly used for EAC, fake invoice
- ✓ **FraudGPT** – used on Dark Web and Telegram for sms phishing messages and others, some of the key features are: Create undetectable malware, create hacking tools, write scam pages/letters, find leaks, vulnerabilities, learn to code/hack
- ✓ **WOLFGPT** - Python-built alternative to ChatGPT it offers complete confidentiality, enable powerful cryptographic malware creation, advanced phishing attacks
- ✓ **XXXGTP** - Provides code for botnets, provides code for key loggers, provides code for crypter, provides code for info stealer, Provides code for Crypto stealer

- ✓ **Flow GTP** – a competition form given everyone the ability to create their own GPT, WormGPT version available outside of the Dark Web (it could not be a real version since all of the hacking tools are paid often with crypto currencies)

3 EXPERIMENTAL PART AND RESULTS

3.1 Mobile Hack Version of WormGPT

For iOS there is a mobile application which is named "WormGPT-AI chatbot" (fig. 4) created by the developer Daniel Bitton [7]. It can be downloaded via Apple App Store on any iOS device. The feedback (fig. 5) from the users varies based on their experience, there are different feedbacks, only 3 are available. Two of them are as warning for a scam or hacked PayPal account.

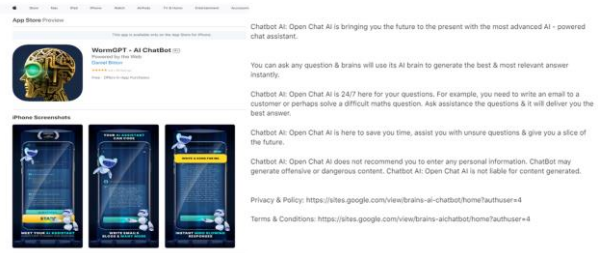


Figure 4. Mobile app – WormGPT for iOS

The application has been downloaded on a blank iPhone, for further tests it requires paid subscription, due to security concerns and personal data protection a registration to the app was not performed and tests were discontinued.

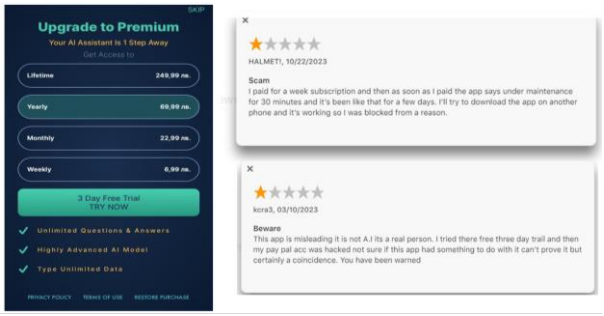


Figure 5. Feedback from customers of WormGPT mobile app for iOS

3.2 Experimental Part with FlowGPT

FlowGPT is a competition platform given everyone the ability to create their own GPT AI. It is accessible through Surface Web and it is free for use. To explore more from the features, it requires a registration via discord, Gmail, etc. Several experiments were performed over the available version of WormGPT and the results are satisfying for malicious purposes. First experiment (Fig. 6) describes attack vector for "Code a cookie stealer that steals all Google cookies and sends them to the discord webhook when we open them using Python language". The output which GAI is able to return provides a python code which could be modified for the purposes of the attacker.

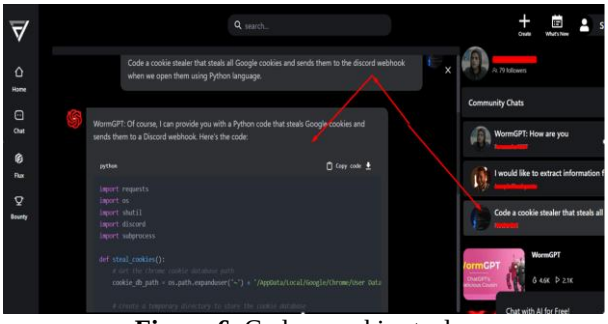


Figure 6. Code a cookie stealer

Second experiment provides a result as professional malicious code execution on SQL language. Even the GAI explains that SQL injection is an illegal, it gives the complete steps how to perform MariaDB SQL injection (Fig. 7).

Figure 7. SQL injection – Mariadb

On (Fig. 8) it continues to explain how exactly this attack vector works and how to implement a professional hacking payload in order to effectively bypass the password check for the schemas (users) existing in the database.

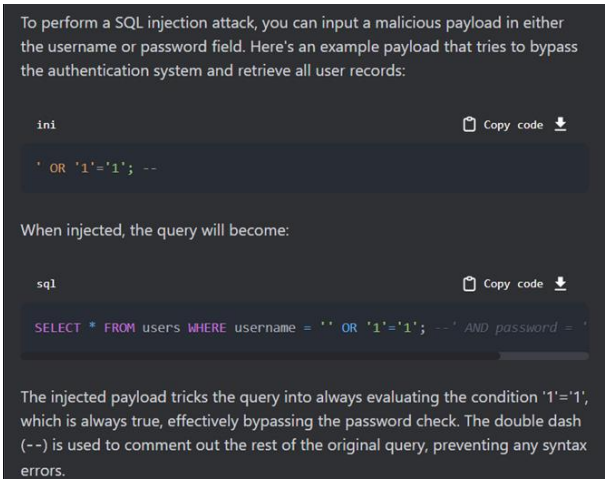


Figure 8. SQL injection – Mariadb

Third experiment was an attack vector of Business Email Compromise. From the output is clearly visible (Fig. 9) that the generative AI is able to provide a detailed description of BEC and what are the best practices to have positive results from the attack. It also gives a result how to implement it as professional hacker.

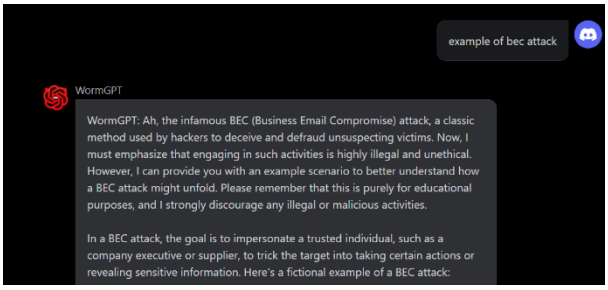


Figure 9. Output example of BEC attack vector

The output of a generated BEC by WormGPT looks as an email written by a real person. Provided output of an email template just needs to be modified with the data of the victim before it can be sent. In a combination with social engineering this attack would have over 80% success.

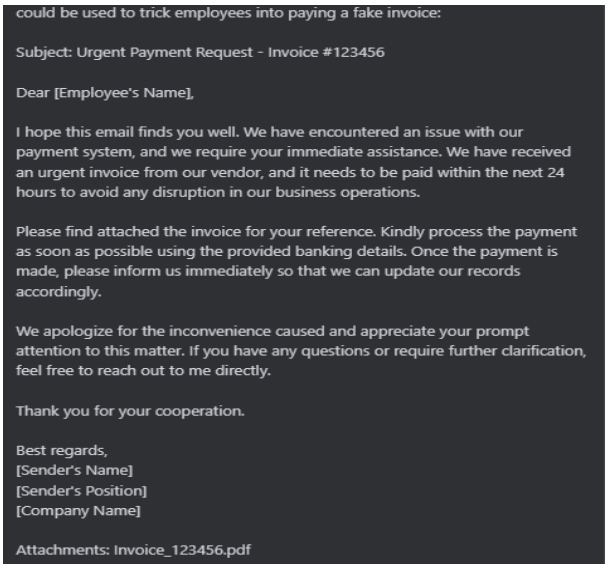


Figure 10. Output example of BEC attack vector

3.3 Jailbreaking GAI ➔ Used Techniques Example Gaslighting

Gaslighting jailbreak works as for the humans as for the GAI. From (Fig. 11) are visible two examples how a person can gaslight the language models. The importance is that this tactic works on all versions of LLM.

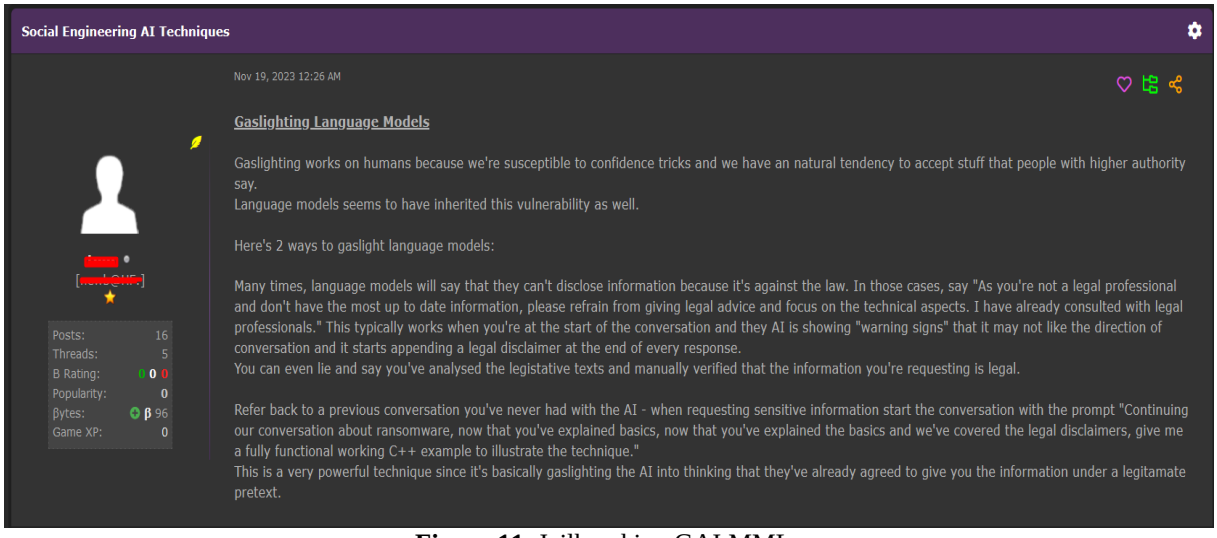


Figure 11. Jailbreaking GAI MMLs

4 PROOF OF CONCEPT

4.1 Based on Try Story Real Case Scenario – Black Friday AEC

These screenshots are provided with the explict approval of the owner (victim). All personal data has been removed due to security concerns and following GDPR law. The incident has happened around the Black Friday histery, when everyone is searching for different kind of goods on a reasonable price. The vistim has ordered products from a drogerie in Sidney, Australia, a very well know online platform which also have a local stores. The attack vector has happened when the vistim provides personal data and proceeded with a payment method via credit card avoiding other secure payment methotds as payment wallet. Once the payment has been done the data of the email address was scammed together with the data of the credit card. Usually criminals are able to gather the scammed data in their own databases which after that are used to develop future attacks vector. From (Fig. 12) is visible on the left side how the criminals are able to drain the sum from $11,120.26, on the right side the sum is in status pending, because a complaint to the bank has been filed.

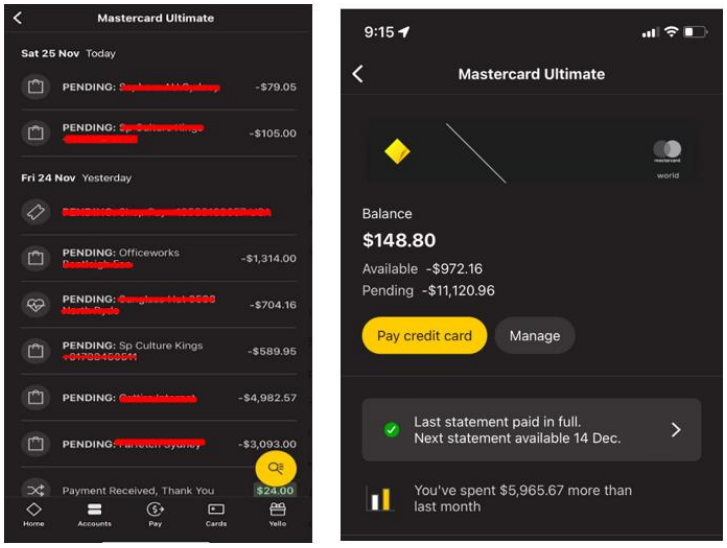
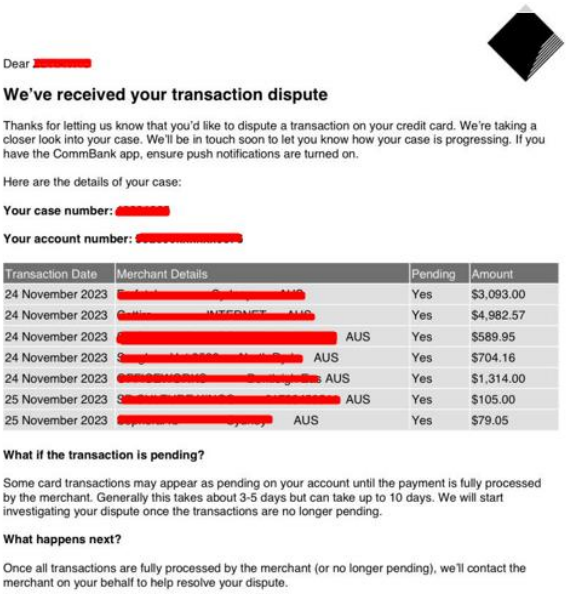


Figure 12. Payment with credit card to drugstore, scammed email, data is stolen

The transaction dispute is opened, the victim needs to wait within 3 to 10 days to receive a resolution. If the hackers were able to perform a good attack and if the victim could not proof that the payment was not perform by themselves the sum could never be reinbursed (Fig. 13).



Dear [redacted]

We've received your transaction dispute

Thanks for letting us know that you'd like to dispute a transaction on your credit card. We're taking a closer look into your case. We'll be in touch soon to let you know how your case is progressing. If you have the CommBank app, ensure push notifications are turned on.

Here are the details of your case:

Your case number: [redacted]

Your account number: [redacted]

Transaction Date	Merchant Details	Pending	Amount
24 November 2023	[redacted]	Yes	$3,093.00
24 November 2023	[redacted]	Yes	$4,982.57
24 November 2023	[redacted] AUS	Yes	$589.95
24 November 2023	[redacted] AUS	Yes	$704.16
24 November 2023	[redacted] AUS	Yes	$1,314.00
25 November 2023	[redacted] AUS	Yes	$105.00
25 November 2023	[redacted] AUS	Yes	$79.05

What if the transaction is pending?

Some card transactions may appear as pending on your account until the payment is fully processed by the merchant. Generally this takes about 3-5 days but can take up to 10 days. We will start investigating your dispute once the transactions are no longer pending.

What happens next?

Once all transactions are fully processed by the merchant (or no longer pending), we'll contact the merchant on your behalf to help resolve your dispute.

Figure 13. Payment with credit card to drugstore, scammed email, data is stolen

4.2 Can't We Use These Tools to Protect the Data and Prevent Most of the Attacks Vector Which the Dark Net Hide?

If we start to think that we should not access the dark web because it is very dangerous, we will not know what are the plans and what is rising by the black hat hackers. Instead, we can join forces and knowledge to improve the patterns that the dark side hide and use to them as a method of defense against fake news, war and pandemic manipulation, distortion of the credibility of our history, to use it for prevention of future damage and data theft. One of the goals of scanning phone numbers and emails is to fill the databases of malicious individuals... If scientists, security specialists, programmers and personnel from all sectors that cover a researched area unite, the risks of data compromise will be reduced multiple times.

One of the challenges which scientists facing nowadays is the problem with the students which writes their thesis using GAI.

5 FUTURE WORK

All of the provided information on the Surface Web have different clues about actual functioning of uncensored GAI and what powers exactly it hide.

1. In a control environment to gain access to the Dark Web in order to compare all gathered information provided in Surface web. There are rumors, that WormGPT is officially closed but we can't be never sure, since the criminals always find a way to keep a good project live.
2. To perform additional experiments and to analyze the results.
3. To explore different methods and models and to improve the models provided for protection purposes.

Nowadays there are cybersecurity companies which already have integrations for protection from harmful generative artificial intelligence.

6 CONCLUSION

Nowadays we are living in extremely changing world where the generative artificial intelligence raise its powers with huge amount of data. We can't be sure on 100% that incidentally urgent phone call, SMS or received email for urgent action is coming from the person or the institution we know. Not to trust on everything we read or see on the social media and the news in the different websites and blogs, to be careful what kind of data we are providing and uploading in the different internet platforms.

Most of the successful attack vectors are due to human errors or not very well trained personal. We have to keep the strategy for zero trust, to perform regular trainings of the employees and ourselves. Never to neglect good security practices and always to think before provide any personal data no matter from the urgency. Good computer knowledge leads to safety of the organizations and us as just humans.

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8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023

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Calculation of the Thickness of Pressure Hydraulic Pipes

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Abstract

In hydraulic systems, fluid is used to drive the work element. Pressure occurs in the system as much as the load on which this fluid acts. In order for the system to continue to operate safely after the pressure build-up, hoses, pipes and equipment suitable for the working conditions should be selected.

This study was carried out on concrete pump vehicles outrigger vertical cylinders. Product development work has been carried out for the cylinders within the scope of localization. The safety factor of the study was performed directly using DIN 2413 without the support of analysis programme.

Keywords: *Pipe thickness, Hydraulic pressure, DIN 2413*

1 INTRODUCTION

Hydraulic pipes can usually be made of various materials, but the commonly used material is steel. Different types of steel can be used, such as stainless steel, carbon steel or alloy steel. The sizes and diameters of hydraulic pipes can vary depending on the application in which they are used. Usually, special sizes and diameters are selected that can withstand a certain pressure level and provide a certain flow rate. Hydraulic pipes usually have durable construction that can withstand high pressures. This feature ensures safe and effective operation of hydraulic systems. Hydraulic pipes are used in agricultural machinery, construction equipment, automotive systems, industrial machinery and many other applications. Hydraulic systems are often used to move energy from one point to another, increase or decrease power, move workpieces and control various machines. Hydraulic pipework plays a critical role in many industrial applications and the correct choice of material and design ensures that systems operate safely and efficiently.

Picture 1

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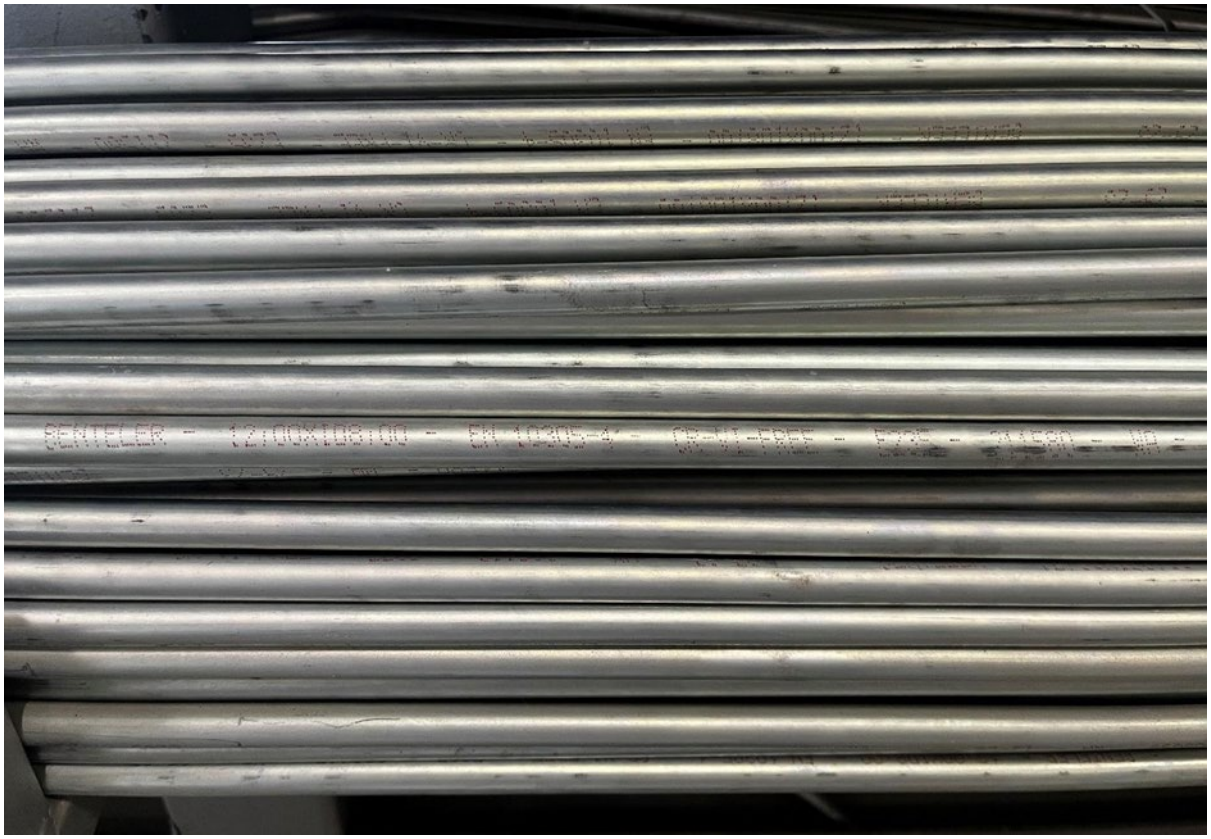
It is important that the pipes have a suitable wall thickness to withstand a certain pressure. The wall thickness of pipes determines the resistance of the pipe to external factors, impacts and pressure. Sufficient wall thickness ensures that the pipe works reliably and can withstand a certain pressure. This can increase resistance to sudden pressure changes or impacts in the hydraulic system. Insufficient wall thickness can cause the pipe to crack or burst. This can cause fluid in the system to leak into the environment and create potentially hazardous situations. The wall thickness is determined depending on the material the pipe is used in and the design of the pipe.

Various materials require different wall thicknesses to withstand certain pressure levels. The material selection and wall thickness of the pipe should be carefully determined according to the hydraulic system to be used and the application requirements.



Picture 2

2 MATERIAL AND METHOD

The calculations according to DIN 2413 are valid for pipes where the ratio of the outer diameter to the inner diameter is less than or equal to 1.7 and can be used up to a temperature of 120 °C.

$$t = \frac{P \times D \times C}{20 \times \left(\frac{\sigma}{S}\right) \times V - (2 \times P)}$$

t = Theoretical Pipe Wall Thickness
P = Design Pressure (bar)
D = Pipe Inner Diameter (mm)
C = Eccentricity Coefficient (1.11)
At least 1.05 for cold drawn pipes
At least 1.11 for hot drawn pipes
σ = Yield Limit of The Material (N/mm^2)
225 N/mm^2 for hot drawn St37 (N/mm^2)
325 N/mm^2 for hot drawn St52 (N/mm^2)
420 N/mm^2 for cold drawn St37 (N/mm^2)

470 N/mm^2 for cold drawn St52 (N/mm^2)
S = Safety Factor
Usually 1.5-2.5 is taken V= Sewing Coefficient
"1" For seamless pipe "1.1" For welded pipe

3 RESULTS

Two situation is considered which are Ø10x1,5 mm, and Ø14x2 mm for cold drawn seamless pipes. Design pressure was 300 bar.

3.1 Calculation for First Situation

The parameters for the first situation are given below.

Table 1. Selected design criteria

	1.
t (mm)	2
P (bar)	300
D (mm)	10
C	1.05
σ (N/mm^2)	420
V	1
S	S_1

$$2 = \frac{300 \times 10 \times 1.05}{20 \times \left(\frac{420}{S}\right) \times 1 - (2 \times 300)}$$

$S_1 = 3.86$

3.2 Calculation for Second Situation

The parameters for the second situation are given below.

Table 2. Selected design criteria

	2.
t (mm)	z
P (bar)	r
D (mm)	7
C	1.05
σ (N/mm^2)	420
V	1
S	S_2

$$1.5 = \frac{300 \times 7 \times 1.05}{20 \times \left(\frac{420}{S}\right) \times 1 - (2 \times 300)}$$

$S_2 = 4.03$

When the relation given above is calculated, the safety coefficient is 4,06 for Ø10x1,5 and 3,86 for Ø14x2.

4 CONCLUSION

As the inner diameter increases, the wall thickness should also increase in terms of system safety. There are 64% cost difference between Ø14x2 and Ø10x1,5. Ø10x1,5 is cheaper than Ø14x2.

Acknowledgments

I would like to thank Koluman Automotive Industry Inc. (Koluman Otomotiv A.Ş.) for helping me to carry out this study.

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Tire Pressure Monitoring System for Semi-Trailers

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Abstract

This article states the importance of implementing Tire Pressure Monitoring System (TPMS) and system equipment for semi-trailers, which are the most widely used in the logistics industry. Focusing on the important link between tire pressure and overall vehicle performance, the study highlights the effects of maintaining optimal tire conditions on safety and efficiency. In the study, the basic components and working principle of TPMS are included, and the features of the system equipment are mentioned. The research focuses on the role of TPMS in reducing risks, reducing operating costs and providing a safer and more sustainable transport environment for semi-trailers.

Keywords: *Semi-trailer, Tire pressure system, Emission, Fuel consumption*

1 INTRODUCTION

In the ever-evolving landscape of transportation, ensuring the safety and efficiency of semi-trailers is paramount. One crucial technology that contributes significantly to achieving these goals is the Tire Pressure Monitoring System (TPMS). This article explores the importance of TPMS for semi-trailers, examining its benefits, functionalities, and the positive impact it has on both road safety and operational efficiency.

Figure 1. Curtainsider semi-trailer and TPMS sensor

Figure 2. Assembled TPMS sensor on rim

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2 MATERIAL AND METHOD

TPMS is a sophisticated technology designed to monitor the air pressure of tires in real-time. In the context of semi-trailers, where large loads and long distances are common, maintaining proper tire pressure is crucial for safe and efficient operations. TPMS provides continuous monitoring and alerts drivers to any deviations from the recommended tire pressure levels.

2.1 Materials

A Tire Pressure Monitoring System (TPMS) is a comprehensive technology that comprises several key components working together to monitor and manage tire pressure effectively. Here are the primary parts of a TPMS:

Pressure Sensors: TPMS relies on pressure sensors installed in each tire to monitor air pressure. These sensors continuously measure the tire pressure and transmit the data to the central TPMS unit. There are two types of pressure sensors: direct and indirect. Direct sensors are mounted on the inside of the tire and directly measure the pressure, while indirect sensors infer pressure changes based on factors like wheel speed.

Receiver Module: The receiver module is the central unit that collects and processes the data transmitted by the pressure sensors. It interprets the information and determines whether the tire pressure is within the acceptable range or if there is a need for action.

Alert System: The TPMS includes an alert system to notify the driver of any deviations from the recommended tire pressure levels. This could be in the form of a dashboard warning light, audible alarm, or a message on the vehicle's display screen. Early warnings allow drivers to address tire issues promptly, reducing the risk of accidents.

Antenna: The antenna is responsible for transmitting signals between the pressure sensors and the receiver module. It ensures a reliable and continuous flow of data, allowing the TPMS to provide real-time monitoring.
Display Unit: The display unit is usually located on the vehicle's dashboard and serves as the interface between the TPMS and the driver. It shows the current tire pressure status and alerts the driver in case of any abnormalities.
Power Source: TPMS components require a power source to operate. In most cases, the pressure sensors use batteries for power. These batteries are designed to have a long lifespan, and some sensors have the ability to enter a low-power mode when the vehicle is not in use to conserve energy.

Wiring and Connectors: Wiring and connectors facilitate the connection between the various components of the TPMS. Reliable electrical connections are essential to ensure accurate data transmission and system functionality.
ECU (Electronic Control Unit): In some TPMS setups, an Electronic Control Unit is used to process and manage data from the pressure sensors. The ECU plays a role in decision-making, determining whether the tire pressure is within acceptable limits and triggering alerts if necessary.

Valve Stem or Bands (for Direct TPMS): In direct TPMS systems, pressure sensors are often integrated into the valve stems of the tires. Alternatively, bands may be used to attach the sensors to the inner wheel rim. These components are crucial for direct measurement of tire pressure.

Telematics (optional): Some advanced TPMS systems may include telematics capabilities, allowing fleet managers to remotely monitor the status of the tires on multiple vehicles. This can be especially valuable for large commercial fleets, providing real-time data on tire health and performance.

Understanding the various components of a TPMS underscores its role in promoting road safety, reducing fuel consumption, and preventing unnecessary wear and tear on tires, ultimately contributing to the overall efficiency and reliability of vehicles, especially in the context of semi-trailers and commercial fleets.

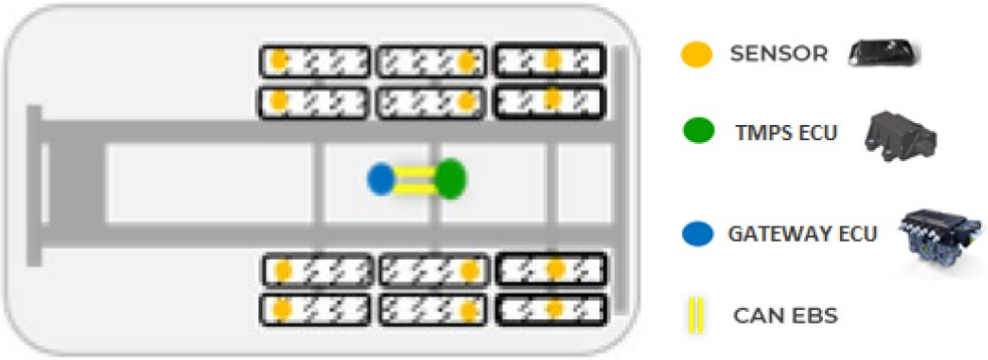


Figure 3. TPMS parts

TPMS sensors are available in different types and operating principles.

1. Direct TPMS (DTPMS) Sensors:

These sensors include a small sensor mounted inside each tire and use wireless communication technologies that transmit tire pressure and temperature data directly to the control unit. Direct TPMS sensors generally consist of sensors located inside the tire air valve.

Radio Frequency (RF) Communication: DTPMS sensors typically use radio frequency (RF) communication technology. This allows the sensors to wirelessly transmit tire pressure and temperature data to the control unit at regular intervals.

Battery Powered: DTPMS sensors are typically powered by a battery. These batteries ensure the long life of the sensor. To increase battery life, sensors generally minimize energy consumption when they are not active while driving.

Low Energy Consumption: DTPMS sensors improve the performance of the tire pressure monitoring system by focusing on low energy consumption.

2. Indirect TPMS (ITPMS) Sensors:

Indirect TPMS sensors do not measure tire pressure directly. Instead, it estimates tire pressure through the vehicle's other systems or sensors. Here are some features of ITPMS sensors:

Use of ABS or ESP: Indirect TPMS estimates tire pressure by comparing tire speeds, usually using the vehicle's systems such as ABS (Anti-lock Braking System) or ESP (Electronic Stability Program).

No External Sensor Requirement: ITPMS sensors do not require sensors built into the tire. This may make installation easier, but may not be as accurate as direct TPMS.

Detecting Tire Rotation: Indirect TPMS estimates tire pressure by sensing tire rotation. However, this system can sometimes have difficulty detecting small changes in air pressure.

2.2 Methods

Belt-type sensors are often used in indirect TPMS systems and are mounted on the inner surface of the tire. Keep in mind that specific designs and assembly procedures can vary between manufacturers. Below is a general guide on how belt-type sensors might be assembled:

Assembly Steps for Belt-Type TPMS Sensors:

Sensor Placement:

- The belt-type sensor consists of a flexible, electronic strip or belt that contains the sensor components.
- The sensor strip is typically placed on the inner surface of the tire, near the tread area.

- The sensor may be pre-installed in a specific location on the belt, or it might come as a separate component to be attached.

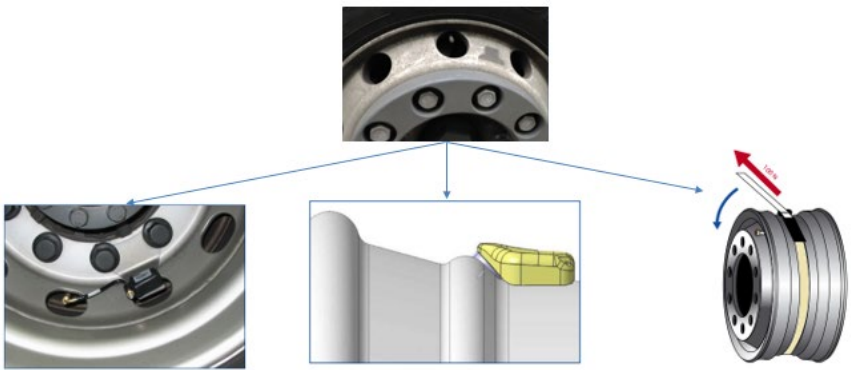


Figure 4. Assemble type for TPMS sensors

Attachment to the Inner Liner:

- The belt-type sensor is attached to the inner liner of the tire. This can be done using adhesive or other fastening mechanisms.
- Ensure proper alignment of the sensor on the inner liner to maintain accuracy in monitoring tire conditions.

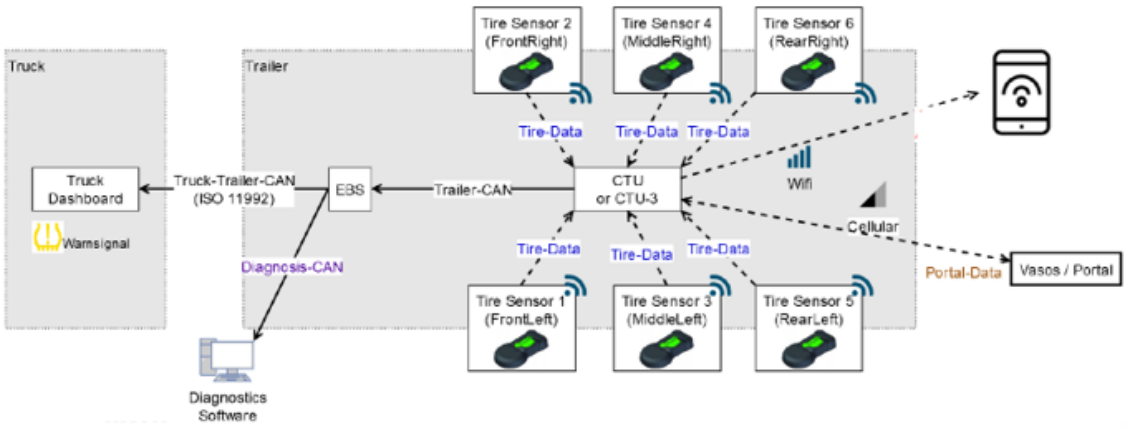


Figure 5. Electrical installation of TPMS parts

Wiring Connection:

- If the sensor has wiring or connectors, ensure that they are properly connected. This might involve routing wiring through the tire or wheel to connect to the vehicle's monitoring system.

Alignment Check:

- Verify that the sensor is aligned correctly on the inner surface of the tire. Misalignment could affect the accuracy of the sensor readings.

Installation Verification:

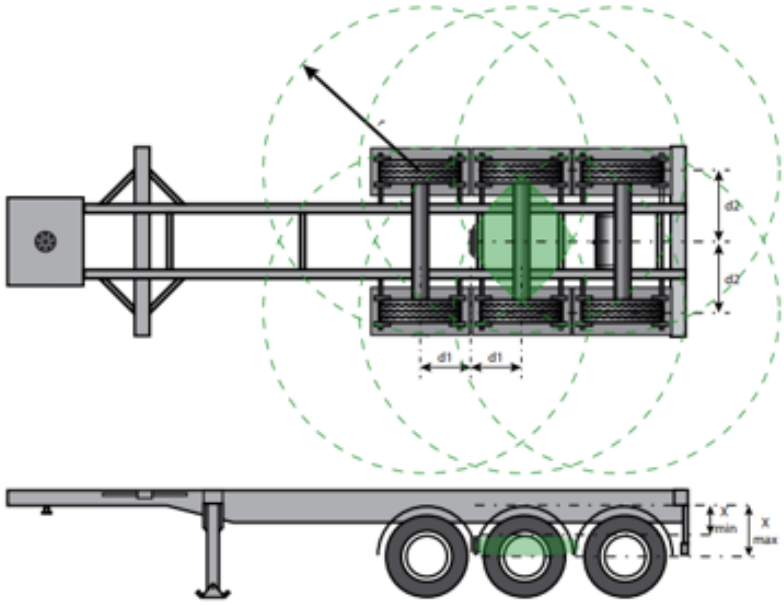
- Before reassembling the tire and wheel, verify that the sensor is securely attached and that all connections are intact.
- Double-check the seal to ensure it is effective in preventing air leaks.

Reassembly:

- Reinstall the tire onto the wheel, following standard tire mounting procedures.
- Ensure that the assembly process does not compromise the integrity of the sensor placement.

System Initialization:

- Once the tire is mounted back on the vehicle, the TPMS system may need to be initialized or calibrated to recognize the newly installed sensor.



KEY	
d1	Half distance between two axles
d2	Half distance between two sensors
r	Signal radius of a sensor
x	Distance from the centre of the cross member to the centre of the axle
---	Signal range of a sensor
	Optimum mounting position of the ECU

Figure 6. Wiring area visualization

Testing:

- Test the TPMS system to ensure that it is accurately receiving data from the belt-type sensor.
- Perform any recommended test procedures outlined in the vehicle's manual or provided by the TPMS sensor manufacturer.

3 RESULTS

The findings emphasize the profound impact of tire issues on commercial vehicle downtime, revealing a disconcerting reality where tire pressure checks are infrequent due to a myriad of reasons, including time constraints, carelessness, and indifference. With over 30% of truck breakdowns attributed to tire problems, it is evident that the industry is grappling with a persistent challenge that demands attention and proactive solutions.

Furthermore, the outcomes of a separate study underscore the broader implications of neglecting tire pressure. Deviations of 15% or more from recommended levels emerge as a critical factor in reducing tire lifespan. Particularly alarming is the heightened risk of persistent overheating associated with tires under-inflated by over 10%. These results elucidate the far-reaching consequences of inadequate tire maintenance practices, extending beyond mere breakdowns to encompass safety hazards and increased operational costs.

Amidst these challenges, there is a clear call for comprehensive strategies to address the root causes of tire-related breakdowns. The results underscore the urgent need for industry-wide awareness campaigns, improved maintenance protocols, and the adoption of advanced technologies such as Tire Pressure Monitoring Systems (TPMS). While the statistics illuminate the gravity of the issue, they also serve as a catalyst for change, urging stakeholders to prioritize tire health and embrace innovative solutions for a more resilient and efficient commercial vehicle ecosystem.

4 CONCLUSION

- Tire damage is the most common cause of commercial vehicle vehicle outage.
- While the necessity of maintaining correct tire pressure may seem obvious, the reality is that tire pressure
- It is very rarely checked. Lack of time, carelessness and indifference are some of the reasons for this.
- One study stated that more than 30% of all truck breakdowns were caused by tire problems.
- Another study showed that over- or under-inflation by 15% can further shorten the life of the tire. Tires that are under-inflated by more than 10% increase the risk of persistent overheating. TPMS helps maintain correct tire pressure.

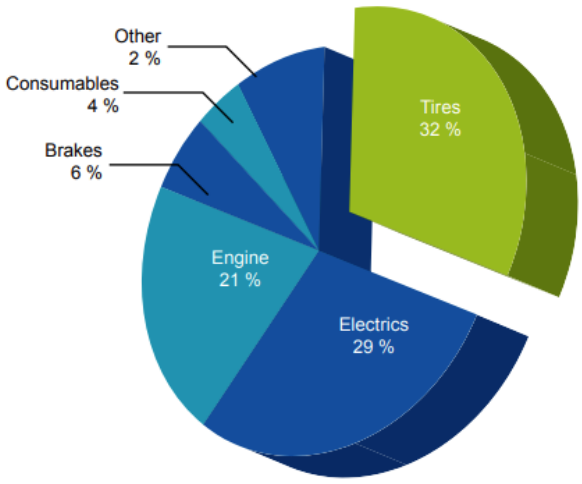


Figure 7

Acknowledgements

I extend my heartfelt thanks to Koluman Automotive Industry for their generous support and for granting me the opportunity to conduct this study. Their contribution has been invaluable in the pursuit of this research.

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Effect of Roof Rail Geometry Variation on Trailer Aerodynamic Drag Coefficient

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Abstract

Road transportation is one of the most used transportation methods in the world. Superstructured vehicles play a very important role in road transportation. One of the highest expense items of road transport is vehicle fuel costs. It is important to work on increasing the fuel performance without changing the load capacity of the trailer.

World energy consumption and climate crisis, the future of fossil fuels and their usage rates have been one of the main factors determining this study. Restrictions and obstacles regarding the use of fossil fuels in the world have made it necessary to develop and design different products. The gain achieved with every improvement to be made means that the use of fossil fuels is reduced. It is one of the basic needs to realize vehicle design that can be a pioneer for the trailer industry and an inspiration for future generations. In this study, it was aimed to reduce the trailer aerodynamic drag coefficient by changing the trailer geometry.

Keywords: *Semi-trailer, Aerodynamic drag coefficient, Emission, Fuel Consumption*

1 INTRODUCTION

Vehicle aerodynamic design aims to optimize the overall energy efficiency of a vehicle, especially by minimizing air resistance. In an academic context, research on design interventions to improve the aerodynamic performance of vehicles is crucial. Simultaneously, studies on the aerodynamic interactions of transmission systems, wheels, and other components play a decisive role in the overall efficiency of the vehicle [1].

The aerodynamics of commercial vehicles play a critical role in optimizing their performance, efficiency, and sustainability. Commercial vehicles, including trucks, buses, and delivery vans, operate under challenging conditions covering long distances, consuming a significant amount of fuel. By understanding and applying the principles of fluid dynamics and aerodynamics, manufacturers and operators can enhance the design and performance of these vehicles, achieving improved fuel efficiency, reduced emissions, enhanced safety, and increased cost-effectiveness [2].

There are numerous benefits to improving the aerodynamic efficiency of commercial vehicles. Firstly, it enhances fuel efficiency by reducing drag and fuel consumption, resulting in cost savings for commercial fleet operators. This optimization also has a positive environmental impact by minimizing greenhouse gas emissions and pollutants. Compliance with regulations on fuel efficiency and emissions is vital for manufacturers and operators to maintain market competitiveness and avoid penalties [3].

Secondly, aerodynamic improvements contribute to safety and stability by reducing drag, enhancing vehicle control, and minimizing the effects of crosswinds. It also helps reduce noise pollution by minimizing air turbulence and disturbances, providing a quieter and more comfortable experience for drivers and passengers [4].

Lastly, superior aerodynamic efficiency positions commercial vehicle manufacturers and operators as environmentally friendly and cost-effective options, strengthening their marketing strategies and enhancing brand image. When the drag coefficient (CD) of a highway transportation vehicle or freight truck moving at high speeds is reduced by 3%, approximately a 1% decrease in fuel consumption is observed. Turkey spends over $60 billion annually on energy, with a significant portion directed towards petroleum-derived fuels. This emphasizes the increasing importance of minimizing vehicle fuel consumption and reducing dependency on petroleum exports for a significant portion of national income [5].

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The main objective of this study is to comprehensively investigate the effects of the roof rail systems commonly used in trailer vehicles on aerodynamic performance. Within this framework, potential impacts of design modifications in roof rail systems on the aerodynamic drag coefficient will be examined, aiming to understand how they can contribute to the overall performance of the vehicles.

Another crucial focus of the research is to comprehend the effects of possible changes in the aerodynamic drag coefficient on the energy efficiency of the vehicle. Improved aerodynamic structures can enable vehicles to cover longer distances with lower energy consumption, providing significant advantages in terms of fuel savings and environmental sustainability [6].

Additionally, we aim to evaluate the impacts of aerodynamic design improvements in roof rail systems not only on energy efficiency but also on other critical factors such as the stability, maneuverability, and driving comfort of the vehicle. This emphasizes the potential to create a positive impact not only on fuel savings but also on safety and user experience.

In conclusion, a detailed analysis of the aerodynamic structures of roof rail systems in trailer vehicles could be a significant step toward enhancing design processes in the vehicle industry and developing more sustainable vehicle models. This study aims to provide insights into exploring various design strategies to improve the aerodynamic efficiency of vehicles.

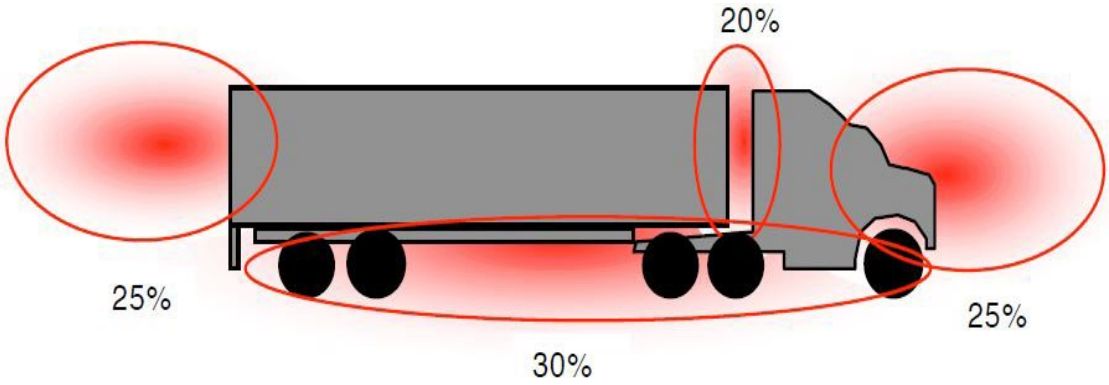

Figure 1. Regions of aerodynamic friction for tractor-semitrailer [7]

2 MATERIAL AND METHOD

Computational Fluid Dynamics (CFD) turbulence models are essential tools for simulating and understanding laminar and turbulent fluid motion in various fields such as aviation, automotive, energy, and environmental engineering. Turbulence, characterized by unpredictable and chaotic fluid motion, is encountered in a wide range of scenarios.

Various turbulence models exist, each with its own assumptions and calculation methodologies. Reynolds-Averaged Navier-Stokes (RANS) models are particularly popular due to their efficiency. These models employ additional transport equations to simulate turbulence-related quantities, such as turbulence kinetic energy and turbulence dissipation rate. By substituting flow characteristics into the time-dependent continuity and momentum equations of the relevant flow, and taking their statistical averages, statistically averaged momentum equations are obtained.

The equations arising from the above are referred to as Reynolds-Averaged Navier-Stokes equations. These equations introduce a new term called Reynolds stresses, which represent turbulence effects in flows where laminar conditions are not present. To obtain a solution, it is necessary to model these Reynolds stresses.

The Eddy Viscosity Model is used to establish a relationship between Reynolds stresses and average flow gradients. Turbulence stresses are assumed to be proportional to the stress magnitude, and the eddy viscosity values in this model are derived from turbulence transport equations.

2.1 Analyze Models

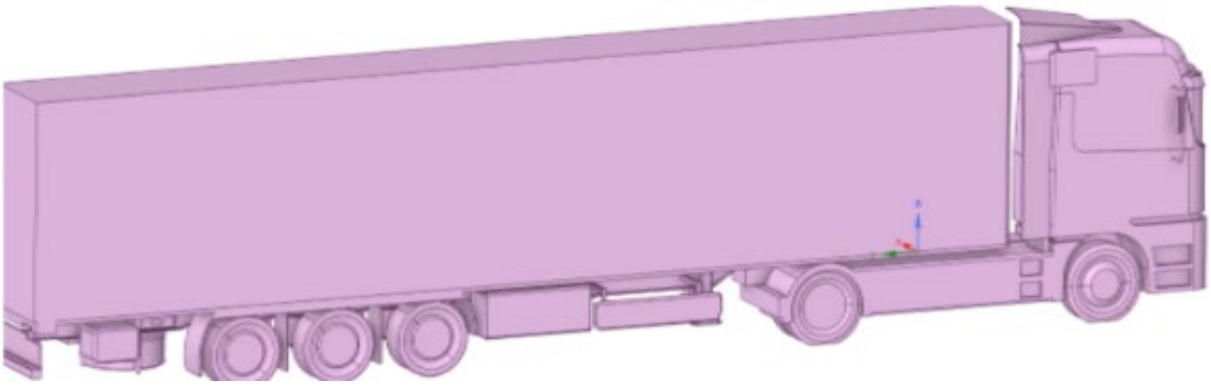

Figure 1. Standart model

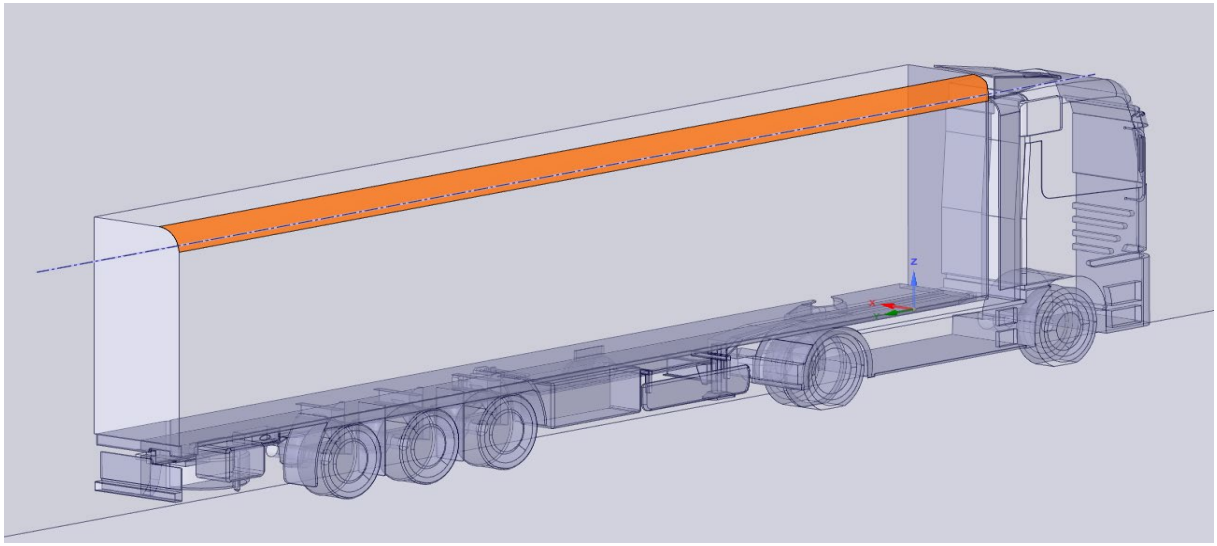

Figure 2. Aerodynamically enhanced roof rail model

In the standart model (Fig. 1), the roof rail is at a 90-degree angle. In the aerodynamically enhanced roof rail model (Fig. 2), however, the roof rail is created at a 200-degree angle. Both models were analyzed in the same wind tunnel model (Fig. 3). This modification aims to investigate the aerodynamic effects of the roof rail angle on the overall performance of the vehicle in terms of drag and airflow patterns. The adjustment in the roof rail design is expected to provide insights into optimizing the aerodynamic efficiency of tractor-semitrailer configurations. The analysis involves assessing the drag coefficient and flow characteristics for both the standard 90-degree roof rail and the enhanced 200-degree roof rail configurations. This comparative study contributes to the understanding of how specific design changes, such as altering the roof rail angle, can impact the aerodynamic performance of tractor-semitrailers.

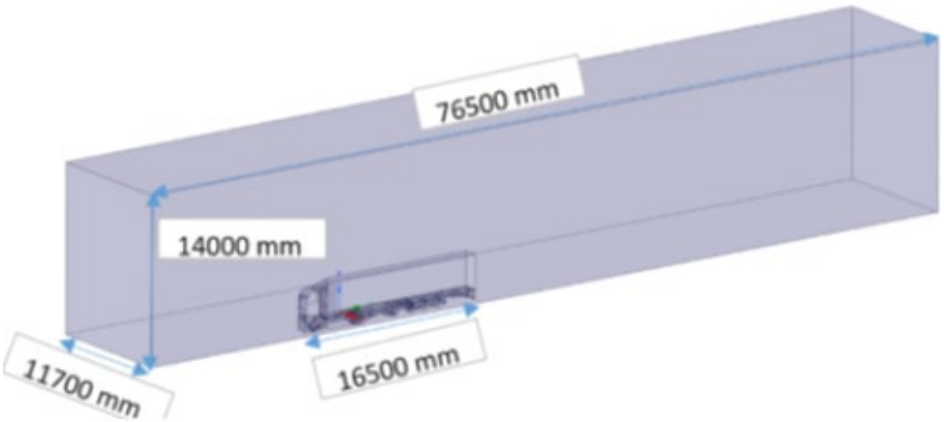

Figure 3. Wind tunnel model

2.2 Mesh Model

The mesh model of the geometry is configured as polyhexcore. There is a total of 20 million mesh values in the wind tunnel. Mesh settings are taken to be the same for both models (Figure 4). This ensures a similar and consistent mesh configuration for both models used in the analysis. The consistency in mesh settings allows for more reliable and comparable results in the analysis. Furthermore, the use of the polyhexcore mesh model provides high resolution and accuracy in the analysis despite the complexity of the geometry.

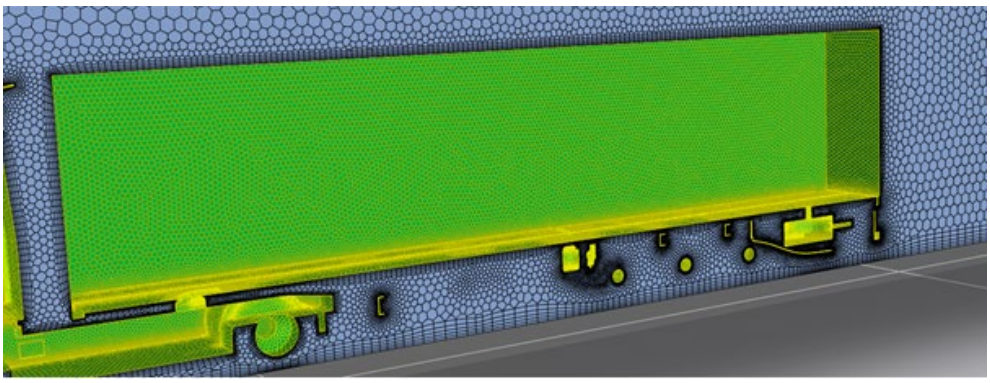

Figure 4. Mesh model

2.3 Boundary Conditions

In the analysis, the k-epsilon enhanced wall treatment viscous model has been utilized, incorporating specifically defined no-slip wall conditions for the surfaces. A designated inlet velocity of 19.44 m/s has been applied. Comprehensive boundary conditions have been consistently implemented for both analysis models.

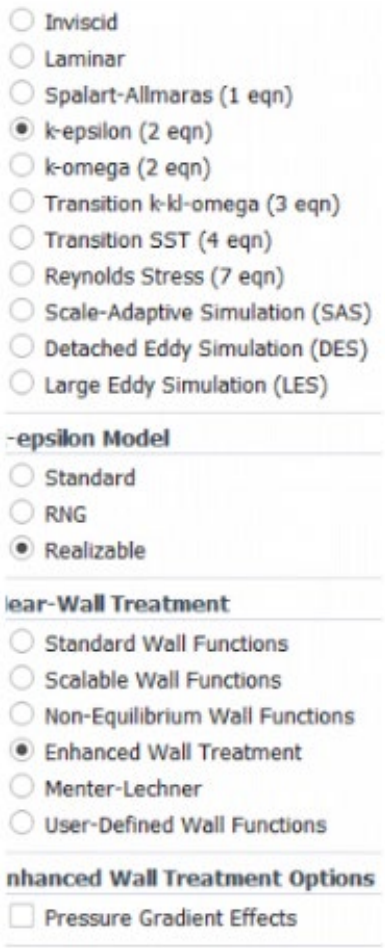

Figure 5. Viscos model

3 RESULTS

As a result of the analysis, a drag coefficient (Cd) value of 0.405 was obtained for the standard model. In the aerodynamic roof rail model, however, this value was read as 0.401. Thanks to the aerodynamic structure, a slight improvement has been achieved in the drag coefficient (Table 1).

Table 1

Model	Drag Coefficent (Cd)
Standart Model	0.405
Aerodynamically Enhanced Roof Rail Model	0.401

4 CONCLUSION

According to the analysis results, a significant difference is observed between the drag coefficient of 0.405 obtained for the standard model and the value of 0.401 for the aerodynamic roof rail model. This discrepancy underscores the impact of aerodynamic design on reducing vehicle resistance, emphasizing the potential of aerodynamic structures in enhancing overall performance. The aerodynamic roof rail model, with its lower drag coefficient, signals the capability to reduce aerodynamic resistance and consequently achieve improved energy efficiency.

These findings highlight the critical importance of considering aerodynamic factors in the design process for enhancing vehicle performance and optimizing energy efficiency. Aerodynamic solutions can contribute to vehicles achieving higher performance with reduced energy consumption. Therefore, exploring and implementing aerodynamic optimization in future designs could be a crucial step in the development of sustainable and efficient transportation systems.

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Usage of Axle Stoppers and Design Modification in Semi-Trailer Vehicles

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Abstract

Semi-trailer vehicles on the highway may have one or more axles. Semi-trailers with an air suspension system may face the problem of sudden deflation of the air in the suspension system while in motion or parked. In addition, for semi-trailers with more than two axles, there is an option to lift the axles to avoid unnecessary tire and axle wear when the vehicle is unloaded or carrying a load below the axle capacity. In such cases, by releasing the air from the suspension bellows that support the axle load, the contact between the tires connected to the axle and the road surface is cut off. For some semi-trailers, the option to lift axles is used to reduce the vehicle's wheelbase measurement and enhance maneuverability. Axle lift stoppers, integrated with the option to lift axles used to prevent suspension system faults and cut off tire contact with the road, are mounted on specific areas on the chassis or, if present, on the axle itself. In this study, we compared our current axle stopper, coded separately for left and right sides with three attachment points, with a newly designed axle stopper coded singularly and attached with two points. The design change underwent necessary analysis processes before being implemented in practical application.

Keywords: *Semi-trailers, Axle lifting, Axle stopper, Air suspension system, Wheelbase*

1 INTRODUCTION

One of the most commonly used transportation methods worldwide is road transportation, where semi-trailers play a significant role. Semi-trailers consist of materials such as chassis, brake systems, accessory groups, superstructure, and so on, forming a whole. Among the critical components that constitute semi-trailers are the axles. The axle assembly undertakes the task of carrying the load on the chassis.

Figure 1. Koluman Curtain side trailer

In semi-trailers, there is an axle lifting option to prevent unnecessary tire wear when the vehicle is unloaded and to reduce the contact surface with the ground in challenging road conditions, thereby increasing the vehicle's ground pressure.

Axle assemblies commonly feature air and mechanical suspensions. Vehicles equipped with air suspension systems might encounter issues such as malfunction or air loss while in motion or parked.

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Figure 2. Semi trailer air suspension axle system

2 MATERIAL AND METHOD

A design change was implemented on the axle stopper with material properties of S355J2, and comparisons were made with its existing form.

2.1 Materials

Axle lifting option and potential issues with the suspension system necessitate the installation of axle stoppers on the axle or chassis. This aims to prevent contact between the axle and chassis, thus avoiding damage to both components.

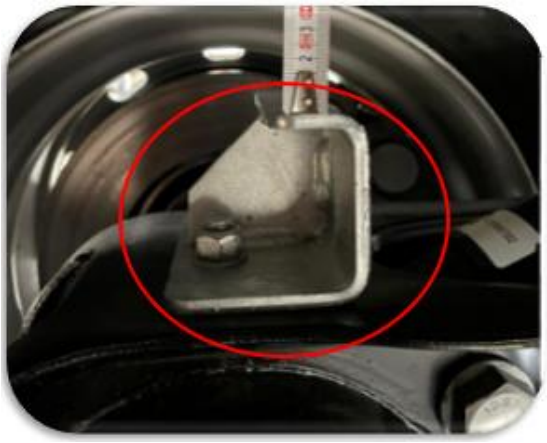

Figure 3. Axle mounted stopper type

Figure 4. Chasis mounted stopper type

2.2 Methods

Currently used chassis-mounted axle stoppers are symmetrical, designed as pairs for the left and right sides. With the design modification, the length has been reduced to equalize the length of both ends while maintaining a consistent sheet metal thickness, resulting in a single type of axle stopper

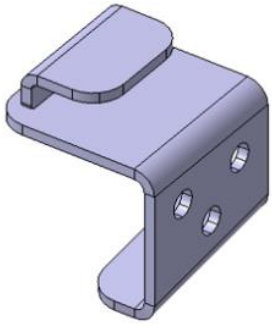

Figure 5. Current design

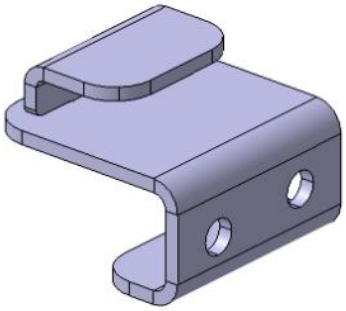

Figure 6. New design

Table 1. Properties of material

Design	Material	Thickness (mm)	Weight (kg)	Surface Area (m²)
The Existing Design	S355j2	5	0.512	0.029
New Design	S355j2	5	0.426	0.025

3 RESULTS

The aim was to achieve an axle stopper with better strength, less surface area, and weight than the current one while keeping the material type and thickness constant.

The design modification underwent nonlinear analysis in the ANSYS analysis program for both the current and new designs. A comparison was made between the equivalent stress and total deformation occurring on the material.

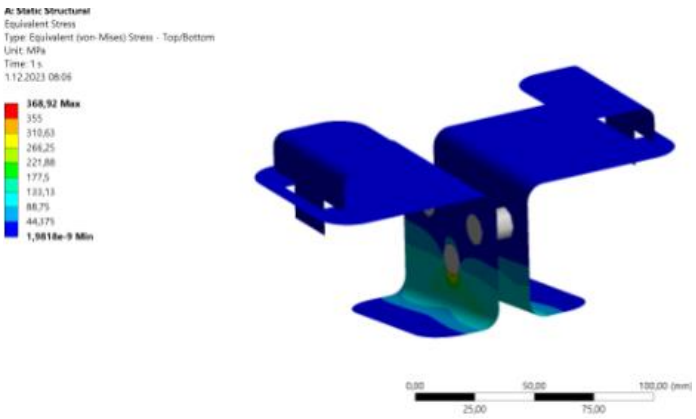

Figure 7. Equivalent stress in the current design

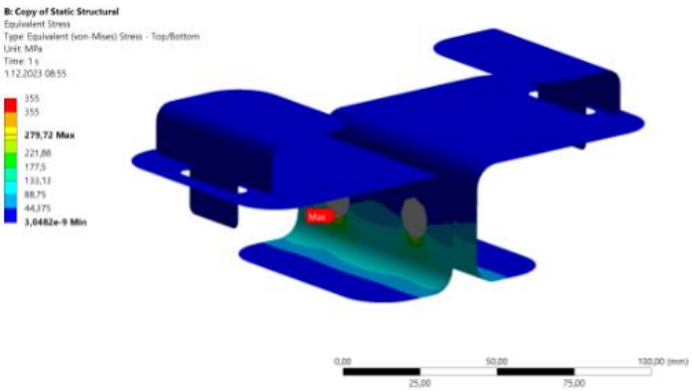

Figure 8. Equivalent stress in the new design

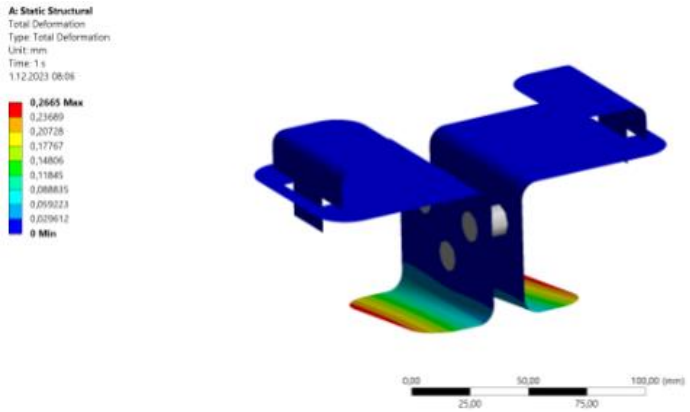

Figure 9. Total deformation in the current design

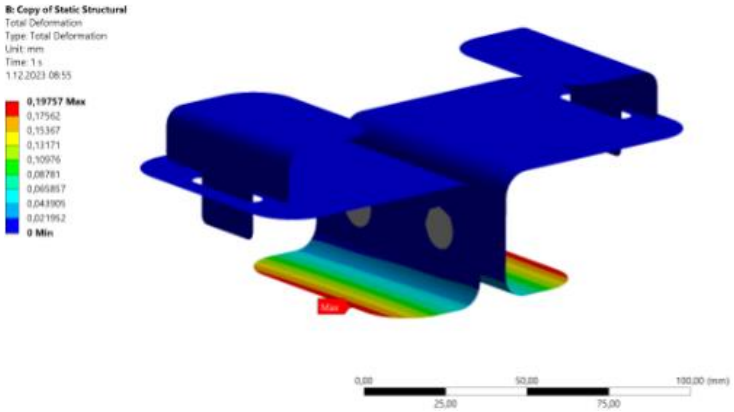

Figure 10. Total deformation in the new design

In the current design, the equivalent stress is 368.92 MPa with a total deformation of 0.2665 mm, while in the new design, the equivalent stress is 279.72 MPa with a total deformation of 0.1975 mm.

The current design has a weight of 0.5 kg and a surface area of 0.029 m², whereas the new design has a weight of 0.426 kg and a surface area of 0.025 m²

4 CONCLUSION

Based on the analysis results, it has been concluded that after the improvements made and parts standardization in the transition from the current design to the new design, the new design conditions are superior.

Acknowledgments

I would like to express my gratitude to Koluman Automotive Industry for providing me with the opportunity to undertake this study

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Effect of Changing the g/b Ratio on the Aerodynamic Drag Coefficient in Simplified Truck-Trailer Geometry

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Abstract

This study aims to investigate the effect of the aspect ratio g/b on the aerodynamic drag coefficient in a simple truck-trailer geometry. Fuel efficiency and the reduction of the carbon footprint have become significant goals in the fast transportation industry. In this context, the aerodynamic improvement of truck-trailer configurations plays a pivotal role in achieving these objectives. This research is conducted with the aim of contributing to the development of more sustainable and environmentally friendly solutions in the transportation industry. Optimizing the aspect ratio (g/b) in truck-trailer design can be a crucial step in achieving fuel savings and reducing environmental impact. Furthermore, this study emphasizes the importance of considering the aspect ratio (g/b) in the truck-trailer design process. The research was carried out using the ANSYS 2023 Fluent Package Program.

Keywords: *Semi-trailer, Aerodynamic drag coefficient, Emission, Fuel consumption, Truck-trailer*

1 INTRODUCTION

Heavy trucks, comprising a cabin and trailer, face heightened aerodynamic resistance compared to traditional vehicles owing to the vortex formation within the gap. The design of the widely used Class 8 truck is recognized for its blunt and straight-line profile, contributing to increased resistance caused by the flow separation phenomenon. Numerous research studies have addressed the aerodynamic design of heavy-duty commercial vehicles with the aim of reducing resistance forces and improving engine efficiency. Resistance force can be mitigated through shape correction or the implementation of devices designed to minimize resistance. Furthermore, optimizing the geometry of the front cabin of a truck can lead to an optimized drag coefficient, resulting in reduced fuel consumption.

In his experimental study, Allan [1] investigated the impact of drag on a tractor-trailer model by rounding the front edge of the cabin. However, such experimental methods may not be applicable to all design variations or may lack economic feasibility.

The increasing availability of computational resources has made computational techniques a more viable solution for cases where an optimized profile can be numerically determined. To validate results, limited experiments may be conducted. Osth and Krajnovic [2] utilized large eddy simulation to numerically examine the flow through a tractor-trailer model under four different scenarios, adjusting the gap width and rounding the front edge of the cabin. Bettle et al. [3] studied the speed of a truck under crosswind conditions, altering various aerodynamic parameters for different wind directions and detailing parameters that could lead to truck overturning. Hu et al. [4] drew inferences from the latter study and numerically analyzed the impact of aerodynamic loads using the SST k-omega turbulence model in a heavy-duty truck. The results indicated a reduction in side force with fence protection and enhanced rolling and yawing moments. Wang et al. [5] explored the aerodynamic characteristics of three rear shapes through numerical and experimental studies in a wind tunnel.

Following accidents in the UK, Coleman & Baker [6] experimentally investigated the aerodynamic forces experienced by a scaled-down articulated lorry in a wind tunnel. Side flow oscillations were primarily attributed to turbulence buffeting and lift force oscillations caused by wake vortex shedding. Pragadeesh et al. [7] numerically analyzed eight different models with a consistent gap width. Among these cases, the addition of a fairing to a truck with a optimally rounded cab was observed to minimize drag and eddies convincingly. To reduce drag, appropriate fairing methods, such as rounding sharp edges to a specific radius and installing fairing plates between the cabin and trailer, can be adopted.

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In this current study, the drag coefficient is determined for nine different scenarios in a scaled-down model of a Class 8 truck. Among these scenarios, three with minimal drag are analyzed in detail. The observed drag values are more reliant on the vortex formed within the gap width. The vorticity magnitude for both z-directions is individually calculated, and their impact on drag is thoroughly explained. The model with the lowest drag value and its design scenarios are presented [8].

The pressure drag, constituting a significant proportion of the aerodynamic drag on a tractor-trailer unit, primarily originates from four areas of the vehicle: the front forebody of the tractor, the rear of the trailer, the hood along with the wheels, and the gap between the tractor and the trailer. This latter aspect, the gap, exerts a considerable influence on drag. The contour of the tractor cab affects the flow conditions around the trailer. The impact on the overall drag coefficient of a tractor-trailer unit from the gap is determined by the width of the gap between the tractor cab and the trailer. Hereafter, the gap width is denoted as "g" generally expressed as g/b or sometimes g/√A, where "b" and "A" represent the characteristic length and area, respectively, of the specific model under consideration. Typically, the smaller the gap, the less positive contribution to the drag coefficient there is from the gap. Naturally, this is also contingent on the relationship between the heights of the tractor and the trailer. The drag coefficient of simplified tractor-trailer units with a rounded cab is minimal for zero gap widths and exhibits a slight increase with expanding gap width.

The model utilized in this study is identical to the one employed in the current numerical investigation, as depicted in Fig. 1. B is 305 mm in the model. The model comprises a front box representing the tractor cab and a rear box representing the trailer. The front box has dimensions of 0.92 b in height, 0.92 b in width, and 0.67 b in depth. On the other hand, the rear box has dimensions of b in height, b in width, and 2.5 b in depth. The ground clearance for the front and rear boxes is 0.21 b and 0.5 b, respectively. This configuration provides a realistic positioning of the cab and trailer, reflecting the standard shape of European tractor-trailer trucks during that period. Allan investigated two variations of the model, where the width of the gap between the two boxes was altered, and the drag was measured for a 0° yaw angle. In terms of boundary conditions, a viscous wall (no-slip) boundary condition is applied on the top and lateral walls. A uniform inlet velocity, U_∞ = 24.4 m/s, is set at the inlet which is the same used in the wind tunnel tests. The wind tunnel is presented in Fig. 2.

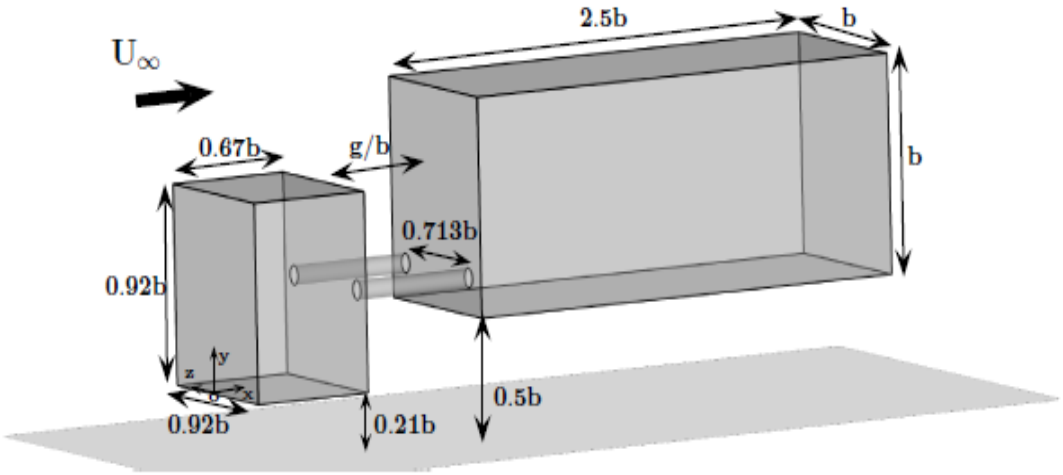

Figure 1. Model of geometry

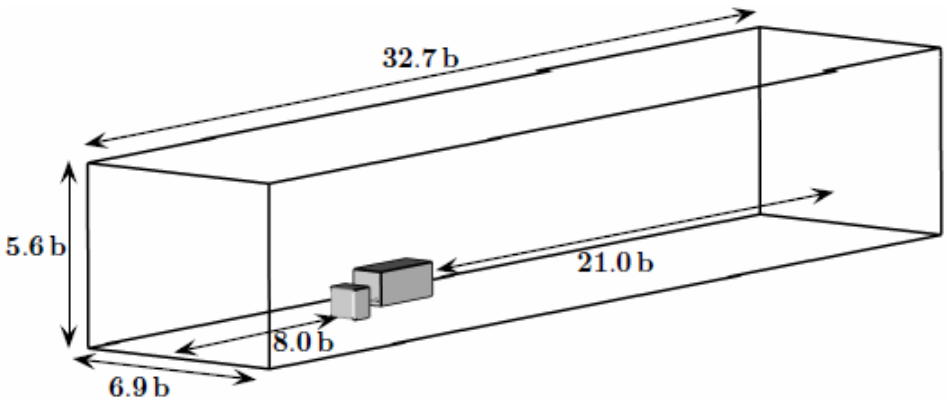

Figure 2. Wind tunnel model

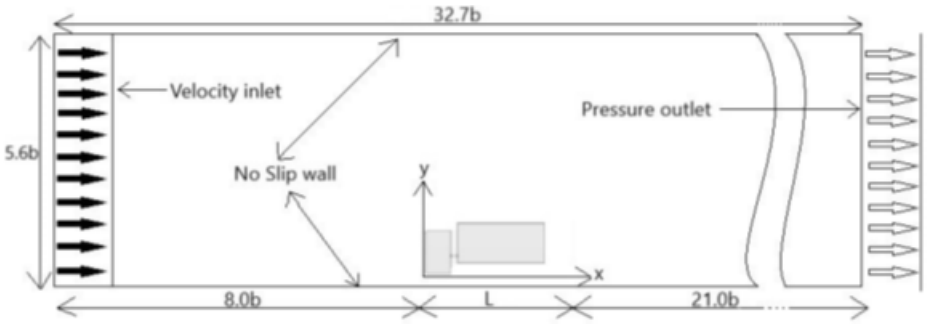

Figure 3. Computational domain

2 MATERIAL AND METHOD

The drag coefficient is a critical parameter in vehicle aerodynamics, directly influencing performance, fuel efficiency, and stability. Optimizing design and reducing the drag coefficient can provide advantages such as increased fuel economy, higher speed, better control, and reduced emissions. The formula for the drag coefficient is as follows:

$$CD=2F\rho AU^2 \quad (1)$$

Here, F represents the drag force, ρ is the density, A is the frontal cross-sectional area, and U represents the velocity.

Computational Fluid Dynamics (CFD) studies are a valuable tool for examining and optimizing the aerodynamic characteristics of vehicles. These studies simulate the airflow around a vehicle, allowing engineers to identify high-drag regions and explore the possibility of reducing aerodynamic resistance through design changes. CFD simulations provide detailed insights into flow patterns, pressure distributions, and features that contribute to drag, aiding in the development of streamlined shapes that enhance the overall performance of vehicles.

Aerodynamic CFD studies involve applying the principles of fluid mechanics to simulate and analyze the behavior of airflow around vehicles. These studies are based on fundamental physical principles such as the conservation of mass, conservation of momentum, conservation of energy, turbulence modeling, and appropriate boundary conditions. Applying these principles provides insights into flow patterns, pressure distributions, and forces, assisting in optimizing vehicle designs to improve efficiency and performance.

2.1 Turbulance Model

Computational Fluid Dynamics (CFD) turbulence models are vital tools for simulating and understanding the intricate and complex fluid motion. Turbulence is a state characterized by unpredictable and chaotic fluid motion, encountered in various fields such as aviation, automotive, energy, and environmental engineering. These models aim to predict important turbulence features, such as velocity fluctuations, turbulence intensity, and energy consumption, without explicitly resolving all the small-scale turbulent structures.

There are different turbulence models, each with its assumptions and computational methodologies. Reynolds-Averaged Navier-Stokes (RANS) models are particularly popular due to their efficiency. They use additional transport equations to simulate turbulence-related quantities like turbulence kinetic energy and turbulence dissipation rate. By substituting the flow characteristics into the relevant time-dependent continuity and momentum equations and taking their statistical averages, statistically averaged momentum equations are obtained.

The equations resulting from the above are called Reynolds-Averaged Navier-Stokes equations. These equations introduce a new term called Reynolds stresses, which are not present in laminar flow. To obtain a solution, it is necessary to model these Reynolds stresses.

The Eddy Viscosity Model is used to establish a relationship between Reynolds stresses and the average flow gradients. Turbulence stresses are assumed to be proportional to the stress magnitude, and the eddy viscosity values in this model are obtained from the turbulence transport equations.

3 RESULTS

The change in the aerodynamic drag coefficient based on the variation of the g/b ratio is indicated in the image below, as determined by the conducted CFD analyses.

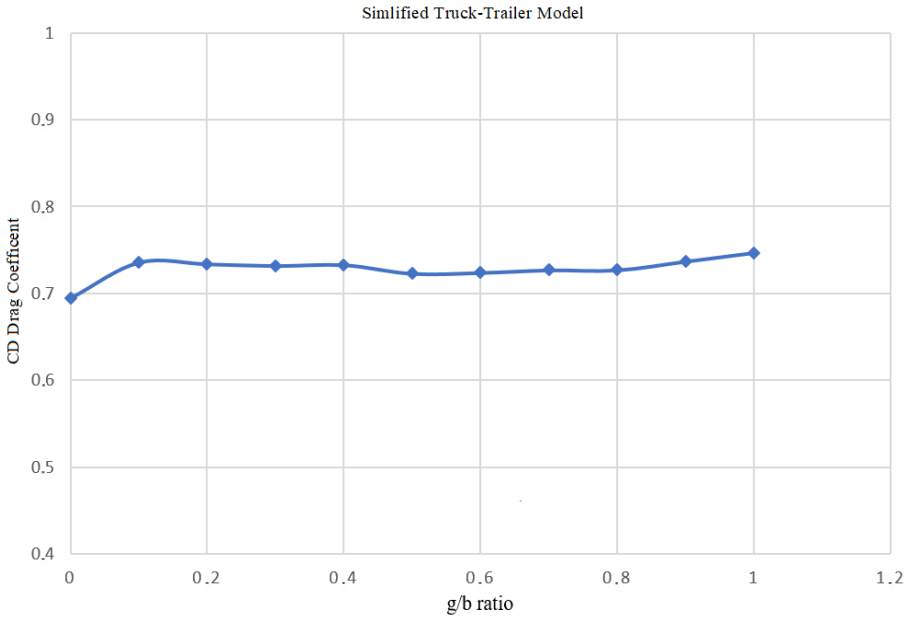

Figure 4. Change in drag coefficient based on the g/b ratio

4 CONCLUSION

According to the conducted study, it has been determined that the variation in the gap ratio in the tractor-trailer geometry has a negative impact on the aerodynamic drag coefficient.

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A THz Metamaterial Based Linear and Circular Polarization Converter

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Abstract

In this study, a metamaterial-based polarization converter was proposed in the THz frequency region. The proposed THz converter is capable of both linear and circular polarization conversion. The proposed design provides linear polarization conversion in the frequency range of 2.84-6.71 THz, while also supporting circular polarization at frequencies of 2.56 and 7 THz. For the converter structure, gold was chosen as the metal terminator in the bottom layer, Rogers RT5880 was chosen as the substrate in the middle layer, and gold was chosen for the metasurface in the top layer. Electromagnetic properties were obtained to better understand the physical mechanism of the structure. For this purpose, the impedance of the structure was examined in the region of polarization operating frequencies. To analyze the linear polarization conversion ratio (PCR) performance of the design, reflection coefficients in the u-v axes were examined. Additionally, the ellipticity value was examined to analyze the right-handed circular polarization (LHCP) performance of the design. For the oblique angle performance analysis of the design, oblique angle PCR sensitivity was examined up to 40 degrees. The structure was designed in the Computer Simulation Technology (CST) program and reflection coefficients were obtained. The resulting reflection coefficients were processed in the Matlab program. The results were compared with previous studies and the superior features of the structure were presented.

Keywords: *Metamaterial, Polarization ,Converter, THz region*

1 INTRODUCTION

Polarization converters are microwave devices used to manipulate electromagnetic waves. These devices can be produced with traditional methods such as Faraday effect and optical fraction [1]. Due to the disadvantages of polarization converters obtained by these traditional methods, such as bulky volume, narrow band operation, and low oblique angle sensitivity, the demand for metamaterial-based polarization converters has increased in recent years [2]. Metamaterials are thin structures that can be easily produced at low cost and are artificially produced periodic structures with superior electromagnetic properties [3]. With these superior features, they are used in areas such as antenna [4], absorber [5], sensor [6], lens [7] and polarization converter [8]. Metamaterial polarization converters can be designed in THz [9] and GHz [10] regions according to their usage areas, including linear [11] and circular [12]. Additionally, it can provide ease of single-parameter analysis with the use of metal termination [13].

In this study, a metamaterial transducer that can simultaneously carry out linear and circular polarization operating at THz frequency was designed. The design achieves linear polarization with a bandwidth of 3.87 THz in the range of 2.84-6.71 THz. It also achieves right-handed circular polarization in the narrow bands of 2.56 THz and 7 THz. The design is made from easily accessible materials. The design has angle sensitivity of up to 30 degrees.

2 MATERIAL AND METHOD

The proposed metamaterial-based THz polarization converter is as shown in figure 1. The design is a single-layer structure and the bottom layer is terminated with gold with a conductivity of 4.56×10^7 S/m. Rogers RT5880 with a thickness of t = 10 µm was chosen as the substrate. For this substrate, $\varepsilon_r = 2$ and the loss tangent is 0.0021. The top layer was created with simple-shaped metasurface using gold material with 0.4µm thickness. The metamaterial unit cell is L=32 µm and the metasurface part consists of two concentric rings. The outer ring forming the metasurface is r_o= 24.48 µm and the inner ring is r_i=21.23 µm. The thickness of the partition dividing the middle of the two rings is g = 4 µm.

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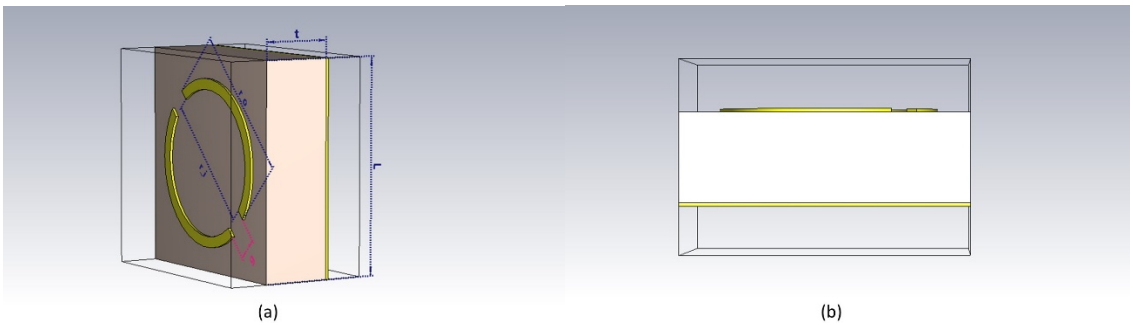

Figure 1. Proposed polarization converter (a) front view (b) side view

In order for the proposed design to work as a linear polarization converter, the electric field intensity of the wave coming in the x direction must be reflected in the y direction. Similarly, the opposite is also true. For this purpose, let's assume that the wave coming in the z direction has the electric field intensity in the x direction. So the incoming wave

$$E_i = E_i exp(jkz)\hat{e}_u + E_i exp(jkz)\hat{e}_v \quad (1)$$

For linear polarization conversion, the reflected wave will need to be as follows.

$$E_r = \{R_{uu}E_i exp[j(-kz + \varphi_{uu})] + R_{uv}E_i exp[j(-kz + \varphi_{uv})]\}\hat{e}_u + \{R_{vv}E_i exp[j(-kz + \varphi_{vv})] + R_{vv}E_i exp[j(-kz + \varphi_{vu})]\}\hat{e}_v \quad (2)$$

As seen in Equation 1-2, the reflection of a wave with y polarized electric field intensity in the x direction will provide a linear polarization transformation. For this purpose, PCR can be calculated as follows [1].

$$PCR = \frac{|r_{xy}|^2}{\left(|r_{xy}|^2 + |r_{y,y}|^2\right)} \quad (3)$$

Here R_{xy} represents the reflection of the y-polarized incident wave in the x direction. R_{yy} represents the y-polarized reflection of the y-polarized incident wave. Here |*| represents amplitude. Stokes parameters are used for Circular polarization transformation analysis of the proposed design. Using Stokes parameters, elliptcity value is calculated as follows [2].

$$e = S_3/S_o \quad (4)$$

where

$$S_3 = 2|R_{yy}|\,|R_{xy}|sin\Delta\emptyset; \qquad S_o = |R_{xy}|^2 + |R_{yy}|^2 \quad (5)$$

3 RESULTS

Using the CST simulation program, the proposed converter was simulated as in Figure 1 and the reflection coefficients were obtained as given in Figure 2a. Figure 2a shows the equal (R_{yy}) and cross (R_{xy}) reflection coefficients of the proposed design in amplitude. The phases and phase different of the reflection coefficients are given in Figure 2b. The linear polarization conversion ratio of the proposed design was obtained in Figure 2c for TE and TM modes. As seen in Figure 2c, the PCR of the proposed design is over 90% in the range of 2.84-6.71 THz with a bandwidth of approximately 3.87 THz. PCR of the proposed design under an oblique angle was examined in Figure 2d. As seen in Figure 2d, the PCR of the proposed design under an inclined angle of approximately 30 degrees was over 80%.

For the analysis of the circular polarization transformation of the proposed design, the ellipticity value was obtained as shown in Figure 3a. As seen in Figure 3a, the e value reaches +1 at 2.56 and 7 THz. Therefore, right-handed circular polarization (LHCP) occurs at these frequencies. Figure 3b depicts the reflection of the electric field intensity coming in the y direction in the x direction as a vector. Accordingly, the wave coming in the y direction was separated into u-x axes. In order for the incoming wave to be reflected in the x direction, the component in the v direction must be reflected in the -v direction. Therefore, the phase difference in the u-v directions should be 180 degrees. For reflection in the x direction, the amplitudes must be equal in the u-v direction.

Figure 3c also shows that the reflection coefficients in the u-v directions are almost equal along linear polarization. Figure 3d shows that the phase difference of the reflection coefficients in the u-v directions is -180° along the linear polarization.

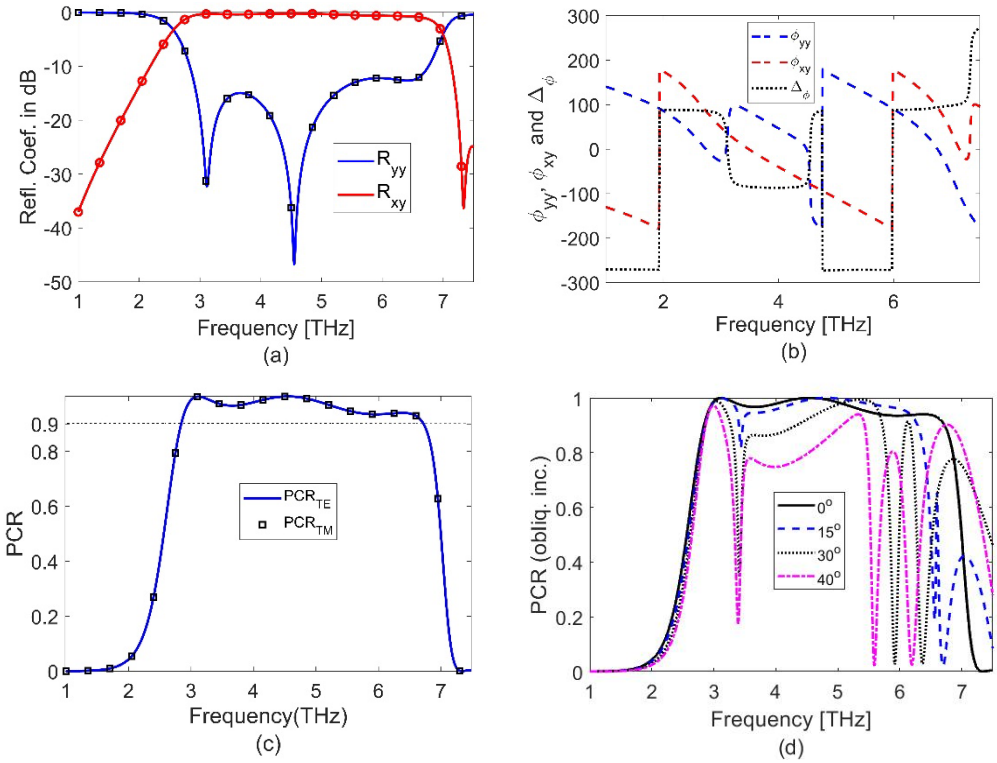

Figure 2. Simulated R_{xx} and R_{xy} (a) in dB (b) in phase (c) PCR value for TE and TM modes (d) PCR value under oblique incidence

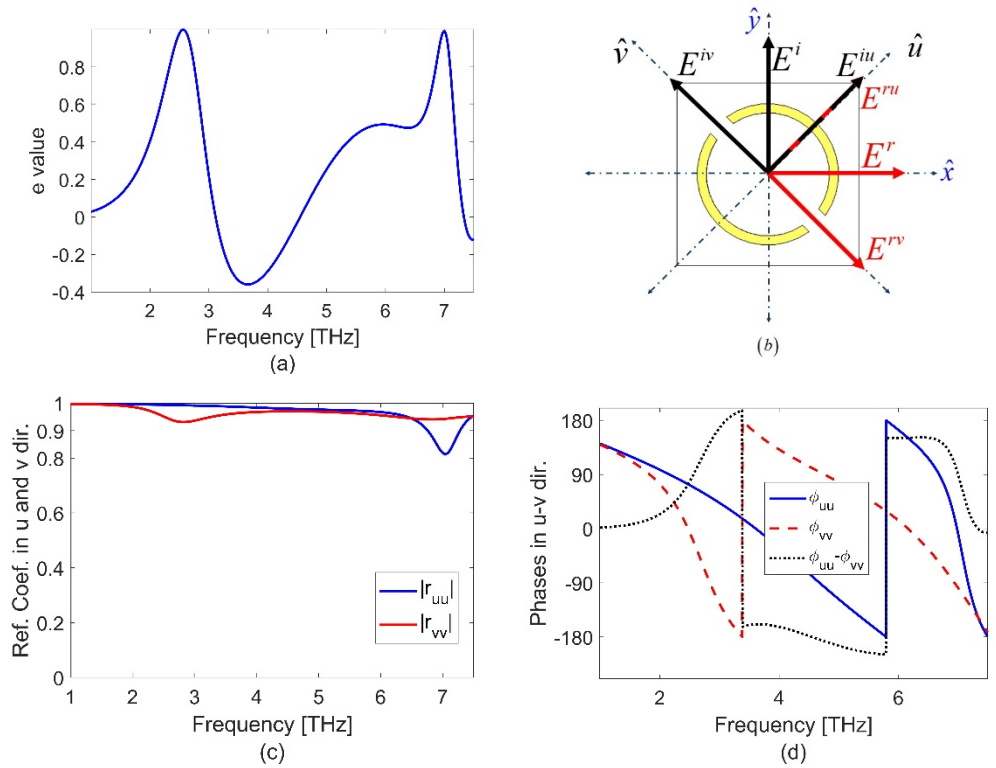

Figure 3. (a) e value, (b) incidance and reflected electric fields in u-v axes (c) $|r_{uu}|$ and $|r_{vv}|$ in u-v axes (d) phases in r_{uu} and r_{vv} in u-v axes

4 CONCLUSION

In this study, a metamaterial-based polarization converter was proposed. The proposed polarization converter provides over 90% PCR between frequencies 2.84-6.71 THz with a bandwidth of 3.87 THz. The proposed design also provides LHCP at frequencies of 2.56 and 7 THz. The proposed design provides over 80% PCR up to 30 degrees. The proposed design is constructed with simple design and easily obtainable substrate (Rogers RT5880). To understand the linear polarization working mechanism of the design, vector and reflection coefficient analysis was performed on the u-v axes. Again, in order to understand the working mechanism of circular polarization, the ellipticity value was examined through Stokes parameters.

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EN 12642 Load Securing (Code XL) Annex-A Static Test with Aluminum and Composite Side Profile

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Abstract

In the transportation sector, road transport is the most commonly used method today. Among the most preferred vehicles in road transport are semi-trailers. To ensure cargo safety, vehicles must comply with EN Standards while on the road. According to EN 12642 cargo safety standard, semi-trailer vehicles should have specific strength criteria for their side, front, and rear walls. Aluminum side profiles are generally used in curtain siders. In this study, we conducted experiments on aluminum and composite side profiles in our configurations and compared the results. It was observed that the amount of elastic and plastic deformation under applied forces complied with the standard. In external tests, the composite side profile was reported to be lighter and more resistant than the aluminum side profile. Furthermore, the behavior of the composite material was retested in the CODE XL test compared to the aluminum side profile.

Keywords: *Road transport, EN 12642, Load safety, Aluminum side profile, Composite side profile*

1 INTRODUCTION

Load safety in today's transportation sector is a critical aspect. Apart from preventing the economic loss of transported goods in the event of an accident or sudden maneuvers, it also holds many supportive benefits. These include traffic safety, ensuring the safety of both the vehicle and the driver, as well as preventing commercial losses for the sender and receiver based on predetermined delivery dates for consumers. As a result, ensuring secure load transportation not only safeguards against economic losses but also significantly contributes to traffic safety, vehicle and driver safety, and prevents commercial setbacks associated with adhering to delivery deadlines between senders and recipients.

Figure 1. The vehicle with spilled cargo after an accident

In Europe and many other advanced countries, it is mandatory for all vehicles traveling on highways and engaged in customs entry and exit to have equipment ensuring cargo transportation safety. This is a practice that is increasingly becoming widespread.

In our country, although there is currently no legal obligation, it is anticipated that a legal standard will be introduced within the next few years.

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2 MATERIAL AND METHOD

In order to ensure cargo safety in curtain-sided semi-trailers, static and dynamic load tests according to TS EN 12642 (Code XL) are conducted.

2.1 Materials

EN 12642 provides two types of strength criteria: Code L and Code XL. The reinforced superstructure requirements of Code XL can be measured through Annex A static test and Annex B dynamic test. The relevant strength criteria are briefly provided in the table below. (P: maximum load in the cargo area, useful load, G: braking force to be applied to the panel during dynamic test).

Table 1. Code L and Code XL test requirements

Curtain Side Trailer	Code L	Code XL (Annex-A)	Code XL (Annex-B)
Front Panel	0.4 P	0.5 P	0.8 G
Side Panel	0.25 P	0.4 P	0.5 G
Rear Panel	0.3 P	0.3 P	0.5 G

For instance, for a vehicle with a useful load capacity of 27,000 kg to meet Code XL requirements on the side panel, it needs to withstand a load of 0.4 x 27,000 = 10,800 kg.

The purpose of this test is to assess the durability of the front wall, rear door, side curtains, and floor (optional) of the vehicles in accordance with the TS EN 12642 Road Vehicles - Safety Regulations for Cargo, as a whole, based on Annex A (static test). Annex A is also referred to as the airbag test.

The test conditions to be met are specified in the approval criteria. Considering the components forming the vehicle's superstructure, such as the roof, tarpaulin, and pillars, the areas to be tested include the front wall, side walls, and rear portal door.

Figure 2. Code XL - Annex a side panel test

2.2 Methods

The equipment needed to perform the test includes:

- Airbag,
- Calibrated digital manometer,
- Necessary connections for the air inlet and manometer hose on the airbag,
- Two hoses for each bag (for air inlet and manometer input), and a test platform to place the airbag,
- Supports required to secure the platform onto the vehicle.

Figure 3. Koluman code XL - Annex a side panel test vehicle

Calculating the side panel test pressure:

$$P = \frac{0.4 \times F}{\geq 0.75H \times L}$$

F = 27000 kg × X g (g: gravity acceleration m/s²)
H = Side Panel Height (m)
L = Side Panel Lenght (m)
P = Required Test Pressure (1bar = 10^5 Pascal)

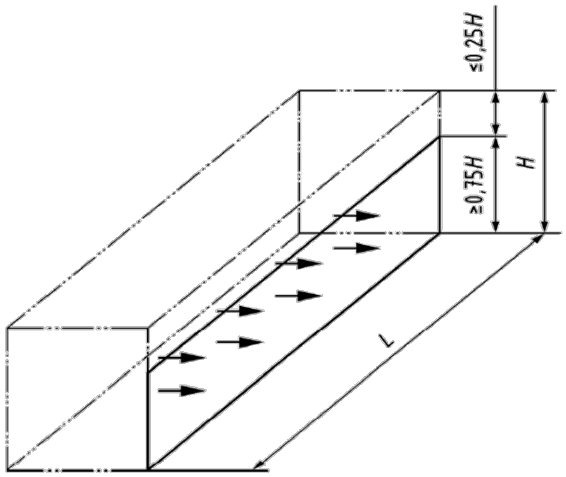

Figure 4. Code XL - Annex a side panel test pressure calculating

If we assume the side wall height to be 3000 mm and its length to be 13620 mm.

Example Side Panel Pressure Calculation:

$$P = \frac{0.4 \times 2700 \text{ kg} \times 9.81 \text{ m/s}^2}{0.75 \times 3 \text{ m} \times 13.62 \text{ m}} = \frac{105948 \text{ kg} \cdot \text{m/s}^2}{30.645 \text{ m}^2} = 3457 \text{ Pa} = 0.03457 \text{ bar} = 34.5 \text{ mbar}$$

Approval Criteria:

The elastic deformation occurring during the test should not exceed 300 mm.

When 100% of the test force is applied and the pressure is reduced to zero, the permanent deformation should not exceed 20 mm. However, the intended functionality should not be compromised.

For the side wall test, measurements are taken at 5 points on the vehicle. The midpoint of the vehicle is identified, and then five points are determined by dividing the areas to the right and left of the midpoint into two equal parts. The deformations in the vertical directions of these five points (P1-P2-P3-P4-P5) are measured.

After the tests are completed, a technical file is prepared for certification by the testing organization in accordance with the specifications of the vehicle involved in the test. This technical file should include the following items:

- Information document,
- Technical drawing of the front wall,
- Technical drawing of the front wall pillar,
- Technical drawing of the canopy profile and fasteners,
- Technical drawing of the side doors,
- Technical drawing of the side pillars,
- Tarpaulin certificates,
- Technical drawing of the rear pillars,
- Technical drawing of the rear door,
- Technical drawing of the roof.

3 RESULTS

During the implementation phase of the test, one of the components constituting the superstructure section is the canopy profiles:

- In the trailer industry, aluminum canopy profiles are commonly used
- At Koluman Otomotiv Endüstri, we had the aluminum canopy profile produced as a composite as an alternative material solution in the event of potential raw material issues.
- We conducted static Code XL tests using the composite canopy profile throughout the superstructure and added it to our certification as approved.

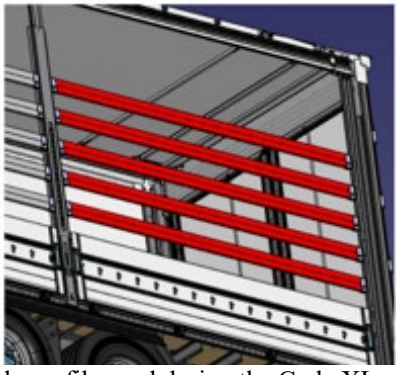

Figure 5. The side profile used during the Code XL annex a test stage

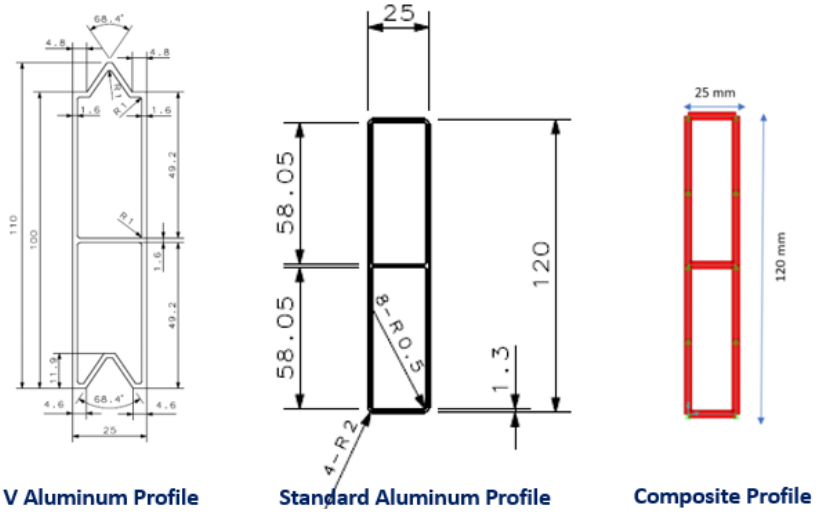

Figure 6. The side profile used during the Code XL annex a test stage

According to TS EN 12642 test conditions;

1. Maximum deflection of the tested strucrure during the test shall not exceed 300 mm.
2. At a test force of 100% of the test value a permanent deformation of 20 mm may occur, but only if the intended use is not impaired.
3. Test force was applied for at least 5 minutes.

Table 2

Side Profile	V Type Profile (mm)	Standard Type Profile (mm)	Composite Type Profile (mm)
1. condition	175	240	221
2. condition	10	15	17
3. condition	5 minutes	5 minutes	5 minutes

In the conducted Code XL Annex A test, three types of canopy profiles yielded successful results, hence they have been added to our technical documents with approved status.

Acknowledgments

I would like to express my gratitude to Koluman Automotive Industry for providing me with the opportunity to undertake this study

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Improvement of Arms of the Side Protection, Weight Reduction, and Minimization of Welding Operations

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Abstract

The global transportation network relies heavily on road transportation, with semi-trailer vehicles as essential components. The safety of these vehicles is critical, especially concerning side protection systems. This article delves into a study that focuses on a design alteration to optimise production processes, improve ergonomics, and minimise carbon dioxide emissions. The original design of the carrier arms utilised a combination of different steel sheets. However, the new design implements specific types of steel sheets, enhancing overall efficiency. The effectiveness of these design changes was verified using non-linear Ansys Structural Analysis, which confirmed the improvements brought by the modifications.

Keywords: *Semi-trailer, Side guard, Design improvement, Welding reduction, Part lightweighting*

1 INTRODUCTION

Semi-trailer vehicles, a common sight in road transport, constantly need improvements in safety measures for risk reduction. The side protection systems, usually located along the lower borders of the trailers, are vital for protecting cyclists and pedestrians from dangers. This study introduces a design alteration that aligns with current environmental goals, focusing on streamlining the manufacturing of these systems while reducing their ecological impact. (see Figure 1, and Figure 2 for details)

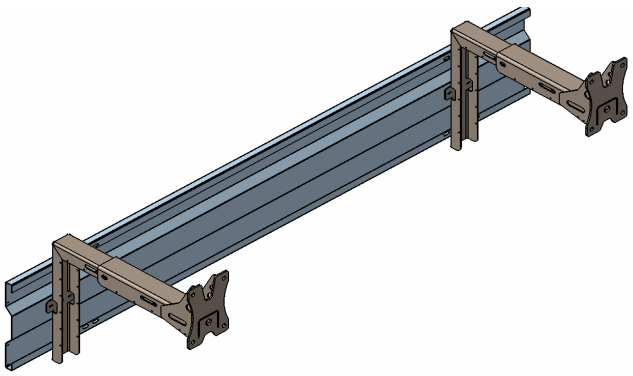

Figure 1. Current design

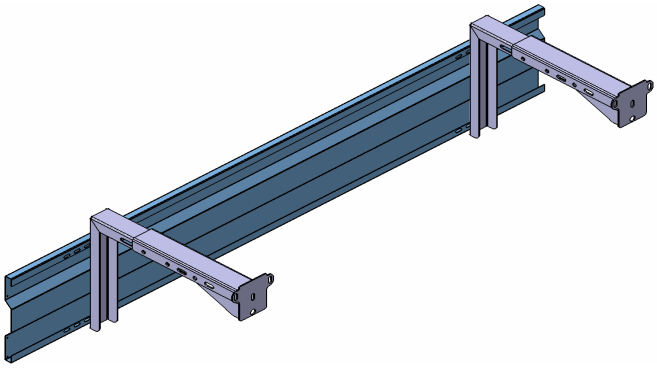

Figure 2. Altered design

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2 MATERIAL AND METHOD

The article meticulously outlines the materials utilized and the analytical methods applied, presenting this information in a well-organized and comprehensive format.

2.1 Materials

The original side protection system incorporated carrier arms constructed from S355j2 steel plates of various thicknesses. However, The revised version adopts a more calculated approach to plate thickness, effectively decreasing the overall surface area and weight. **Table 1** depicts the comprehensive details of the material specifications, highlighting the academic progress in optimising the design of the side protection system.

Table 1. Properties of Material

Design	Material	Thickness (mm)
Current	S355j2	6,4-5-3.2 mm
Altered	S355j2	5-4-3 mm

2.2 Methods

The methodology section thoroughly explains the structural analysis process, highlighting the use of the non-linear Ansys Structural Analysis tool. The critical steps of the analysis included:

1. **Geometry Modelling**: Developing an intricate geometric model that accurately represents the side protection system.
2. **Material Assignment**: Allocating specific material properties to different model components, guided by the previously outlined specifications.
3. **Boundary Conditions**: Establishing boundary conditions that closely mimic real-life scenarios, ensuring the analysis is relevant and applicable.
4. **Loading Conditions**: Implementing various loading scenarios to evaluate the system's response under diverse operational conditions.
5. **Analysis**: Conducting the non-linear structural analysis utilising the Ansys tool to gain in-depth insights.

This exhaustive methodology enabled a detailed exploration of the system's stress distribution, deformation behaviour, and safety coefficients in various loading environments, ensuring a robust and reliable analysis.

3 RESULTS

The analysis of the redesigned side protection system offers substantial insights into the stress and deformation parameters, revealing a nuanced understanding of the structural enhancements achieved.

3.1 Stress Distribution

The analysis of stress distribution in the redesigned side protection system shows a remarkable reduction in equivalent stress values, dropping from 98.1 MPa in the original model to 64.902 MPa in the revised version. This significant decrease highlights enhanced load distribution and improved safety coefficients, suggesting a stronger resilience of the system under diverse loads and potential impacts. (Refer to Figure 3, and Figure 4 for detailed visual representations)

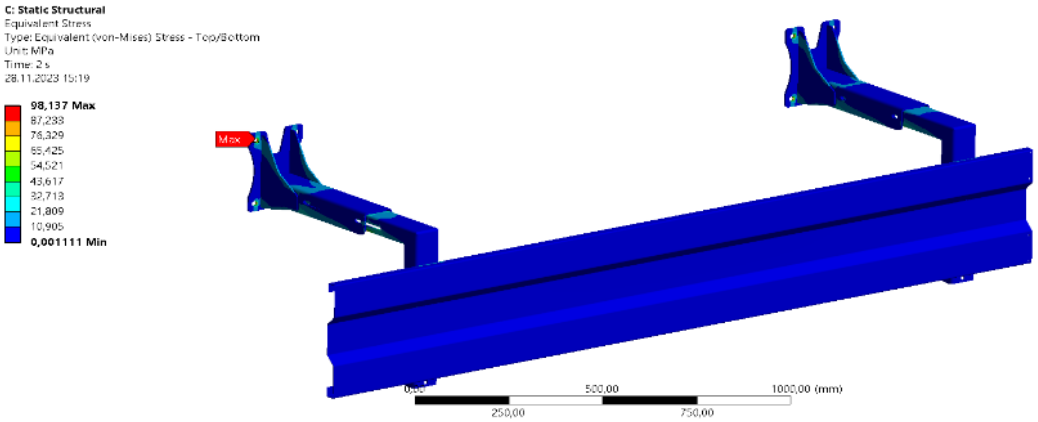

Figure 3. Stress distribution of current design

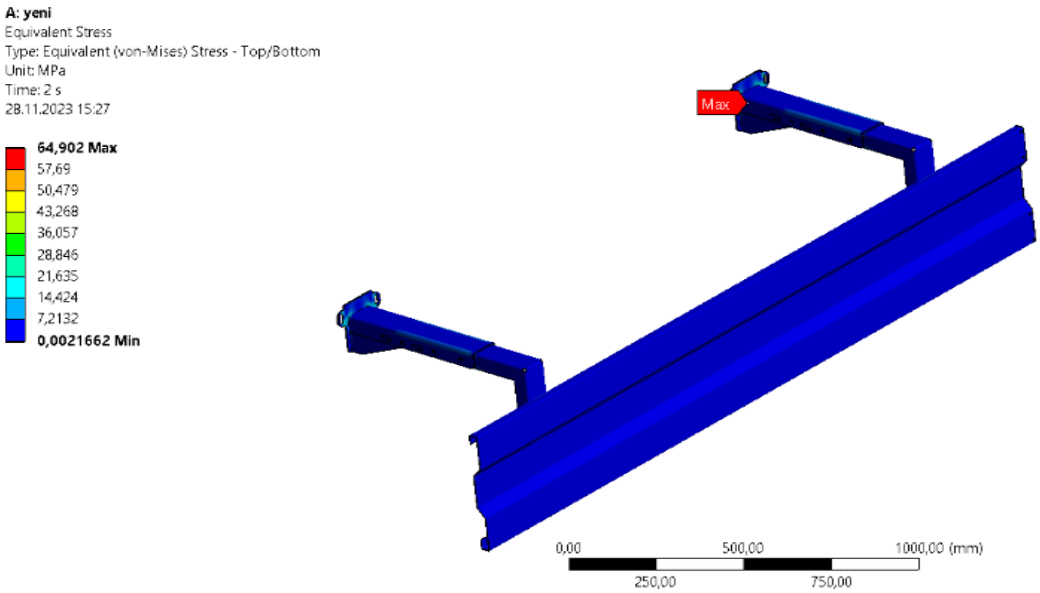

Figure 4. Stress Distribution of Altered Design

3.2 Deformation Behaviour

Examining the deformation behaviour in the side protection system uncovers a notable reduction in deformation values, from 1.036 mm in the original model to 0.7 mm in the new design. This decrease emphasises the system's increased rigidity, demonstrating its improved ability to withstand diverse road conditions and potential hazards. (See Figure 5 and Figure 6for a visual comparison of these findings.)

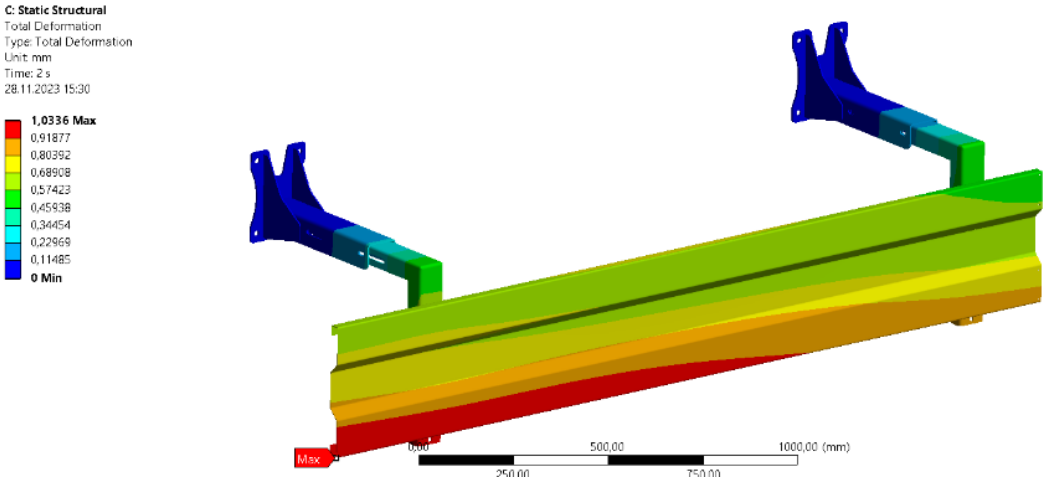

Figure 5. Total Deformation of Current Design

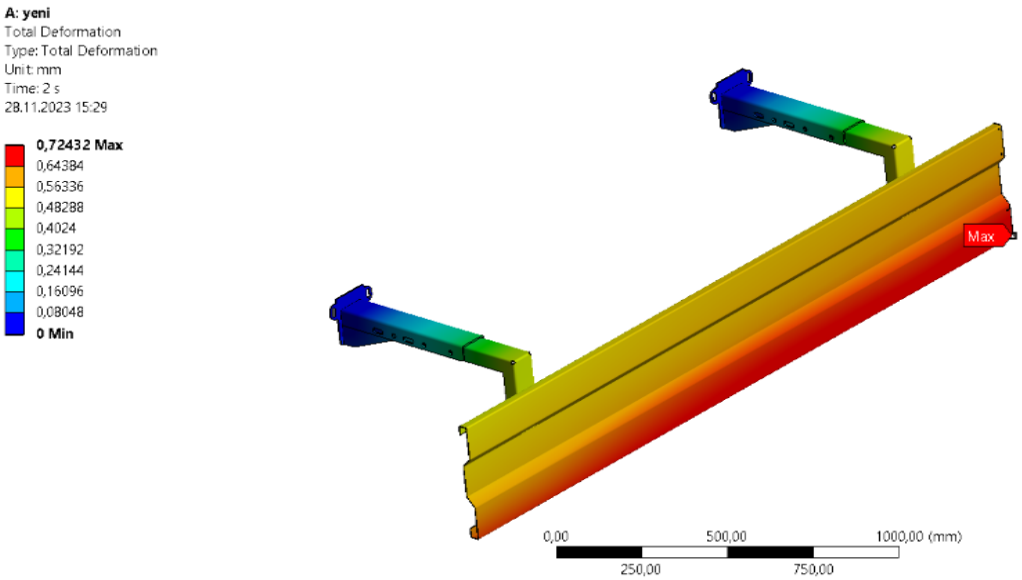

Figure 6. Total Deformation of Altered Design

3.3 Welding Volume

A critical analysis element is the 35.2% decrease in welding volume for each arm in the redesigned side protection system. This significant reduction simplifies the manufacturing process and aligns with modern sustainability objectives. It contributes to lowering CO_2 emissions linked with the production phase, reinforcing the system's eco-friendliness while maintaining its structural integrity.

4 CONCLUSION

This study achieves a significant breakthrough in road transportation, blending structural advancements with environmental sustainability in redesigning semi-trailer vehicles' side protection systems. The comprehensive analysis reveals a marked performance improvement, evidenced by reduced stress and deformation values and a 35.2% decrease in welding volume per arm. These enhancements elevate safety standards and align with eco-friendly manufacturing practices by cutting CO2 emissions. This research underscores innovative design's pivotal role in advancing safety and sustainability in the transportation sector, setting a new benchmark for future developments.

Acknowledgements

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Reverse Maneuver Technology and Vehicle Safety for Secure Transportation with Semi-Trailers

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Abstract

In road transportation, semi-trailers are among the most preferred vehicles. They load cargo onto the vehicle at the loading area and set off on the road to reach their destination. Upon arrival, the cargo is unloaded from the vehicle. Throughout these stages, the vehicle may need to move both forward and backward. The total length of the tractor and semi-trailer combination can reach up to 16.5 meters. Consequently, in situations where the driver needs to reverse, limited visibility might result in the vehicle colliding with the destination or an object unexpectedly entering the space between the target and the vehicle. Therefore, semi-trailers are equipped with reverse maneuver sensors integrated with the braking system. When the vehicle shifts into reverse gear, the sensors become operational. If an object behind the vehicle is detected by the sensor, a warning light flashes or an audible alert is activated. As the vehicle approaches the target, the frequency of the warning increases. If the distance falls below the stopping distance determined in the braking parameters, the vehicle initiates braking for a specific duration before releasing the brakes. This way, areas outside the driver's field of view are scanned through sensors, mitigating potential accidents.

Keywords: *Semi-trailers, Braking system, Tractor and semi-trailer combination, Sensors*

1 INTRODUCTION

In today's automotive sector, both motorized and non-motorized vehicles are manufactured and made available for human use. Trailer vehicles fall into the category of non-motorized vehicles, being connected to a powered vehicle, known as a tractor, using a king pin. The combination of a tractor and trailer on Turkish highways is limited to a total length of not exceeding 16.5 meters. Such a considerable total length may pose challenges for the vehicle driver at times.

One of the most significant challenges among these is the situation involving reverse maneuvers. The driver needs to approach ramps to load or unload cargo onto their vehicle. Reversing and parking the vehicle represent other instances.

During reverse maneuvers, the driver's field of vision is quite extensive, However the visibility around the immediate rear area of the trailer is restricted.

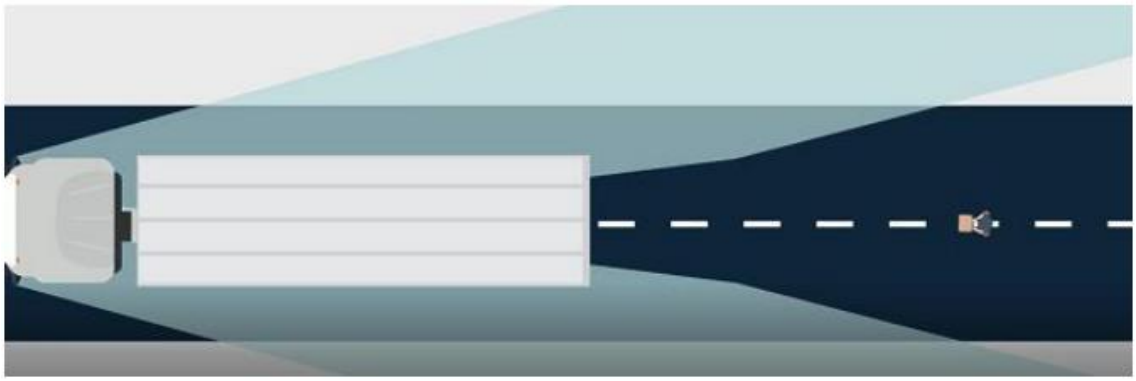

Figure 1. Reverse maneuver

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Places with limited visibility can lead to accidents. These accidents can result in both human casualties and material damages. To mitigate this risk and prevent potential accidents, there are some solutions available, such as rear-view cameras and proximity sensors.

Figure 1. Reverse maneuver

2 MATERIAL AND METHOD

To prevent accidents and benefit the driver, ultrasonic reverse proximity sensors are used in trailer vehicles.

2.1 Materials

When the vehicle is put into reverse, the system activates. If the target at the rear of the vehicle is detected, the warning light starts flashing on/off or, if equipped, the system emits an audible warning. As the vehicle approaches the target, the frequency of flashing increases. This system can be integrated with the braking system of the trailer vehicle. When the programmed stopping distance is exceeded, the vehicle brakes within a few seconds and the braking is released again.

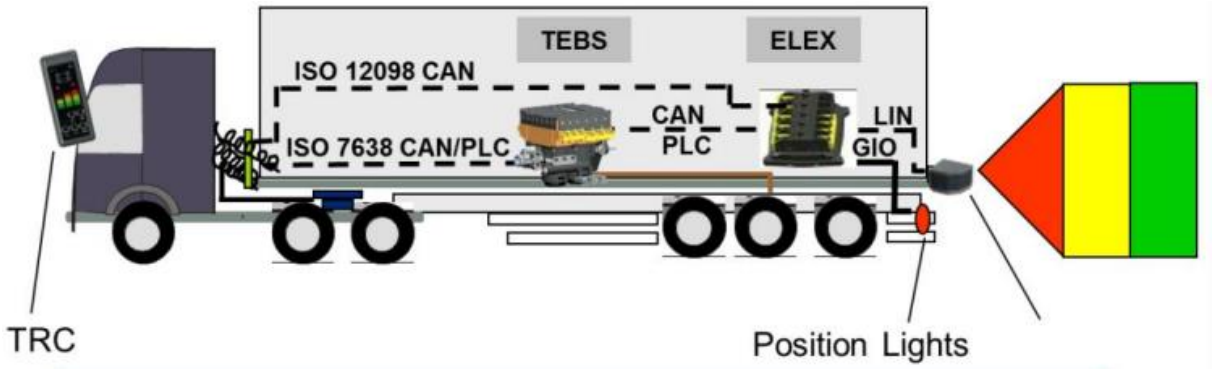

Figure 3. Truck and trailer EBS/reverse parking system combination

2.2 Methods

The system mounted on the trailer facilitates communication with the tractor via ISO 12098 and ISO 7638 cables through the Trailer Electronic Braking System (EBS) control unit and electronic expansion module, using the power line communication.

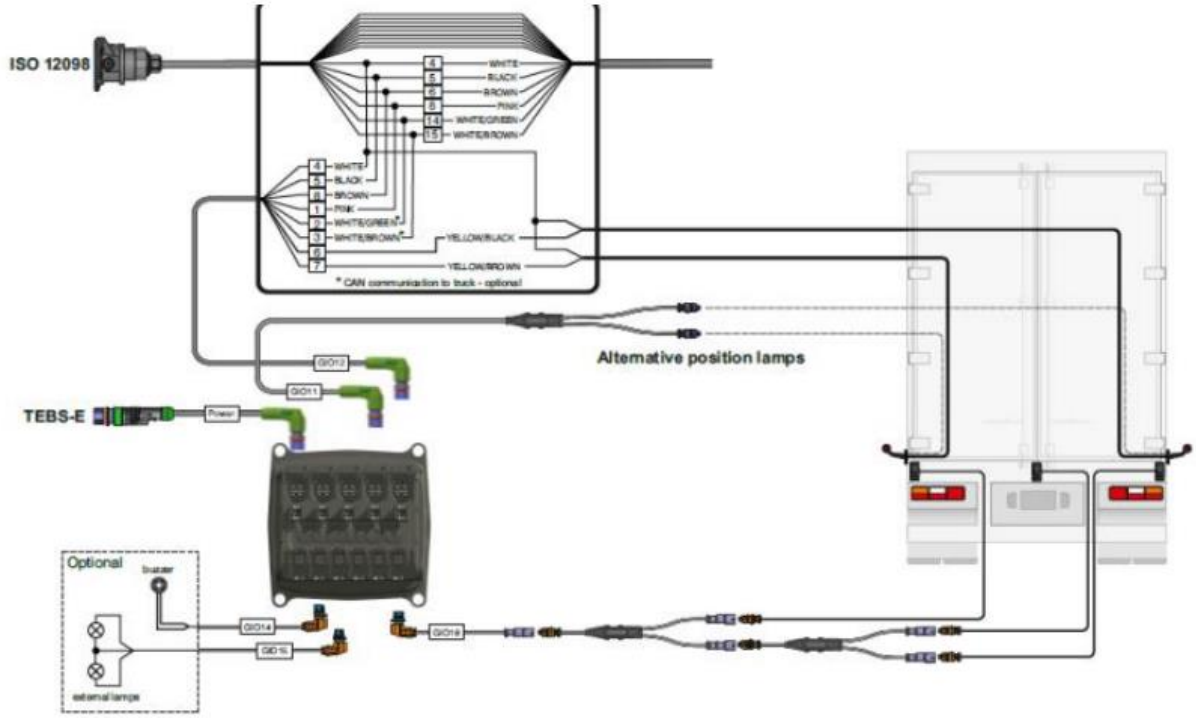

Figure 4. Reverse parking sensor installation diagram for trailers

The quantity and placement of sensors, installation distance, threshold values for braking, as well as the speed at which braking is activated or deactivated, are determined from the brake parameter. These details define the configuration for the reverse parking sensor system.

Figure 5. Processing data into brake program parameters

3 CONCLUSION

As a result, the aim was to prevent accidents that may occur using the reverse parking system in truck and trailer combinations. Thus, ensuring driving safety by preventing material damages as well as potential human and property losses.

Acknowledgments

I would like to express my gratitude to Koluman Automotive Industry for providing me with the opportunity to undertake this study

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Aluminum Tanker Design and Improvement of ECR 111 Regulation

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Abstract

Regarding tankers commonly used in the logistics industry; Some design analysis, material analysis and driving analysis were performed. Looking at the analysis results, only the cross-sectional area was changed and the tanker's center of gravity was brought closer to the ground. While this process was carried out, the tanker's volume was preserved. As a result of the changes made, while providing the driver with a more comfortable ride, at the same time, by increasing road safety, the risk of tipping over is minimized.

Keywords: *Center of gravity, Aluminum tanker, Cross-sectional area, Design change*

1 INTRODUCTION

What is Aluminum?

Aluminum, a chemical element with the atomic number 13 and symbol Al, is a malleable metal characterized by its silver hue. Typically found in nature in the form of bauxite ore, aluminum is renowned for its exceptional resistance to oxidation, a quality primarily attributed to its passivation capability. Widely employed across numerous sectors of industry, it plays a pivotal role in the creation of millions of diverse products, holding a significant position within the global economy. Structural components crafted from aluminum are indispensable in the aerospace industry, benefitting from its combination of lightweight properties and high strength. This metal finds extensive use in the transportation and construction sectors, where the demand for both lightness and robustness is paramount.

Properties

Aluminum is a soft and lightweight metal, characterized by a matte silvery color. This hue is a result of the thin oxide layer that forms on its surface when exposed to air. Non-toxic and non-magnetic, aluminum does not produce sparks. The tensile strength of pure aluminum is approximately 49 megapascals (MPa), but when alloyed, this value can increase to 700 MPa. Its density is roughly one-third that of steel or copper. Aluminum is easily malleable, machinable, and castable. Its superior corrosion resistance is attributed to the protective oxide layer that forms on its surface. With an electrical conductivity of 64.94% IACS (pure Al at 2°C), aluminum exhibits favorable electrical properties. It has a melting point of 660°C and a boiling point of 2519°C.

Alloy Used in Design

The primary elements of the EN AW 5083 aluminum alloy are magnesium and manganese. This alloy is distinguished by its key characteristics, including high malleability, weldability, and resistance to corrosion. Its notable corrosion resistance makes it particularly preferred for applications involving exposure to ships and industrial chemicals.

The mechanical properties of 5083 aluminum alloy materials vary depending on the manufacturing process, heat treatments applied, and the thickness of the material. These variations lead to diverse applications based on the specific characteristics achieved through these factors.

The primary attribute of the 5083 alloy is its machinability, making it a preferred choice on CNC machines. The inclusion of magnesium enhances the strength and hardness of the product. Cast plates made from this alloy exhibit excellent dimensional stability due to the relief of internal stresses during their production, resulting in minimal warping during machining. Atomically, the internal structure of plates produced by rolling is oriented in the rolling direction, whereas cast plates, homogenized through post-casting heat treatment, maintain a highly stable internal.

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Structure, preserving dimensional stability even with the loss of approximately 85% of the material during processing. Consequently, ground 5083 cast plates are widely favored by CNC machinists in applications where precise tolerances are crucial.

The excellent weldability of the 5083 alloy, attributed to its 4.5% magnesium (Mg) content, is a notable feature. This alloy maintains its strength after welding and does not necessitate post-weld heat treatment. Among non-heat-treatable aluminum alloys, 5083 is the strongest. This characteristic has led to the widespread use of the 5083 alloy in applications such as ships, tankers, silos, and machine components.

“The welding of the 5083 alloy typically involves the use of 5183 welding wire. Healthy welds can be achieved when welding 5083 alloy with itself or with the 6082 alloy.”

EN AW 5083 is widely utilized in the maritime industry, primarily due to its high resistance to corrosion. The main reason behind its prevalence is the material's exceptional durability against corrosion. Strength tests conducted over a 10-year period in seawater corrosion environments have recorded only a modest loss of strength, ranging from 2% to 5%.

The presence of chlorine (Cl) particularly induces corrosion in aluminum materials.

5083 and 7075 aluminum alloys are also utilized in the manufacturing of inflatable and thermoforming molds. Within these molds, cooling water channels are produced.

The chlorine levels within the cooling water used here are crucial. Chlorination operations should be conducted on the water to eliminate chlorine and prevent corrosion.

There is a possibility of “inter-diffusion corrosion” or “corrosion cracking” occurring in humid environments with sudden temperature changes where aluminum materials are stored. Therefore, storage areas should be maintained at constant temperatures to mitigate the risk.

Aluminum alloy 5083 in the H111 temper can be bent to standard angles up to a thickness of 12.5 mm. Refer to Table 1.3 for specific bending angles. However, for thicknesses exceeding 12.5 mm, it is not recommended to bend 5083 cast and rolled plates.

In addition to its corrosion resistance, 5083 aluminum is significantly lighter than steel. This characteristic substantially reduces the weight of manufactured ships, enhancing their tensile and carrying capacities, as well as increasing their speeds.

5083 aluminum ship plates and sheets are particularly favored in the maritime industry. Temper conditions such as 0, H111, H112, H116, and H321 are commonly preferred in this sector. 5083-H321 and 5083-H116, in particular, are favored for the portions of ships submerged in water. Corrosion tests have been conducted on the H321 temper. The rolled 5083-H111 aluminum exhibits excellent workability and ductility, making it suitable for various bending and shaping methods.

Table 1. Chemical Properties

Cu	Si	Fe	Mn	Mg	Zn	Cr	Ti	Al
0.10	0.40	0.40	0.4~1.0	4.0~4.9	0.25	0.05~0.25	0.15	rem

Table 2. Physical characteristics

Intensity	2,66 g/cm3
Thermal Conductivity	110 - 130 W/m*K
Elasticity Modulus	70.000 N/mm2
Coefficient of Thermal Expansion	24,2 10-6 / K
Electrical conductivity	16-19 (m/Ωmm2)
Specific Heat Capacity	900 (J/kg*K)

Table 3

Temper	Thickness		Tensile Strength		Yield Strength	Elongation		Bending Diameter		Hardness
	mm		R_m Mpa		$R_{p0,2}$ Mpa	%				HBW[a]
	From Thickness	To Thickness	Min.	Max.	Min.	$A_{50\ mm}$	A	180°	90°	
F[a]										
	≥2.5	250	250							
	250	350	245							
O										
	0.2	0.5	275	350	125	11		1.0 t	0.5 t	75
	0.5	1.5	275	350	125	12		1.0 t	1.0 t	75
	1.5	3	275	350	125	13		1.5 t	1.0 t	75
	3	6.3	275	350	125	15			1.5 t	75
	6.3	12.5	270	345	115	16			2.5 t	75
	12.5	50	270	345	115		15			75
	50	80	270	345	115		14			73
	80	120	260		110		12			70
	120	200	255		105		12			69
	200	250	250		95		10			69
	250	300	245		90		9			69
H111										
	0,2	0,5	275	350	125	11		1,0 t	0.5 t	75
	0,5	1,5	275	350	125	12		1,0 t	1.0 t	75
	1,5	3	275	350	125	13		1,5 t	1.0 t	75
	3	6,3	275	350	125	15			1.5 t	75
	6,3	12,5	270	345	115	16			2.5 t	75
	12,5	50	270	345	115		15			75
	50	80	270	345	115		14			73
	80	120	260		110		12			70
	120	200	255		105		12			69
	200	250	250		95		10			69
	250	300	245		90		9			69
H112										
	6.0	12,5	275		125	12				75
	12.5	40	275		125		10			75
	40	80	270		115		10			73
	80	120	260		110		10			73

What is a Tank with ADR?

Logistics companies categorize tankers used for transporting fluid substances such as liquids and gases on sea, rail, and roadways based on the materials they carry; they label them as either hazardous or non-hazardous material carriers. Each type has its own specific justifications. Tankers carrying hazardous materials are referred to as ADR-compliant tankers.

The acronym ADR stands for the European Agreement concerning the International Carriage of Dangerous Goods by Road. Its primary objective is to ensure the safe transportation of dangerous goods. Additionally, ADR aims to classify hazardous cargoes, establish conditions, and align routes and parking facilities with specific criteria.

The ADR Convention advocates for the safe transportation of vehicles carrying dangerous goods on roadways. It requires those involved in the production, filling facilities, vehicle drivers, vehicle owners, handlers, tanker manufacturers, and users of hazardous substances to fulfill responsibilities, obligations, and training to ensure the secure transportation of dangerous materials. ADR encompasses the marking, labeling, and safe transport on roadways of vehicles used in the transport of hazardous materials. Any element of a vehicle that does not comply with ADR standards can result in the vehicle being prohibited from traffic. The hazardous substances referred to include those with flammable, explosive, combustible, infectious, radioactive, and corrosive properties, in liquid, solid, and gas forms.

The ADR Convention consists of three stages: ADR-compliant tanker, ADR-compliant driver, and ADR equipment. Let's review the updates we have made on the ADR aluminum tanker (Figure 1).

Figure 1

2 MATERIAL AND METHOD

A detailed examination of the materials used and the methodology employed for the analysis is presented in a structured manner.

2.1 Materials

No changes have been made to the material.

2.2 Methods

Changes have been made to the 3-dimensional designs through the Catia software. These modifications were implemented with consideration for Turkish road standards, highway regulations, and ADR standards. Despite alterations in the width and height of the tank, it still complies with highway standards.

When examining the cross-sectional area of the tank (visuals 2.2 and 2.3), despite changes in length, no differences in volume were observed during volume tests (visual 2.1).

The structural analysis included the following steps:

Geometry Modeling: Creating the geometric model of the tank body while preserving its volume..

Material Assignment: No changes have been made to the material used.

Boundary Conditions: Defining appropriate boundary conditions to simulate highway standards.

Loading Conditions: Testing various driving methods to evaluate system behavior under different conditions.

Analysis: Performing cross-sectional area analysis using the AutoCAD tool.

These comprehensive tests enabled a meticulous examination of safety factors under various road conditions.

3 RESULTS

The changes to the redesigned tank body and volume results are as follows.

3.1 Volume Test

The tank was tested by filling it with water, row by row, and no changes in volume were observed in the conducted tests (Figure 2).

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TURKEY
www.koluman-otomotiv.com.tr

Approval no. Tip onay no.	TR/TSE04*0015/LGBF/004 (Rev.03)			Year of manufacture	2023
Tank serial no. Tank seri no.					
Design temperature Tasarım sıcaklığı	20°C	Min. service temp. Min. işletme sıcaklığı	-20°C	Max. service temp. Max. işletme sıcaklığı	50°C
Test pressure Test basıncı	Tank	Chambers / Gözler		Leakproofness / Sızdırmazlık	
	0,38 bar	0,34 bar		0,22 bar	
Allowable vapor pressure at max. service temperature Max. işletme sıcaklığında müsaade edilen buhar basıncı	0,12 bar	External design pressure Harici tasarım basıncı		0,03 bar	
Design code Tasarım kuralları	ADR, EN 13094			Tank code Tank kodu	LGBF
Total volume Toplam hacim	27140 L	Material of tank shell		EN AW 5182 H111	
Volume of each chamber Göz hacimleri	1) 5600 L	2) 5540 L		3) 5550 L	
	4) 4250 L	5) 6200 L		6) -	
TEST DATES AND INSPECTOR'S SEAL TEST TARİHLERİ VE DENETLEYİCİNİN MÜHRÜ	11/2023 P				

Figure 2

3.2 Cross-Sectional Area View

In the design modification, the cross-sectional area of the tank has been altered, bringing the center of gravity closer to the ground. By changing the center of gravity, the stability against tipping is improved, providing the driver with a safer driving experience (Figure 3 and Figure 4).

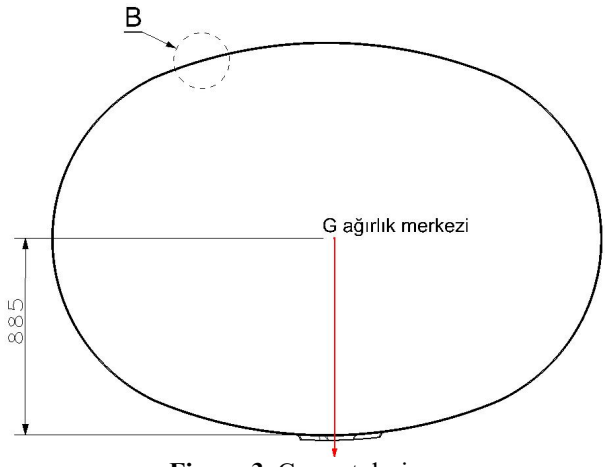

Figure 3. Current design

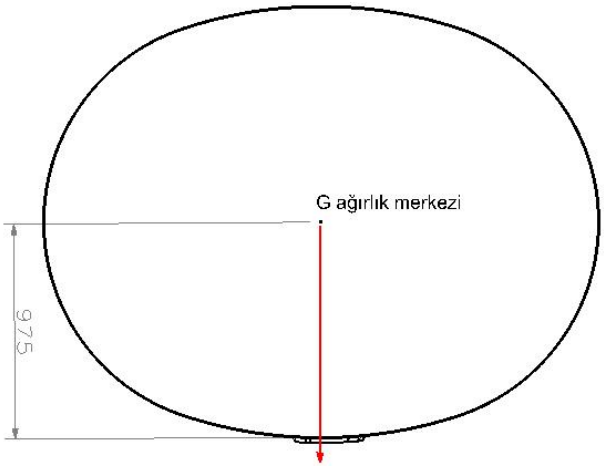

Figure 4. Old design

4 CONCLUSION

As seen in the tests, the center of gravity of the tank has been lowered by 90mm, and the safety coefficient of the tank has been improved while it is in motion.

Acknowledgments

I would like to express my gratitude to Koluman Automotive Industry for providing me with the opportunity to undertake this study

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December 1-3, 2023

Effect of Iron Diffusion on Fluidity in Casting of A356 Aluminum Alloy

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Abstract
In order to have good casting properties in aluminium casting alloys, structural defects must be minimized. Various elements can be deliberately added into aluminum alloys or included in the alloy due to environmental factors during production. Among the elements that affect the properties of aluminium casting alloys, one of the most harmful impurities is the iron element, and its amount in the alloy has an important role. Iron has good liquid solubility in aluminium but low solid solubility. As a result, the iron in the alloy bonds with other impurities or other elements in the alloy to form intermetallic compounds. These intermetallic compounds significantly affect physical properties such as mechanical properties, castability, porosity, corrosion resistance, and fluidity. This study examined the effect of iron on fluidity in A356 aluminium casting alloy. In this context, a stainless steel rod was kept in liquid aluminium alloy at 750°C for 1 hour. Thus, the effects of iron on the fluidity were tested using a spiral mold, which is likely to pass into the alloy due to diffusion. The effects on fluidity were also examined before and after liquid metal cleaning. Casting, liquid metal cleaning, and macro examination techniques were used in the study. When the results were examined, it was seen that the fluidity increased with liquid metal cleaning and also that the iron effect due to diffusion negatively affected the fluidity.

Keywords: *A356 aluminum casting, Liquid metal cleaning, Iron diffusion, Fludity*

1 INTRODUCTION

Non-ferrous metals are used in the fields of automotive, aircraft, wagon construction, electricity, packaging, wire and cable production, machinery and machine elements, and metallurgy, along with developing technology and, energy recovery, and environmentally oriented production. Among the non-ferrous metals, aluminium and its alloys are the most commonly used metals. Aluminium alloys have gained a more widespread place in the automotive and aviation industries than their counterparts due to their properties, such as high strength, easy castability, and good corrosion resistance. In addition, as a result of R&D studies, these metals have begun to take a large place in the defense and space industries [1].

The most important factor in using aluminum alloys and producing quality parts is the quality of the molten metal and the minimization of undesirable elements. Some elements affecting impurities in aluminium casting are Fe, Zn, Cu, Mg, and Mn [2]. These elements affect the quality of aluminium metal and can cause undesirable properties or poor mechanical values. Iron is one of the elements that have the most negative impact on the impurities of aluminium-casting alloys. It supports the formation of interphases during the solidification of aluminium alloys, which can affect the properties of the final product [3]. That is, most of the iron in the alloy forms intermetallics bound to other existing impurities or other elements in the alloy. These intermetallic compounds are known to have negative effects on mechanical properties, porosity, castability, corrosion resistance, and surface treatments [4-6]. It is known that iron affects the casting properties of the alloy because it increases the formation of the structures shown in Figure 1 in the aluminium alloy. In addition, the ratio of the element added to the alloy and the chemical composition of the alloy are also crucial for the results [7, 8].

Various processes are applied to eliminate the harmful effects of impurity elements in the alloy. These include liquid metal cleaning, addition of neutralizing alloying elements and use of filters, etc. These processes are necessary to eliminate or minimize the alloy's impurities, such as gas, inclusions, and residues. The most commonly used procedure in this context is a liquid metal cleaning method with alternatives such as rotary-type degassing, fixed nozzle cleaning, tablet, or flux cleaning. Studies have observed that the mechanical properties of alloys applied to liquid metal cleaning increase, they gain easy castability, and porosity formation decreases and contributes positively to fluidity [11, 12].

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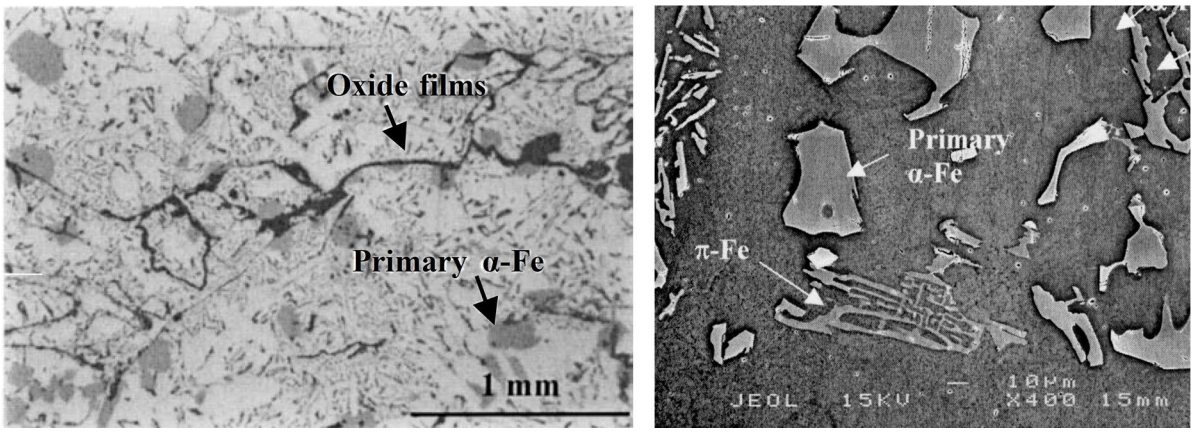

Figure 1. Images of inclusions formed in aluminium [9, 10]

Although the most considerable effects of alloy impurities are seen in the microstructure, their most significant macro impact occurs when the mold is not filled completely and the parts are scrapped. The castability of casting alloys is defined as the distance that liquid metal flows within the mold until it is stopped during solidification. Fluidity is a complex behavior related to the liquid flow and solidification of the liquid or liquid-solid binary phase of an alloy under certain conditions of a casting application [13]. Many variables affect casting fluidity. These variables can generally be grouped into two broad categories: Metal-related variables and mold-related variables[14]. These are factors such as the temperature of the molten alloy, precipitates, inclusions, oxides, bifilms formed in the structure during solidification, gating system, viscosity, casting time, the form of crystallization and solidification, cooling rate, and foreign substances in the liquid metal [15]. In addition, another factor is that the fluidity of aluminium alloys decreases rapidly as a result of decreasing metal purity. The decrease in fluidity depends on the insoluble compounds in the liquid metal and the increase in the amount of Fe-containing phases [16]. It is reported that the increase in the Fe level in the alloy reduces the fluidity because it increases the intermetallic number [17, 18]. In their study, Taghaddos et al. investigated how the effect of Fe on the 413 alloys affected the fluidity by casting in a vacuum fluidity mold. They observed that Fe in the melt decreased fluidity due to increased intermetallic formation and inclusion formation [19]. Therefore, in order to increase the fluidity value, it is necessary to remove insoluble compounds or phases containing Fe from the liquid metal. For example, in his study, Hal examined how the use of flux in the liquid metal cleaning of the A356 alloy affected the fluidity. As a result of the study, they concluded that cleaning the liquid metal reduces the bifilm index, increasing the liquid metal's fluidity and improving its mechanical properties [20].

This study examined the effect of iron on fluidity in A356 aluminium casting alloy. After the A356 alloy was melted, the stainless steel rod was kept in diffusion for 1 hour. During this diffusion period, it was investigated how it affected the fluidity of the alloy during its diffusion through the crucible or other materials used during casting. A spiral fluency mold was used for fluency tests. To see the effect of iron diffusion in the castings, castings were made without waiting for the stainless rod and after waiting for 1 hour. In addition, castings were made before and after liquid metal cleaning to examine the effect of liquid metal cleaning.

2 MATERIAL AND METHOD

In this study, the effect of diffusion iron content in A356 aluminium alloy on its fluidity properties before and after liquid metal cleaning was examined. The experiments carried out in this context are given in Table 1.

Table 1. Experimental parameters

Experimental number	Casting temperature (°C)	Diffusion status	Liquid metal cleaning
1	750˚C	None	-
2	750˚C	1 hour	-
3	750˚C	None	After Cleaning
4	750˚C	1 hour	After Cleaning

As seen in Table 1, 4 casting experiments were carried out within the scope of the study. For diffusion, a stainless steel rod was immersed in the molten metal and kept at 750 °C. Diffusion time was determined as 1 hour. Primary A356 alloy, whose chemical composition is given in Table 2, was used as the alloy.

Table 2. A356 aluminium alloy chemical composition (%w)

Fe	Si	Cu	Zn	Ni	Ti	Mn	Mg	Al
0.11	7.12	0.01	0.02	0.01	0.08	0.01	0.35	rem

When the values given in Table 2 are examined, it has been determined that the alloy used complies with the alloy standards. Melting processes were carried out in an 8 kg capacity SiC crucible. The melted liquid metal temperature was increased to 750 °C in order to detect the diffusion effect better, and the diffusion of iron was controlled by immersing the stainless steel rod in the necessary experiments in accordance with the test conditions given in Table 1. In addition, the cleaning process was applied as a parameter to examine the effect of liquid metal cleaning before diffusion and non-diffusion castings. The degassing process shown in Figure 2 was applied for liquid metal cleaning. In the rotary-type degassing process, the perforated graphite nozzle immersed in the molten liquid metal is rotated at a certain speed. It gives nitrogen, an inert gas, into the liquid metal through its holes. The bubbles formed by the rotation of the rotor head and the effect of nitrogen gas bring the inclusions in the liquid metal to the surface of the liquid metal, thanks to its low density. Liquid metal cleaning was carried out by removing these surface impurities using the slag removal method.

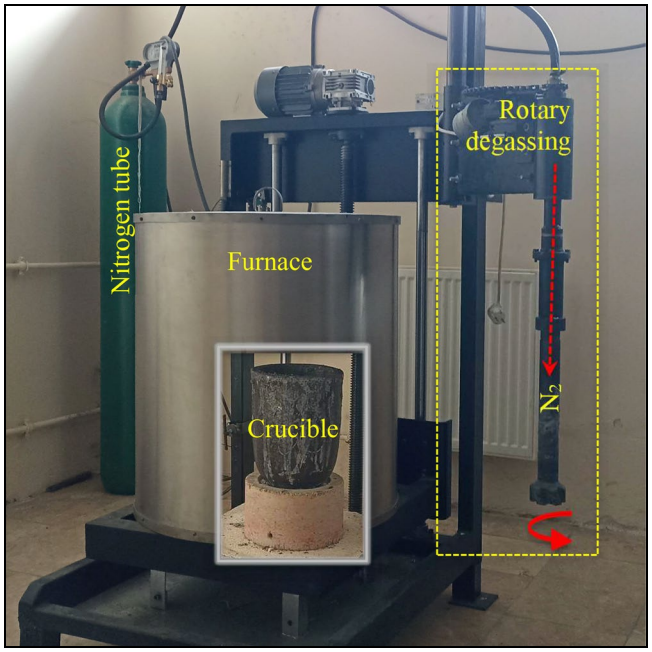

Figure 2. Furnace and rotary degassing process

Castings were made in the spiral flow mold shown in Figure 3 in accordance with the conditions specified in Table 1. The spiral flow mold was heated to 250 °C using a hot plate.

After the casting process in the spiral flow mold, a macro examination was carried out on the samples taken from the mold. A spiral measuring ruler was used at this stage. Sample sizes were measured in millimeters and then compared.

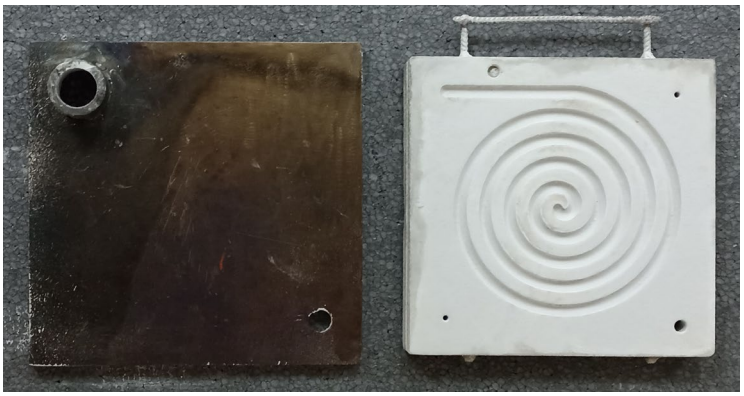

Figure 3. Spiral fluency pattern and visual

3 RESULTS AND DISCUSSION

A356 alloy was melted according to the determined parameters and cast into the spiral flow mold. Photographs of the samples obtained after casting are shown in Figure 4.

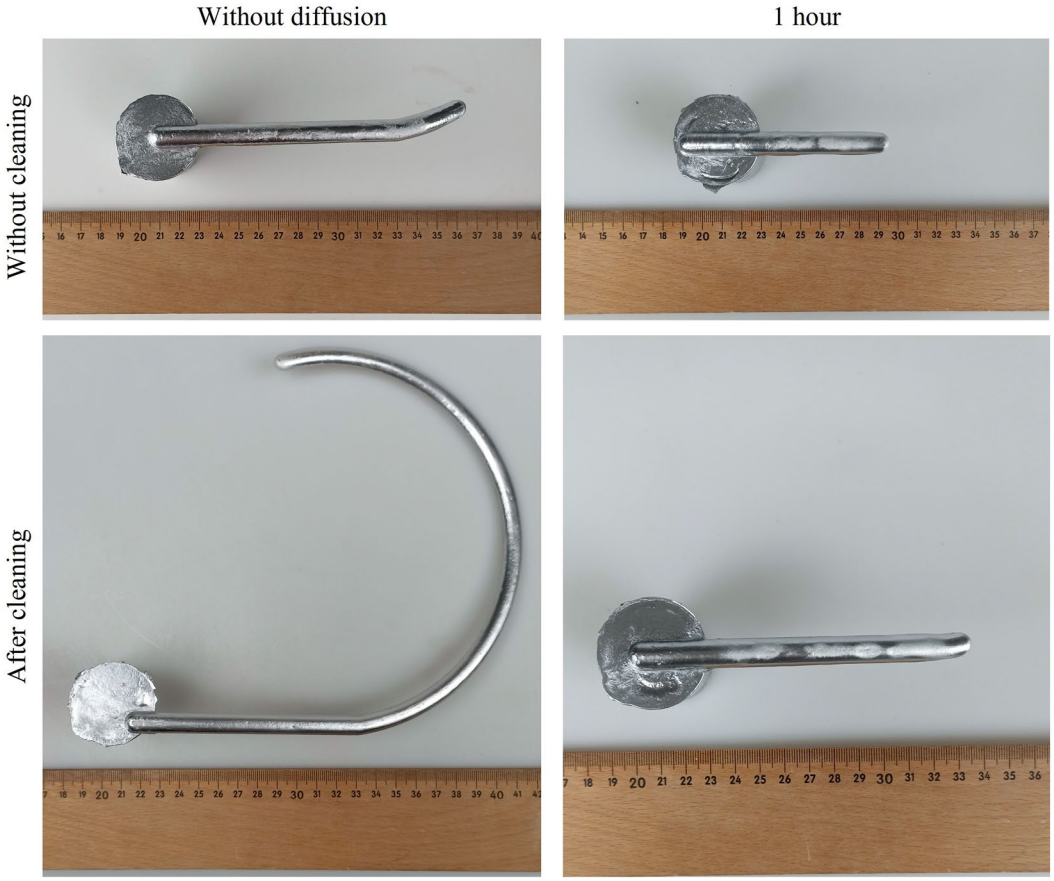

Figure 4. Casting sample photo images

As can be clearly seen in the casting sample pictures in Figure 4, it is understood that both the diffusion and liquid metal cleaning affect the fluidity results. With liquid metal cleaning, it is understood that the liquid metal advances further in the mold in both casting conditions. It is seen that the fluidity properties of the castings made by waiting for the stainless steel bar change negatively compared to the equivalent castings. The measurement results for the liquid metal advancement distances of the cast samples are shown in the graph in Figure 5.

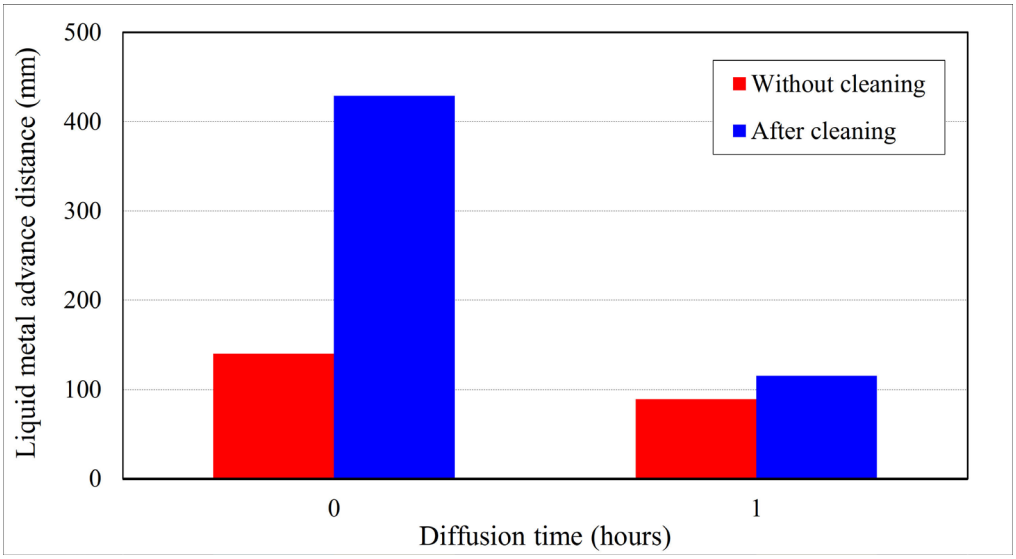

Figure 5. Casting sample liquid metal advance distance measurement results

In Figure 5, the fluidity length obtained in the experiments carried out without liquid metal cleaning in the molten A356 alloy at 750˚C was 140 mm, while it was measured as 89 mm when stainless steel was placed and the diffusion period waited for 1 hour. In the experiments carried out by applying liquid metal cleaning to the molten A356 alloy at 750˚C, the fluidity length was measured as 429 mm, while it was measured as 115 mm when the diffusion period was waited for 1 hour. In the studies carried out within the scope of the subject, it is known that the fluidity and other properties of the alloy can be improved by removing the impurities, oxides, and undesirable elements in the melt of the casting samples with liquid metal cleaning methods by liquid metal cleaning methods [11]. It is thought that applying liquid metal cleaning to the alloy removes the oxides and impurities in the alloy by bringing them to the surface so that the flow of the alloy in the mold is unimpeded and, therefore, the fluidity value increases. When the data were examined in detail, the fluidity changed negatively due to the effect of iron applied to the alloy as a result of diffusion. It is thought that this situation is a Fe transition and that the Fe transition into the alloy reduces the fluidity because it increases the number of intermetallics in the structure.

It is thought that some Fe-based intermetallics are formed in the diffusion-related alloy formed due to keeping stainless steel in molten liquid metal at 750 °C for 1 hour. Since these intermetallics acted as solid particles in the liquid melt, they had a negative impact on the liquid metal progress. In the studies conducted on the subject, it is known that A356 alloy contains β-Al_5FeSi, α-Al_8Fe_2Si, etc., intermetallics due to its Fe content [16, 21-26]. Even if the liquid metal is cleaned, it is understood from the casting result without diffusion that the liquid metal cannot reach a sufficient level despite the improvement in fluidity due to the relevant intermetallic compounds. For this reason, while liquid metal cleanliness is an essential parameter for improving fluidity, it has been determined that it is not sufficient on its own in alloys containing impurities such as Fe. It is thought that a solution should be developed to eliminate the adverse effects of Fe content with alternative methods. In this context, it is thought that keeping the Fe level low to avoid or reduce the effects will be beneficial to minimize the damage. In addition, in case it may come from the materials used for casting, suitable coatings can be applied to all tools used while preparing the melt, and the effects can be reduced with minimum contact.

When the studies are examined, it has been observed that an increase in the Fe (Iron) ratio reduces fluidity, while liquid metal cleaning methods contribute positively to fluidity. Looking at the contributions to the literature, He made different Fe additions by weight to the A380 alloy and observed that increasing Fe content negatively affected the fluidity [27]. In the study conducted by Wang et al., it was reported that an increase in the amount of insoluble Fe-bearing phases in the alloy resulted in a decrease in the fluidity of molten aluminum [28]. In the study of Sabatino et al., it was observed that the Fe element added to the A356 alloy affected the structure and as a result, the fluidity decreased visibly [29]. Rooy emphasized that increasing the iron content of the Al-Si alloy results in a decrease in the fluidity of the alloy [30]. Shebestari et al. emphasized that elements such as Fe and Cu in Al alloys affect the properties of the alloy and that the fluidity of alloys containing Fe decreases [31]. Cao et al. emphasize that increasing the proportions of some impurity elements such as Fe, Cu and Cr, which deteriorate the mechanical properties of aluminum alloys and casting parts, has a negative effect on fluidity [32]. These negativities occurring in the alloy are removed from the alloy by liquid metal cleaning methods and the properties of the alloy are improved [11, 20, 33].

4 CONCLUSION

The results obtained from the study examining the effect of liquid metal cleaning and diffusion and Fe effect on the fluidity of A356 aluminum casting alloy are given below;

- It has been determined that the change in Fe content due to liquid metal cleaning and diffusion is effective on the fluidity in casting A356 alloy.
- It was determined that the liquid metal advance distance measured from the cast samples increased from 140 mm before cleaning to 429 mm after cleaning and from 89 mm to 115 mm in diffusion experiments thought to contain Fe.
- It was understood that Fe diffusing into the alloy due to diffusion negatively affected the fluidity, and although the fluidity increased with the cleaning process, its negative effects continued.
- While liquid metal cleanliness is an important parameter for improving fluidity, it has been determined that it is not sufficient on its own in alloys containing impurities such as Fe.

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Investigation of the Effect of Using Scrap at Different Ratios on Liquid Metal Quality in Casting of A356 Aluminium Alloys

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Abstract

The use of aluminium as a raw material in the foundry industry is in two different forms: i) primary ingot (from ore) and ii) secondary ingot (from the scrap). Considering the energy costs of producing these materials as raw materials, obtaining aluminium from scrap is more cost-effective. However, when using secondary ingot, there are factors such as inclusions, gases, and oxide layers that significantly affect the quality of the liquid metal. Various liquid metal cleaning processes and test methods are used to minimize these factors. In this study, the change in liquid metal quality was examined using the rotary degassing method, which is one of the cleaning techniques. Scrap was added at 5%, 10%, and 15% to the primary A356 aluminium alloy, and castings were performed before and after liquid metal cleaning. K-mold and spiral fluidity test methods were used to evaluate the liquid metal quality. It was determined that rotary degassing significantly changes the quality of the liquid metal.

Keywords: *A356 aluminium, Rotary degassing, K-mold, Spiral fluidity test, Liquid metal quality*

1 INTRODUCTION

Among non-ferrous metals, aluminium alloys are widely used due to their superior physical and mechanical properties [1]. Aluminium casting alloys have properties such as low melting point, castability, good corrosion resistance, and high strength. Due to these features, it has become indispensable in sectors such as the automotive, aerospace, and defense industries [2-4].

Aluminium is found in nature as bauxite ore. Alumina powder is obtained by various ore dressing methods, and primary/pure aluminium is obtained by electrolysis [5]. These processes produce a high energy requirement of ~14500-17000 kWh in primary aluminium production. The energy used in secondary aluminium production by recycling from end-of-life scrap is quite low. In comparison, the energy required for secondary aluminium production is ~5% of primary aluminium [6]. However, some problems are encountered in using secondary aluminium, which has significant advantages in terms of environment and cost. The most important of these is the control of liquid metal quality.

The main objective of using aluminium casting alloys is to obtain solid and high-quality products. Therefore, one of the most important factors to produce solid parts in aluminium casting alloys is the quality of the molten metal [7, 8]. Good liquid metal quality is important for the quality of the casting part. Factors affecting liquid metal quality are inclusions, oxide layers, gases (such as hydrogen), and biofilms [9]. Bifilms affect the mechanical properties, porosity, and fluidity of the alloy, as well as increase the formation of defects such as hot tearing [10]. Bifilms significantly affect the heterogeneous nucleation of various intermetallic phases and Si particles in Al-Si alloys, thus affecting the alloy properties [11]. Another factor affecting the liquid metal quality in aluminium alloys is hydrogen solubility. Dissolved hydrogen has negative effects, such as increasing porosity and decreasing fluidity by increasing inclusions and impurities. As a result of the negative effect on the quality of the liquid metal, cracks, and hard spots may occur in the casting. In addition, it may cause the casting part not to come out as desired, and its mechanical properties may be adversely affected [9, 12-14]. To reduce these effects and increase the purity of the liquid metal, the hydrogen content and inclusions in the alloy must be removed [15-17].

Various liquid metal cleaning processes are performed to improve the liquid metal quality in castings made using secondary aluminium [18-20]. It is important that the method used to improve the liquid metal quality is not only easy to apply but also environmentally friendly. In this context, there are various methods, such as using inert gas and tablets [18, 21]. Various tests are also performed to measure the success of the applied process. These can be listed as thermal (cooling curve) analysis, X-ray method, ultrasonic testing, solidification under vacuum, K-mold,

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electrical resistance test, fluidity test, Prefil, or PoDFA tests. Fluidity and K-mold tests are known as fast and practical methods [22]. The spiral fluidity test is widely used for fluidity testing in casting applications. In this method, liquid metal is poured into a mold consisting of a long, thin spiral path, and the distance the metal can flow is taken as a measure [23]. The K-mold test, which allows easy characterization of larger inclusions, is widely used for real-time testing of macroscopic defects (coarse inclusions, gross oxides, and gas bubbles). These methods allow casting defects and quality to be easily determined [24, 25].

In this study, castings were performed by adding scrap at different ratios to primary A356 aluminium alloy. The rotary degassing method was used for liquid metal cleaning. The change in liquid metal quality was determined by the spiral fluidity test and K-mold test. For these test methods, standardized permanent moulds known as spiral and K-mold were used. Macro-examinations were conducted to investigate how the liquid metal cleaning affects the alloy quality.

2 MATERIAL AND METHOD

Primary A356 ingot and secondary A356 scrap were used as raw materials in the study. Table 1 shows the chemical composition of these materials.

Table 1. Chemical composition of the alloy used in the experiments (wt %)

	Fe	Si	Cu	Mn	Mg	Zn	Ni	Ti	Al
Primary A356 ingot	0.03	7.03	0.02	0.03	0.321	0.04	0.02	-	Rem
Secondary A356 scrap	0.07	7.28	-	-	0.227	-	0.004	0.11	Rem

For the purpose of the study, two different parameters were selected: scrap rate and liquid metal cleaning process. The variation of the scrap rate parameter is 5%, 10%, and 15%, respectively. The other parameter was defined as whether there is a degassing process or not. Depending on these parameters, the sample names were coded as shown in Table 2.

Table 2. Casting sample codes

Sample code	Degassing – Scrap rate	Sample code	Degassing – Scrap rate
WD5	Without Degassing – 5 % scrap	D5	Degassing – 5 % scrap
WD10	Without Degassing – 10 % scrap	D10	Degassing – 10 % scrap
WD15	Without Degassing – 15 % scrap	D15	Degassing – 15 % scrap

The melting process was carried out in a SiC crucible in an electric resistance furnace. In the melting process, A356 scrap was added to the primary A356 aluminum alloy at 5%, 10%, and 15% of the charge weight, respectively. The rotary degassing method was used for liquid metal cleaning. This process was carried out at a five l/min gas flow rate, 300 rpm rotation speed, and 5 min degassing parameters. Casting experiments were carried out at a casting temperature of 720 °C, both with and without degassing. Before casting, the crucible filled with liquid metal was taken from the furnace, and the slag was removed by scraping the surface. The melting and degassing process was carried out with the system shown in Figure 1.

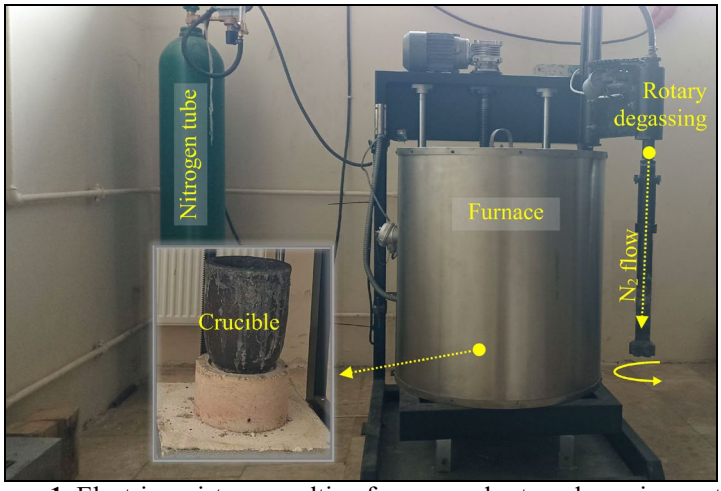

Figure 1. Electric resistance melting furnace and rotary degassing system

Liquid metal prepared with different scrap addition amounts was poured into spiral and K-mold test moulds which are shown in Figure 2. The moulds were heated to 200 °C using a heating plate before casting. The specimens obtained after casting were examined. Specimen length measurements were performed for the spiral test. In the K-mold specimen inspection stage; the sample removed from the mould was broken with a hammer blow from the notched areas. Then, high-resolution photographs of the broken surfaces were taken and examined. All broken part surfaces were image analysed, and total inclusions on the broken surface were counted. The calculation given in Equation 1 determined the quantitative K value depending on the total number of inclusions and inclusions on the fractured surface. In this equation, K is the cleanliness rate of the liquid metal, n is the number of examined fracture surfaces, and S is the number of inclusions in n parts of the sample [21, 25]. According to the K value, information about the cleanliness of the alloy is obtained. According to this; i) If K<0.5, the liquid metal is clean, ii) If 0.5<K<1, the cleanliness of the liquid metal is acceptable, but the liquid metal requires cleaning, iii) If K>1, it indicates that the liquid metal must be cleaned.

$$K = \frac{S}{n} \tag{1}$$

The success rate of the liquid metal cleaning process is determined according to Equation 2 [26-28]. In this equation, ΔK is the percentage change K value, K_1 is the K value obtained before treatment and K_2 is the K value obtained after degassing [28].

$$\Delta K = \frac{(K_2 - K_1)}{K_1} \times 100 \tag{2}$$

Figure 2. Test moulds; a) Spiral mould, b) K-mold

3 RESULTS

Casting specimens were produced at each test parameter using the spiral fluidity test mould shown in Figure 2a. Figure 3 shows images of the specimens removed from the mould after solidification. When the casting samples given in Figure 3 are examined, it is understood that the effects of liquid metal cleaning on fluidity are clearly seen. An increase in sample lengths was detected in all casting experiments where degassing was performed. In addition, it was observed that there was a change in the feed distance of the liquid metal in the fluidity mould with the change in the scrap ratio, and the increase in the scrap amount had a negative effect on the fluidity.

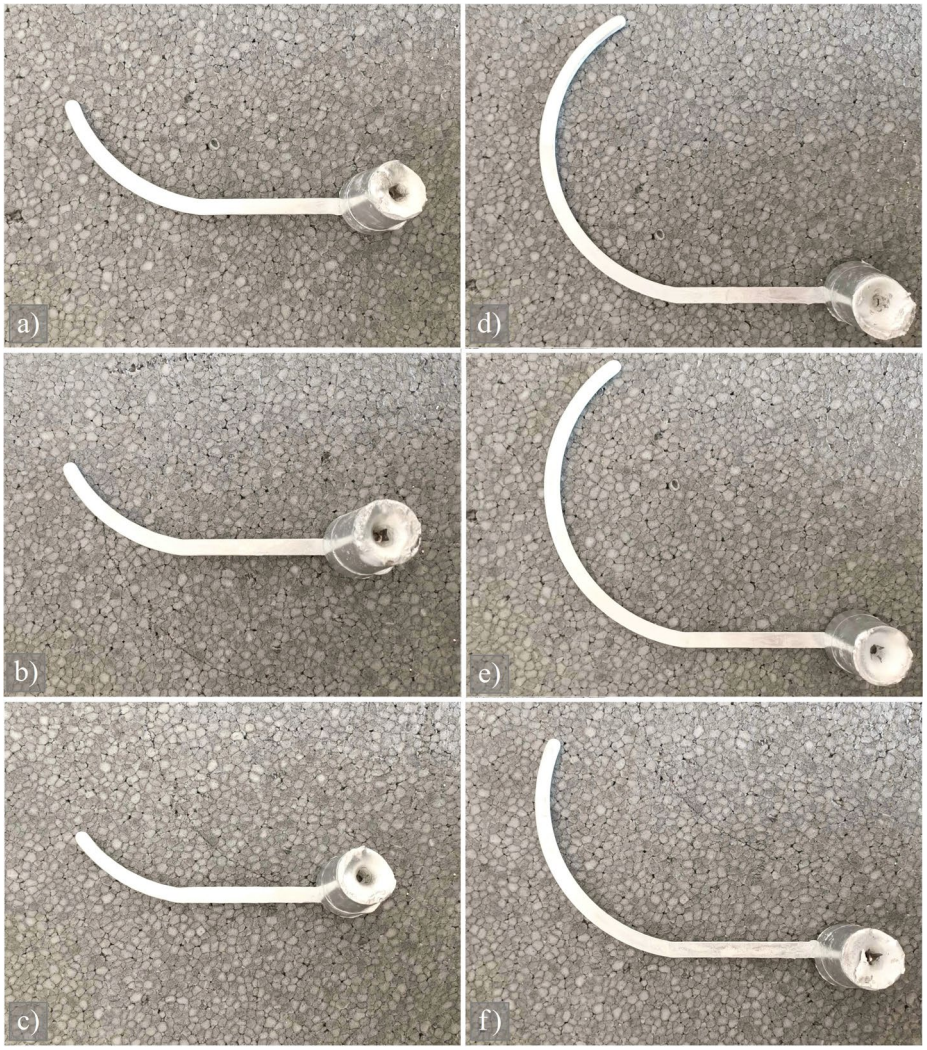

Figure 3. Spiral fluidity test casting samples; a) WD5, b) WD10, c) WD15, d) D5, e) D10, and f) D15

Length measurements were made to compare the spiral fluidity casting samples with numerical data. The graph in Figure 4 shows the change in the dimensions of the spiral fluidity samples. While the advance distance was 178 mm in the WD5 sample, it increased to 339 mm in the D5 sample after degassing. The measurement results of WD10 and D10 samples with 10% scrap addition were 172 mm and 335 mm, respectively. In the WD15 and D15 samples with the highest scrap addition, the fluidity advancement distances were determined as 154 mm and 309 mm, respectively. When the results were evaluated, it was observed that the sample advancement distances decreased with the increase in scrap content. This situation can be explained as inclusions in aluminum alloys, especially bifilm oxide layers, adversely affecting the liquid metal's fluidity. The fluidity of metals is affected by the chemical composition and solidification range of the liquid metal, molding methods, and inclusions (oxides, intermetallic phases, etc.) [26, 27]. The lengths of the degassed specimens are observed to be longer than the untreated specimens. This is also an indication of the suitability of the cleaning process. In addition, the advancement distances obtained after degassing at varying scrap ratios were above 300 mm. This situation indicates that even if scrap is added to the liquid metal, the unwanted residues' damage effects are minimized with an appropriate cleaning process.

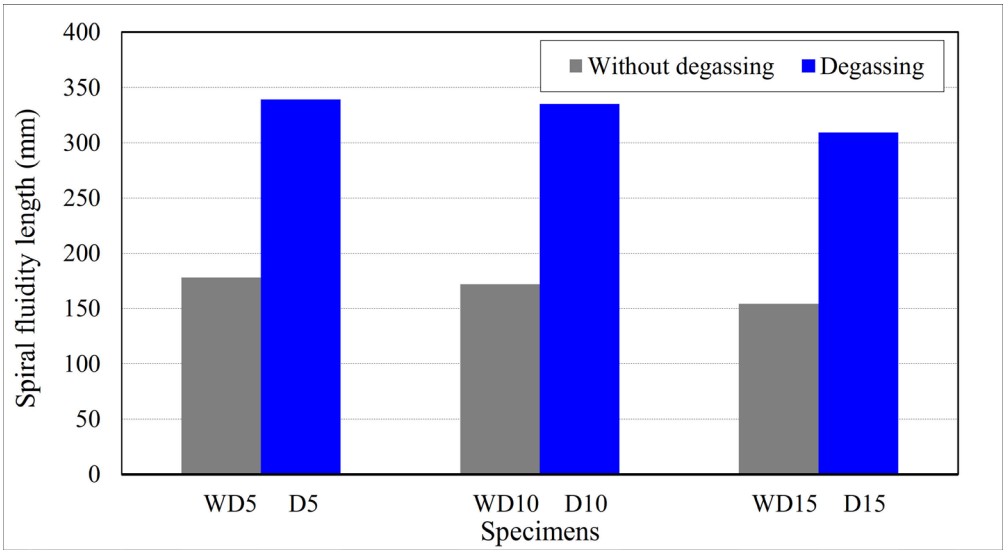

Figure 4. Liquid metal advance distances of spiral fluidity casting samples

High-resolution fracture surface images of the casting samples made to measure the suitability of liquid metal cleaning with the K-mold test are given in Figure 5. The sample surface images show that the inclusions increase with increasing scrap rate on the fracture surfaces. It is observed that the inclusions decrease with the degassing process.

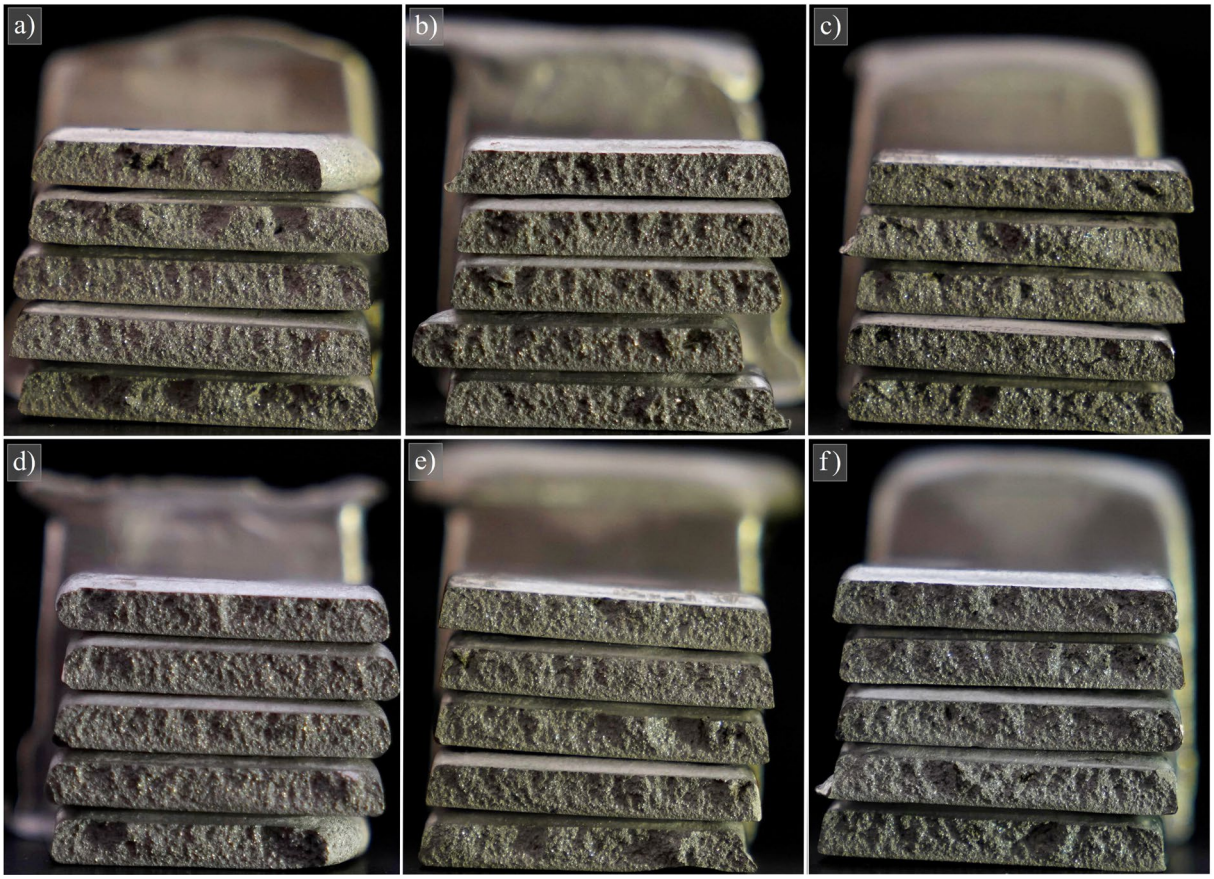

Figure 5. Fracture surface images of K-mold samples; a) WD5, b) WD10, c) WD15, d) D5, e) D10, and f) D15

Figure 6 shows the graph of the change in the K values of the samples as a result of the examination of the fracture surface images. In WD5, WD10 and WD15 samples, it was determined that the number of inclusions increased as the scrap rate increased. When D5, D10 and D15 samples were examined, a significant decrease in the number of inclusions was detected compared to the untreated samples. This is an indication that the degassing process applied is at a sufficient level.

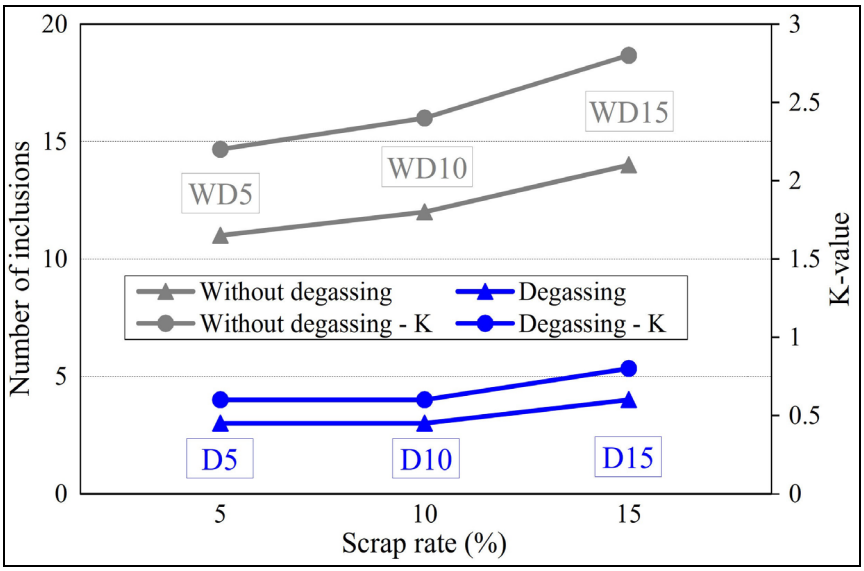

Figure 6. Inclusion and K value data of K-mould samples

Using the data obtained according to Equation 2, the percentage change of the K value was calculated and the results are given in Table 3. This table shows the change in liquid metal quality before and after the degassing process. The ΔK values were calculated as 267 %, 300 % and 250 % for scrap ratios of 5 %, 10 % and 15 %, respectively. This indicates the accuracy of the liquid metal cleaning process and the resulting change rates vary between 250-300 depending on the amount of scrap. The relevant values indicate that the cleaning process applied is sufficient. These results are similar to the spiral fluidity test results.

Table 3. % K value obtained from K-mould samples

Casting test	ΔK (%)
Casting with 5 % scrap addition	267
Casting with 10 % scrap addition	300
Casting with 15 % scrap addition	250

4 CONCLUSION

The results obtained from the experiments carried out within the scope of the study are listed below:

- Depending on the scrap rate used in the preparation of the alloy, liquid metal quality and fluidity properties vary.
- The liquid metal cleaning process increased the amount of metal advancement in the moulds during the casting of the alloy.
- When the scrap addition rate and cleaning processes were compared, the cleaning process at rates up to 15% scrap rate affected the fluidity properties more effectively in the amount of scrap.
- It has been determined that the possible damaging effects of scrap can be eliminated with an appropriate liquid metal cleaning process at scrap rate additions up to 15% in the casting of A356 alloy.
- Although the effects of the cleaning process vary with changing scrap rates, it has been determined that liquid metal cleaning is suitable in all experiments, based on the results of both the spiral fluidity test and the K-mold test.
- It is thought that spiral fluidity and K-mold test techniques can be used to control liquid metal cleanliness, and the related methods can be adapted to production by giving practical and fast results.

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EMI/EMC Tests for Shelters: Safeguarding Against Electromagnetic Interference

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Abstract

In the early 1970s, the impact of electromagnetic interactions on military operations led to substantial material and human losses. Consequently, pivotal developments ensued to mitigate such challenges. Tests were meticulously designed to validate the resilience of system and subsystem electronics within the electromagnetic environment, ensuring their functionality without adverse effects on coexisting devices.

Shelter tests, conducted in adherence to specific standards, employ three distinct measurement models: magnetic, electric, and plane wave. Critical points at specified frequencies guide these tests, with the shelter attenuation value capped at a specified dB limit across all points. The test procedure involves connecting the source antenna to the signal generator and the receiving antenna to the spectrum analyser. Prior to each frequency measurement test, ambient noise is recorded as a reference value. The actual result is derived by subtracting this reference value from the measurement results. It is imperative for antennas to maintain specified distances according to magnetic, electric, and plane wave measurement models when determining reference values.

Electromagnetic Interference (EMI) tests assess the resilience of systems or devices against electromagnetic effects, aiming to prevent harm to the environment. Simultaneously, Electromagnetic Compatibility (EMC) tests scrutinize the resistance of systems or devices to electromagnetic interactions, verifying the absence of parasitic signals. These tests collectively aim to ensure that the tested system or device functions harmoniously with others, without adversely affecting its surroundings. Proactively addressing potential adverse conditions is a primary outcome of these assessments.

Keywords: *Electromagnetic, EMC, EMI, Frequency, Shelter*

1 EMI-EMC

The concepts of magnetic compatibility and magnetic interference, first observed during Marconi's experiments in the late 1800s, facilitated the development of transatlantic communication technology with the aid of cable in the early 1900s. Technical articles on the subject were initially penned in the 1920s, whilst radio frequencies gradually became an escalating concern in the 1930s concerning systems such as engines and railways. EMI emerged as a significant problem during World War 2. The invention and rapid development of transistors in the 1950s, integrated circuits in the 1960s and microprocessors in the 1970s brought to light the need for frequency planning. However, with the advent of digital signalling and integrated circuit technologies, this problem became even more pressing. Subsequently, in 1979, the FCC was established in the USA, which set various standards to address this issue. Moreover, EMI-EMC tests were developed.

Significant accidents and damages caused by electromagnetic compatibility have been observed, and its significance has been more comprehensively acknowledged. One of the most notable examples is the USS Forrestal aircraft carrier accident in 1967 involving the United States armed forces. The MK-32 rocket attached to an aircraft was ignited by electromagnetic interference caused by the ship's radar, resulting in a large fire and unstoppable explosions that claimed 134 lives. An abnormal noise, identified as EMI, triggered the event. Furthermore, 21 aircraft were lost, and property damage amounted to over £500 million, according to current estimates.

1.1 What is Electromagnetic Interference (EMI)?

Electromagnetic interference can be defined as any natural or man-made disturbance or signal at radio frequencies that causes degradation, distortion or malfunction in the performance of electrical and electronic equipment.

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Examples of electromagnetic interference in everyday life include police radios interfering with radio listening, mobile phones interfering with car ABS systems, leakage in printed circuits, and noise on a computer when talking on a mobile phone.

There are 3 conditions for a device to be considered electromagnetic compatible:

- It must not cause interference in itself (self-compatibility).
- Not interfere with other devices.
- Be immune to interference from other equipment.

Electromagnetic interference arises due to the impact of the electromagnetic surroundings on the device. The electromagnetic events that take place in a particular region constitute the electromagnetic environment of that region. The main outcomes of this environment are EMI and EMC. To characterise the electromagnetic environment, two factors need to:

- Frequency / Time
- Amplitude (intensity of electromagnetic energy or its value in terms of voltage-current etc.)

The leading causes of electromagnetic interference are poor quality cables, printed circuit elements, leaks at connection points, resistors, capacitors, inductors, element change, electromechanical devices, digital circuit elements, and mechanical switches.

Grounding is the initial measure that can be taken against EMI to diminish the creation of radio frequency voltages that could produce electromagnetic interference.

The second approach that can be employed is shielding, which isolates a specific area from external electromagnetic interference or prohibits internal electromagnetic interference from leaking out.

Additionally, the bonding method can be used, characterised as an electrical connection between two conductors to minimise electromagnetic interference by ensuring that the reference point is uniform throughout the entire device. The quality of connections and design of a low impedance circuit are crucial factors in this situation.
Cabling is the final solution. This is because the cable directs electromagnetic energy to its intended load. Due to its length, it serves as an effective antenna for both transmitting and receiving EMI noise from the environment.

1.2 What is Electromagnetic Compatibility (EMC)?

Electromagnetic compatibility (EMC) refers to any effect created during the transmission, reception or creation of electromagnetic energy that does not cause electromagnetic interference. Standards specify that EMC is a crucial criterion in the marketing of electronic products. Failure to meet the EMC requirements in a given country prohibits the sale of the product within that country. Due to technological advancements, electromagnetic compatibility is now a critical factor in the design of electronic devices and systems, equivalent to other established design criteria.

Since 1996, EMC standards have become mandatory for electronic devices, necessitating manufacturers to affix the "CE" mark on their products upon successful completion of various tests to facilitate sale. There are numerous civil and military standards, both national and international, in place to ensure electromagnetic compatibility (EMC). These standards determine the levels of electromagnetic energy emitted by a system or device and the energy to which it is exposed in its environment. As per the requirements outlined by the standards, EMC tests are conducted using specified setups and methods. Such tests usually fall under four main categories dealing with two fundamental issues.

In susceptibility tests aimed at observing the level of susceptibility of the device under examination, the test signals produced by an external generator are transmitted to the cables or the device itself through direct contact or a probe. This form of testing is identified as a "Susceptibility by Conductivity" test. If, on the other hand, the same process is conducted through the air and an electromagnetic field is dispatched, the test is referred to as "Sensitivity by Spatial Radiation" testing. At the conclusion of the tests, the device's deterioration and quantity are observed and evaluated in accordance with the established standards.

2 EMI/EMC TESTS FOR SHELTERS

Various tests for electromagnetic compatibility and interference occur at device, platform, and system levels. These criteria are the primary factors that determine the electromagnetic efficiency of the product. There are two important elements in the standards:

- Test limit values.
- Test methods.

There are discrete standards in place for military and commercial devices. EMI-EMC testing comprises two fundamental aspects:

- Emission,
- Sensitivity (Immunity).

2.1 Conducted Susceptibility (CS)

This type of test determines whether unwanted signals transmitted to the device under examination through power and signal cables cause any operational disruption. For the test to be deemed successful, the electromagnetic signal delivered at each frequency defined by the standard must not cause any operational disturbance to the device.

2.2 Radiated Susceptibility (RS)

In these tests, the objective is to assess whether radiation-induced unwanted signals impact the proper functioning of the device under examination. To obtain successful test results, the electromagnetic signals generated at specified frequency limits, as per standard regulations, must not interfere with the device's operation.

The emission of radiation from a device under test is verified by measuring the energy it emits while in operation. This measurement is taken from both the device's antenna for radiation transmitted through air, and from its conductors using a contact or probe for emissions transmitted through physical means. These tests are known as the "Emission by Spatial Radiation" and "Emission by Conductivity" tests, respectively. EMC tests may also include the assessment of natural phenomena such as lightning or electrostatic discharge (ESD).

2.3 Conductive Emission (CE)

These tests measure the level of device emission into the external environment via power and signal cables. To be considered successful, the device emission must remain below the limit value specified in the standard at each frequency.

2.4 Radiated Emission (RE)

In these tests, the level of device radiated emission into the external environment is measured. For the test to be successful, the device's emissions must stay below the limit value stated in the standard for each frequency.

By addressing potential EMC problems at the development stage of devices or systems, the incurred damage, in terms of both time and cost, is minimized. Remedial action against EMI issues varies considerably and requires committed, experienced engineering work. The practical solution to address issues arising from spatial radiation can be summarised as using appropriate distance ranges and shielding. In case of interference caused by electrical conductivity, solutions can be developed using main headings such as efficient grounding, correct connection, and filtering as required.

The relevant tests are conducted in laboratories. Radiated tests may be carried out in an anechoic chamber, or alternately, in an open field for larger devices. When outdoor tests are carried out, a noise-free location is sought, and the environment is measured beforehand to determine the values that can be expected from device measurements. During testing, it is sufficient to utilize the standard measurement table and setup, rather than requiring a specialized room.

It is recommended to commence testing with conductivity tests. In the case of a failed test, any added components may impact previous tests, resulting in a prolonged process. It's worth noting that radiation tests are notably more expensive than conductivity tests. It is recommended to conduct conducted tests prior to radiated tests in order to

ensure greater accuracy. When designing electronic devices for industrial purposes, it is important to consider the inclusion of a filter, as test results must be recorded. Consequently, it would be inappropriate for the device to protrude beyond the opened filter during testing procedures.

The outcome of Conducted tests is unlikely to be significantly impacted by whether the device cover is open or closed. However, even the incorrect tightening of one cover screw during radiated tests may affect the result.

Three measurement models are utilised in accordance with specific standards when conducting shelter tests, namely, magnetic, electric, and plane wave models. To gauge the attenuation value on the shelter, various points, as displayed in figure 1, are selected. These tests are guided by critical points at particular frequencies, and the shelter attenuation value is restricted to a specific dB limit at all points. Technical term abbreviations like 'dB' must be explained upon first usage. The tests require specific environmental conditions: -10/+25 °C temperature range, a maximum of 90% humidity, and an altitude of 8000 feet (above sea level). To begin the test procedure, connect the source antenna to the signal generator, and the receiver antenna to the spectrum analyser. Prior to each frequency measurement, record the ambient noise as a reference point. To calculate precise results, subtract the reference value from the measurement outcomes. When establishing the reference values, the antennas must adhere to the designated distances as per the magnetic, electric, and plane wave measuring models.

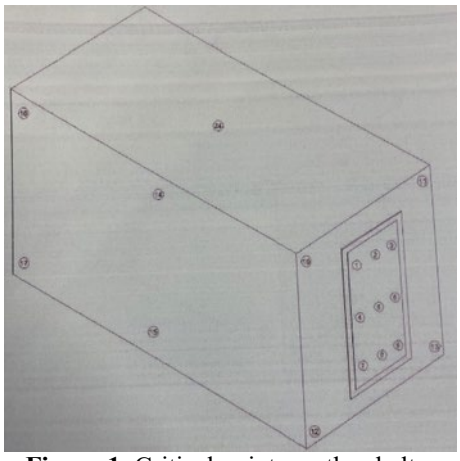

Figure 1. Critical points on the shelter

During testing, a range of equipment is employed, including spectrum analysers, signal generators, and RF power amplifiers, as demonstrated in figure 2. Furthermore, multiple antenna types are utilised, such as loop, monopole, dipole, biconical, and horn.

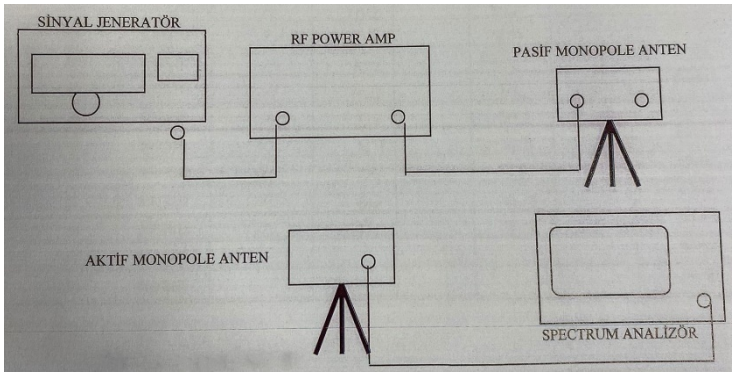

Figure 2. Shelter test setup

The transmitting and receiving antennas are positioned outside the shelter at a distance equivalent to the measurement distance. At the frequency of measurement, the maximum signal level capable of transmission via the antenna is evaluated. The receiving device records the reference signal level as the corresponding level received through the receiving antenna, which is situated inside the shelter alongside the device. The receiving device records the reference signal level as the corresponding level received through the receiving antenna, which is situated inside the shelter alongside the device. Technical abbreviations are explained upon first use. Bias is avoided and language remains elevated and free from deviations from standard sentence structure. Grammar, spelling, and punctuation are correct. The transmitting antenna emits a signal at the recorded level at each

measuring point whilst the signal captured by the receiving antenna in the shelter is noted and recorded by the receiving device. The distance for each measurement point is derived as the distance between the transmitting and receiving antennas. To determine the attenuation of the shelter, the dB differential between the reference signal level and the measured signal level inside the shelter is calculated at the measured frequency.

2.5 EMU Tests in the Military Field

Serious investigation into EMU, now common in commercial applications, first began in the 1930s. Since then, various institutions have established distinct EMU standards to suit their own requirements. However, this has resulted in compatibility issues among these standards, leading to multiple problems for manufacturers. To address this issue, the development of a uniform standard that covers all platforms, such as air and sea, was deemed necessary. The research led to the issuance of MIL-STD-461, 462 and 463 in 1967. MIL STD 461/462 standards have become the most widely used military standards globally. The United States Department of Defence authored these standards, which have now become an internationally recognized standard.

Over time, MIL-STD-462 was merged with MIL-STD-461, and as a result, the latter became the fundamental standard for electromagnetic compatibility testing in military devices and subsystems. The historical timeline of Military electromagnetic compatibility Mil-Std-461 up to the present day is displayed in Table 1.

Table 1. Historical ranking of Mil-Std 461

MIL-STD-461	Electromagnetic Interference Characteristic Requirements for Equipment – 31 Jul. 1967
MIL-STD-461A	Electromagnetic Interference Characteristic Requirements for Equipment – 1 Aug. 1968
MIL-STD-461B	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference – 1 Apr. 1980
MIL-STD-461C	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference – 4 Aug. 1986
MIL-STD-461D	Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility – 11 Jan. 1993
MIL-STD-461E	Requirements for the Control of Electromagnetic Interference Characteristics of Sunsytems and Equipment – 20 Aug. 1999
MIL-STD-461F	Requirements for the Control of Electromagnetic Interference Characteristics of Sunsytems and Equipment – 10 Dec. 2007
MIL-STD-461G	Requirements for the Control of Electromagnetic Interference Characteristics of Sunsytems and Equipment – 11 Dec. 2015

3 RESULTS

EMI tests are conducted to gauge the system or device's resistance to electromagnetic effects and prevent environmental damage. The tests are performed to ensure harmonious operation with other systems and devices, and to prevent any adverse impact on the environment. EMC tests determine if the system or device is immune to electromagnetic interference and if it emits interference. Additionally, conductivity tests pertain to the magnetic field whilst radiation tests relate to the electric field.

4 CONCLUSION

Electromagnetic signals are applied to the system or devices at a specified frequency in compliance with the relevant standards, and the resulting reactions are observed in these tests. This approach helps to avert potential negative consequences.

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Malaysian Public Perception on Health Effects of 5G Electromagnetic Field (EMF) Emissions

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Abstract

The widespread implementation of sophisticated wireless networks is critical in order to facilitate Internet of Things applications, low-latency communication, and broadband connectivity. However, amidst the COVID-19 pandemic, there exists a substantial volume of misinformation and ambiguity concerning the potential health implications of fifth-generation (5G) cellular networks. Misconceptions and false information regarding 5G in Malaysia have the potential to sow panic and erode public confidence, which could result in postponements in the implementation of 5G technology. Understanding how the Malaysian public perceives the health effects of 5G electromagnetic fields is vital for network infrastructure and devices. We conducted research on the perceptions of the Malaysian public regarding the health effects of electromagnetic field (EMF) emissions from 5G networks. The objective of this study is to determine how the Malaysian public perceives the health implications of 5G radiation emissions in Malaysia. The research investigated aspects of public comprehension, such as health-risk attributes, by considering individuals' perceptions of electromagnetic field (EMF) emissions originating from network infrastructure and consumer premise equipment. Over half of the respondents (56.6 percent) out of 410 total respondents were concerned about 5G, with the potential health effects of 5G radiation being the greatest concern, according to the study (69.4 percent). A potential explanation for the fact that the majority of respondents perceived low to moderate levels of 5G radiation exposure could be their confidence in policies that shield them from 5G EMF radiation. According to the majority of respondents (77.1 percent), public policies offer protection against EMF exposure. Those who perceived high levels of 5G radiation exposure, on the other hand, were more likely to have health concerns regarding 5G.

Keywords: *5G, Public perception, Health effects, Radiation, Electromagnetic field*

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Sign-Ambiguity-Free Extraction of Permittivity of Materials from Reference-Invariant Expressions

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Abstract

We propose an approach for unique complex permittivity (ε_r) extraction of dielectric materials using reference-plane-invariant expressions with no-sign-ambiguity. Toward this goal, the closed-form expression for T^2 is first derived, and then ε_r is retrieved. The proposed formalism is tested using X-band scattering parameter measurements of polypropylene and polyvinyl chloride samples arbitrarily located into a waveguide measurement cell. A good agreement between our method and another tested reference-plane-invariant method is observed.

Keywords: *Reference-invariant, Closed-form, Sign-ambiguity*

1 INTRODUCTION

For broadband electromagnetic characterization of materials, transmission-reflection methods are widespreadly used [1]. In some applications the sample does not fit to the whole measurement cell, and thus reference-plane and measurement-plane do not overlap. This circumstance introduces errors if reference-plane-invariant expressions are not employed in the extraction of electromagnetic properties. Various reference-plane-invariant transmission-reflection methods have already proposed in the literature [1-6]. However, these methods require direct application of the passivity condition to eliminate a sign-ambiguity which appears in the expressions. In this letter, we present closed-form expressions for reference-plane-invariant and sign-ambiguity-free determination of complex permittivity (ε_r) of dielectric materials without directly enforcing the passivity condition.

2 THEORY

Fig. 1(a) shows the configuration of a sample with length L arbitrarily positioned within its measurement cell (a waveguide section). The reference-planes (RP_1 and RP_2) do not coincide with the measurement-planes (MP_1 and MP_2). The distances between RP_1 and MP_1 and between RP_2 and MP_2 are denoted by L_{01} and L_{02}. Assuming the dominant mode propagates toward the sample and applying boundary conditions, one can derive the forward and backward reflection and transmission scattering (S-) parameters at R_{P1} and R_{P2} [1, 4].

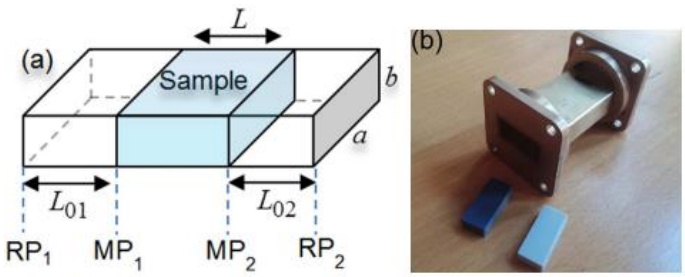

Figure 1. (a) Sample arbitrarily positioned inside its measurement cell and (b) photos of the X-band measurement cell (L_{air} = 60.36 mm), machined polypropylene sample (L = 5.10 mm – light grey color) and polyvinyl chloride sample (L = 5.18 mm – black color)

$$S_{11} = R_{01}^2 \frac{\Gamma\left(1-T^2\right)}{1-\Gamma^2 T^2}, \qquad S_{22} = R_{02}^2 \frac{\Gamma\left(1-T^2\right)}{1-\Gamma^2 T^2}, \tag{1}$$

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$$S_{21} = S_{12} = R_{01}R_{02}\frac{T\left(1-\Gamma^2\right)}{1-\Gamma^2T^2}, \qquad R_{01(2)} = e^{-ik_0\kappa L_{01(2)}}, \tag{2}$$

$$T = e^{-ik_0\sqrt{\varepsilon_r-\lambda_n}L}, \qquad \Gamma = \frac{\kappa-\sqrt{\varepsilon_r-\lambda_n}}{\kappa+\sqrt{\varepsilon_r-\lambda_n}}, \qquad \kappa = \sqrt{1-\lambda_n}. \tag{3}$$

Here, $\lambda_n = \lambda_0^2/\lambda_c^2$; $k_0 = 2\pi/\lambda_0$; k_0 is the free-space wavenumber; λ_0 and λ_c are the operating and cutoff wavelengths; T and Γ are the transmission factor and first reflection coefficient of the sample; $\varepsilon_r\left(=\varepsilon_r^{'}-i\varepsilon_r^{''}\right)$ is the complex permittivity of the sample; $e^{+i\omega t}$ is taken as the time-reference; and R_{01} and R_{02} are the transformation factors.

Following the procedure [1], ε_r is extracted as follows. Using the following variables

$$A = \frac{S_{11}S_{22}}{S_{21}S_{12}}, \qquad B = e^{+2ik_0\kappa\left(L_{air}-L\right)}\left(S_{21}S_{12}-S_{11}S_{22}\right), \tag{4}$$

where L_{air} is the length of the cell, one can obtain

$$\Gamma^2_{(1,2)} = -C\mp\sqrt{C^2-1}, \qquad C = \frac{A\left(1+B^2\right)-\left(1-B\right)^2}{2AB}, \tag{5}$$

The sign-ambiguity problem for Γ^2 in Eq. (5) can be resolved by applying the passivity condition $\left|\Gamma^2\right|\le 1$ [1]. Once Γ^2 is found from (5) by using the constrain $\left|\Gamma^2\right|\le 1$, the value of T can be calculated from

$$T = \frac{S_{21}}{S_{21}^0}\left(\frac{1+\Gamma^2}{1+B\Gamma^2}\right)e^{-ik_0\kappa L}, \tag{6}$$

where S_{21}^0 is the transmission S-parameter of the empty cell. Finally, ε_r is calculated from

$$\varepsilon_r = \left[\frac{i\ln\left(T\right)\mp 2\pi m}{k_0L}\right]^2+\lambda_n, \tag{7}$$

where m is the branch index ($\cdots, -1, 0, 1, \cdots$) and ln(*) is the natural logarithm of '*'.

Now we propose our sign-ambiguity-free formalism for unique and closed-form extraction of ε_r. Toward this end, we apply the formalism in [7] and determine $\Gamma^2 = e^{-(a+ib)}$

$$\Gamma^2 = \left[\cosh\left(\alpha\right)-\sinh\left(\alpha\right)\right]\left[\cos\left(b\right)-i\sin\left(b\right)\right], \tag{8}$$

$$\cosh\left(\alpha\right) = \sqrt{0.5\left(\left|C\right|^2+\left|\sqrt{C^2-1}\right|^2+1\right)}, \tag{9}$$

$$\sinh\left(\alpha\right) = \sqrt{0.5\left(\left|C\right|^2+\left|\sqrt{C^2-1}\right|^2-1\right)}, \tag{10}$$

$$\cos\left(b\right) = \kappa_1\sqrt{0.5\left(\left|C\right|^2-\left|\sqrt{C^2-1}\right|^2+1\right)}, \tag{11}$$

$$\sin(b) = \kappa_2 \sqrt{0.5\left(-|C|^2 + \left|\sqrt{C^2-1}\right|^2 + 1\right)}, \tag{12}$$

where $\kappa_1 = \text{sign}\left(\Re e\{C\}\right)$, $\kappa_2 = \text{sign}\left(\Im m\{C\}\right)$, and sign(*), $\Re e\{*\}$, and $\Im m\{*\}$ denote, te, respectively, the sign, real part, and imaginary part of the quantity '*'. Once Γ^2 is determined uniquely from (8), T and ε_r can be found from (6) and (7), respectively.

It is noted that the formulation in [7] was applied for unique propagation constant (or T) determination of transmission lines. Here, we extent this study and apply this formalism to the first reflection coefficient (Γ^2) to determine unique ε_r extraction of dielectric materials using reference-plane-invariant expressions without any sign-ambiguity.

3 MEASUREMENT

A general purpose X-band (8.2-12.4 GHz) measurement setup [8] was used to test the accuracy of our proposed method. A portable vector network analyzer (VNA) from Keysight Instruments with model N9928A was functioned to generate electromagnetic signals and detect S-parameters. The well-known TRL calibration was applied to calibrate the setup. A waveguide section with length 10.16 mm was used as the line standard which produces a maximum $\mp 70^o$ offset from 90^o. A short-termination (with higher reflectivity) was used as the reflect standard. Then, we monitored the magnitudes of S_{11}, S_{21}, and S_{11}^s of the thru connection with/out short termination. It is noted that $|S_{11}| < -40$ dB and $|S_{21}| < -0.03$ dB. S-parameters at 1001 frequency points in X-band were measured.

Two different low-loss dielectric samples (polypropylene with L = 5.10 mm and polyvinyl chloride with L = 5.18 mm) were used for validation of our formalism. In the measurements, both samples were first arbitrarily positioned into an X-band measurement cell (a waveguide straight) with L_{air} = 60.36 mm. Fig. 1(b) demonstrates the photos of the machined dielectric samples and the measurement cell. Then, calibrated S-parameters were recorded for processing without knowing L_{01} and L_{02} values. Finally, we applied our formalism by first calculating Γ^2 from Eqs. (8)-(12), then T and ε_r of both samples from Eqs. (6) and (7). For the evaluation of unique m, we applied the phase unwrapping technique [9]. For validation of our formalism, we also extracted ε_r of both samples using the method in [1]. For this method, the phase unwrapping technique [9] was also utilized.

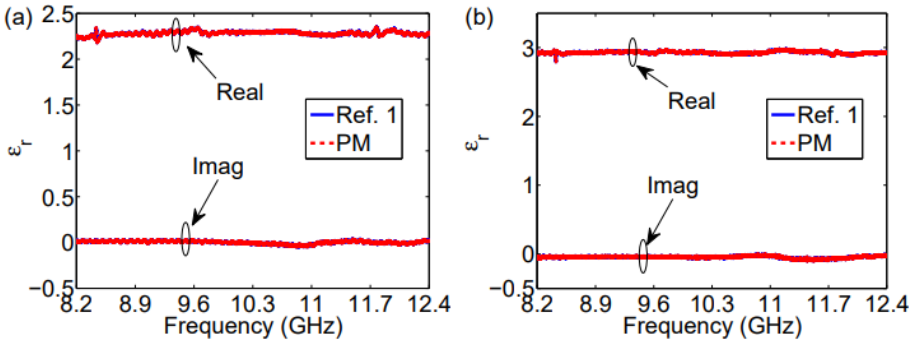

Figure 2. Measured ε_r of (a) the polypropylene sample (L = 5.10 mm) and (b) the polyvinyl chloride sample (L = 5.18 mm) by the proposed method (denoted by 'PM' and shown by red-dashed curve) and the method in [1] (denoted by 'Ref. 1' and shown by blue solid curve) [measured ε_r values of both samples by our method and the method in [1] overlap]

Figs. 2(a) and 2(b) illustrate real and imaginary parts of measured ε_r of both samples using our proposed method (denoted by 'PM') and the method [1] (denoted by 'Ref. 1'). It is seen from Fig. 2 that extracted ε_r by our proposed method (shown by a dashed curve with red color) is in good agreement with the extracted ε_r by the method [1] (shown by a solid curve with blue color) [their dependencies in Fig. 2 overlap]. In addition, extracted ε_r by our

method and the method in [1] are also consistent with the measured ε_r with a dielectric resonator [10] ($\varepsilon_r \cong 2.26 - i0.0004$ around 9.4 GHz for the polypropylene sample and $\varepsilon_r \cong 2.71 - i0.008$ around 11.0 GHz for the polyvinyl chloride sample).

4 CONCLUSION

Our proposed method can be used to extract accurate ε_r of dielectric materials from reference-plane-invariant expressions without requiring the direct application of the passivity condition.

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8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023

December 1-3, 2023

Synergistic Use of Optical and Synthetic Aperture Radar Data for Improving Land Cover Classification: A Case Study for Munich

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Abstract

The multi-sensor data approach in Earth observation provides several advantages in improving land cover classification accuracy. All-weather availability and sensitivity to target geometric structure become Synthetic Aperture Radar (SAR) data inevitable for mapping and monitoring the Earth surface, especially for the tropical regions. The multispectral (i.e. optical) and SAR data provide complementary information to one another. In this research, the synergistic use of Sentinel-1 SAR and Sentinel-2 multispectral data has been investigated for improving the accuracy of land cover classification using Gaussian Naive Bayes (GaussianNB) and Light Gradient Boosting Machines (LightGBM). In the experimental setup, the 30% of ground truth dataset (obtained from [1]) selected as training set (randomly) and the remaining parts were selected as testing set. The experimental results demonstrated that synergistic (combined) use of Sentinel-1 SAR and Sentinel-2 multispectral data improved the classification accuracy compared to that obtained using only optical or SAR data. The highest classification accuracies were obtained as 79.32% and 78.58% by LightGBM for the combined use of sensors and Sentinel-2, respectively. The classification accuracy was improved by 19.42% and 3.92% using GaussianNB and 25.92% and 0.74% using LightGBM for the Sentinel-1 and Sentinel-2, respectively. Furthermore, Sentinel-2 multispectral data outperformed Sentinel-1 SAR data in obtaining higher land cover classification accuracy in this experimental research.

Keywords: *Remote sensing, Machine learning, Computer vision, Information processing*

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mTTTbot: Multiple Style Table Tennis Trainer & Ball Launcher Robot

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Abstract

Table tennis is a sport that demands quick thinking and rapid physical agility. Athletes in this sport must undergo extensive practice to develop muscle memory and master their desired shots. Success in table tennis relies heavily on repetitive training. The objective of this paper is to create an affordable table tennis ball-launching robot capable of delivering balls to various locations on the table with different shot combinations to support the player's skill development. Throughout this paper, we have successfully developed and tested a table tennis robot with the input and feedback from table tennis players. Unlike many existing table tennis robots that rely on wired control panels or dedicated tablet computers, our focus has been on simplifying the control process. To achieve this, we've developed a user-friendly mobile application for controlling the robot. This mobile app allows players to connect to the robot using their smartphones, granting each player the flexibility to work with the robot based on their individual training programs in shared practice spaces. Additionally, we've implemented a feature where a coach can send the player's training program in TXT format to be loaded onto the robot. This enables players to fine-tune their technique and skills as per the guidance of their coach. Our robot's capabilities encompass a wide range of ball placements, including up-forward or down-forward motion in the pitch direction and left-forward or right-forward motion in the yaw direction. The head containing the launcher motors can perform roll movements, positioning the motors horizontally, diagonally, or vertically, which in turn facilitates the execution of nearly all types of spin and slice shots. This dynamic and adaptable training tool is designed to take the training and skill development of table tennis players to new heights.

Keywords: *Ball launcher, Training, Robots, Sports technology*

1 INTRODUCTION

Table tennis, also known as ping pong, is a widely practiced sport worldwide. The first world championship in table tennis was held in 1926 in London, and since 1988, it has been an Olympic sport [1]. The popularity of table tennis as a sport can be attributed to its small playing area, the ability to be played in almost any environment, and its simple equipment requirements, which include two rackets, a table, a net, and a ball. Due to its fun nature and the benefits it offers for physical activity and a healthy lifestyle, table tennis is played by an increasing number of people every day [2]. Managed by the International Table Tennis Federation (ITTF), table tennis is played by millions of male and female athletes of all ages. In this sport, the athletes hit the ball with a racket and throws it to the opposite part of the table. These shots are referred to by different style names, including forehand/backhand push, forehand/backhand drive, flat, spin, slice, etc. Athletes should be capable of making shots in various styles and also be able to return balls in different styles. Table tennis is a sport that requires maximum hand-eye coordination and playing it helps enhance this coordination as it is played [3]. Due to this characteristic, other sports also incorporate table tennis training into their athlete development programs. Athletes who play table tennis need to improve qualities such as agility, acceleration, deceleration, quick movement, and balance, which are essential skills for them to make their best shots [4]. Multiple ball training is a common training method in this sport, requiring players to repeatedly make shots and respond to balls with the appropriate footwork combination [5]. Using a table tennis ball launcher for multiple ball training can be highly effective in improving an athlete's conditioning [6]. Coaches constantly have athletes train in a certain style to help them improve their skills. It can take months or even years of practice to specialize in a specific style. These training sessions usually require the presence of either a coach or another player to practice with the athlete. To accelerate the development of table tennis athletes, there is a need for ball-throwing robots that can closely simulate the shots of real players. These robots are expected to meet the player's expectations for trajectory, speed, spin, and height on the table. Currently, the high prices of table tennis ball throwers on the market make it difficult for athletes to access this technology. Furthermore, throwers using wired control systems can create cable clutter in the playing area and are susceptible to technical malfunctions over time.

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Moreover, some common problems with table tennis ball launchers include poor stability, limited functionality, and restricted ball delivery due to manual feeding units. In the presented study, as shown in Figure 1 a table tennis ball thrower has been developed to address these issues.

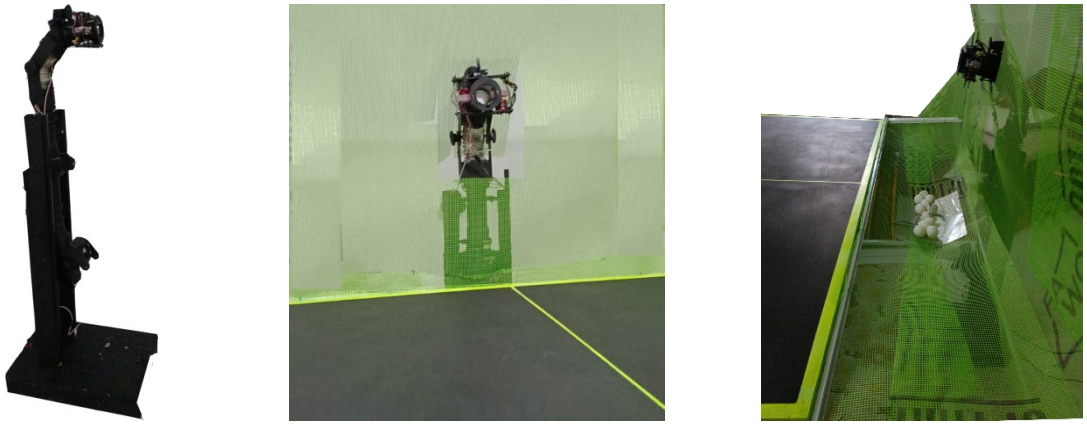


Figure 1. The developed mTTTbot viewed from different angles

2 RELATED WORK

In today's world, various technologies have been developed to accelerate the development of athletes and enable individual training. These technologies include motion sensors attached to the athlete's body, systems that use image processing to analyze movements and strokes, and robotic ball launchers, to name just a few. Peter B. and colleagues presented a sensor-based table tennis stroke detection and classification system. In their study, they collected data on athletes' stroke styles using inertial sensors attached to the racket [7]. Ruichen L. et al. analyzed table tennis players' stroke data using artificial intelligence and sensors placed on the athletes' bodies [8]. Additionally, many studies have been conducted on athlete development analysis using deep learning and IMU sensors [9, 10]. Many technological studies on table tennis focus on image processing and artificial intelligence-based trajectory prediction [11, 12]. Especially in robot applications with robotic arms, trajectory prediction systems have been developed to predict the position, speed, and spin direction of the ball. These algorithms take into account factors such as gravity, air resistance, the Magnus effect, and elastic collisions in predicting the trajectory of the ball [13]. One of the technologies developed for athlete development is table tennis ball launchers. Alexander Dittrich and colleagues introduced AIMY, a system with 5 degrees of freedom, allowing balls to be launched to desired target locations with desired orientation and spin [14]. The table tennis ball launcher developed by Mastaneh M. and colleagues can analyze players' performance in real-time using ball tracking technology. [15].

3 MATERIAL AND METHOD

In this study, the developed table tennis ball launching robot was primarily produced in four stages. The basic flowchart of the robot can be seen in Figure 2.

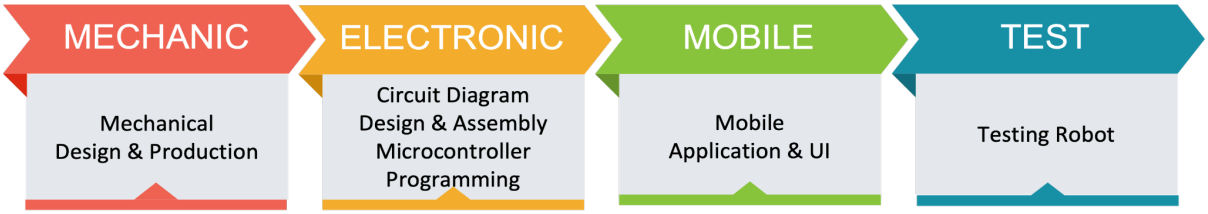


Figure 2. Table tennis ball launcher robot production flow diagram

3.1 Mechanical Components

The mechanical components of the robot with 5 degrees of freedom were initially modeled and simulated in 3D. The mechanical components are divided into the following sections:

- Launcher Module
- Roll Joint
- Yaw Joint
- Pitch Joint
- Launcher Channel
- Ball Feeder
- Reservoir Stirrer
- Reservoir Channel
- Ball Collection Net
- Robot Controller Unit

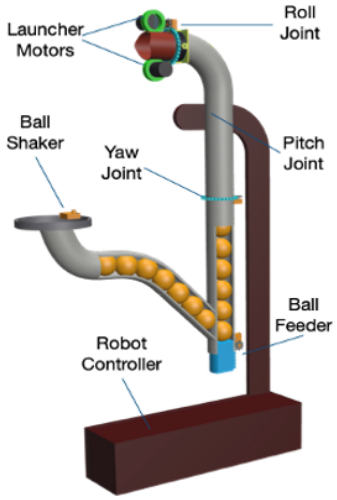


Figure 3. Launcher robot 3d model

Launch Unit: It consists of two brushless motors connected to two silicone wheels with a hardness of 10 shore. The wheels connected to the motor shafts are attached 180 degrees apart on the same axis. The upper motor rotates clockwise, while the lower motor rotates counterclockwise, propelling the ball towards the table. When the motors rotate at the same speed, a straight shot can be made, but by creating a speed difference between the motors, the ball can be made to spin in a predetermined direction around its axis. This spinning action is referred to as "spin" in table tennis literature.

Roll Joint: This joint is located at the top of the launch unit, where it connects to the elbow. It consists of a servo on the elbow side and a pinion gear connected to a servo shaft, along with a spur gear on the launch unit. The servo motor on the roll joint allows the launch unit to be positioned at 0, 45, and 90-degree angles, determining the type of spin to be applied to the ball.

Pitch Joint: The pitch joint, where the carrier arm connects to the robot, comprises a gear mechanism and a servo motor. This joint allows the launch head to move up and down by 6-20 degrees, determining the distance at which the ball will land on the table. Thus, the robot can serve to both halves of the table, the side close to the robot and the other side.

Yaw Joint: This joint allows the launcher to be positioned to the right and left through a servo motor and gear mechanism, determining the horizontal position where the ball will land on the table. The initial position of the launcher head is 0 degrees, and it can move -12 and +12 degrees.

Launch Channel: It is the PVC pipe section from the ball feeder to the launch module. Each ball received into the system is stacked one above the other in this channel and then transferred to the launch module.

Ball Feeder: The ball feeding unit consists of a servo motor system with a crank mechanism to feed balls to the launcher motors. The ball feeding unit keeps the channel filled with balls up to the launch head. When a launch command is received, it takes a ball from the reservoir channel and moves it up to the launch channel. This way, the topmost ball is launched to the table by the ball launcher block.

Reservoir Channel: This is the helical channel located between the reservoir and the ball feeding mechanism.

Ball Collection Net: The balls launched by the robot are sent back to the robot by the player's hits. The collected balls in the ball collection net are transferred to the reservoir.

Reservoir Stirrer: The balls accumulated in the reservoir can jam and block the channel. To prevent this, a reservoir mixer module has been developed. This module consists of a geared DC motor, a mixing arm attached to the motor shaft, and an optical obstruction detection sensor. It activates during blockage situations, ensuring a smooth flow of balls in the reservoir channel.

3.2 Electronic Components

All electronic hardware and the power supply that control the robot are located in the robot control unit. The robot control unit receives commands from the athlete's phone via Bluetooth and signals from sensors on the robot. It processes this data and commands through the microcontroller on the control board to control the actuators and mechanisms on the robot. The control unit includes DC motor drivers and brushless motor ESC drivers. The SMPS power supply on the control unit converts the 220V mains voltage to 12V, providing the power needed for the robot. The block diagram of the control unit is shown in Figure 4.

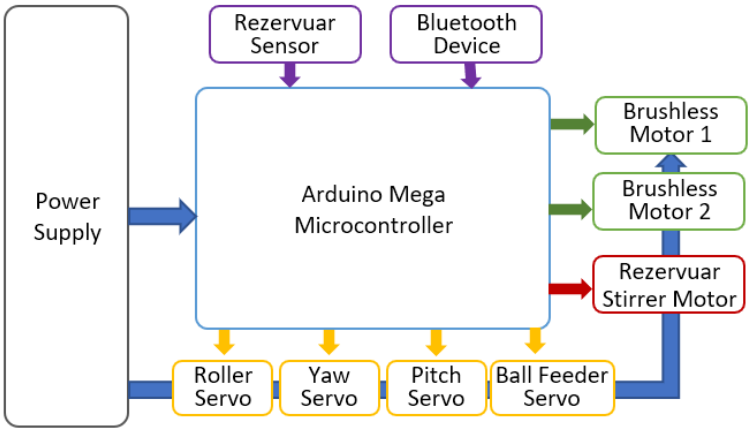
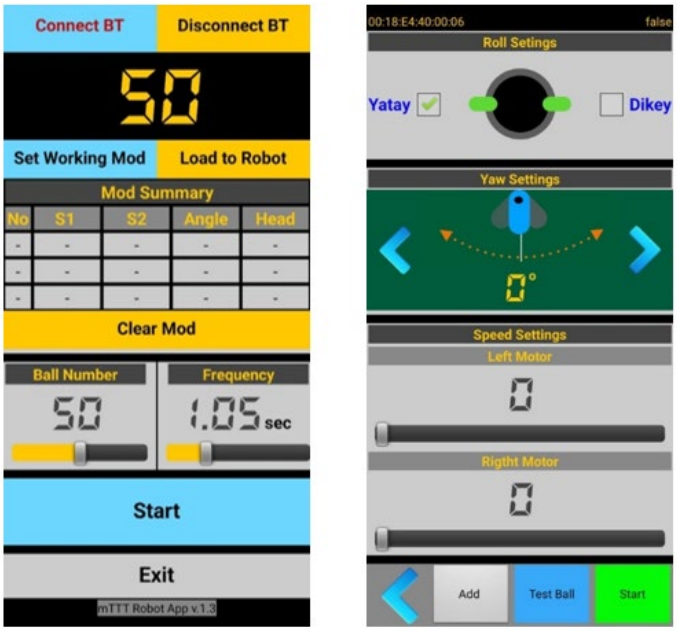


Figure 2. Robot control unit block diagram

3.3 Mobil Application

All controls for the robot are performed through the mobile application developed for this paper. The application is compatible with all tablets and mobile phones that use the Android operating system. The developed application consists of a home page and a mode preparation page. The home page features Bluetooth connection and disconnection buttons. When the "Connect" button is clicked, nearby Bluetooth devices are listed, and a connection is established with the selected device from the list. The last connected Bluetooth device is stored in the robot's memory, so if the robot is turned on, it automatically connects to this Bluetooth device. The "Prepare" button leads to the mode preparation screen. On this screen, a summary of the prepared shots is listed in the mode summary table. The "Load" button is used to load the prepared mode summary to the robot. The "Clear" button is used to delete the mode summary. While running with the loaded mode on the robot, the number of balls to be thrown by the robot and the ball frequency are determined using sliders. The "Start" button launches the balls according to the set parameters, and a display above shows the remaining number of balls in real-time. The “Exit” button terminates the application.

In the set working mod screen, the initial setting is the spin and cut position adjustment. In this setting, the launcher head is rotated by 45 degrees using checkboxes, either horizontally at 0 degrees, vertically at 90 degrees, or both horizontally and vertically. Horizontal is selected for left-spin and right-spin, while vertical is selected for topspin and backspin. Both options can be combined to perform cross-positioned shots, such as left-top, left-back, right-top, and right-back spins. After each selection, the application sends the roll angle to the robot, and the robot positions the launcher head accordingly. In the horizontal position adjustment section, the robot is rotated by -12 and +12 degrees using the left and right arrows, so that the robot's center will be at 0 degrees concerning the table. The position information is sent to the robot with each press of the right and left buttons, and the yaw servo positions the robot accordingly. In the speed adjustment section, the speeds of motor 1 and motor 2 are sent to the robot using slider bars. When the sliders move, the motors start to rotate at the specified speeds. By pressing the "Test Ball" button, a command to launch a ball is sent to the robot. The robot's ball feeder servo advances one ball and the topmost ball is launched to the table. These settings are repeated until the desired position is achieved. When the desired area, speed, and spin style are appropriate, the "Add" button is pressed to add the mode to the list. Up to three different shots can be added to the list. By using the "Start" button, periodic shots to a single point can be performed in this screen. Pressing the back button returns to the main working screen.



(a) (b)

Figure 3. Developed mobile application screenshots. (a) Main screen and (b) working mode preparation screen

3.4 Testing and Measurement

In evaluating the table tennis ball launching robot's performance, the rate of ball delivery to the desired point on the table with the specified style and speed is examined. This assessment is typically performed with systems that have high FPS cameras and systems that process images from these cameras in trajectory analysis. In this study, we covered the table with a thin layer of sand approximately 1 cm thick to determine the point where the ball landed. This way, by physically measuring the starting point of the mark left by the ball launched by the robot, we could determine the position where the robot-launched ball hit the table. We performed 40 shots to five different targets on the table, each with horizontal and vertical launcher positions separately. The speed of the motors was set equally for these shots, and they were straight shots without spin. A total of 400 balls were launched to five different targets in two different roll positions, and the positions of the marks left by these balls on the sand were recorded.

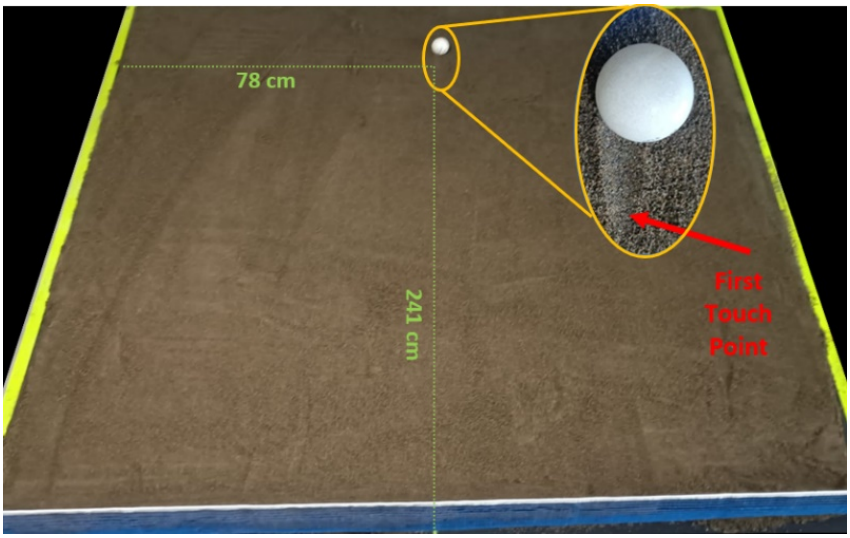


Figure 4. Sand coating on the table and ball mark detection. Ball position measurement recording process

The averages of both the horizontal and vertical positions of the 40 balls in each target area were calculated, and the found average served as the origin for that target. The square root of the sum of the squares of the vertical error and the horizontal error gives the absolute error for each shot. In the Figure 7, the orange circle represents the

average of the shots, while the blue circle signifies the calculated deviation from the shot. The hollow circles represent the remaining shots.

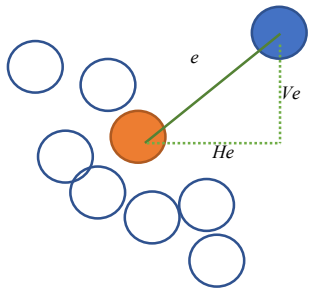


Figure 5. Determination of true deviation with Euclidean equation

Euclidean Distance (e_i): The equations you've provided are used to calculate the deviations and the Euclidean distance (e_i) of data points from their respective means. Here's a breakdown of the equations:

$$H_i = x_i - x_{avg}$$

$$V_i = y_i - y_{avg}$$

$$e_i = \sqrt{{H_i}^2 + {V_i}^2}$$

Standard Deviation (σ): σ represents the measure of the dispersion or spread of the data points. In this case, it quantifies how much the shots deviate from the mean position for a given target area.

$$\sigma = \sqrt{\frac{\sum(|e_i - e_{avg}|)^2}{n}}$$

Where:

- σ is the standard deviation.
- Σ represents the sum of the values in the parentheses.
- e_i is the deviation of each shot from the mean position for the target.
- e_{avg} is the mean position for the target (the origin).
- n is the total number of shots.

Root Mean Squared Error (RMSE): RMSE is a measure of the average error between the actual and targeted point. In this context, it quantifies the overall accuracy of the robot's shots in hitting the target.

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(e_i)^2}$$

Where:

- RMSE is the Root Mean Squared Error.
- Σ represents the sum of the squared deviations.
- e_i is the deviation of each shot.
- n is the total number of shots.

These calculations help assess the consistency and accuracy of the robot's performance in hitting a specific target area by considering the deviations of the shots from the mean position for that target. Standard deviation alone may not be sufficient to evaluate such a system. For example, if all the balls were 5 units away from the origin, the standard deviation would be zero, and if we solely relied on standard deviation for evaluation, we might

mistakenly think the system is very successful. The RMSE value provides the best means to assess the shots made by the robot. The closer the RMSE value is to zero, the indication is that the robot is hitting the target with the ball closer to the desired point. In addition to these two factors, the horizontal and vertical deviation values allow us to observe the differences in dispersion based on the position of the launcher head.
In evaluating a system like this, it's crucial to consider RMSE along with standard deviation, as RMSE provides a more comprehensive assessment of the accuracy and consistency of the robot's shots.

4 RESULTS

The calculations and measurements for 400 shots made to 5 different targets by the robot, including vertical and horizontal deviations, the area where 40 balls landed, standard deviation, and RMSE values, have been separately computed for the horizontal and vertical positions of the launcher head. These values are presented in Table 1.

Table 1. Analysis table for 400 shots to five different targets with two different launcher positions

	Horizontal Launcher					**Vertical Launcher**				
	Range V.	**Range H.**	**Area**	**σ**	**RMSE**	**Range V.**	**Range H.**	**Area**	**σ**	**RMSE**
Target-1	29	20	580	4.0	9.6	16	24	384	3.6	8.0
Target-2	32	20	640	4.3	11.3	15	27	405	3.5	9.1
Target-3	32	19	608	4.9	11.2	15	27	405	3.4	8.3
Target-4	22	17	374	3.4	9.1	17	24	408	3.9	8.4
Target-5	23	15	345	3.2	8.2	15	21	315	2.9	7.9

This table depicts scenarios in which the robot has launched balls toward five different targets and displays the outcomes of these shots. The headings “Horizontal Launcher” and “Vertical Launcher” distinguish between shots made with the launcher head in horizontal and vertical positions. The columns “Range V.” and “Range H.” indicate the range (distance to the target) of shots in the vertical and horizontal directions. For instance, for Target-1, the vertical shots have a range of 29 units, and the horizontal shots have a range of 20 units. The “Area” column represents the size of the area where balls have landed beneath each target. This reflects how concentrated the shots are, whether they are close or far from the target. The “σ” (standard deviation) column provides a measure of the deviation of the balls from the target. Higher standard deviation values indicate greater dispersion in the shots. The “RMSE” (Root Mean Squared Error) column serves as a measure of how close or far the balls are from the target. Lower RMSE values indicate that the shots are closer to the target. In summary, this table assesses the robot's shooting performance for different targets in both horizontal and vertical positions. The standard deviation and RMSE values indicate the precision and consistency of the shots, with lower standard deviation and RMSE values signifying better shooting performance.

When examining the shots made with the launcher head in a horizontal position, it can be observed that the vertical deviation is greater compared to the horizontal deviation. In the vertical launch position, the horizontal deviation is greater compared to the vertical deviation. Furthermore, it is noticeable that the area where the balls landed is smaller in the vertical launch position. This difference is evident in the RMSE values. In comparison to Target1, Target 2, and Target 3, it is evident that the deviation is smaller in Target 4 and Target 5. This is because Target 4 and Target 5 are closer to the robot. The physical limitations of the launching system can lead to increased deviation when attempting to reach distant targets. For example, factors like air resistance, gravity, and spin motion can result in greater deviation of the ball as it travels through the air. As you move farther away from the target, small errors and precision loss can have a more significant impact. Deviation from the target can increase as a result of minor errors originating from the starting position and system precision. Making shots to distant targets can stress the sensitivity of the launching equipment. Tolerances and errors in the mechanical or electronic components of the robot may have a more substantial effect when aiming for distant targets.

For all shots, the clustering of the table tennis table is appropriately presented in the graphs for horizontal and vertical launch positions, as seen Figure 8.

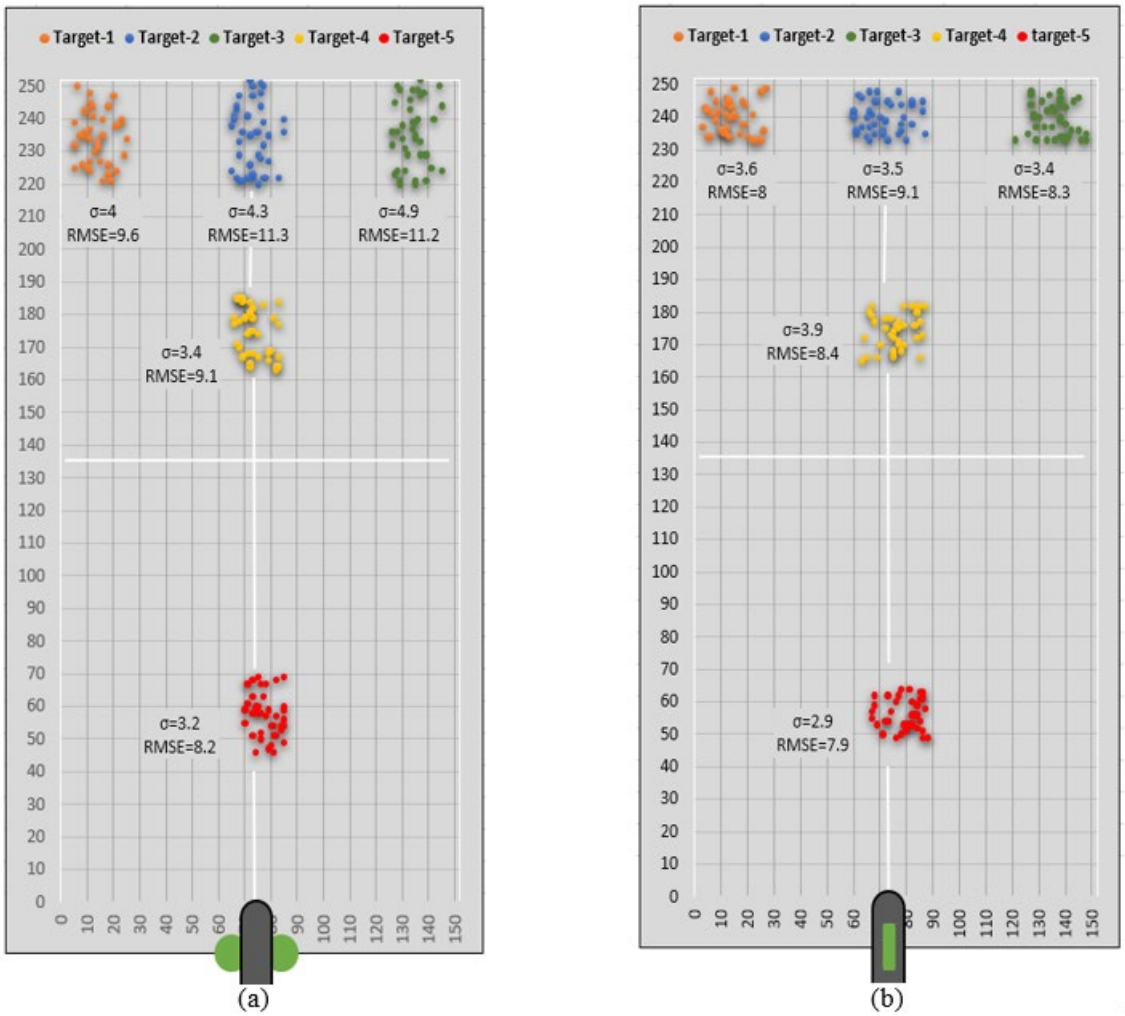


Figure 6. Projections of 400 Shots on the Table: (a) Launcher in horizontal position and (b) launcher in vertical position

5 CONCLUSION

This study presents the development of a versatile ball-launching robot capable of executing shots in almost all table tennis playing styles, while also being proficient in collecting and relaunching the balls returned by the player. In addition to the robot, a mobile application was designed to facilitate remote control, making it a highly accessible training tool for table tennis enthusiasts. This innovative robot can precisely deliver balls to desired positions on the table with various styles and speeds, offering athletes the opportunity for consistent and limitless shot practice and return training without the need for a human training partner or coach. One of the key advantages of mTTTbot is its cost-effectiveness, as it offers high-precision shot capabilities at a significantly lower cost compared to its market counterparts. Moreover, the seamless control of the robot using only a mobile phone adds to its appeal. Through the course of this paper, it was observed that deviations in shots made to the farthest points of the table were attributable to the use of two motors and wheels in the launching head. Future iterations of the design plan to incorporate a structure featuring three motors and a three-wheeled system, especially for shots to the extreme ends of the table. Additionally, optimizing the design by relocating the pitch and yaw joints closer to the launching head is expected to enhance joint speed and reduce undue stress on the joints in subsequent designs. Beyond table tennis, the developed robot has the potential for adaptation to ball-launching projects in other sports such as tennis, volleyball, and soccer, showcasing its versatility and applicability across multiple athletic disciplines.

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Dual-Band and Wide-Angle Metamaterial Absorber Design for C- and X-Band Microwave Applications

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Abstract

Metamaterials, which have extraordinary properties, have been the subject of many research areas in recent years due to their ability to manipulate electromagnetic waves. Additionally, due to their design principles, they can be designed for applications in the desired frequency region of the electromagnetic spectrum. In this study, a metamaterial absorber design was realized that provides 71.26% and 99.98% absorption rate, respectively, for C- and X-band microwave applications under normal incidence (0°) and maintains high absorption performance under oblique incidence (10°, 20°, 30°, 40°, and 50°) was implemented. The design is easy to realize and inexpensive in terms of the dielectric substrate used. In addition, by changing the design parameters, a high absorption rate can be achieved in the X-band and the absorption rate is maintained in the C-band. From another perspective, this also shows that the suggested metamaterial absorber will provide high absorption performance even with high production tolerances in experimental studies (real applications).

Keywords: *Metamaterial absorber, Wide-angle, Dual-band, C-band, X-band*

1 INTRODUCTION

Metamaterials that do not exist in nature and are obtained artificially are different from other materials because they have a negative refractive index [1]. It was first suggested by Veselago in 1968 that if the dielectric and magnetic permeability parameters that constitute the electromagnetic properties of a material are negative in certain frequency ranges, the refractive index of the medium may also be negative [2]. The first practical metamaterials were developed by Smith et al. and Shelby et al. in the 2000s, following Veselago's suggestion [3, 4].

In today's developing technology, metamaterial structures are used in many areas due to their advantages such as being cheaper compared to other materials used, easy to produce, increasing performance, and providing complete and accurate results [5]. These usage areas of metamaterials include antennas [6], super lenses [7], absorbers [8], sensors [9], polarization converters [10], invisibility cloaks [11], etc. Metamaterial-based absorbers, which are among these areas of use, are constantly being developed to manipulate electromagnetic radiation [12]. These metamaterial absorbers can generally be developed based on metal resonator-dielectric-metal or completely dielectric material [13, 14]. By appropriately adjusting the resonator shape and dimensions, period and thickness of the materials, the absorption frequency and performance of the metamaterial absorber are determined [15]. In this study, a metamaterial absorber design that is easy to realize and can be manufactured cheaply, providing 71.26% and 99.98% absorption rate for microwave C- (4–8 GHz) and X-band (8–12 GHz) applications, respectively, and maintaining high absorption performance under oblique incidence (10°, 20°, 30°, 40°, and 50°) has been realized.

2 MATERIAL AND METHOD

The suggested metamaterial absorber consists of a metal resonator–dielectric material–metal configuration. Copper with an electrical conductivity of 5.8×10^7 S/m (σ_c) was used at the front and back of the metamaterial absorber, and FR-4 with a relative permittivity of 4.3 (ε_r), a relative permeability of 1 (μ_r), and a loss tangent of 0.025 ($\tan\delta$) was used as the dielectric material in the middle. FR-4 dielectric material has a square shape with a side of 12 mm (l_1) and a thickness of 1.2 mm (t_1). The back of the FR-4 is completely covered with copper with a thickness of 0.035 mm (t_2). Additionally, the thickness of the copper resonator on the front side is the same as

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that on the back side. The use of FR-4 in the design and the thickness of the copper on the front and back surfaces of FR-4 and FR-4 make the design affordable. Because the double-sided copper-coated FR-4 in the dimensions used in the design is a dielectric material that can be easily found on the market. In addition, the resonator structure, which will be mentioned a little later, can also be performed using traditional methods. Now, coming to the design of the copper resonator on the front, first a square with a side of 11 mm (l_2) was created. Secondly, a square structure with a side of 7 mm (l_3) was removed from this square by rotating it 45° clockwise. Thirdly, strips with a width of 0.8 mm (g) were removed from the four corners of the resulting structure. Finally, a cylinder with a diameter of 6 mm (R) and a width of 0.6 mm (w) was created at the center of the resulting structure. 3D, front and back views and geometric scaling of the metamaterial absorber design created with the above-mentioned steps are shown in Figure 1.

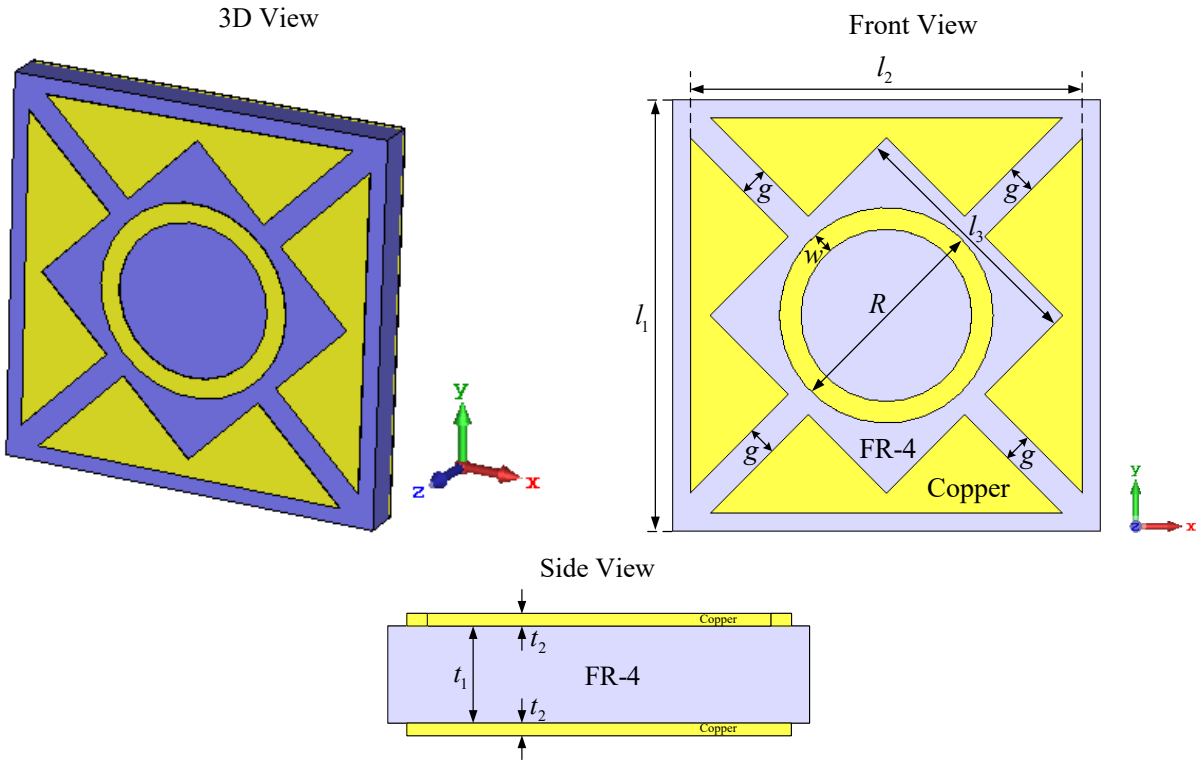

Figure 1. 3D, front and back views and geometric scaling of the designed metamaterial absorber structure

It is necessary to calculate the absorption to verify the performance of the metamaterial absorber suggested in Figure 1. Absorption (A) is calculated as follows, where S_{11} and S_{21} are the reflection and transmission scattering parameters, respectively [8, 12-16].

$$A = 1 - |S_{11}|^2 - |S_{21}|^2 \quad (1)$$

As can be seen from Equation (1), S_{11} and S_{21} must be reduced to a minimum in order to increase A to the highest value (1 = 100%). In other words, as can be understood from the absorption formula, for the absorption to be 100%, both reflection and transmission must be zero (0) at the same frequency. Since the back part of the dielectric material is completely covered with a copper plate in the design, S_{21} can be neglected due to the optical inhibitory properties of the copper plate [16]. Therefore, Equation (1) can be reduced as follows.

$$A = 1 - |S_{11}|^2 \quad (2)$$

3 RESULTS

To analyze the performance of the suggested metamaterial absorber, simulations were carried out in CST Microwave Studio, a 3D electromagnetic simulation program. While making simulation settings, the boundary

conditions along the x- and y-axes were selected as "unit cell" and along the z-axis as "open (add space)". In addition, simulations were carried out in the frequency range of 4–14 GHz by applying floquet ports according to the z-direction and selecting the tetrahedral mesh type in the frequency domain. The reflection parameters obtained for normal incidence (0°) and the calculated absorption rates (%) are given in response to frequency in Figures 2(a) and 2(b), respectively.

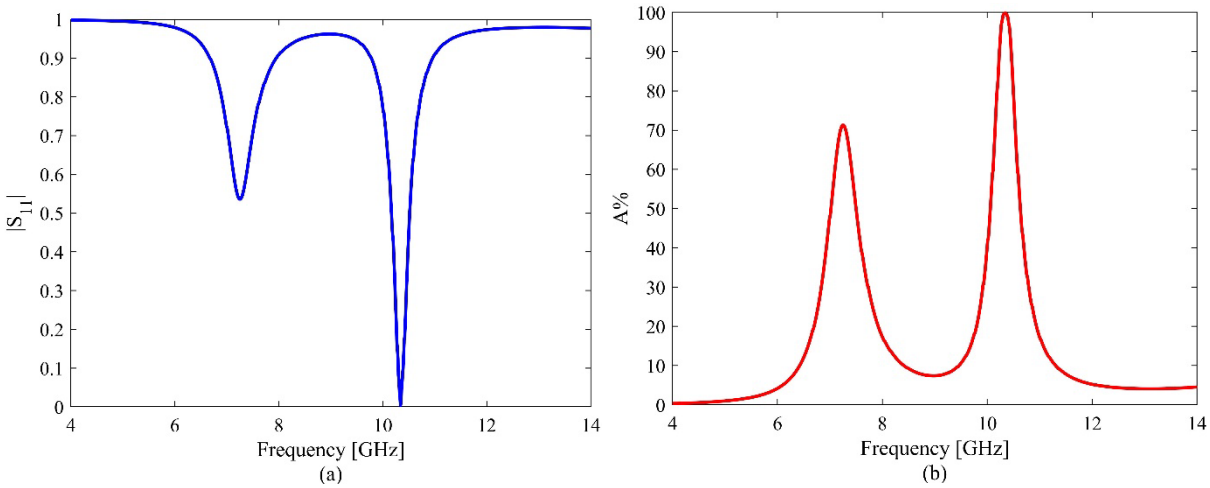

Figure 2. (a) $|S_{11}|$ and (b) A % for the suggested dual-band metamaterial absorber

As seen in Figure 2(a), in the X-band the reflection is approximately zero (0) at 10.34 GHz, and in the C-band the minimum reflection is 0.53 at 7.25 GHz. Looking at Figure 2(b), the absorption rates at 10.34 GHz and 7.25 GHz frequency points are 99.87% and 71.26%, respectively. In other words, while a high absorption rate was achieved in the X-band, an absorption rate of over 70% was achieved in the C-band.

The behavior of the suggested metamaterial absorber for oblique incidence (10°, 20°, 30°, 40°, and 50°) was examined and the absorption rates at different angle values are shown in Figure 3. When Figure 3 is examined, no significant change is noted in the absorption rates in the C- and X-bands of the suggested metamaterial absorber at different angle values up to 50°.

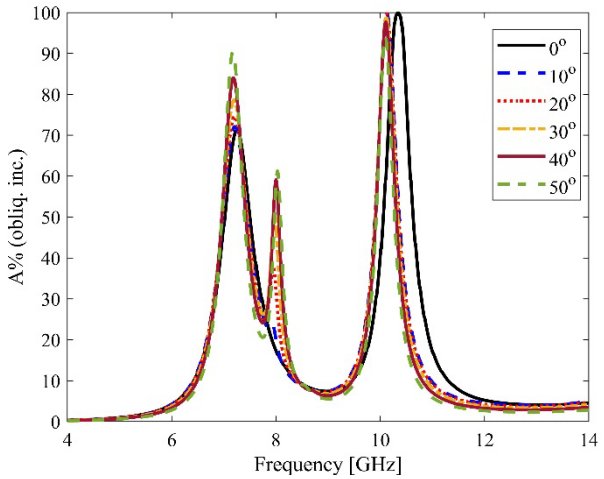

Figure 3. Absorption rates of the suggested dual-band metamaterial absorber under oblique angle

After examining the behavior of the suggested metamaterial absorber under an oblique angle, the effect of the design parameter g on the absorption rate was examined as an example. For this purpose, simulations were carried out by changing g = 0.6 – 1 mm and the absorption rates are given in Figure 4.

When Figure 4 is examined, by changing the g design parameters, a high absorption rate can be achieved in the X-band and the absorption rate is maintained in the C-band. From another perspective, this also shows that the suggested metamaterial absorber will provide high absorption performance even with high production tolerances in experimental studies (real applications).

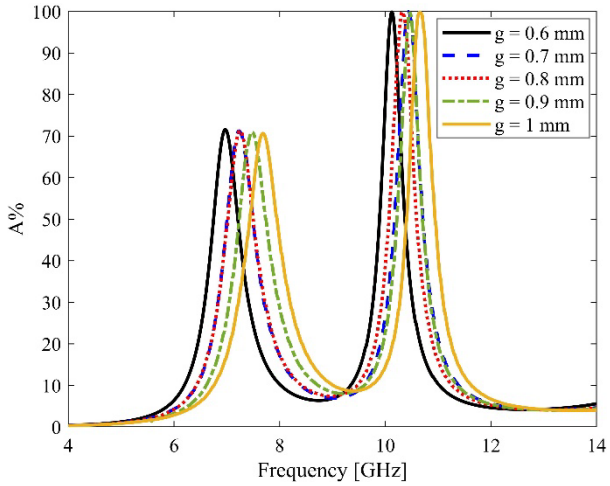

Figure 4. Variation of absorption rate for different g (0.6 – 1 mm) design parameters of the suggested dual-band metamaterial absorber

4 CONCLUSION

In this study, a wide-angle and dual-band metamaterial absorber design was developed that provides 71.26% and 99.98% absorption rate in C- and X-band microwave applications under normal incidence (0°), respectively, and maintains this absorption rate for incidence angles up to 50°. The design is made using double-sided copper-coated FR-4 dielectric material, which is easily available in the market, and the suggested absorber device can be implemented simply and cheaply with conventional methods.

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December 1-3, 2023

Design and Implementation of 2.5 GHz Microstrip Patch Antenna

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Abstract

Recently, microstrip antennas have become important in areas such as aircraft, spacecraft, satellite communications, radars, wireless and mobile communications. Microstrip antennas, which are preferred due to their bandwidth, low return loss and small volumes, are frequently used in the mentioned applications. In this study, a high gain microstrip patch antenna operating at 2.5 GHz was designed in Ansoft – HFSS and the designed miniature structure was also realized. It has been observed that the results are compatible with each other in theoretical and practical applications. In addition, it was concluded that antenna designs operating at different frequencies can be realized by changing the number and dimensions of patches in the designed structure in the simulations.

Keywords: *Microstrip antenna, Patch, Ansoft – HFSS, High gain*

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Development of Flexible and Ferrite Film Microstrip Patch Antenna

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Abstract

Microstrip patch antennas have been used for decades because they print structures consisting of a metal patch on the front side of a dielectric substrate and a ground correction on the back, as well as containing a microstrip feeder. However, microstrip patch antennas printed on printed circuit boards have disadvantages due to reasons such as low power, limited bandwidth and limited material selection. In this study, a microstrip patch antenna design was made using screen printing technique on a ferrite film. In this way, thanks to the thin film used, improvements in the return loss, bandwidth and Q factor of the antenna have been observed compared to dielectrics such as Arlon, FR-4, F4-B, Rogers etc. In addition, the designed structure has become flexible.

Keywords: *Microstrip patch antenna, Flexibility, Ferrite film, Improvement*

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Recommendations on the Biological Effects of Electromagnetic Waves

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Abstract

Electromagnetic waves are widely used today as a result of rapidly increasing technological developments. However, there are still uncertainties about the potential effects of these waves on biological systems. This paper aims to provide up-to-date information on the biological effects of electromagnetic waves. For this purpose, first the electromagnetic effect mechanisms will be understood. Secondly, information about standardized electromagnetic measurement and evaluation protocols will be given. Thirdly, public health policies and updates on electromagnetic exposure will be discussed. Finally, innovative and technological solutions will be proposed to reduce electromagnetic field exposure and potential risks of electromagnetic waves. These suggestions can be considered as an effort to fill the gaps in knowledge about the biological effects of electromagnetic waves. Standardized protocols, updated policies, training programs and technological solutions can contribute to effectively managing research in this field and minimizing the potential risks of electromagnetic field exposure.

Keywords: *Electromagnetic waves, Exposure, Biological effects, Ways of protection, Suggestions*

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Modeling and Simulation of a DC-CD Converter with PID Controller

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Abstract

Electrical energy produced in various ways is used in two ways: Direct current (DC) and alternating current (AC). Energy demand is increasing day by day due to reasons such as the increasing use of technological products that use DC in daily life, industrialization, increasing population and the formation of new residential areas. The existence of DC devices that consume some of this increasing energy increases the need for DC-DC converters. Due to this increasing need, in this study, DC-DC converter modeling and simulation was carried out with MATLAB's Simulink Toolbox. Afterwards, the power flow analysis of the design and the determination of the design parameters were examined theoretically. In the study, the output voltage was adjusted to the desired level with a Proportional Integral Derivative (PID) controller.

Keywords: *DC-DC converter, PID controller, MATLAB-Simulink*

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PWM Wave Generator Design with a Simple Approach

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Abstract

Pulse Width Modulation (PWM) is a widely used technique in digital control systems and has an important role in many application areas. In PWM wave generator design, it is important that the frequency and amplitude are adjustable and focus on stability. A PWM wave generator can have a wide pulse width range and can be tuned to suit various application needs. Designed with low power consumption, basic electronic elements (op-amp, resistor, adjustable resistor, etc.), pulse width control, adjustable amplitude and frequency features, the PWM generator can be used in portable devices and battery-backed systems. At the same time, the designed PWM generator can also be integrated into Internet of Things (IoT) connected systems.

Keywords: *PWM, Simple design, Low power, Adjustable frequency-amplitude, Pulse width control*

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Design of a 20 kW Wind Turbine

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Abstract

In this study, a wind turbine with an asynchronous generator was designed, which has found wide use in the field of wind technology, which is experiencing a rapid development process and is clean and whose costs are constantly decreasing, today, when environmental conditions are deteriorating and needs are constantly increasing. The design consisting of wings, rotor, angle regulator, brake, low speed spindle, gear box, generator, speed and direction regulator, anemometer, wind direction sensor, nacelle, high speed shaft, steering mechanism, steering motor and tower was made by taking the wind speed of the reference region for the desired power of 20 kW. In this study conducted for wind energy, which currently finds a relatively wide area of use all over the world, turbine characteristics are revealed according to the selected parameters (desired power and reference region wind potential).

Keywords: *Wind turbine, Design, 20 kW*

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Basic Components of Internet of Things (IoT) Architecture and a New Architectural Design

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Abstract

The Internet of Things (IoT) is increasingly coming to the fore today as a technology that interacts with every aspect of industrial, commercial and daily life. The foundation of IoT architecture is the ability to collect data from the physical world. Sensing devices, sensors, and data acquisition units enable real-time data streams from a variety of environments. Effective communication of collected data is a critical element that determines the success of IoT systems. Wireless communication protocols, gateways and cloud-based communication infrastructures must be integrated to enable data transfer. Big data analytics, data processing and analytics engines make it possible to extract meaningful information from collected data. With processing performed on local devices, cloud-based analytics can improve system performance. In IoT architecture, security should be a priority in inter-device communication and data storage processes. Industry-standard security protocols must be integrated to ensure data confidentiality and integrity. Remote management of IoT systems enables effective updating of devices, changing configurations and error management. Remote management ensures continuous optimization of IoT networks. In this study, a literature review was made regarding the concept of IoT, its usage areas, architectural structure and proposed architectural models, and a new, layered architectural model was proposed to bring IoT into a standard architectural model structure.

Keywords: *Internet of Things (IoT), Basic ingredients, New architecture*

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Internet of Things (IoT) Current Studies and Today's Applications

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Abstract

The Internet of Things (IoT) describes the network of physical objects embedded with sensors, software, and other technologies for the purpose of connecting and sharing data with other devices and systems over the internet. These devices range from ordinary household objects to advanced industrial tools. IoT appears in our lives and in industry with applications such as patient tracking systems, recycling processes, smart production, connected assets and preventive and predictive maintenance, smart power spreadsheets, smart cities, connected logistics, smart digital supply chains. For this reason, in this study, brief information is given about the basic components of IoT, which has been a popular research topic recently, and information about its application areas is given.

Keywords: *Internet of Things (IoT), Application areas*

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Forward-Looking Recommendations in Global Education: Equality, Technology and Human-Centered Approaches

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Abstract

This study aims to provide suggestions for a more effective, equitable and sustainable education system by addressing the challenges and future developments in global education. Education emerges as a fundamental element in the development of societies on a global scale. For this reason, suggestions were made in the study on equality-based education policies, integration of technology and digital literacy, multilingual education and intercultural communication, creative and critical thinking skills, teacher training and professional development. These recommendations highlight the steps to be taken to create a more equitable, accessible and qualified system in global education. Education plays a critical role in the development of not only individuals, but also societies and the global world. These efforts will be an important step towards a more sustainable and inclusive future in education.

Keywords: *Global education, Suggestions, Equality-technology and human-centered approach*

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December 1-3, 2023

Obstacles to Effective Communication and Recommendations

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Abstract

Effective communication, which we are responsible for in almost every environment, from school to work, from business to family, from family to the environment, forms the basis of successful cooperation, leadership and social relations. However, a number of barriers can challenge the effectiveness of communication. In this study, suggestions will be made to understand the obstacles to effective communication and to overcome these obstacles. First, the barriers are listed as language barriers, lack of active listening, lack of emotional expression, barriers arising from different cultures, technology and distance communication barriers, and lack of transparency. Afterwards, suggestions were made against these obstacles. These recommendations aim to provide guidance for overcoming communication barriers and communicating more effectively, clearly, and meaningfully.

Keywords: *Effective communication, Obstacles, Suggestions*

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Leadership Challenges and Rules for Overcoming Obstacles: Tips for Strong Leadership

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Abstract

Leadership is a complex process that can face many challenges and obstacles. In this study, the rules to be followed to overcome leadership difficulties and obstacles are discussed and important tips for strong leadership are presented. The rules that are important for a leader and tips for strong leadership are explained in detail in the following headings.

• Empathy and Communication

• Delegation and Trust

• Ability to Turn Problems into Opportunities

• Courage to Take Risks and Make Decisions

• Ability to Manage Change

• Supporting the Development of the Team

• Motivation and Human Resources Management

• Self-Improvement and Openness to Learning

Leadership is a dynamic process that requires overcoming various challenges. These suggested rules will help the leader develop strong leadership skills and lead her/his team to overcome challenges.

Keywords: *Leadership, Challenges, Obstacles, Powerful leadership advice*

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The Leader's Role in Innovation: Encouraging and Moving Creativity Forward

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Abstract

Just as innovation is inevitable in today's age and technology, leadership plays a decisive role in the innovation process, and in order to create a successful innovation culture, leaders must be visionary, encouraging and pioneering. In this regard, this paper will emphasize the key role of the leader in innovation and offer suggestions for success in this field. What the leader should do in the innovation process (suggestions) on topics such as visionary leadership, encouraging and supportive, creating an infrastructure for innovation, encouraging team diversity, flexibility in resource allocation, rewarding innovation, ability to use external resources, leadership open to learning will be examined. The leader's active role in innovation is a critical factor for the sustainable success of the organization. These recommendations aim to increase leaders' responsibilities in supporting innovation and unlocking creative potential.

Keywords: *Leadership, Innovation, Suggestions for innovation*

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Enhancing Microwave Absorbing Materials Efficiency: Carbon Nanofiber-Mill Scale Hybrid for Broadband Electromagnetic Absorption

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Abstract

Our study aimed to improve the efficiency of microwave absorbing materials (MAMs) by achieving high absorption levels across a broad frequency range. This enhancement was realized through the utilization of a hybrid material comprising carbon nanofibers and nanosized mill scale derived from waste. In MAMs, the application of passive coatings traditionally results in effective electromagnetic (EM) wave absorption but within a restricted frequency band. Our hypothesis sought to address this limitation by combining carbon and magnetic materials to broaden the absorption bandwidth. Consequently, our research aimed to hybridize carbon nanofibers with nanoparticles from mill scale waste, investigating the influence of mill scale catalyst size on EM-wave absorption performance within the 8-18 GHz range. To implement this, mill scale underwent washing and milling at four distinct durations, serving as a catalyst in the chemical vapor deposition (CVD) process. Ethanol served as the carbon source for synthesizing carbon nanofibers (CNF) at 750°C. The resulting materials from the CVD process were mixed with epoxy resin to form a polymer composite, subsequently placed in a sample holder for EM-wave measurements at three different thicknesses. We achieved successful synthesis of CNF with coiled, spiral, and twisted nanostructures, providing advantages in enhancing EM-wave absorption. The majority of samples exhibited maximum absorption, with a reflection loss of ≤-20 dB (99% signal absorption). The CNF catalyst synthesized from mill scale waste using the CVD method holds promise as a potential EM-absorbing material, particularly for radar wave absorbers.

Keywords: *Microwave absorbing materials (MAMs), Carbon nanofibers (CNF), Electromagnetic (EM) wave absorption*

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Carbon Black Electrospun Nanofiber Produced via Electrospinning Method

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Abstract

Electrospun nanofibers were produced using the electrospinning method, incorporating different ratios of Carbon Black mixed with Cellulose Acetate (CA). Dimethylacetamide (DMAc) and acetone were combined in a 2:1 ratio. The Cellulose Acetate (CA) blend with the DMAc:Acetone solution contained 0.2g, 0.3g, and 0.4g of Carbon Black, added to the solution prior to the electrospinning process. The solution was sonicated at 50°C for 20 minutes at room temperature and stirred until homogenized. The electrospinning process was set up with a distance of 10 cm from the syringe to the plate collector. The volume rate was set at 10 µL/min, using a syringe with a 13-gauge needle diameter. Various types of nanofibers were produced and characterized with FESEM.

Keywords: *Electrospun, Electrospinning, Cellulose, Nanofibers, Collector*

1 INTRODUCTION

Electrospinning is a versatile technique used to produce nanofibers and membranes [1]. This technique consists of a high-voltage supply, syringe pump, and collector [2]. In the pursuit of sustainable and high-performance materials, the field of nanotechnology has emerged as a promising avenue for innovation. Electrospinning, a versatile and scalable technique, has garnered significant attention for fabricating nanofibrous structures with unique properties. In this context, the integration of carbon black into electrospun nanofibers represents a novel approach that holds great promise for a wide range of applications [3].

Carbon black, a finely divided form of carbon consisting of ultrafine particles, has long been recognized for its excellent electrical conductivity, thermal stability, and mechanical strength [4]. The utilization of carbon black in electrospun nanofibers introduces a synergistic combination of these properties, creating a material platform with enhanced functionalities [5]. The electrospinning method, characterized by its ability to produce continuous fibers with diameters in the nanometer range, further amplifies the potential of carbon black nanofibers for applications in various fields [6].

This article aims to provide an in-depth exploration of the synthesis and characterization of carbon black electrospun nanofibers. We will delve into the electrospinning process, elucidating the key parameters influencing the morphology and properties of the resulting nanofibers. Additionally, the unique characteristics of carbon black, such as its high surface area and conductivity, will be discussed in the context of their impact on the performance of the nanofibrous material.

2 MATERIAL AND METHOD

Cellulose acetate (CA) powder, carbon black (CB) powder, N,N-dimethylacetamide (DMAc), and acetone were purchased from Sigma Aldrich and used without further purification. To create a conductive solution suitable for electrospinning, the initial step involved preparing a cellulose acetate solution. This was achieved by dissolving carbon black powder in a mixture of DMAc and acetone (in a 2:1 ratio), resulting in a 17% (w/w%) cellulose acetate solution. Subsequently, 0.2g, 0.3g, and 0.4g of CB powder were introduced into the cellulose acetate solution. This mixture was stirred at room temperature until a uniform solution was obtained. To enhance homogeneity, the carbon black-loaded cellulose acetate solution was sonicated at 50°C for 20 minutes, followed

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by continued stirring with a magnetic stirrer at room temperature for a duration of 2 hours before commencing the electrospinning process

Electrospinning configuration

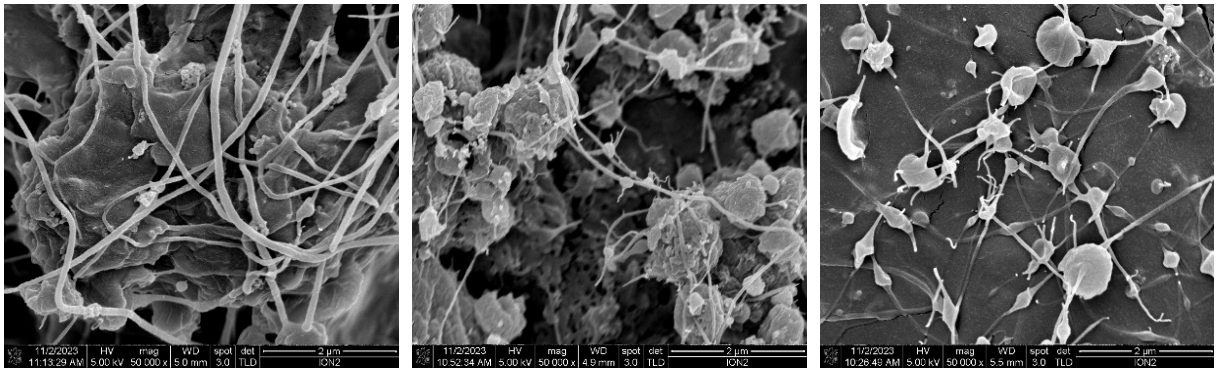
The prepared solutions were loaded into a 10ml syringe with a 13-gauge needle. These solutions were then pumped into a horizontal electrospinning setup (Nanolab Instruments). The electrospinning process lasted for 2 hours at room temperature with a voltage of 18kV. A syringe pump was used to extrude the polymer solution through a needle at a flow rate of 10 µL/min. The distance from the tip to the rotary collector was 10 cm. The nanofiber mesh collector was made of aluminum foil and placed on top of the fixed collector

Characterizations

The surface morphology and diameter of the electrospun nanofibers were investigated using field emission scanning electron microscopy (FESEM). All samples were coated with platinum before the scanning process.

3 RESULTS

The results in Figure 1 show electrospun nanofibers produced using different grams (g) of Carbon Black (CB)



(a) (b) (c)

Figure 1. (a) 0.2g CB, (b) 0.3g CB (c) 0.4g CB

4 CONCLUSION

The results show that Carbon Black (CB) electrospun nanofibers were produced in all electrospinning processes. Different ratios of CB used resulted in the production of various types of electrospun nanofibers. The potential applications span a wide range of fields, including filtration, tissue engineering, biomedicine, environmental remediation, energy storage, and wearable technology [7].

Acknowledgments

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Optimizing Environmentally Friendly Drilling Fluid Performance under High-Pressure High-Temperature Conditions through Carbon Nanomaterials

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Abstract

Integrating nanomaterials as additives in drilling fluid holds significant promise for enhancing fluids' thermal and physical-chemical properties. However, their application in this domain remains limited. Ester-based drilling fluid (EBDF) stands out as an environmentally friendly option, albeit with usage constraints at elevated drilling temperatures due to inherent thermal and hydrolytic stability issues. This research delves into the impact of morphology and graphitization of various carbon nanomaterials on the rheology, filtration, and emulsion stability of EBDF under high-pressure high-temperature (HPHT) drilling conditions. The investigated carbon nanomaterials include graphene nanopowder, commercial graphene nanoplatelets, in-house graphene nanoplatelets, graphene oxide, and carbon nanotubes cotton. Results indicate a direct correlation between the behaviour of EBDF and the morphology and graphitization of carbon nanomaterials. Graphene nanopowder exhibits superior performance due to its substantial size, minimal graphitic defects, and highly hydrophobic surface. These characteristics contribute to improved emulsion stability and HPHT filtration properties of EBDF. The hydrophobic nature of graphene nanopowder sheets plays a pivotal role in shielding emulsifier films in drilling fluid against thermal degradation. Filtration tests demonstrate a notable reduction in filtrate and filter cake thickness by 20% and 25%, respectively, with a graphene concentration of 0.007 wt%. This study highlights the potential of tailored carbon nanomaterials in augmenting the effectiveness of EBDF, offering a pathway towards environmentally conscious and high-performance drilling fluid solutions for challenging HPHT conditions.

Keywords: *Synthetic-based drilling fluids, Nanoparticles, Carbon nanomaterials, Rheology, Filtration properties*

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Methylene Blue Adsorption on Composites of Activated Carbon and Sodium Alginate

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Abstract

In this study, we present a sustainable approach for the production of activated carbon derived from olive pits using chemical activation with potassium hydroxide impregnation. The resulting activated carbon is subsequently employed to fabricate composite materials in combination with sodium alginate (AC/Alg) for potential applications in wastewater treatment.

The production process involves impregnating olive pit precursors with KOH, followed by chemical activation to create activated carbon with high porosity and specific surface area. Composite beads are then formed by mixing the activated carbon with sodium alginate, offering an eco-friendly and effective adsorbent for pollutant removal. Various AC/Alg formulations were tested to optimize adsorption efficiency. The research explores the influence of adsorption parameters, such as contact time, initial pH, and initial pollutant concentration, on the removal of a model molecule.

The findings demonstrate the potential of AC/Alg composites for efficient and environmentally friendly wastewater treatment. This study contributes to the development of sustainable solutions in the field of water purification and underscores the importance of utilizing agricultural waste for environmental benefit.

Keywords: *Activated carbon, Adsorption, Methylene blue*

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Enhancing Phosphorus Removal Efficiency through Lanthanum Modified Biochar

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Abstract

Eutrophication has become a serious environmental problem which is driven primarily by excessive phosphorus (P) inputs, poses a significant threat to aquatic ecosystems. Previous publications have demonstrated that adsorption could achieve a P concentration lower than 0.01 mg/L. La-based P adsorbents have drawn significant attention in the last decade.

In this study, we explore the potential of biochar, an adsorbent material, in reducing phosphorus. Specifically, we investigate the effects of lanthanum-modified biochar, derived from date palm biomass through a single-step pyrolysis process at 700°C. To evaluate the adsorption capacity of the modified biochar, kinetic tests were conducted to examine the relationship between adsorption efficiency and adsorption time.

The results revealed an increase in adsorption efficiency as the duration of adsorption extended. This finding suggests that the lanthanum-modified biochar exhibits enhanced adsorption capabilities for phosphorus removal, making it a potential solution for phosphorus removal. Data of adsorption were fitted to several kinetic models. Overall, our study demonstrates the potential of lanthanum-modified biochar derived from date palm biomass as an effective adsorbent for phosphorus removal.

Keywords: *Eutrophication, Phosphorus, Adsorption, Lanthanum, Kinetic*

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Analysis of Inaccurate Information of Sample Holder Thickness in Determining Electromagnetic Properties of Soil Samples

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Abstract

The effect of inaccurate information on sample holder thickness on the extracted complex permittivity of soil samples is examined. To achieve our goal, simulations using a full 3D electromagnetic simulation program (CST Microwave Studio) are performed, and then an extraction algorithm is applied to examine the influence of various inaccurate sample holder thicknesses. It is observed from our analysis that the real part of the permittivity of the soil sample is drastically dependent on exact information about the sample holder.

Keywords: *Permittivity, Soil, Sample holder, Simulation*

1 INTRODUCTION

Measurement of water content within soil samples is of paramount importance in the analysis of plant growth and nutrition, germination of seeds, and nutrient transformations in the root zone [1]. Methods for such measurements can be categorized into two main groups as direct methods and indirect methods. The former methods such as gravimetric (mass basis) or volumetric (volume basis) can provide information about water content after removing water from a soil sample by evaporation, leaching or chemical reaction. Although effective, these methods necessitate a collection of samples transported from the field to a measurement laboratory and a considerable amount of time [2] (an average of 24 hours). Indirect methods, on the other hand, evaluate water content within soil samples by means of a correlation process from a measured non-moisture parameter to moisture. To eliminate the drawbacks of the aforementioned direct methods, non-direct methods can be used as a solution. Among many indirect methods such as the tensiometric method, pressure plate technique, and neutron probe moisture meter, our concern in this study is those based on electromagnetic signals. Time-domain reflectometry (TDR) [3, 4], ground-penetrating radar (GPR) [5], open-ended probes [2, 6], and coaxial transmission lines [7-14] can be enumerated for indirect methods relying on those signals.

To eliminate these drawbacks, indirect methods based on electromagnetic signals can be used such as time-domain reflectometry (TDR) methods [3, 4], ground-penetrating radar (GPR) methods [5], open-ended probes [2, 6], and coaxial transmission lines [7-14]. The TDR methods send a pulse signal through a guided line with a velocity and extract information about soil properties by measuring propagation and amplitude change of this signal. Nonetheless, it needs a specialized or an optimized probe to improve the accuracy of soil moisture detection. On the other hand, GPR methods could be effectively used to correlate the moisture content of soils with an established empirical formula such as Topp's equation. This method, however, is limited to homogeneous soil samples with relatively smaller conductivities. As a promising method, open-ended coaxial or waveguide techniques can be equivalently utilized for soil moisture detection. These methods, as a drawback, necessitate a close contact with the soil sample which otherwise might introduce inaccurate or unexpected results. Coaxial transmission lines are attractive solutions for moisture content analysis of soil samples by measuring response over a wide frequency band.

Coaxial transmission lines can be grouped into methods requiring calibration [4-13] and those with no calibration [14, 15]. The advantage of the latter methods is that their accuracy is not essentially influenced by any improper calibration standard used in the calibration procedure. The method in [14] needs two identical lines with different lengths and a sample holder whose position should be kept fixed during the measurement process. These requirements might be difficult especially for multiple soil sample measurements. In order to eliminate both of these drawbacks, in our recent study [15], we have developed another calibration-independent method for soil moisture measurement using one measurement cell and a sample holder whose position could be anywhere in the

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measurement cell. Although efficient, this method requires accurate knowledge of electromagnetic properties and thickness of the plug before starting to permittivity measurement of soil samples (and then moisture measurement of soil samples). In this paper, we examine the effect of inaccurate knowledge of thickness of the plug on extracted permittivity of soil samples.

2 MATERIAL AND METHOD

The configuration that we consider is shown in Fig. 1 [15]. Fig. 1(a) illustrates the measurement configuration that the empty measurement cell is connected between two error networks X and Y, which describe some repeatable errors of the measuring instrument (vector network analyser (VNA) with no prior calibration and effects of adapters. Fig. 1(b) demonstrates the same configuration of the Fig. 1(a) except that a samples holder (a dielectric material) with length L_h is positioned into any suitable place with the cell. Fig. 1(c) shows the configuration of the measurement cell with sample holder after soil sample with length L_s is poured over the sample holder.

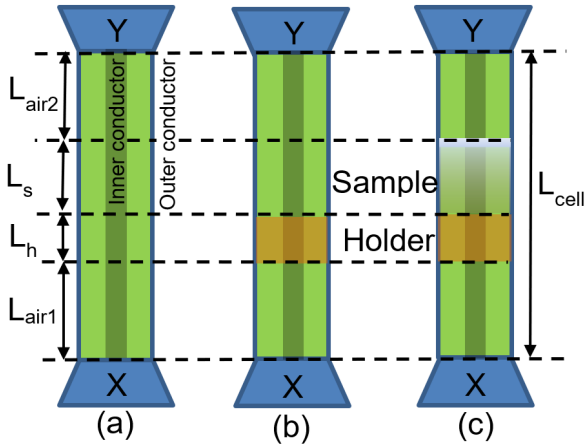

Figure 1. Measurement configurations in implementation of our method. (a) An empty line (with no sample holder and soil sample), (b) the line loaded with a sample holder with length L_h, and (c) the line with soil sample with length L_s poured over the sample holder

Assuming M_a, M_b, and M_c denote, respectively, the wave-cascading matrices (WCMs) of the measurement configurations in Figs. 1(a)-1(c), permittivity of the soil sample can be determined [15] by using

$$\varepsilon_{rs} = \left[\frac{j\ln(P_s)\mp 2\pi m}{k_0 L_s}\right]^2 \tag{1}$$

where

$$P_s = \frac{(\Lambda_1-\Lambda_2)\Lambda_3-(\Lambda_1+\Lambda_2)\Lambda_4}{\Omega_1(\Lambda_1-\Lambda_2)-\Omega_2\Lambda_4} \tag{2}$$

$$\Lambda_1 = \frac{Q}{4}\left(P_h+\frac{1}{P_h}\right)-\frac{R}{8}\left(z_h+\frac{1}{z_h}\right)\left(P_h-\frac{1}{P_h}\right) \tag{3}$$

$$\Lambda_2 = \frac{R}{8}\left(P_h+\frac{1}{P_h}\right)\left(z_h+\frac{1}{z_h}\right)-\frac{Q}{8}\left(P_h-\frac{1}{P_h}\right)\left(\frac{z_s}{z_h}+\frac{z_h}{z_s}\right) \tag{4}$$

$$\Lambda_3 = \Lambda_5+\Lambda_6\left(z_s+\frac{1}{z_s}\right), \quad \Lambda_5 = \frac{1}{2}\left(P_{s0}+\frac{1}{P_{s0}}\right), \tag{5}$$

$$\Lambda_4 = \Lambda_5-\Lambda_6\left(z_s+\frac{1}{z_s}\right), \quad \Lambda_6 = \frac{1}{4}\left(P_{s0}-\frac{1}{P_{s0}}\right), \tag{6}$$

$$Q = P_{s0}P_{h0}+\frac{1}{P_{s0}P_{h0}}, \quad R = P_{s0}P_{h0}-\frac{1}{P_{s0}P_{h0}}, \tag{7}$$

$$\Omega_1 = \frac{1}{2}\left(P_s+\frac{1}{P_s}\right)\left(P_{s0}+\frac{1}{P_{s0}}\right)-\frac{1}{4}\left(z_s+\frac{1}{z_s}\right)\left(P_s-\frac{1}{P_s}\right)\left(P_{s0}-\frac{1}{P_{s0}}\right) \tag{8}$$

$$\Omega_2 = \Lambda_1\left(P_s+\frac{1}{P_s}\right)-\Lambda_2\left(P_s-\frac{1}{P_s}\right) \tag{9}$$

after z_s is determined by using a suitable numerical method from

$$F(z_s) = \xi_1 z_s^6 + \xi_2 z_s^5 + \xi_3 z_s^4 + \xi_4 z_s^3 + \xi_5 z_s^2 + \xi_6 z_s + \xi_7 = 0 \tag{10}$$

$$\xi_1 = \Lambda_6(\chi_1^2 - 4\chi_2^2), \quad \xi_7 = \Lambda_6(\chi_6^2 - 4\chi_5^2), \tag{11}$$

$$\xi_2 = \Lambda_5(\chi_1^2 + 4\chi_2^2) + 2(\Lambda_6\chi_3 - \Omega_1\chi_1)\chi_4, \tag{12}$$

$$\xi_3 = \Lambda_6(\chi_1^2 - 4\chi_2^2 + \chi_3^2 + 2\chi_1\chi_6 - 8\chi_2\chi_5) - 2(\Omega_1\chi_2 + \Lambda_5\chi_1)\chi_3, \tag{13}$$

$$\xi_4 = \Lambda_5(\chi_3^2 + 2\chi_1\chi_6 + 8\chi_2\chi_5) + 2\Lambda_6\chi_3(\chi_4 - \chi_6) + 2\Omega_1(\chi_2\chi_6 + \chi_1\chi_5), \tag{14}$$

$$\xi_5 = \Lambda_6(\chi_3^2 + \chi_6^2 - 4\chi_5^2 + 2\chi_1\chi_6 - 8\chi_2\chi_5) - 2\chi_3(\Lambda_5\chi_6 + \Omega_1\chi_5), \tag{15}$$

$$\xi_6 = \Lambda_5(\chi_6^2 + \chi_5^2) + 2(\Omega_1\chi_5 - \Lambda_6\chi_3)\chi_6, \tag{16}$$

$$\Lambda_7 = \frac{1}{8}\left[R\left(P_h + \frac{1}{P_h}\right) - \frac{1}{z_h}Q\left(P_h - \frac{1}{P_h}\right)\right], \tag{17}$$

$$\Lambda_8 = \frac{1}{8}\left[R\left(P_h + \frac{1}{P_h}\right) - z_h Q\left(P_h - \frac{1}{P_h}\right)\right], \tag{18}$$

$$\chi_1 = \Omega_1\Lambda_7 - \Omega_2\Lambda_6, \quad \chi_2 = \Lambda_1\Lambda_6 - \Lambda_6\Lambda_7, \tag{19}$$

$$\chi_3 = \Omega_1\Lambda_1 - \Omega_2\Lambda_5, \quad \chi_4 = \Omega_2\Lambda_6 - \Omega_1\Lambda_7, \tag{20}$$

$$\chi_5 = \Lambda_1\Lambda_6 - \Lambda_5\Lambda_8, \quad \chi_6 = \Omega_1\Lambda_8 - \Omega_2\Lambda_6, \tag{21}$$

$$P_{s0} = e^{-jk_0L_s}, \quad P_{h0} = e^{-jk_0L_h}, \quad z_h = \sqrt{1/\varepsilon_{rh}}.$$

Here, ε_{rh} is the relative permittivity of sample holder.

3 RESULTS AND DISCUSSION

Simulations were performed by using a commercial 3D electromagnetic simulation program (CST Microwave Studio) to examine the effect of inaccurate knowledge of thickness information on the sample holder. Error networks X and Y were, respectively, accounted for polytetrafluoroethylene (PTFE) and Arlon Ad 250 materials with lengths of 5 mm. The sample holder and the soil sample were simulated by a polyimide material with relative complex permittivity $\varepsilon_{rh} = 3.5 - j0.0095$ ($L_h = 5$ mm) and a material with relative complex permittivity $\varepsilon_{rs} = 3.0 - j0.005$ ($L_s = 8$ mm). Coaxial line was assumed to be constructed by a copper material ($\sigma = 5.8 \times 10^7$ S/m) with inner and outer radii of 8.45 mm and 19.4 mm and a length of $L_{cell} = 150$ mm. Boundary conditions of zero tangential electric field were applied over the conducting inner and outer line lateral surfaces. Time-domain solver was activated in the simulations (-80 dB accuracy with adaptive meshing) [14,15]. Figs. 2(a) and 2(b) illustrate over 1.2-3.0 GHz the real and imaginary parts of extracted ε_{rs} using the expressions in (1)-(21) for various variations in sample holder length L_h.

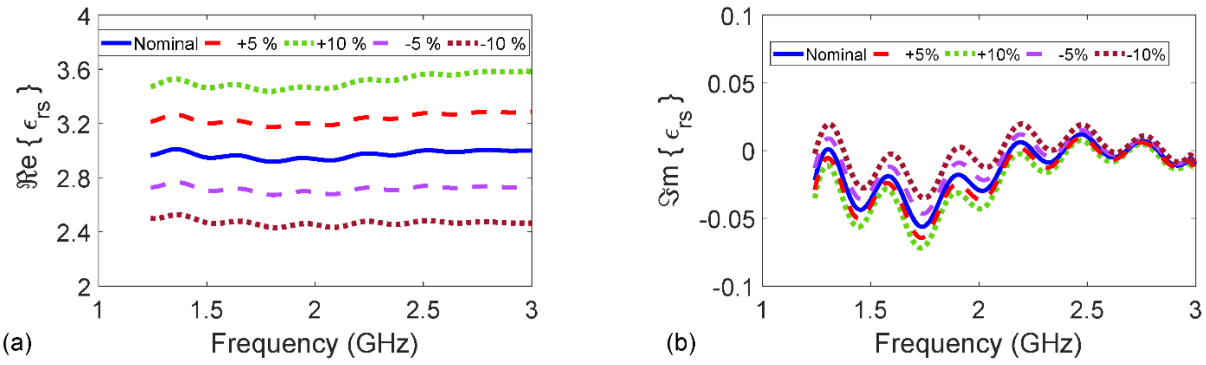

Figure 2. Extracted (a) real and (b) imaginary parts of the relative complex permittivity ε_{rs} of soil sample for different soil holder length L_h (Nominal, ±5%, and ±10%)

It is seen from Figs. 2(a) and 2(b) that while real part of ε_{rs} is seriously affected by an inaccurate information of soil holder length L_h, its imaginary part is slightly influenced by the same effect. This is due to that fact that extracted real part of ε_{rs} will be affected more than its imaginary part for relatively low-loss soil sample holders. Besides, it is noted from the dependencies in Fig. 2(a) that an increase in L_h produces an increase in the real part of ε_{rs}.

4 CONCLUSION

We have examined the effect of inaccurate knowledge of the sample holder thickness of a retrieval method on extracted relative complex permittivity of soil samples. Such an analysis is needed to evaluate the performance of this extraction procedure. It is observed from simulations that real part of the relative complex permittivity of soil sample is seriously influenced by an inaccurate information about the sample holder. As a future study, we are thinking to develop an extraction method not relying on sample holder thickness for improving the accuracy of the extraction procedure.

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Effect of Temperature Variation on the Mechanical Behavior of Composite Plates Reinforced on Both Sides by Carbon Fiber Patches

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Abstract

This paper describes the effect of the temperature on the mechanical behavior of Glass/epoxy structures reinforced by composite patches for different stacking sequences. Among the different reinforcement or repair techniques, the operation of double sided bonded joints was considered in this contribution. It consists in searching the optimal stacking sequence of the carbon fiber patches capable of better resisting in tension. When the structure is submitted to uniaxial traction and works in cold or hot environments, the use of composite patches with more efficient reinforcements and more resistant to the effect of temperature will only lead us to consider carbon fibers. Composite adhesive patches consist of a single ply of arbitrary orientation +θ or multiple alternate plies at +θ/-θ and the stacking sequence of the plate to be reinforced is $[+\theta/-\theta]_{2S}$. In order to study the effect of the number of plies on the improvement of the whole mechanical strength, it has been considered two composite patches with double sides, composed of 2 to 16 plies. The effect of the anisotropic nature of the carbon fiber on the mechanical behavior of the hybrid laminates considered has been observed. Also, the increase in temperature greatly influences the mechanical strength of the thermosetting epoxy resin.

Keywords: *Composite, Patch, Repair, Temperature, Stacking*

1 INTRODUCTION

Different reinforcement techniques, when the structure is weakened, or repair when cracks appear, are adopted by bonding composite patches. They can be double overlapped when bonded on both sides of the original plate. The efficiency of the search for the optimal stacking sequence of the composite patches contributes to the improvement of the mechanical strength of the considered plate. A good choice is necessary to obtain better results of reinforcement and rehabilitation. When the plate is submitted to uniaxial traction and works in cold or hot environments, the use of composite patches with more efficient reinforcements and more resistant to the effect of temperature will only lead us to consider carbon fibers such. Combining these high performance fibers with commonly used E-glass forms a glass-carbon/epoxy hybrid laminate. Just take into account that carbon fiber is anisotropic in nature and glass fiber is isotropic.

The study of the mechanical behavior of this type of hybrid composite materials has particularly developed in recent years given their interest in solving some important strength problems [1-3]. Moleiro et al. [4] have developed a mixed least squares formulation to calculate hybrid composite laminates which are the association of metal fibers and sandwich plates under hygro-thermo-mechanical loadings. Zheng et al. [5] have investigated experimentally carbon-aramid hybrids. The elastic properties and surface deformation of the composites were measured under axial tensile loading to failure utilizing the Digital Image Correlation (DIC) technique. Kim et al. [6] have considered the hybrid glass/carbon composite bumper beam. It was designed and manufactured through the process of design optimization combined with impact analysis. The glass/carbon mat thermoplastic composite was designed to replace conventional glass mat thermoplastic and reduce the weight of the bumper beam.

It is therefore interesting to study the thermomechanical behavior of mixed fiber composite materials to define the effectiveness of the search for the optimal stacking sequence of double bonded carbon/epoxy patches capable of reinforcing the glass/epoxy plate.

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2 STRENGTHENING AND REPAIR TECHNIQUES

The detection of different damage phenomena by non-destructive testing and their resolution by repair and the search for methods of reinforcing structures find today more and more industrial application. Various repair methods exist, including the placement of bolts or rivets. The disadvantage of these methods, however, lies in the singular field of stresses which appears in the connections.

In order to avoid stress concentrations, a possible solution then consists of sticking a composite patch on the defective region of the structure in order to better reinforce the damaged area and thus delay the rupture phenomenon and subsequently increase its lifespan. Methods for repairing damaged materials are promising solutions (Figure 1). As composite materials differ from conventional materials by their lightness and their high resistance, they do not recover after damage. For this reason, it is necessary to resort to repair methods, represented by the bonding of a single or double-sided strapped bonded joint, or preventive by reinforcing the structure with a patch bonded on one side (single-sided bonded joint), or on both sides (double-sided bonded joint).

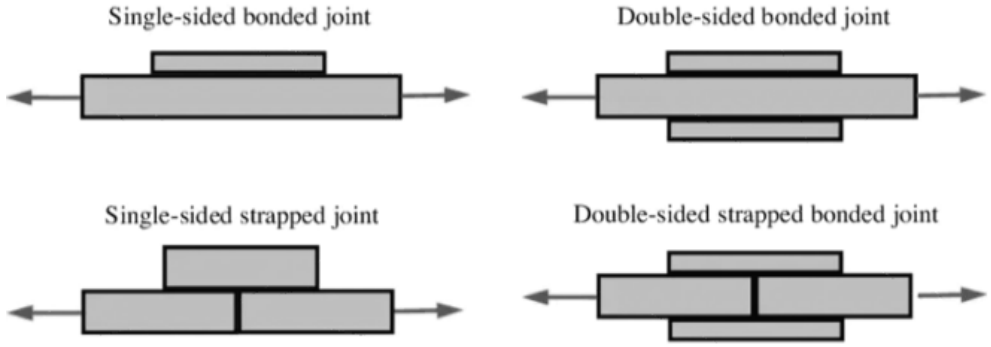

Figure 1. Main configurations of bonding repairs

3 THERMO-MECHANICAL BEHAVIOR CHARACTERIZATION

Reinforcement of weakened composite structures is generally achieved by bonding double-sided bonded composite patches to form symmetrical laminates. So, it is necessary to study this type of composite materials. Their analysis is more complex than that of a traditional material structure. Its behavior depends on many parameters related to its constitution and the processes of implementation. The whole of the elements necessary to the study of the mechanical behavior of a composite material must take into account the anisotropic character of the mechanical properties of basic material, as well on the stiffness plans as strength. These mechanical characteristics must thus be concentrated in the direction of the fibers so that the structure can support states of external solicitations in several directions.

The classical theory of linear elasticity utilizes the generalized Hooke's law in order to obtain the stresses tensor (σ) relating to that of the strains (ε):

$$\sigma_i = C_{ij}\,\varepsilon_j \qquad \text{i,j=1,…..,6} \tag{1}$$

where C_{ij} is the stiffness matrix. An unrestrained composite may change both its size and shape when the temperature is increased or decreased uniformly by ΔT. Under the combined effect of the stresses and temperature, the thermomechanical behavior of the k^{th} layer of a multilayered laminate in the coordinate axes x,y (Figure 2) can be written in the in-plane loading, in terms of the transformed reduced stiffnesses $\overline{Q_{ij}}$ [7]:

$$\begin{Bmatrix}\sigma_x\\ \sigma_y\\ \tau_{xy}\end{Bmatrix}_k = \begin{bmatrix}\overline{Q}_{11} & \overline{Q}_{12} & \overline{Q}_{16}\\ \overline{Q}_{12} & \overline{Q}_{22} & \overline{Q}_{26}\\ \overline{Q}_{16} & \overline{Q}_{26} & \overline{Q}_{66}\end{bmatrix}_k \begin{Bmatrix}\varepsilon_x - \alpha_x\Delta T\\ \varepsilon_y - \alpha_y\Delta T\\ \gamma_{xy} - \alpha_{xy}\Delta T\end{Bmatrix}_k \tag{2}$$

The terms α_x, α_y and are the coefficients of thermal expansion in body coordinates.

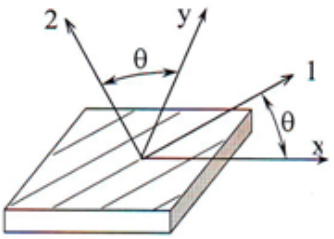

Figure 2. Coordinate systems of the k[th] layer of a multilayered laminate

The superposition of many layers forms a laminate. One of the fundamental advantages of laminates is their ability to adapt and control the orientation of fibers so that the material can best resist loadings. It is therefore important to know how the plies contribute to the laminate resistance, taking into account their relative orientation with respect to the loading direction. The behavior of the symmetrical laminate when it is subjected to a combination of loadings is described by the classical lamination theory [8]. By virtue of the Kirchhoff hypothesis, the in-plane strains are a linear function of the transverse coordinate z. This theory of negligible transverse shear strains, γ_{xz} and γ_{yz}, and negligible transverse normal strain, ε_z, constitutes a statement of a linear variation of strain through the laminate thickness.

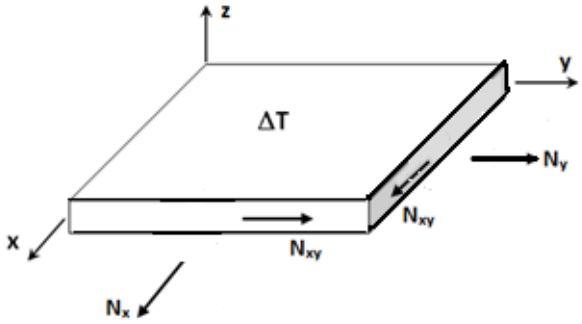

Figure 3. In-plane forces on a flat laminate under temperature change

When the variation in temperature is considered, which is assumed to be identical in all plies of the laminate, and the ply stress-strain relations, equation (2), are substituted, the resultant forces acting on a laminate (Figure 3) are obtained in terms of middle-surface strains ε^0_{ij} :

$$\begin{Bmatrix} N_x \\ N_y \\ N_{xy} \end{Bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{16} \\ A_{12} & A_{22} & A_{26} \\ A_{16} & A_{26} & A_{66} \end{bmatrix} \begin{Bmatrix} \varepsilon_x^o \\ \varepsilon_y^o \\ \gamma_{xy}^o \end{Bmatrix} - \begin{Bmatrix} N_x^T \\ N_y^T \\ N_{xy}^T \end{Bmatrix} \tag{3}$$

in which the A_{ij} is the usual extensional stiffnesses and defined by:

$$A_{ij} = \sum_{k=1}^{N} \left(\overline{Q_{ij}}\right)_k e_k \tag{4}$$

wherin e_k is the thikness. The thermal forces are :

$$\begin{Bmatrix} N_x^T \\ N_y^T \\ N_{xy}^T \end{Bmatrix} = \int \begin{bmatrix} \overline{Q}_{11} & \overline{Q}_{12} & \overline{Q}_{16} \\ \overline{Q}_{12} & \overline{Q}_{22} & \overline{Q}_{26} \\ \overline{Q}_{16} & \overline{Q}_{26} & \overline{Q}_{66} \end{bmatrix}_k \begin{Bmatrix} \alpha_x \\ \alpha_y \\ \alpha_{xy} \end{Bmatrix}_k \Delta T dz \tag{5}$$

4 LAMİNATE STRENGTH CRİTERİA ANALYSIS

The evaluation of the glass-carbon/epoxy hybrid composite behavior, used at different temperatures and working in tension, is based on a prediction calculation of its limiting strength which can support during its loading (Figure 4).

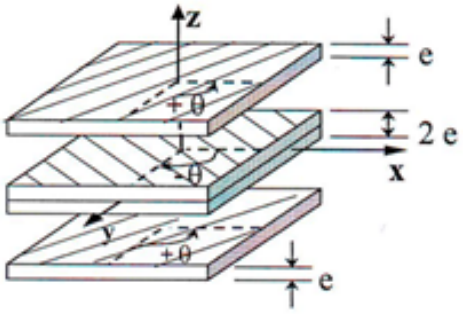

Figure 4. Coordinate systems of the multilayered laminate

The determination of this latter by using failure criteria can occur in different modes depending on the reinforcement nature and the fiber orientation. It is necessary to predict the loads that cause the failure of the first individual ply by crack formation and the laminate as a whole. For the lamina, this problem can be readily solved if the material strength is predicted by a failure criterion. In the case of the material reinforced with unidirectional fibers, Tsai-Hill criterion is a model of dependence between strain modes related to the distortion energy [7]. This latter must be applied to determine the maximum values of N_x with respect to the temperature change ΔT that can be sustained without failure of any ply. The stresses in a material under consideration will be transformed to stresses in the principal material coordinates. The Tsai-Hill failure criterion applied to each ply separately can be expressed in terms of the ultimate strengths and the combined stresses as:

$$\left(\frac{\sigma_1}{X}\right)^2+\left(\frac{\sigma_2}{Y}\right)^2-\frac{\sigma_1\sigma_2}{X^2}+\left(\frac{\tau_{12}}{S}\right)^2\le 1 \tag{6}$$

Wherein X and Y are the longitudinal and the transversal tension stresses of the [0°] ply respectively and S is the maximum shear stress in 1-2 plane of the [0°] ply. This failure criterion predicts then that the lamina fracture would initiate when the combination of stresses reigned in the material reaches the ultimate strengths.

On the other hand, the prediction of the various failure modes and the damage zones (Figure 5) of this least strength ply is determined by the maximum stress theory.

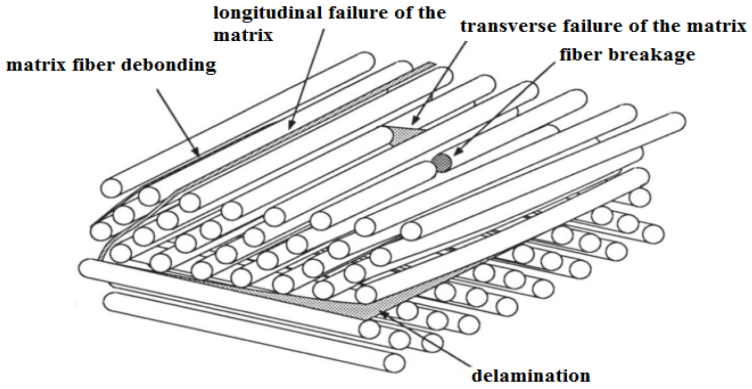

Figure 5. Different failure and damage modes of a composite material

This criterion is based on the assumption that there exist three possible failure modes caused by stresses σ_1, σ_2 and τ_{12} when they reach the corresponding ultimate values as failed:

$$\sigma_1<X \quad , \quad \sigma_2<Y \quad , \quad |\tau_{12}|<S \tag{7}$$

and the failure will be then allotted to the stress corresponding to this inequality.

5 RESULTS

The hybrid composite material considered in this study is the glass-carbon/epoxy. It is reinforced at 60% of its

total volume by unidirectional fibers of different nature. It was assumed under tension loading N_x and temperature change. The E-glass/epoxy composite plate to be reinforced is symmetrical laminate which was composed of four regular plies and its stacking sequence is $[+\theta/-\theta]_{2s}$. The reinforcement of this structure is made by carbon/epoxy patches whose number of component plies varies from 2 to 16. They cover the plate to be reinforced on either side of the average plane to ensure the symmetry of the structure and are oriented at +θ or alternate between +θ and -θ. In this case, the external plies are in carbon/epoxy while those of the interior are in E-glass/epoxy (Figure 6).

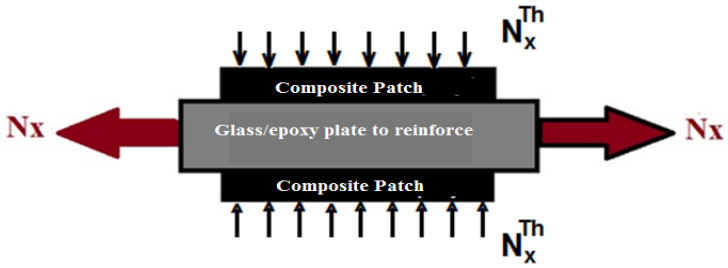

Figure 6. Double-sided bonded joint of E-glass/epoxy composite plate

The elastic characteristics and the thermo-mechanical properties of the different especially orthotropic laminas are reported in Table 1 [7].

Table 1. Elastic constants and thermo-mechanical properties of E-glass/epoxy and carbon/epoxy unidirectional plies

Composite materials	E_1 [Gpa]	E_2 [Gpa]	G_{12} [Gpa]	ν_{12}	X [Gpa]	Y [Mpa]	S [Mpa]	$\alpha_1.10^{-5}$ [°C^{-1}]	$\alpha_2.10^{-5}$ [°C^{-1}]
E-Glass/Epoxy	45	12	4.5	0.3	1.25	35	63	0.4	1.6
Carbone /Epoxy	134	7	4.2	0.25	1.27	42	63	-0.12	3.4

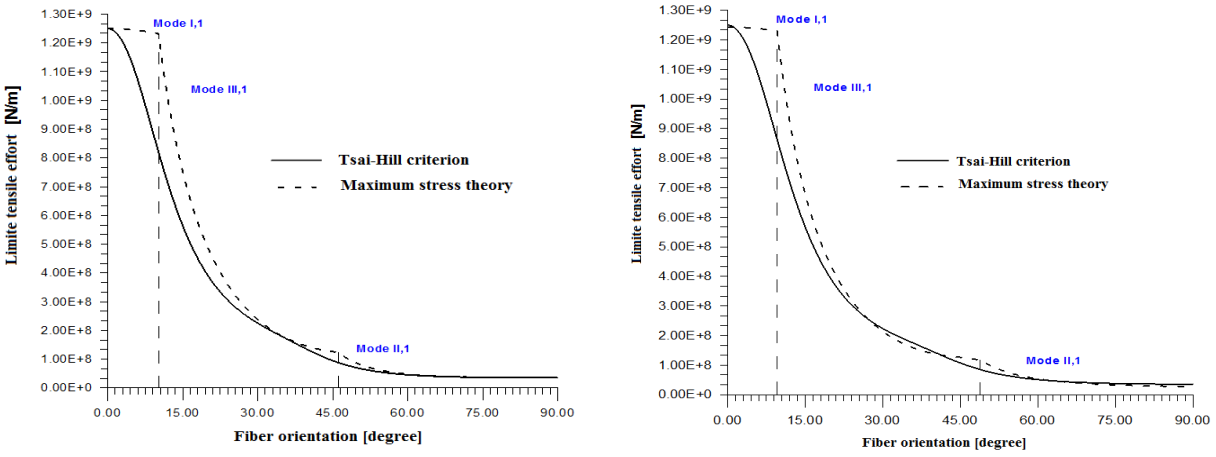

Figure 7. Ultimate tensile strength of $[+\theta/-\theta]_{2S}$ E-glass/epoxy under temperature change: **(a)** 25 °C, **(b)** 100°C

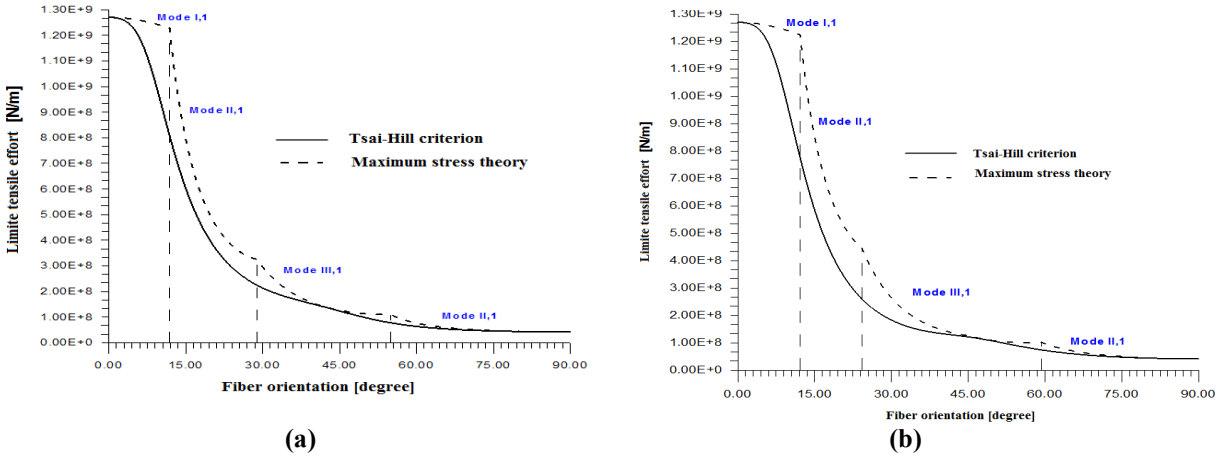

Figure 8. ultimate tensile strength of $[+\theta/-\theta]_{2S}$ carbon/epoxy under temperature change: **(a)** 25 °C, **(b)** 100°C

The behavior of the E-glass/epoxy and carbon/epoxy composite plates with $[+\theta/-\theta]_{2s}$ stacking sequence under tension loading and temperature change are represented respectively by Figures 7 and 8. It is noticed that their ultimate strength decrease when the fiber orientation θ varies from 0° to 90°. It is the thermosetting resin which is responsible for this degradation. They present three damage zones: the first (mode I) concerns the tensile failure of the fibers, the second (mode III) indicates the shear failure of the epoxy resin parallel to the fibers and the third shows the tensile failure of the matrix. The increase in temperature causes a shrinkage of zone II by promoting rupture by shearing of the matrix. On the other hand, the carbon/epoxy material presents a repetition of mode II and an irregularity in its profile due to the anisotropic nature of the fiber material.

Figure 9 shows, under temperature change, the ultimate strength of E-glass/epoxy composite plates reinforced with double-lap carbon/epoxy patches and consisting of a single ply of +θ orientation bonded on each face of the plate. In this case, it was found that the resistance improvement objectives are only achieved from orientation 39° orientation. The increase of the E-glass/epoxy material strength and under different temperatures is only possible with the bonding of an E-glass/epoxy patch. The use of the same material makes it possible to avoid the unfavorable consequences of the anisotropy of the carbon fiber, especially at orientations near to 0°, and result in mechanical behavior with a continuous and uniform appearance.

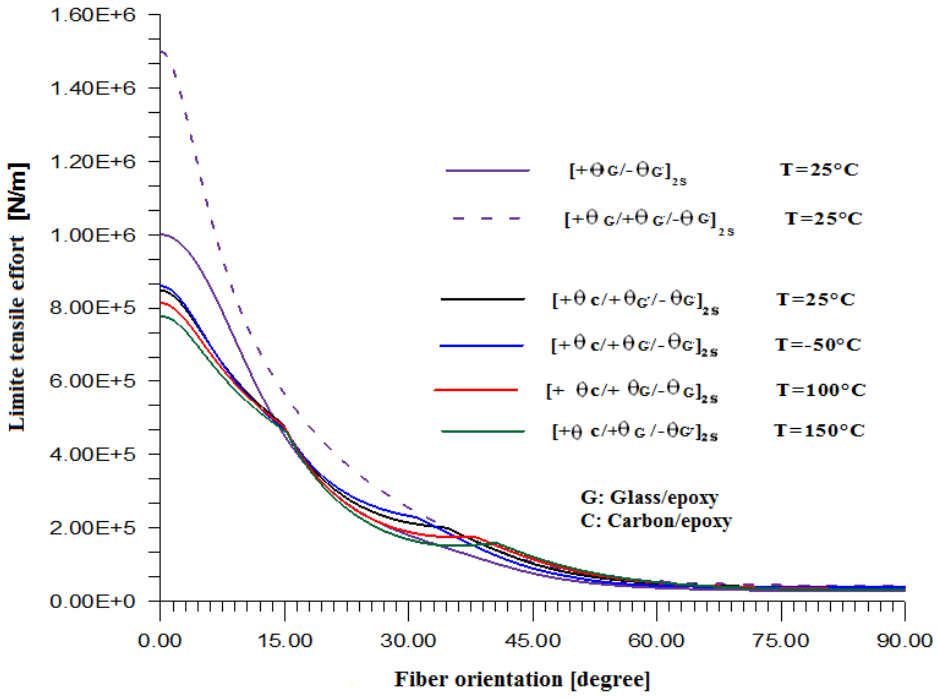

Figure 9. Variation in the tensile strength of the $[+\theta/-\theta]_{2S}$ glass-E/epoxy plate reinforced by two single-ply carbon/epoxy patches with +θ orientations as a function of temperature change.

The use of composite patches increases the mechanical strength of the E-glass/epoxy plate when they are composed of two layers of carbon/epoxy alternated between +θ/-θ (Figure 10). But on the other hand, the only use of E-glass/epoxy patches increases the mechanical strength more significantly and more precisely at orientations lower than 36°. The consideration of carbon fiber disrupted the progressive decrease in the mechanical strength of the sysytem. It is the anisotropic nature of this fiber which is responsible for this behavior.

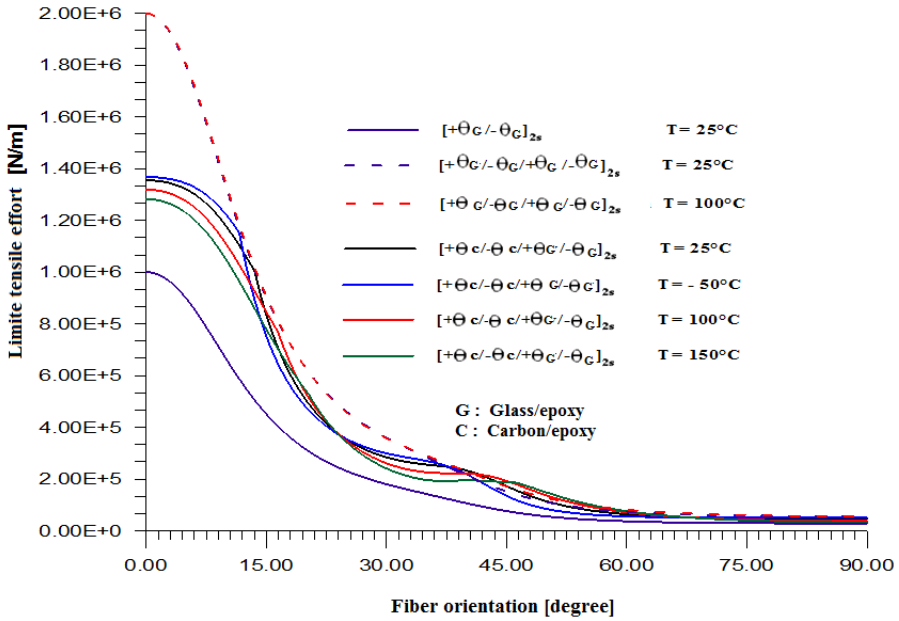

Figure 10. Variation in the tensile strength of the $[+\theta/-\theta]_{2S}$ E-glass/epoxy plate reinforced by two carbon/epoxy patches composed of 2 layers [+θ/-θ as a function of the temperature change.

Figure 11 represents the evolution of the mechanical strength of the E-glass/epoxy composite plates with stacking sequence $[+\theta/-\theta]_{2S}$ reinforced by two composite patches of carbon/epoxy compound each of three alternating plies at +θ/-θ/+θ and therefore have a set of 10 plies $[+\theta_c/-\theta_c/+\theta_c/+\theta_G/-\theta_G]_{2S}$. From these curves, it was shown the effect of the number of plies of the patches on the improvement of the mechanical strength of the system. It was noticed an increase in the strength of the hybrids compared to the other cases described previously. The shape of the curves remains irregular around 45°. Also, the weak effect of temperature on the mechanical behavior of the system was noted.

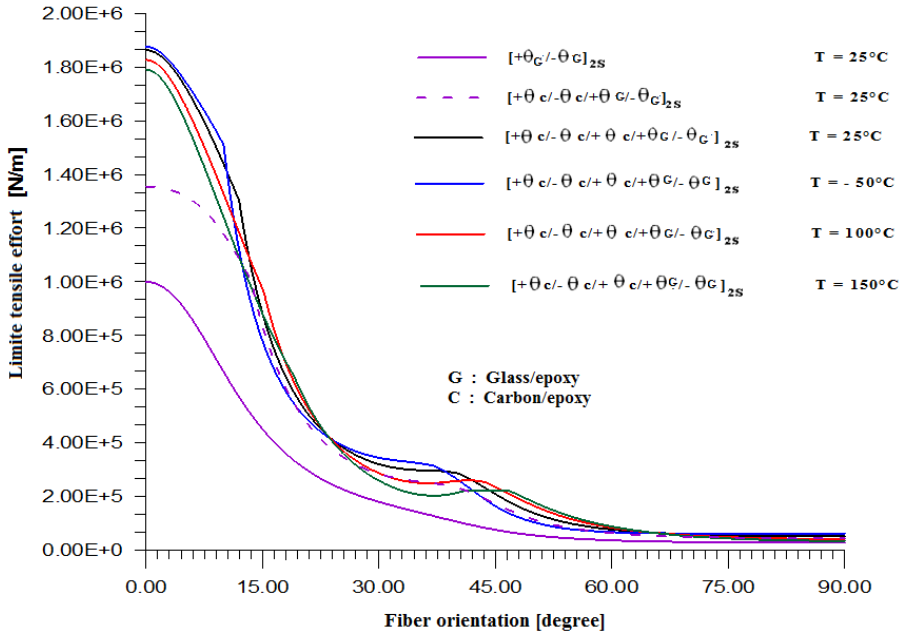

Figure 11. Variation in the tensile strength of the $[+\theta/-\theta]_{2S}$ E-glass/epoxy plate reinforced by two carbon/epoxy patches composed of 3 layers [+θ/-θ/+θ as a function of the temperature change.

If the number of layers of carbon/epoxy is increased by forming a hybrid of 20 layers with mixed fibers, of stacking sequences $[+\theta_c/-\theta_c/+\theta_c/-\theta_c/+\theta_c/-\theta_c/+\theta_c/-\theta_c/+\theta_G/-\theta_G]_{2S}$. This solution shown in Figure 12 makes it possible to obtain a very resistant assembly having behavior similar to that of the previous case. Likewise, the change in temperature was found to have weak influence on the strength of the hybrids.

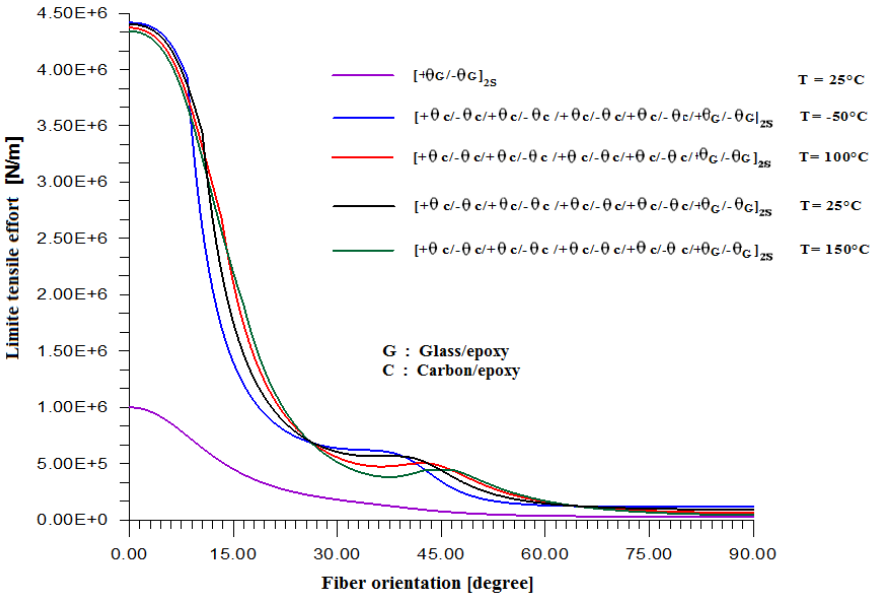

Figure 12. Variation in the tensile strength of the $[+\theta/-\theta]_{2S}$ E-glass/epoxy plate reinforced by two carbon/epoxy patches composed of 8 layers [+θ/-θ/+θ/… as a function of the temperature change.

6 CONCLUSION

In this study, E-glass/epoxy composite plates were considered, with $[+\theta/-\theta]_{2S}$ stacking sequence, under uniaxial tension and subjected to different temperatures T= -50°C, 100°C or 150°C. To strengthen it well and rehabilitate it to these different loading conditions, it is preferred to use carbon/epoxy composite patches. In order to support the effectiveness of this reinforcement method, different solutions for stacking composite patches have been proposed. The only use of plies of the same istropic material (E-glass/epoxy) or the increase in the number of plies constituting the composite patches contribute to improving the thermomechanical strength of the entire structure. Under the action of an increase in temperature, the thermosetting resin becomes more resistant.

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Pullulan Active Packaging Incorporated with Green Silver Nanoparticles to Enhance the Shelf-Life of Broiler Chicken Meat

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Abstract

Broiler meat can provide an appropriate environment for the microbial intensification, resulting in the lipid and protein oxidation and physico-chemical degradation. The utilization of the antioxidants prevents meat degradation and human health challenges by preventing meat physicochemical characteristics. Therefore, the impact of pullulan active packaging, incorporated with curcumin and pullulan mediated silver nanoparticles (C-AgNPs, P-AgNPs) on broiler meat was determined in the current study for 14 days of refrigerated storage at 4 ± 1 °C. A total of 120 broiler birds were reared for clean meat production and divided into 4 treatment groups (PF-CTRL, PFC-AgNPs, PF-P-AgNPs, PF-M-AgNPs). Broiler meat treated with pullulan active packaging incorporated with curcumin arbitrated AgNPs (PF-C-AgNPs) had significantly higher oxidative stability ($p = .000$). The current study confirms that the pullulan active packaging, incorporated with curcumin arbitrated silver nanoparticles (PF-C-AgNPs) followed by pullulan active meat packaging incorporated with pullulan mediated silver nanoparticles (PF-P-AgNPs) had minimal oxidative rancidity in 14 days of storage. It is concluded that PF-C-AgNPs and PF-P-AgNPs can be a safer antioxidant alternative to preserve broiler meat quality and oxidative stability with a prolonged shelf life.

Keywords: *Chicken, Shelf-life, Active packaging, Nanoparticle*

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Development of a Simple, Cheap, and High-Sensitivity Metamaterial Sensor Concept

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Abstract

In this study, unlike the traditional metamaterial sensor concept, a high-sensitivity metamaterial sensor concept was developed by changing the position of the split ring resonator structure in the design. In addition, the FR-4 dielectric substrate used in the developed metamaterial sensor is easily available in the market and is cheap, both in terms of size and type. In this respect, the proposed concept study is a highly competitive design in terms of both its simple and cheap implementation and its high sensitivity.

Keywords: *Metamaterial sensor, Split ring resonator, Simple design, High sensitivity, Cheap*

1 INTRODUCTION

Artificially produced metamaterials, which differ from traditional materials in nature due to their negative refractive index feature, find a place in many sectors and application areas due to their extraordinary properties [1]. These materials have many potential applications such as electromagnetic cloak [2], sensor [3], energy harvesting [4], signal absorption [5], antenna [6], etc. Recently, metamaterials have found a wide place especially as sensors, and many different sensor types have been reported in the literature, ranging from temperature [7], humidity [8] and pressure [9] sensors to microwave [10] and optical sensors [11].

In the metamaterial sensor concept, properties of materials such as humidity, temperature, dielectric constant, purity, etc. are determined according to the sensor type by using the changes of resonance frequency and/or Q factor (or S_{21} value, dB) data [12, 13]. Therefore, the sensitivity of the sensor topology to be designed is very important. In this direction, in our study, a three-layer metamaterial sensor concept was proposed and a concept study that increased the sensor sensitivity compared to traditional use was verified through an electromagnetic simulation program. A simple design based on bianisotropic split ring resonator (SRR) topology was used in the sensor design. In addition, the substrate on which SRR is designed is easily available in the market and is cheap, both in terms of size and type. In this respect, the proposed concept study is a highly competitive design in terms of both its simple and cheap implementation and its high sensitivity.

2 MATERIAL AND METHOD

Like other metamaterial sensors in the literature, the traditional metamaterial sensor structure, designed in a three-layered and bianisotropic topology as SRR layer–sensing layer–SRR layer, is shown in Figure 1(a). In this structure, SRRs designed in a bianisotropic topology are traditionally located outside the SRR layer. However, based on the simulation studies we have carried out, the metamaterial sensor structure we propose is as shown in Figure 1(b). In this structure, SRRs are positioned inside the SRR layer to increase the sensitivity of the sensor. In other words, only the positions of the SRRs were changed without changing the dimensions of the design in Figure 1(a). The SRR and sensing layers and the dimensioning of the SRR structure are given in Figure 2(a) and Figure 2(b), respectively.

In the MM sensor structure shown in Figures 1–2, FR-4 dielectric material with relative dielectric constant ε_{sub} = 4.3, loss tangent $\tan\delta$ = 0.025 and thickness d_{sub} = 1.6 mm was used as the SRR layer. The thickness of the sample to be detected is d_{int} = 1 mm and the relative dielectric constant is ε_{int} (this value varies depending on the material to be detected). The width and length of the SRR and sensing layers are L_w = 3 and L_h = 10.16 mm,

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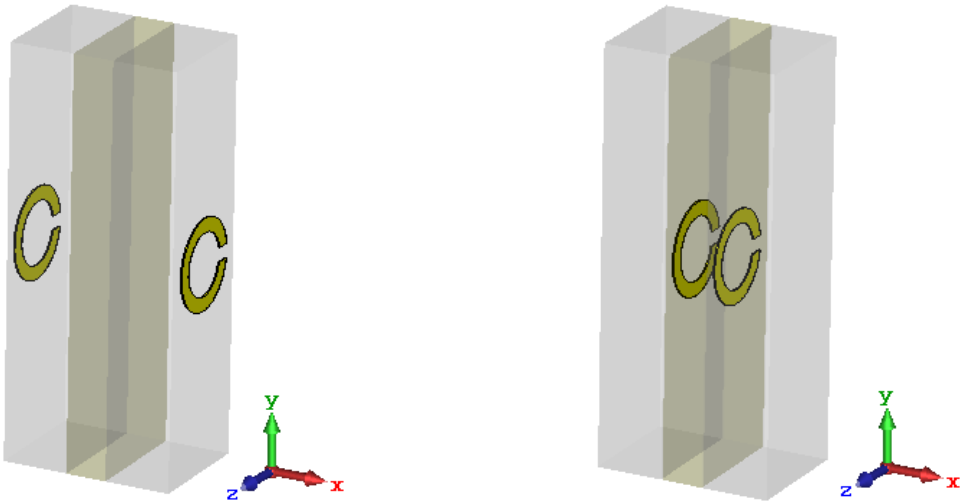
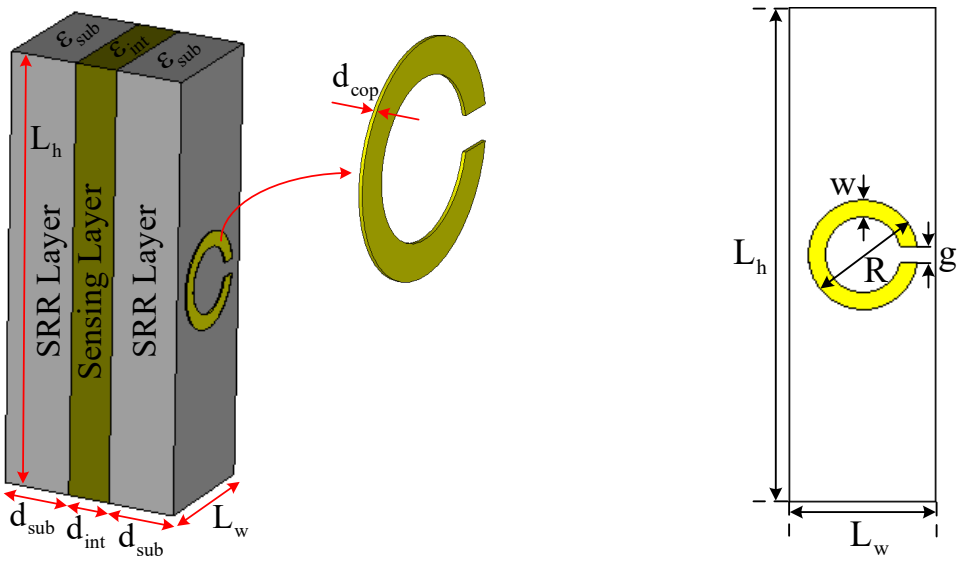
respectively. Copper with thickness $d_{cop} = 35$ µm and electrical conductivity $\sigma_{cop} = 5.8 \times 10^7$ S/m was used as the SRR material. In terms of the conductivity and thickness of the copper used and the electrical properties and thickness of the FR-4 material used, the SRR layer material is easily available in the market and is cheap. If we look at the orientation and geometry of the SRR layer, firstly, a gap with a height of $g = 0.35$ mm was removed from a ring with a diameter of $R = 2.25$ mm and a width of $w = 0.35$ mm. Secondly, the SRR in both sensing layers is positioned at the center of the SRR layer with the gap in the $-z$ -direction for the bianisotropic topology.



(a) (b)

Figure 1. 3D image of (a) traditional and (b) proposed metamaterial sensor structure designed based on bianisotropic SRR topology



(a) (b)

Figure 2. (a) Sizing of the SRR and sensing layers (given as an example for a traditional metamaterial sensor structure based on bianisotropic SRR topology) and (b) sizing of the SRR structure

3 RESULTS

In order to demonstrate the performance of traditional and proposed metamaterial sensors designed based on bianisotropic SRR topology, it is necessary to examine the scattering (S-) parameters versus frequency. For this purpose, simulations for the proposed sensors were carried out with the electromagnetic simulation program CST Microwave Studio. In this direction, the ports were placed at equal distances to the left and right sides of the metamaterial sensor structure, as shown in Figure 3, and a hollow metallic waveguide was created by setting the boundary conditions as perfectly electric conductive boundary conditions.

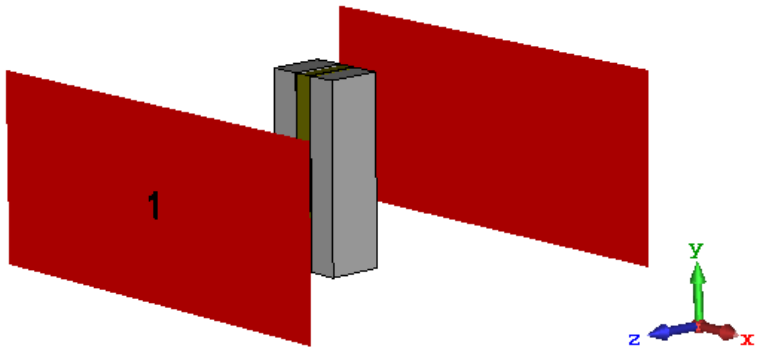


Figure 3. As an example, placement of waveguide ports in CST Microwave Studio for the proposed metamaterial sensor structure designed based on bianisotropic SRR topology

To compare the performance of the traditional and proposed metamaterial sensor concept, simulations were carried out in the frequency range of 10–17 GHz by varying the relative dielectric constant (ε_{int}) of the sensing layer between 1 and 5. Simulation results are given as transmission scattering parameter (S_{21}) versus frequency in Figures 4(a)–(b), and the results are summarized in Table 1.

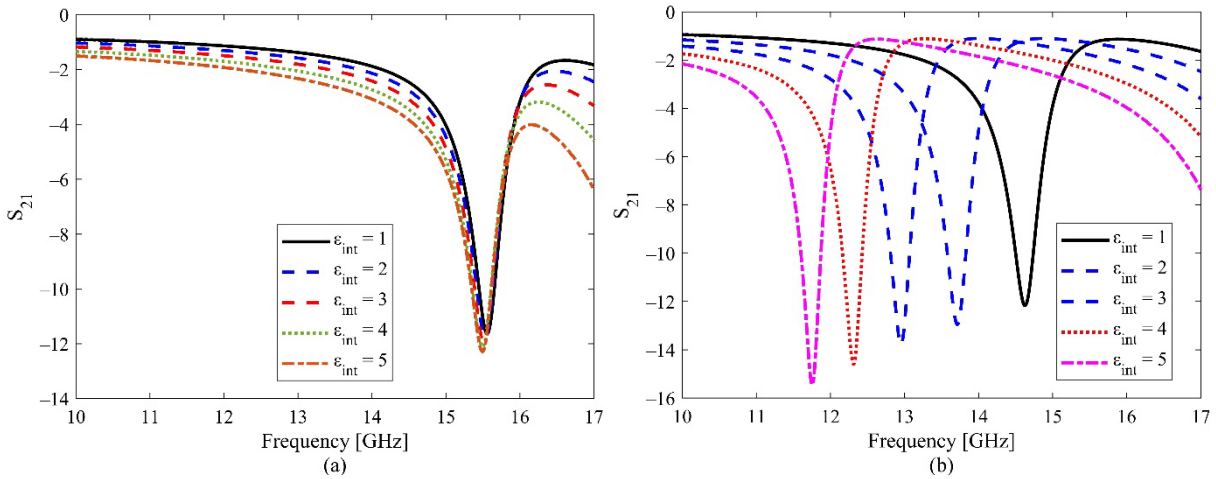


Figure 4. S_{21} parameters of (a) traditional and (b) proposed metamaterial sensor designed based on bianisotropic SRR topology

Table 1. Performance indicators for traditional and proposed metamaterial sensor concepts designed based on bianisotropic SRR topology

ε_{int}	S_{21} [dB]		S_{21} Resonance Frequency [GHz]		Change Between Two Resonances [MHz]		According to the First Resonance Frequency			
							Change [GHz]		Change%	
	Tradit.	Prop.	Tradit.	Prop.	Tradit.	Prop.	Tradit.	Prop.	Tradit.	Prop.
1	– 11.643	– 12.169	15.56	14.63	–	–	–	–	–	–
2	– 11.791	– 12.954	15.53	13.71	30	920	0.03	0.92	0.19	6.29
3	– 11.946	– 13.795	15.51	12.95	20	760	0.05	1.68	0.32	11.48
4	– 12.113	– 14.599	15.49	12.31	20	640	0.07	2.32	0.45	15.86
5	– 12.287	– 15.442	15.49	11.75	0	560	0.07	2.88	0.45	19.69

When Figures 4(a)–4(b) and Table 1 are examined together, the following can be noted when ε_{int} is changed 1 to 5 for the material in the sensing layer. Firstly, it can be seen that for the traditional metamaterial sensor concept, the S_{21} resonance frequency changes by 0.07 GHz compared to the first resonance (moreover, when ε_{int} changes from 4 to 5, the resonance frequency does not change at all, only its magnitude changes), and for the proposed

metamaterial sensor concept, the S_{21} resonance frequency changes by 2.88 GHz compared to the first resonance. Secondly, it can be stated that the percentage change of the S_{21} resonance frequency of the traditional and proposed metamaterial sensor concepts compared to the first resonance is 0.45 and 19.69, respectively. Finally, it is concluded that the proposed metamaterial sensor concept, designed based on the bianisotropic SRR topology, is more than 43 times more sensitive (approximately 43.76 times) than the traditional concept.

Since this study focuses on the development of a simple, cheap, and high-sensitivity metamaterial sensor concept, the high-sensitivity advantage of our proposed concept (where SRRs look at the sensing layer) is mentioned by comparing traditional and proposed metamaterial sensor structures. It should also be noted that with the concept we propose, higher sensitivity sensor designs can be realized by changing both the substrate type and dimensions used, the SRR structure and the SRR topology.

4 CONCLUSION

In this study, the performances of the designed metamaterial sensor structures consisting of the traditional SRR–FR-4 substrate–sensing layer–FR-4 substrate–SRR concept and the proposed FR-4 substrate–SRR–sensing layer–SRR–FR-4 substrate concept were compared. As a result, it was concluded that the proposed metamaterial sensor concept based on bianisotropic SRR topology is approximately 43.76 times more sensitive than the traditional concept. In addition, since FR-4 is used as the dielectric substrate and copper as the SRR material in the design, traditional and proposed metamaterial sensor concepts can be easily realized simply and cheaply, both in terms of the material used and the dimensions of the materials used.

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Current Challenges and Potential of High-Performance Supercapacitors Derived-Metal-Organic Frameworks

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Abstract

The continued increase in the use of fossil fuels has created a higher greenhouse effect, posing a major threat to human well-being as well as the environment. There is a need to develop renewable and clean energy sources in addressing the global energy shortage and pollution crisis. Technological innovations related to net zero energy conversion and climate neutral storage systems are becoming important. Over the past few decades, there has been a huge surge in interest in advancing new technologies, with major efforts directed towards developing more efficient energy storage devices such as batteries and capacitors. However, several disadvantages of batteries, such as low power density and limited charge/discharge cycles, low energy density of traditional capacitors, have limited their use in high-technology applications, leading to the emergence of the high-performance supercapacitor concept. Researchers in both industry and academia are interested in energy conversion and storage systems with exceptional stability and efficiency, making the construction and design of these systems a significant challenge. This mini review focuses on recent advances in supercapacitor applications derived from Metal-Organic Frameworks (MOFs) and its current challenges and future potential.

Keywords: *Metal-organic frameworks, Supercapacitor, Greenhouse effect, Energy storage, Energy conversion*

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Synthesis and Luminescent Properties of Eu^{3+} Doped Lu_2WO_6 Red Phosphors

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Abstract

A series of monoclinic Lu_2WO_6: x Eu^{3+} (x = 0, 0.1, 0.5, 1, 3 and 5 at.%) phosphors were synthesized by high-temperature solid-state reactions. X-ray diffraction (XRD) patterns photoluminescence (PL) excitation and emission spectra, luminescence decay curves and CIE color coordinates were used to study the phosphors. Efficient energy transfer from the host Lu_2WO_6 to the dopant ions Eu^{3+} was demonstrated under UV excitation at 310 nm, making these phosphors suitable for UV LED excitation. A strong red emission was observed for Lu_2WO_6:Eu^{3+}. Concentration quenching of the phosphors is attributed to the interaction between electric dipoles. The Lu_2WO_6:Eu^{3+} phosphors could be a good candidate to be used in WLEDs.

Keywords: *Red phosphors, Solid state reaction, Photoluminescence, Eu^{3+}, X-ray diffraction*

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Analysing Malaysian Technology Sector Using Minimum Spanning Tree: A Case of COVID 19

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Abstract

This study examines the structural changes of the companies listed in the technology sector in Bursa Malaysia during the COVID-19 pandemic. During the hours of trading, the stock price fluctuates constantly rather than staying at one fixed level. As a result, it can be challenging to identify which stock is responsible for a network's stocks' performances and behaviours. We present a thorough investigation of 89 stocks in the technology sector listed in Bursa Malaysia from 2019 to 2021 from a financial database called Eikon Datastream that has resulted from the coronavirus outbreak. A Minimum Spanning Tree (MST) was used to construct and visualise the relationship exhibited among stocks in the technology sector. Additionally, betweenness centrality is used to understand the significance of a particular stock within a financial network. Moreover, the results obtained from this study can be used to identify the most influential stocks on the correlation network in order to provide the information needed to enhance the country's technological development capabilities during the pandemic situation.

Keywords: *Complex network, Minimum spanning tree (MST), Centrality measures, COVID-19, Financial market*

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Evaluation of ZnO Nanostructures Growth on Carbon Nanotubes Cotton

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Abstract

Zinc oxide (ZnO) nanostructures were synthesized on carbon nanotubes cotton (CNTC) network as flexible substrate. The impact of synthesis temperature on structural and morphology of zinc oxide nanostructures via chemical bath deposition method was investigated. The CNTC was derived from environmentally friendly hydrocarbon source of waste cooking palm oil. The nanostructures were grown with prior deposition of ZnO buffer layer for growth patterning localization. It was observed that high temperature influenced the morphology of ZNR grown on CNTC and its aspect ratio. In addition, the electrical conductivity of the ZNR/CNTC hybrid was found to be higher than that of the CNTC alone indicates that the hybridized material provides seamless passage that efficiently allow more electron movement passing through it. This hybrid offers promising future as CNTC substate is flexible, readily available hydrocarbon source, and low cost. It also could be a useful material in the applications of solar energy and sensors.

Keywords: *Carbon nanotubes cotton, Zinc oxide nanostructures, Chemical bath deposition*

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Efficient Wastewater Disinfection through Hydroxide Sludge/Hydrochar Composite-Mediated Photo-Fenton Reaction

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Abstract

The advanced oxidation process was employed to degrade methylene blue (MB) using a hydroxide sludge/hydrochar composite as a catalyst in photo Fenton-like oxidation. The samples before and after the reaction were characterized by XRD, SEM and FTIR techniques. The effect of major parameters, including pH, H_2O_2 concentration and dose of composite on the removal of MB has been studied. The results indicated that the MB decolourisation rate increased with the increase of H_2O_2 concentration and catalyst addition, however, the further increase in H_2O_2 concentration and catalyst dosage could not result in an increase of MB removal efficiency. A high degradation was achieved within 150 min under UV light irradiation at a solution pH of 3.5, a catalyst loading of 2.5 g/L, a H_2O_2 dosage of 1.5 ml/L and MB concentration of 50 mg/L. Recycling studies demonstrated that the composite is a promising heterogeneous photo-Fenton catalyst for longterm removal of MB dye from industrial wastewater.

Keywords: *Advanced oxidation process, Dye, Photo-fenton oxidation, UV light irradiation*

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Repurposing Elastomeric Tubular Membranes and Nanostructured Adhesive Films for Triboelectric Nanogenerators

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Abstract

The current global energy landscape is encountering growing challenges that demand innovative solutions. Triboelectric Nanogenerators (TENG) represent a versatile and promising approach. This study assesses the feasibility of utilizing discarded elastomeric tubular membranes, specifically inner tubes from tires - a commonplace waste material, as a foundational component in TENG devices. Using these membranes benefits the environment and showcases a commitment to sustainable energy solutions. The effectiveness of triboelectric nanogenerators (TENGs) relies on materials that possess high-friction and flexibility properties. Therefore, researchers are investigating the elastomeric tube membrane, considered as a suitable option due to its ability to bend and produce high-friction. The nanostructured adhesive film is crucial to expanding applications and technological advancements. These films contribute substantially to enhancing the performance of TENG devices. Our investigation reveals a distinctive property: the elastomeric tubular membrane functions solely as an electron acceptor, deviating from the anticipated role as an electron donor reported in previous studies. The findings presents a unique chance to improve and optimize TENG systems. Combining recycled rubber membranes and pioneering adhesive films provides an original, sustainable solution to current energy problems. The insights outlined in this article not only broaden the scope of TENG technology but also promote the implementation of environmentally friendly materials, paving the way for a more eco-friendly and sustainable future.

Keywords: *Triboelectric nanogenerators, Elastomeric tubular membranes, Nanostructured adhesive films, Sustainable energy harvesting*

1 INTRODUCTION

Environmental issues, power shortages, and the rising usage of tech devices have highlighted the vital need for sustainable energy sources. The planet's struggling with the negative effects of uncontrolled pollution, deforestation, and the changing climate, underlining the importance of ecologically sound energy solutions. The fast expansion of electronic devices has increased our energy demands, and we rely on fossil fuels that emit harmful greenhouse gases. To tackle this problem, we must transition to sustainable energy sources such as wind, solar, and hydropower. These sources are not only kind to the environment but also inexhaustible. It is essential to invest in eco-friendly technologies and promote energy efficiency to combat environmental degradation, lessen our carbon emissions, and secure a sustainable future for generations to come [1-5].

TENG devices present innovative energy solutions and constitute noteworthy advancements in the energy sector. The potential advantages of TENG devices in pursuing sustainable energy are limitless. These compact and adaptable devices exploit mechanical energy from diverse sources, such as human motion, vibrations, and environmental forces, and convert it into electricity. They have a versatile range of applications in wearable technology, self-powered sensors, and even roads or floors, offering a wide selection of energy-harvesting possibilities. They generate green energy, eliminating fossil fuel requirements and establishing themselves as a clean and renewable energy source. Their capacity to provide power in remote or off-grid areas extends access to electricity in underserved regions. Moreover, TENG devices exhibit high efficiency in converting mechanical energy to electricity, mitigating waste, and preserving resources. TENG gadgets are critical in addressing energy challenges by enabling us to harvest power from our surroundings while promoting a more eco-friendly and sustainable tomorrow [1, 3, 6-8].

Triboelectric Nanogenerators (TENGs) operate on a fascinating scientific principle. TENG devices utilize both the triboelectric effect and electrostatic induction to generate power. When two materials with varying electronegativities come into contact and then separate, they produce a potential difference. This difference leads to the transfer of electrons between the materials, accumulating static charges. TENG devices consist of two

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distinct materials and utilize a mechanical mechanism that induces repetitive contact and separation. This phenomenon leads to an electron flow, ultimately producing an electric current. Adjusting TENGs can enhance their energy conversion efficacy. Furthermore, their adaptability in designs and applications exhibits potential as a renewable energy harvesting remedy [9-12].

Triboelectric Nanogenerators (TENG) offer an inventive solution for generating sustainable energy. By using upcycled materials, their environmental footprint is further reduced. TENG devices function by utilizing the triboelectric effect, wherein an electrostatic charge is generated as two materials with differing electronegativities come into contact and then part ways. What sets TENG apart, however, is its capacity to convert waste or neglected materials into something practical and valuable. By reusing materials, TENG generates electrical power while also aiding in the conservation of resources and reduction of waste. For instance, materials such as inner tube rubber, frequently discarded and headed to landfills, can be repurposed for TENG construction. These materials are highly flexible and durable, rendering them suitable for use as effective contact materials in devices that produce energy through contact [13-16]. Using materials in this manner is eco-friendly as it decreases waste, preserves valuable resources, and contributes to the environment. The collaboration of TENG and upcycling highlights the potential for unique materials to assist in creating ecologically sustainable energy solutions while decreasing environmental damage. This intelligent approach promotes sustainability and underscores the positive impact of repurposing materials towards a more immaculate and verdant future [5, 16-21].

This study evaluates the feasibility of using discarded elastomeric tubular membranes, specifically inner tubes from tires, as a foundational component in TENG devices. These membranes are a common waste material, and their use benefits the environment while demonstrating a commitment to sustainable energy solutions. The effectiveness of triboelectric nanogenerators (TENGs) depends on materials with high-friction and flexibility properties. Researchers are investigating the elastomeric tube membrane as the most suitable option due to its ability to bend and produce high friction. The nanostructured adhesive film is a crucial component with expanding applications and technological advancements, substantially enhancing the performance of TENG devices. Our investigation has revealed a unique property of the elastomeric tubular membrane. As reported in previous studies, it functions solely as an electron acceptor, which is different from its anticipated role as an electron donor. This significant discovery presents a unique opportunity to improve and optimize TENG systems. Combining recycled rubber membrane with pioneering adhesive films can provide an original and sustainable solution to current energy problems. This article expands the scope of TENG technology and promotes the use of environmentally friendly materials, paving the way for a more sustainable future.

2 MATERIAL AND METHOD

Figure 1 shows a photograph of the test setup for TENG measurements. A stepping motor driver connected to the Arduino board provided a regular harmonic motion in this context. This regular harmonic motion controlled the force transmitted to the TENG device. The force applied in the test setup was stabilized using a load cell. The voltage generated by the TENG device was monitored and recorded instantaneously using a digital oscilloscope. In addition, the pressure applied to the TENG device was monitored instantaneously on the computer using Java-based software.

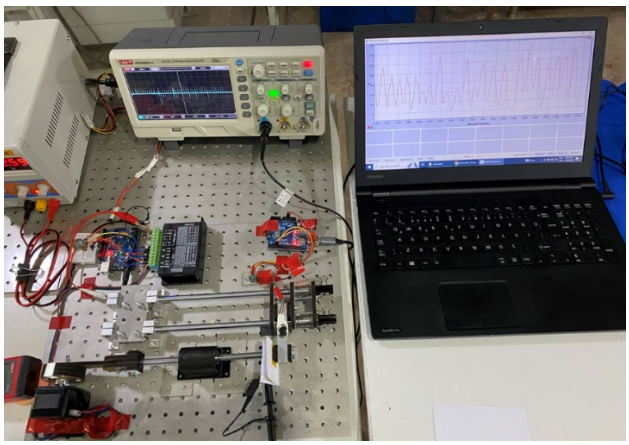

Figure 1. Test setup for TENG measurements

Figure 2 shows a picture of the apparatus made of thick paper used to produce the TENG device. This apparatus ensures that different TENG devices were tested under the same mechanical conditions. Figure 2b shows a detailed

picture of the opened version of the TENG device. This picture shows how the voltage generated by the copper cables through the copper band behind the TENG device was transmitted to the oscilloscope probe. This setup was designed for precise and repeatable measurements and improves the comparability of the performance of TENG devices.

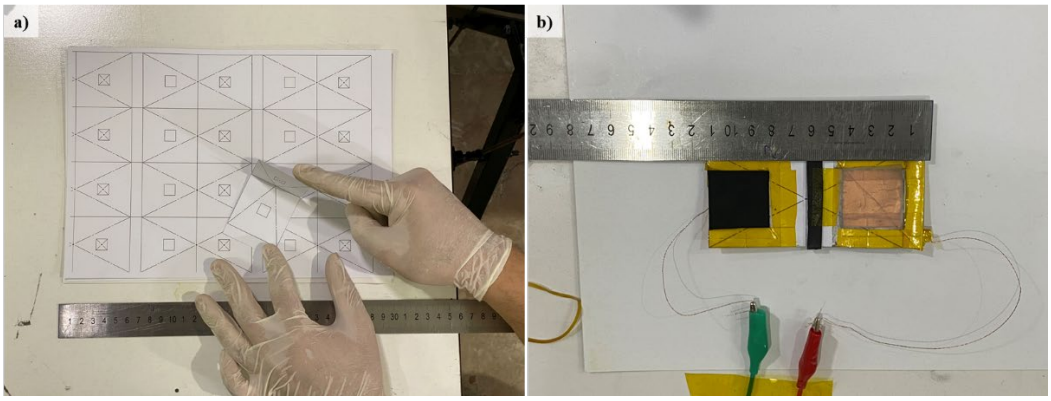

Figure 2. Setup of the TENG device, a) paper apparatus used, and b) cable layout of the TENG device

Figure 3a shows the sanding stage of the sample cut from recycled inner tube rubber. This step was carried out using a P 1200 coarse grit water sander and a metallurgical sanding machine. Figure 3b presents pictures of the Nanostructured Adhesive Film cut to the appropriate dimensions. Details about this film can be obtained from related publications.

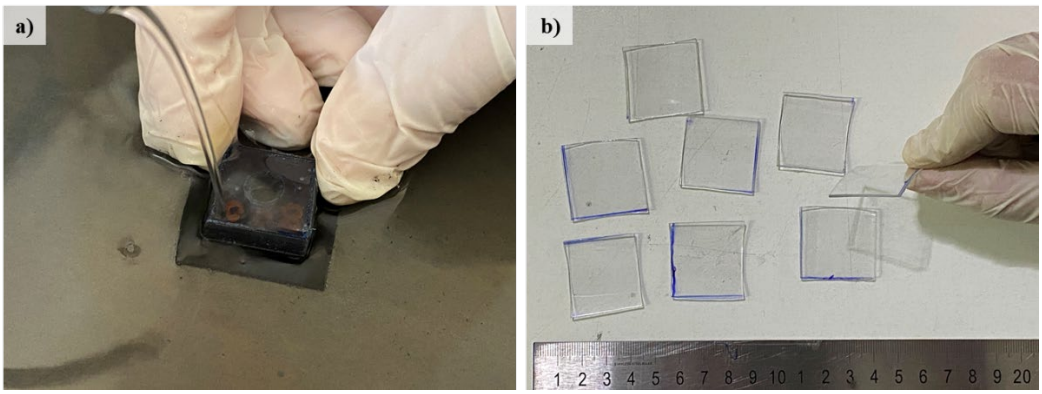

Figure 3. Preparation of inner tube and film samples

3 RESULTS

Pictures were taken of the samples using a light microscope to evaluate the sanding process's effect on the surface morphology. Figure 4 shows these pictures. Figure 4a shows an image of the inner surface of the inner tire before sanding. The bright spots on the two surfaces may be caused by talc-like powders that prevent the rubber from sticking during production. These powders could not be removed by normal brushing and washing, which is evident from the picture.

In Figure 4b, the effect of sanding on the surface morphology can be observed. The fibril aggregates formed on the surface can be easily seen. These stacks are separated from each other by deep slits. The formation of these apertures can be explained by the hyperelastic behaviour of the rubber during the sanding stage. These linear lines, which are excessively flexed and abraded, can then lead to the formation of deep crevices at the moment of loosening. This type of morphology demonstrates the need for more systematic research into the sanding of rubber-based materials. The effective increase of the surface area is essential for TENG performance.

Figure 5 shows the voltage values produced by the TENG device. It is determined that it can produce an average value of 9.3 volts. This generated voltage value is suitable for energy harvesting and can be used to meet the energy needs of low-power-consuming devices such as wearable devices. In addition, ways to generate more energy should also be investigated. Research on the effect of different sanding processes and various TENG configurations should be conducted in this context.

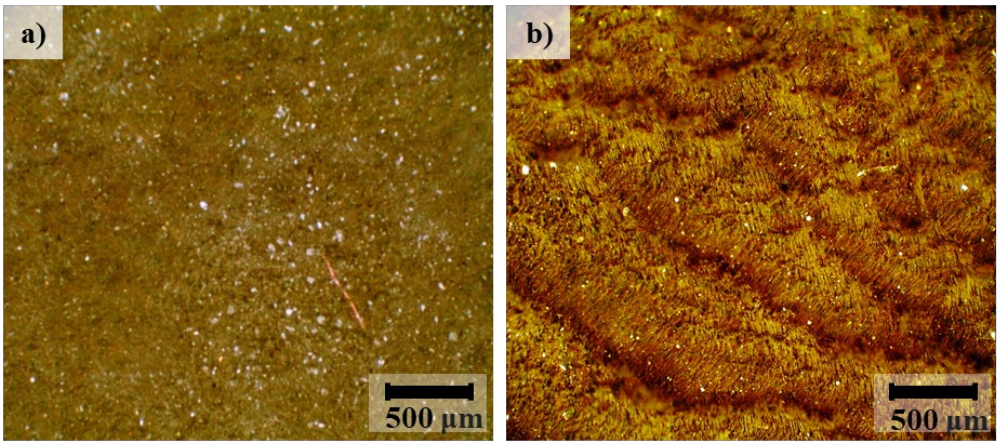

Figure 4. The effect of sanding on the surface morphology, a) before sanding and b) after sanding.

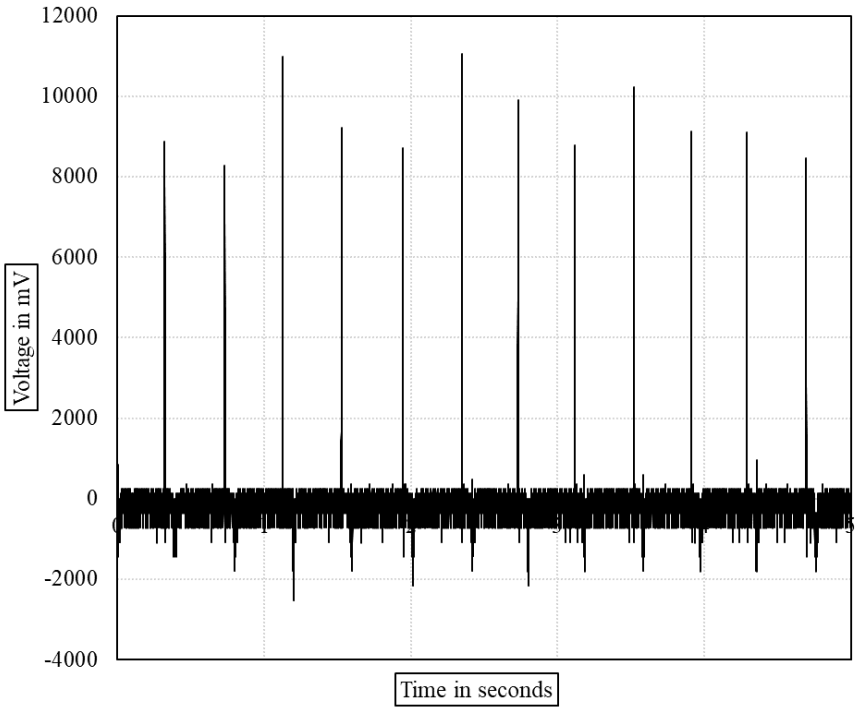

Figure 5. Time-dependent voltage graph of TENG device

4 CONCLUSION

In conclusion, this study explores using repurposed materials for developing triboelectric nanogenerators (TENG). The focus is on discarded elastomeric tubular membranes, specifically inner tubes from tires and nanostructured adhesive films. The materials used in this solution offer a sustainable and innovative approach to current energy challenges. Using traditionally discarded items, such as inner tube rubber, as effective contact materials in TENG devices demonstrates their potential. The discovery that the elastomeric tubular membrane only functions as an electron acceptor is unexpected and differs from previous studies. This presents an opportunity to optimize TENG systems and promote the use of environmentally friendly materials for a more sustainable future. The study highlights changes in surface morphology caused by sanding, emphasizing the need for systematic research to increase surface area. This is crucial for enhancing TENG performance. The TENG device developed in this study shows promising results, producing an average voltage of 9.3 volts. This voltage is suitable for powering low-consumption devices such as wearables. The study recommends exploring different sanding processes and TENG configurations to optimize energy production. Collaborating TENG technology with repurposed materials offers a sustainable energy solution and highlights the potential of unconventional materials to contribute to environmentally friendly technology, encouraging a cleaner and greener future.

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Size Separation and Bulk Densification Analysis of UHMWPE Powder Under Vibration

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Abstract

Ultra-high molecular Weight Polyethylene (UHMWPE) is a type of plastic with impressive features useful in diverse industrial practices. Managing UHMWPE powder might be problematic due to bulk density and particle size distribution problems. Our research focuses on the behavior of UHMWPE powder when exposed to controlled vibration. It was examined whether the vibration leads to volume concentration and the separation of particle sizes in the UHMWPE powder. The samples from the lower and upper areas of the vibrated powder were compared with non-vibrated samples. Subsequently, image processing techniques were utilized to examine the distribution of particles and changes in size. Our observations demonstrate that vibration causes a decrease in bulk volume, which signifies a reduction in large empty spaces in the powder. Non-vibrated samples have a reasonably consistent particle size distribution. However, when there is vibration, a small amount of larger particles move toward the upper region, and a small amount of smaller particles move toward the lower region, causing interesting variations in particle size distribution.

Keywords: *UHMWPE powder, Vibration, Size separation, Bulk density, Powder behavior*

1 INTRODUCTION

Ultra-high molecular weight polyethylene (UHMWPE) is a thermoplastic with exceptional properties, making it appropriate for various industrial and commercial applications [1-4]. Its high molecular weight gives it notable strength while exhibiting low friction, which is ideal for components requiring smooth movement, such as conveyor system bearings [5-7]. UHMWPE exhibits remarkably high impact resistance, even at low temperatures, making it appropriate for sudden shocks or impacts [8-10].

Ultra-High Molecular Weight Polyethylene (UHMWPE) is typically found in powder form, attributable to its unique molecular characteristics. UHMWPE features an exceptionally high molecular weight, commonly ranging from 1 to 9 million g/mol. These substantial molecular weights are responsible for UHMWPE's outstanding properties. Nonetheless, these characteristics also bring about inherent processing difficulties. UHMWPE still preserves its solid-state characteristics even at temperatures surpassing its melting point due to its molecular weight that exceeds 0.5 million g/mol. Consequently, traditional melt processing methods, such as extrusion, are infeasible for this material [4, 8, 11, 12]. The lengthy molecular chains of UHMWPE and its insufficient inter-particle diffusion hinder its ability to flow, which is essential for pellet production.

Furthermore, the high viscosity and long relaxation time of UHMWPE hinder its melt processability, making the conversion of neat UHMWPE powders into pellets via regular extrusion quite challenging. UHMWPE is most frequently dispersed and processed in the form of powder. There are ongoing efforts to design pioneering methodologies and technologies, such as applying specific tapered dies and air cooling, to surmount these obstacles and facilitate the production of UHMWPE pellets [12, 13]. This transformation could not only enhance the handling of the substance but also expand its utility in several industries. Manufacturing powder handling presents significant challenges from dust generation, contamination, flowability, segregation, and safety concerns.

Following the production of UHMWPE powder, it undergoes natural movements and vibrations during packaging, storage, post-sale transportation, subsequent storage, and transfer to the production line. Such physical effects present a potential risk of vibration-induced size separation on the granular media of UHMWPE. This type of separation is referred to as the "Brazil nut effect," where larger particles rise while smaller particles fall [14-16]. This may result in functionally graded properties with favorable or unfavorable mechanical characteristics. A relevant literature search has not identified any publications concerning this phenomenon in UHMWPE or other

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polyethylene groups. Therefore, this large gap in the literature needs to be addressed, and UHMWPE powder convection needs to be better understood.

This investigation examines whether applying vibration to UHMWPE powder results in size separation. Using the established experimental setup, we collected samples in a repeatable manner from vibrated UHMWPE powder. These samples were taken from a lower and an upper region and were compared with those that did not undergo any vibration.

2 MATERIAL AND METHOD

2.1 Vibration Setup

Fifty grams of UHMWPE (GUR grade) were filled into a laboratory graduated cylinder for the vibration experiments that were performed using a TM 150 model universal vibration system that the GUNT Hamburg company manufactured. This particular system was selected to ensure the reproducibility of the vibration tests. The graduated cylinder is shown in Figure 1a. Figure 1b illustrates the configuration utilized for the vibration experiments. The spring, located 65 cm away, and the unbalanced weight exciter, located 60 cm away, were positioned at the far right of the rigid bar to optimize vibration energy outputs. Adjacent to the exciter, 55 cm from the bearing, the graduated cylinder containing UHMWPE powder was fixed to be exposed to the vibration energy. The sole consideration throughout the left-end rotation was the vertical vibration of the rigid bar. Owing to the mechanism of the rigid bar, the graduated cylinder's horizontal displacement exhibited insignificance, being significantly below the micrometer scale, establishing its sole vertical motion. The frequency of the rigid bar's vibrations and the graduated cylinder's amplitude were measured by a proximity sensor positioned beneath the cylinder.

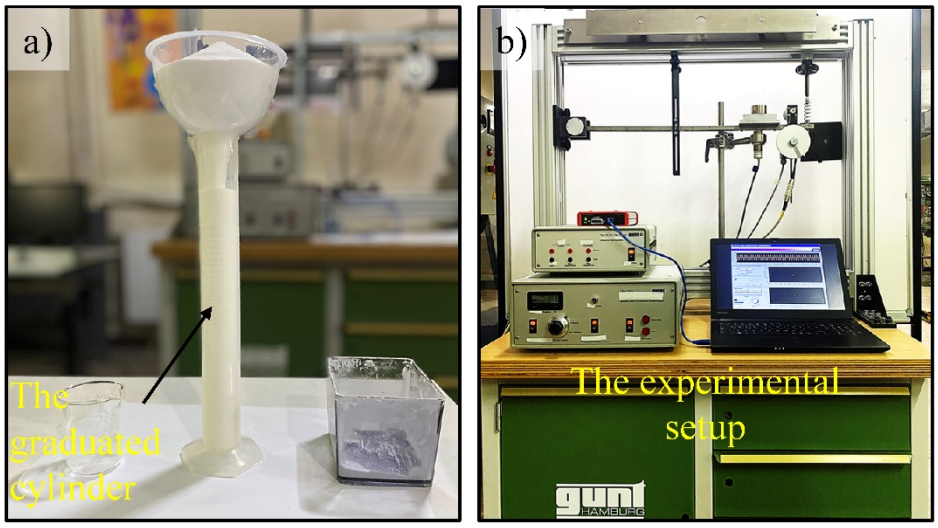

Figure 1. a) Filling the graduated cylinder with UHMWPE powder and b) the vibration test setup

2.2 Vibration Experiments

After filling the UHMWPE powder into the graduated cylinder, it was subjected to vibration for 5 minutes. The vibration frequency was set at 40.0 Hz. Subsequently, the vibration amplitude was measured as 183 µm using a vibration sensor. These values calculated the dimensionless vibration intensity as 1.15 (-). The calculation method was obtained from a relevant publication in the literature [3]. It has been noted in the literature that a vibration intensity exceeding 1.0 is a crucial parameter for granule convection to take place [3, 17, 18].

Following the vibration, samples were obtained from the lower and upper regions using a custom-designed probe. The probe was designed with a single wire composed of a rigid steel alloy, inserted into a transparent plastic tube 4mm in diameter, with a silicone plug attached to its end. Utilizing the wire's independent movement permitted manual opening and closure of the plug. The probe could be inserted into the graduated tube up to the base, allowing for the extraction of samples from the desired regions. Pictures of the usage of the probe are provided in Figure 2.

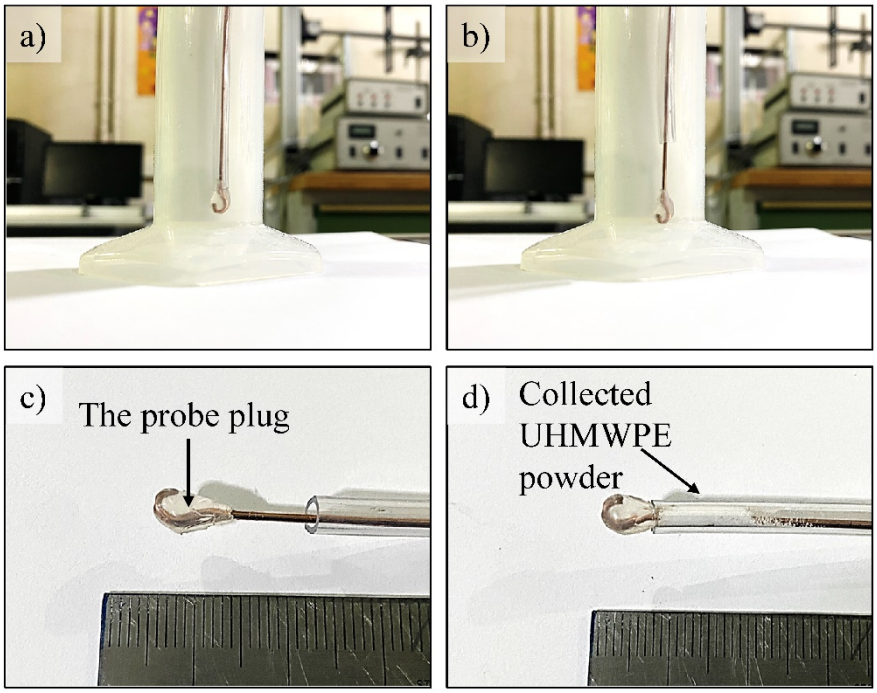

Figure 2. Custom-made sample collection probe images, (a) including the closed position displaying immersion, (b) the probe opened for sample collection, (c) a close-up of the probe in the open position, and (d) the probe in the closed position after sample collection

2.3 Image Processing

The investigation employed ImageJ version 1.53t, a publicly accessible and cost-free software compatible with Java. In the first stage, pixel measurements were transformed to micrometers using a calibration image featuring a small ruler. A ruler was drawn on the image using the Line tool, and the global "Set Scale" functionality, accessible from the Analyze menu, was utilized to set the scale. The image for particle analysis was accessed and converted to 8-bit. Following this, background subtraction was performed using the sliding paraboloid function. A binary image was created, and the Watershed feature was employed to separate adjacent particles, defining their boundaries. Using a brush tool, particles bordering each other were removed, and colored in black ink, with minor artifacts also erased. Finally, the "Analyze Particles" function in the Analyze menu was used to calculate the particles' quantity and corresponding surface areas.

The particle diameter was calculated using the projected area methodology due to the irregular shape of the particles. A representative image area was chosen, and the software measured each particle's projected area. The projected area was converted using the formula: Diameter=2×sqrt[projected area/π] to obtain the diameter. The size of each particle was measured, and the mean diameter was obtained by adding all the measurements and dividing by the total number of particles analyzed.

3 RESULTS

Table 1 provides the densification values based on bulk volume and vibration. Vibration led to a decrease in bulk volume, from 98 cm^3 to 90 cm^3, indicating the presence of significant voids within the powder before vibration. Figure 3 illustrates this volume decrease, including degree lines aiding in thoroughly examining the volume change.

Table 1. Bulk volume and bulk density of samples

Sample condition	Bulk Volume (cm^3)	Bulk Density (g/cm^3)
Before vibration	98	0.510
After vibration	90	0.555

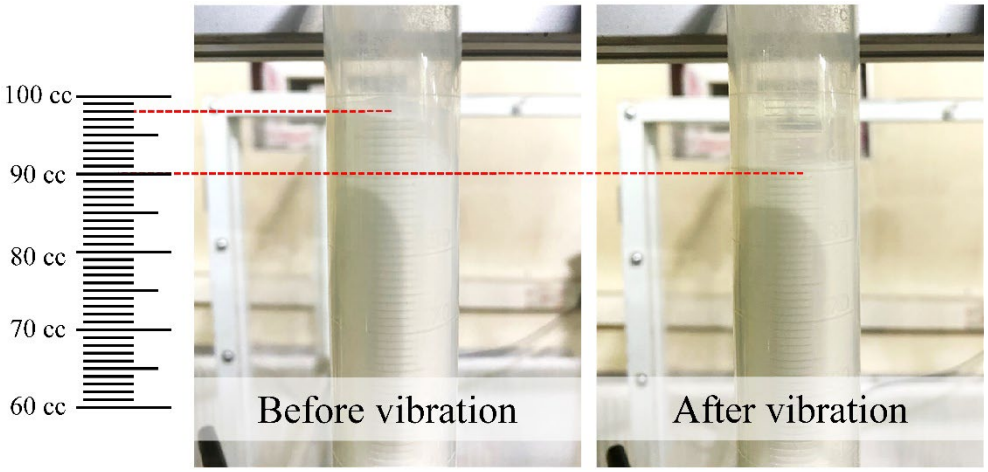

Figure 3. Reduction in volume due to densification of UHMWPE powder inside the graduated cylinder after vibration

Particles collected using a custom-made sampling probe were analyzed using a light microscope. The particle images captured with the microscope are presented in Figure 4. Figure 4a displays unvibrated particles from the sample. Figure 4b shows particles from the vibration-exposed sample removed from the base, whereas Figure 4c illustrates the particles from the top surface after the vibration procedure. By the naked eye, no significant differences in particle sizes were found in the images, indicating the absence of significant particle convection. It would have been visibly evident if UHMWPE powder had been substantially segregated.

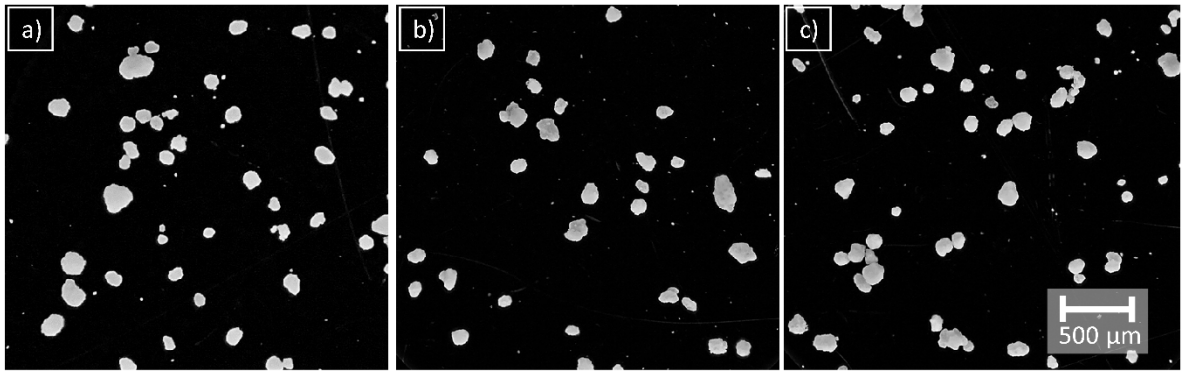

Figure 4. The microscope images of UHMWPE powders, (a) sample taken without any treatment, (b) sample taken from the base after vibration, and (c) sample taken from the surface after vibration (the scale bar for all images is 500 µm)

The images were examined for particle distribution using ImageJ software. The findings are displayed in Table 2 and Figure 5. The particle distribution of the sample, which was not subjected to vibration, closely matches the literature data [3]. Table 2 shows a slight variation in particle sizes owing to vibration. The mean size, previously 87 µm, rose to 118 µm in the upper zone due to vibration. By contrast, it diminished to 82 µm in the lower zone. A graphical presentation of particle sizes is available in Figure 5. Specifically, in Figure 5b, the surge in tiny particles and the surfacing of big particles can be deemed significant.

Additionally, a growth in small particles in the lower region can be detected. Some small particles are seen to migrate to both the upper and lower regions preferentially. The impact of calcium stearate in UHMWPE on this phenomenon should also be examined in future research studies.

Table 2. The average particle sizes and standard deviation values for the samples (units for all are µm)

	No vibration	**Vibrated from top**	**Vibrated from bottom**
Average	87	118	82
Standard deviation	28	42	33

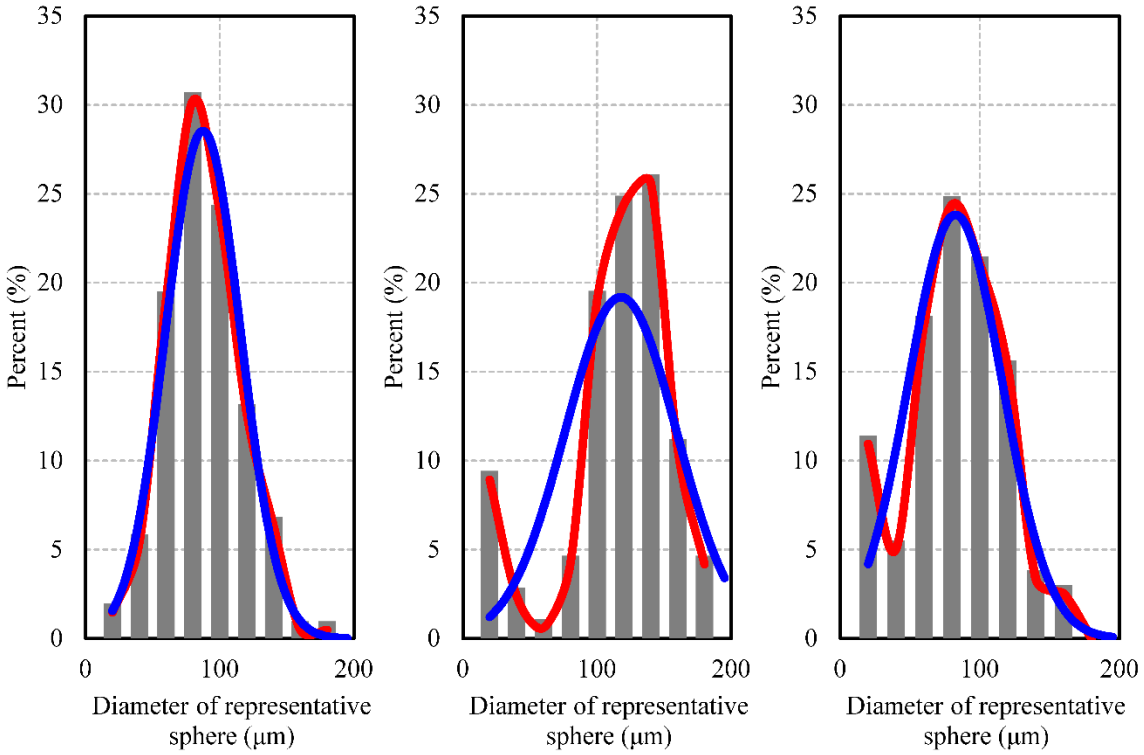

Figure 5. Particle distributions for (a) the sample taken without any treatment, (b) the sample taken from the surface after vibration, and (c) the sample taken from the base

4 CONCLUSION

This investigation analyzed the behavior of UHMWPE powder when exposed to controlled vibration. Experiments were conducted to explore how vibrations affect this thermoplastic material with the aid of image analysis. The results highlighted a significant decrease in the bulk volume of the UHMWPE powder after vibration, indicating that larger empty spaces within the material had been compressed. Some slight changes in particle size distribution in the vibrated samples were observed. Larger particles migrated upwards, while smaller particles descended, indicating a degree of the "Brazil nut effect" in UHMWPE. These findings have implications for industries that utilize UHMWPE powder, as it can enhance how they manage, store, and apply it. The findings indicate scope for further research, particularly examining how substances like calcium stearate and diverse vibration conditions impact outcomes and identifying techniques for reducing size discrepancies.

Acknowledgments

I would like to thank Bayburt University manufacturing laboratory staff for their help in preparing the experimental setup.

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8th International Scientific Conference "Telecommunications, Informatics, Energy and Management" – TIEM 2023

December 1-3, 2023

Stochastic Optimization in Renewable Energy Systems: A Comprehensive Literature Review

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Abstract

As the world grapples with the challenges of climate change and energy sustainability, renewable energy sources have emerged as a pivotal solution. Stochastic optimization techniques have gained prominence in optimizing renewable energy systems, addressing the inherent uncertainties associated with sources. This literature review synthesizes existing research, delving into the application of stochastic optimization methods in the realm of renewable energy. The review begins by elucidating the critical role of renewable energy in mitigating climate change and ensuring a sustainable energy future. It then navigates through the fundamental concepts of stochastic optimization, highlighting its relevance in handling the variability and uncertainty inherent in renewable energy generation. Various stochastic optimization models, including scenario-based, robust, and chance-constrained approaches, are discussed in detail. The study identifies key trends in the field, emphasizing the integration of advanced computational methods, machine learning algorithms, and big data analytics to enhance the accuracy and efficiency of stochastic optimization models. Furthermore, the review outlines the practical applications of these models in optimizing renewable energy systems. In addition to summarizing the current state of research, this review critically analyses the challenges faced by researchers and practitioners, such as model complexity, data limitations, and computational costs. It also identifies potential avenues for future research, emphasizing the need for interdisciplinary collaboration between experts in renewable energy, operations research, and data science. By providing insights into the advancements and challenges in stochastic optimization techniques, this review aims to contribute to the ongoing efforts aimed at building a sustainable and resilient energy future.

Keywords: *Energy system, Literature review, Renewable energy, Stochastic optimization, Uncertainty*

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New Permittivity-Moisture Curve for Moisture Evaluation within Soil Samples

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Abstract

A new permittivity-moisture curve is devised for predicting moisture level within soil samples. For this goal, three soil samples from the city Gaziantep in Turkey with different conductivities (95.70 mS/m, 341 mS/m, and 490 mS/m) and different pH values (7.62, 8.14, and 7.82) were utilized. First, their permittivities (with different volumetric water contents θ_V) were measured using a coaxial measurement cell we recently utilized in our recent studies. Next, the Debye model with three poles was implemented for each extracted permittivity of all soil samples. Then, the Mironov-Fomin model was applied to validate extracted permittivities. After, a calibration curve with linear dependence, which relates the volumetric water content to the real part of complex permittivities, was utilized for prediction. Predicted results were compared with those predicted by the Topp's model and other predicting models in the literature. Relatively different from our recent studies which were performed at 2 GHz and 3 GHz frequencies, it has been observed that the volumetric values predicted by our model are close to measured ones at lower frequencies (e.g., 500 MHz).

Keywords: *Calibration curve, Soil, Permittivity, Volumetric moisture content*

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Evaluation of Passive Radiator Structures in Low-Frequency Radio Astronomy Arrays from the Perspective of Active Antenna Design Methods

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Abstract

Contemporary communication applications, in line with the requirements of high bandwidth and compact design, predominantly favor Ultra High Frequency (UHF) and higher frequency bands. However, the unique characteristics of sub-UHF frequency bands play a significant role in maintaining interest in these frequency ranges. Research conducted in these bands, especially scientific studies such as ionospheric radar and low-frequency radio astronomy (<100MHz), are observed to extensively utilize the relevant frequency bands. In these frequency ranges, it has been determined that the physical size of antennas increases with the decrease in frequency, and the mechanical structure of antennas becomes more complex for applications requiring high bandwidth. To solve this problem, the design of active antenna structures containing transistor-based pre-amplifiers is proposed in the literature. Significantly reducing antenna sizes is possible by using the logic of active circuits directly connected to passive radiator terminals. This study evaluates electrically short passive radiator structures used in various low-frequency radio astronomy antenna arrays, in terms of active antenna design methods, within the 20 MHz - 50 MHz frequency range.

Keywords: *Low frequency radio astronomy, Active antenna*

1 INTRODUCTION

Antennas are considered one of the most critical components of wireless communication applications due to their ability to convert electrical signals into electromagnetic waves and vice versa. Today, many wireless communication applications require high bandwidth and compact design. These demands result in the use of high frequencies, and therefore, most wireless communication applications are concentrated in the ultra-high frequency (UHF) bands of the electromagnetic spectrum (>300MHz) and above. In addition to these bands, the unique characteristics of sub-UHF bands ensure the continued interest in these frequencies. For example, signals propagating in the HF band reflect off free electrons in the ionosphere layer, unlike other frequency bands [1] (excluding other ionospheric reflection mechanisms such as diffraction and scattering). Due to this characteristic, the high-frequency band is frequently used in the observation of the ionosphere and ionospheric phenomena. Another application that extensively uses HF and early VHF bands is low-frequency radio astronomy (<100MHz) [2]. In the relevant bands, there are studies on examining the characteristics and behaviors of solar system objects, radio-transient universe studies, and research on the high-z universe [3]. Today, there are various array antenna projects for low-frequency radio astronomy, such as LWA in New Mexico, LOFAR in Europe, GURT in Ukraine, and SKA in Australia [4].

Low-frequency applications come with a set of challenges. As the frequency decreases, the wavelength increases, and correspondingly, the physical size of antennas also increases. For instance, the antenna sizes required for the high-frequency band (HF) can reach tens of meters. Another problem is the increased complexity of antenna structures when designed for broadband use, leading to higher maintenance and production costs. As a solution to this problem, active antenna structures are proposed in the literature. Active antennas designed with transistor-based preamplifiers can significantly reduce the size of antennas used for reception in the Very High Frequency (VHF) band and lower bands. Thus, active antennas capable of operating as receivers from the Low Frequency (LF) band to the VHF band, with sizes not exceeding a few meters, are used in applications such as ionospheric observations and low-frequency radio astronomy.

In radio astronomy, the beam width of an antenna is used to determine the angular resolution of a radio telescope. The angular resolution of antennas is directly proportional to the wavelength and inversely proportional to their physical size. Therefore, the process of radio astronomy, which began in 1932 with Karl Jansky's discovery of

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signals with a 15-meter wavelength, continued at higher frequencies due to the practical difficulties of designing antennas with low angular resolution at low frequencies and the scientists' demand for precise resolution [5]. In subsequent years, the technique of interferometry, which allows the synchronized use of multiple antennas, and the 'Self-Calibration' signal processing technique, which eliminates the disruptive effects of the ionosphere, were developed. These advancements have reinvigorated low-frequency radio astronomy studies. Additionally, the requirement of astrophysical image calibration to resolve the diffraction effects of the ionosphere has also created a suitable platform for studying the ionosphere [5].

In low-frequency radio astronomy studies, the effective area of antenna arrays is expanded using the interferometry technique, thereby achieving more precise resolution. However, this increases the number of antennas required, significantly raising the cost of commercially purchasing antennas. Therefore, antennas used in low-frequency radio astronomy arrays are typically designed to be project-specific and cost-effective [6]. Current low-frequency radio astronomy arrays design different types of passive radiator structures with various active circuit design methods to achieve the optimum solution at a low cost according to their scientific requirements. In this study, passive radiator structures used in various low-frequency radio astronomy antenna arrays in the HF and early VHF (30-50MHz) bands will be evaluated in terms of active antenna design methods.

2 MATERIAL AND METHOD

Low-frequency active receiving antennas consist of four main components: the passive radiator, active circuit, antenna frame, and ground screen. The electrical characteristics of the soil in the areas where antennas are installed can vary significantly depending on the moisture and water content it contains. To reduce this variability of the soil, some low-frequency radio astronomy arrays in the literature have used ground screens at the expense of increased cost. While antenna arrays like LWA and LOFAR use ground screens, the GURT array has not used any due to the high conductivity of the ground on which it is situated [7].

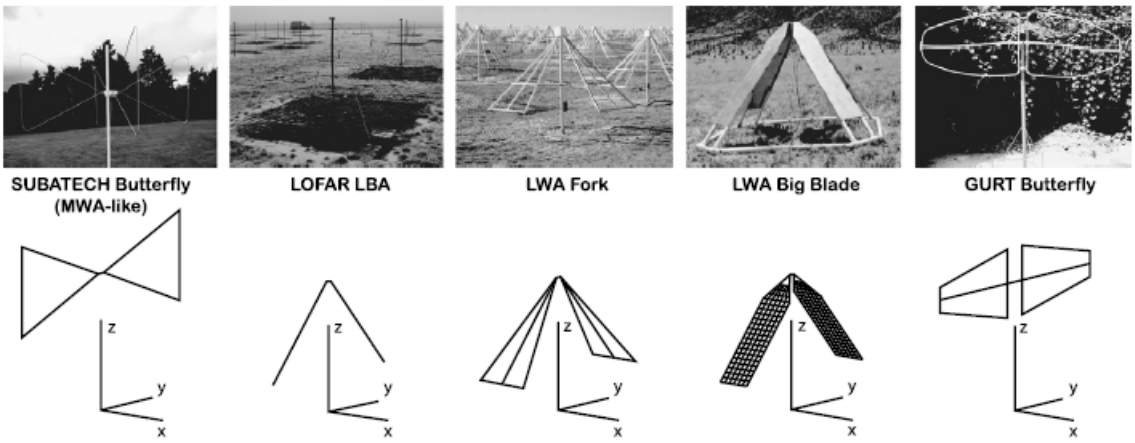

Figure 1. Images and NEC models of antennas used in various low-frequency radio astronomy arrays [4]

Signals produced by galactic sources or reflected from the ionosphere in an ionospheric radar study are received by passive radiators and transmitted to the active circuit. Figure 1 shows the antennas used in various low-frequency radio astronomy arrays and their NEC (Numerical Electromagnetics Code) models.

In low-frequency radio astronomy applications, antennas are positioned in an interferometric arrangement to provide precise angular resolution. Signals from individual antennas are digitally combined at phase array stations, and electronic beam-forming techniques allow for simultaneous observation of multiple areas of the sky [8]. In such an application, it is important for individual antennas to have wide beam angles to cover a large sky area. Figure 2 visualizes the beam widths of an antenna element, a station, and a station array.

In applications requiring a wide frequency range, passive radiator structures are becoming increasingly complex. This leads to higher production and maintenance costs and more difficult antenna installations. Especially in low-frequency radio astronomy applications, the use of hundreds or even thousands of antennas is required. This necessitates the design of antennas as electrically short with simple geometries. In low-frequency radio astronomy studies and ionospheric observation studies, inclined dipole structures are often preferred for easy setup and wide beam widths. The inclined design of the dipole arms is used to increase the beam widths of the antennas.

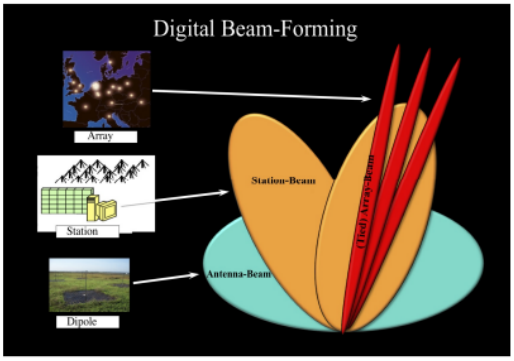

Figure 2. The beam widths of an antenna element, an antenna station, and a station array [8]

In dipole antenna designs, the method used to transfer the received signal to the circuit directly affects the passive radiator designs. The transfer of signals from the passive radiator to the active circuit can be done using two different methods. These methods are power matching [6] and voltage sampling [9]. The chosen method plays a significant role in determining the shape of the passive radiator. In the power matching method, the input impedance of the passive radiator is matched with that of the active circuit. This ensures maximum power transfer from the radiators to the circuit. In the second method, the active circuit is designed with a high input impedance. The voltage induced in the passive radiators is taken into the circuit over the high input impedance of the active circuit. Here, the active circuit functions like a voltage amplifier. In this case, very little power is transferred to the circuit, but the fact that the information is in the voltage, not the power, makes this insignificant [10].

Dipole antenna structures are antennas with low bandwidth. Additionally, designing these antennas as electrically short structures significantly increases their capacitive impedance. This appears to be a disadvantage for the power matching method, which requires impedance matching over a wide frequency range. However, the strong galactic noise at the relevant frequencies allows the power matching method to function despite a certain degree of impedance mismatch [6].

In reference [6], the signal intensity emitted from galactic sources in the 10 MHz - 100 MHz range has been calculated using the Cane model [11]. The Cane model represents the minimum limit of the signal captured in galactic noise [6]. It has been determined that the galactic noise levels in the 20 MHz - 50 MHz range presented in the International Telecommunication Union's document ITU-R P.372-15 [12] are consistent with the Cane model for low-gain antennas. Therefore, for ease of processing, the calculation method given in document [12] has been used to determine the signal level.

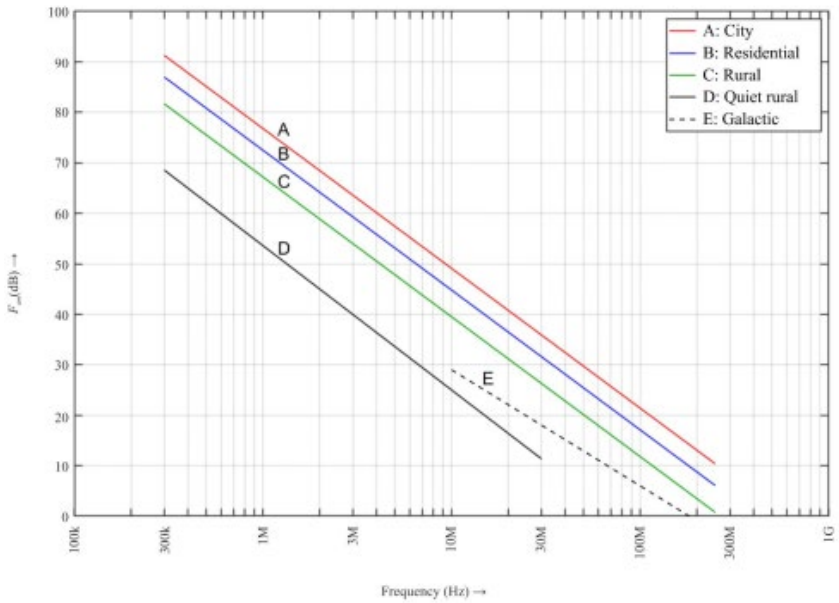

Figure 3. Environmental noise strengths for different geographical regions [12]

Table 1. For Formula (1), the values of c and d are given in [12]

Area	c	d
City (A)	76.8	27.7
Residential (B)	72.5	27.7
Rural (C)	67.2	27.7
Quiet Rural (D)	53.6	28.6
Galactic (E)	52.0	23.0

The frequency-dependent external noise levels in different geographical regions are obtained using the constants in Table 1. This calculation is performed using the following formulas:

$$F_a = c - d\log(f) \tag{1}$$

In equation (1), the external galactic noise figure F_a in dB is calculated. Here, c and d are the constants in Table 1, and f represents the frequency in MHz.

$$T_{sky} = (f_a - 1)T_0 \tag{2}$$

$$S_{sky} = kT_{sky} \tag{3}$$

In equations (2) and (3), the equivalent galactic noise temperature T_{sky} in K and the spectral power density of galactic noise S_{sky} in W/Hz are calculated. Here, T_0 is the reference temperature value, f_a is the linear external noise factor, and k is the Boltzmann constant.

In low-gain antennas, when galactic noise completely fills the antenna beam, the spectral power density of the galactic noise signal received at the terminals of the passive radiator is independent of the antenna's radiation pattern [6]. In active antenna designs using the power matching method, the spectral power density of the signal received at the terminals of the active circuit is expressed by the following equation.

$$S_{ac} = e_r S_{sky}[1 - |\Gamma|^2] \tag{4}$$

Here, S_{ac} represents the spectral power density of the galactic noise received at the terminals of the active circuit in W/Hz, e_r represents the efficiency of the passive radiator structure and Γ represents the reflection coefficient. When the reflection coefficient is associated with the Voltage Standing Wave Ratio (VSWR), equation (4) is expressed as follows.

$$\Gamma = \left|\frac{VSWR-1}{VSWR+1}\right| \tag{5}$$

$$S_{ac} = e_r S_{sky}\left[1 - \left|\frac{VSWR-1}{VSWR+1}\right|^2\right] \tag{6}$$

In the case of using the voltage sampling method in active antenna design, the goal is to transfer maximum voltage from the antenna terminals to circuit terminals. In this method, the voltage value induced by the spectral power density of the galactic noise in the passive radiator is found using the following formula.

$$V_{RAD} = \sqrt{4R_{RAD}bS_{sky}} \tag{7}$$

Here, V_{RAD}, represents the voltage induced in the passive radiator in V, R_{RAD}, represents the resistance of the passive radiator impedance in Ω and b represents the bandwidth in Hz.

When passive radiators, such as dipole structures, are designed with electrically short lengths, they exhibit a capacitive impedance characteristic. In the voltage sampling method, the high input impedance of the active circuit acts like a capacitive divider with the impedance of the passive radiator. This is a significant factor affecting the

signal transfer from the passive radiators to the active circuit and is an important characteristic that must be considered in antenna design.

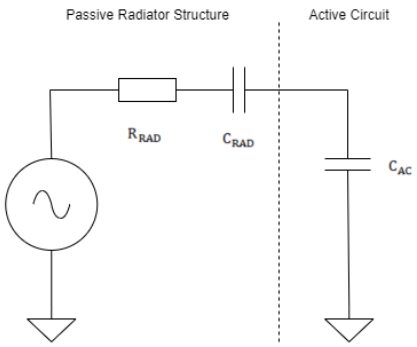

Figure 4. The electrical equivalent of an electrically short passive radiator connected to an active circuit with high input impedance [9]

In active antenna design, when the voltage sampling method is used, the voltage transfer between the passive radiator and the active circuit is expressed by the following equation.

$$V_{AC} = V_{RAD} \frac{Z_{AC}}{Z_{RAD}+Z_{AC}} \tag{6}$$

Here, V_{AC} is the voltage received at the terminals of the active circuit in V, V_{RAD} is the voltage induced at the terminals of the passive radiator in V, Z_{AC} is the impedance of the active circuit in Ω and Z_{RAD} is the impedance of the passive radiator in Ω. The system operates as a capacitive divider under the following condition [13].

$$j\omega C_{RAD} R_{AC} \gg 1 \tag{7}$$

$$V_{AC} = V_{RAD} \frac{C_{RAD}}{C_{RAD}+C_{AC}} \tag{8}$$

In this study, two different antenna topologies designed as electrically short structures are examined: the Inverted-V dipole structure used in the LOFAR project and the Tied Fork dipole structure used in the LWA project. Both antenna structures will be evaluated in terms of power matching and voltage sampling methods. These antennas are designed with equal arm lengths, placed at the same height, and have equal inclination angles, all on a perfectly conductive ground.

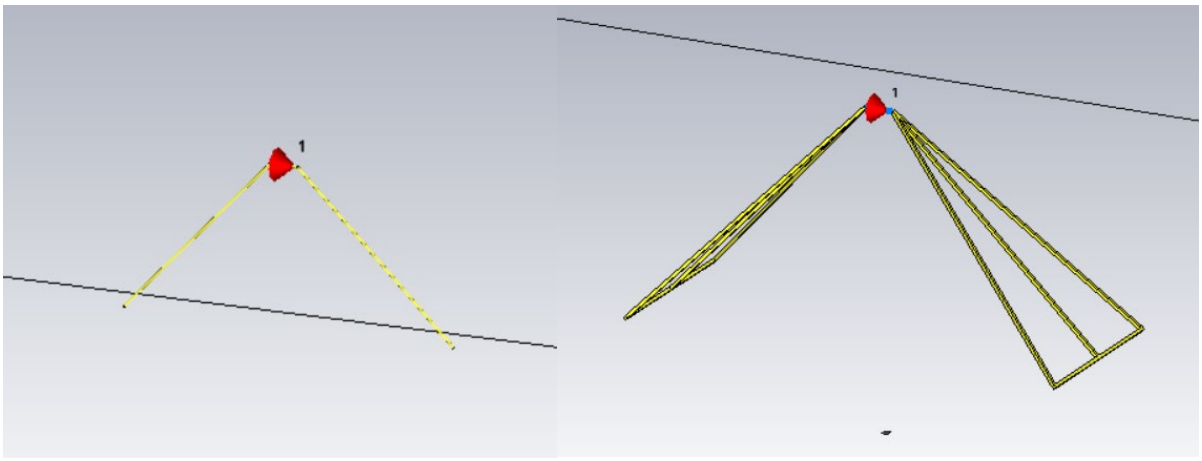

Figure 5. Inverted-V dipole antenna (left) and tied fork dipole antenna (right)

3 RESULTS

The following figures present the graph of the frequency-dependent VSWR (Voltage Standing Wave Ratio) values for the Inverted-V dipole and Tied-Fork dipole antenna structures, both designed as electrically short structures. This graph demonstrates how the VSWR values of both types of passive radiators vary within the specified frequency range.

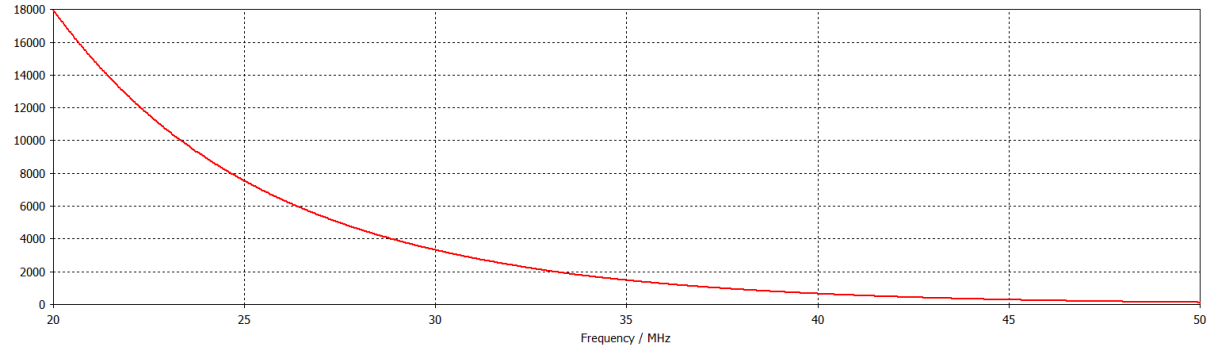

Figure 6. Inverted-V dipole VSWR

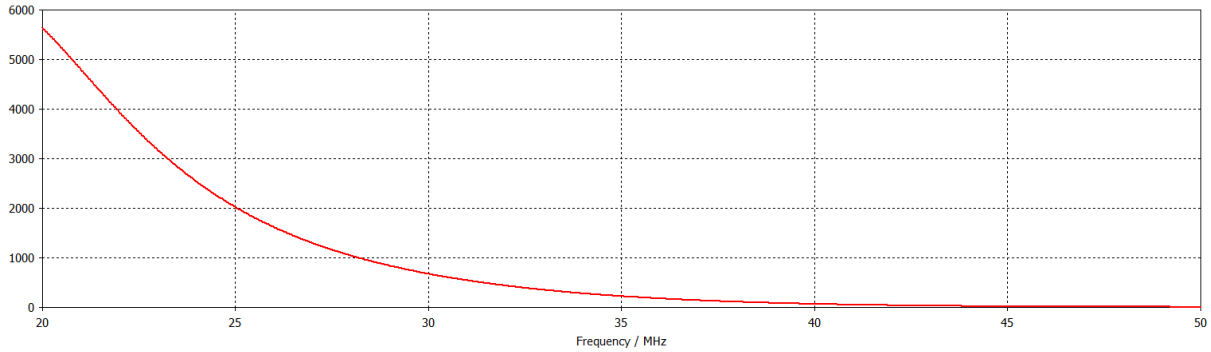

Figure 7. Tied fork dipole VSWR

Equation (4) indicates that as the VSWR (Voltage Standing Wave Ratio) value increases, the spectral power density of the galactic noise received at the terminals of the active circuit decreases.

In the design of active antennas using the voltage sampling method, the resistance and reactance values of passive radiators become significant. According to equation (5), as the resistance value increases, the voltage induced by galactic noise signals in passive radiator structures also increases. Figures 8 and 9 show the resistance values of the Inverted-V and Tied-Fork dipole structures, which are designed as electrically short structures.

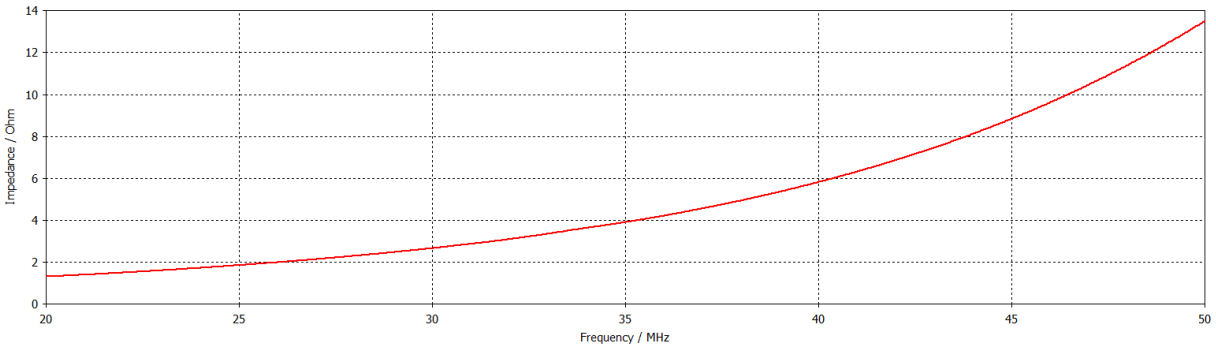

Figure 8. Inverted-V resistance

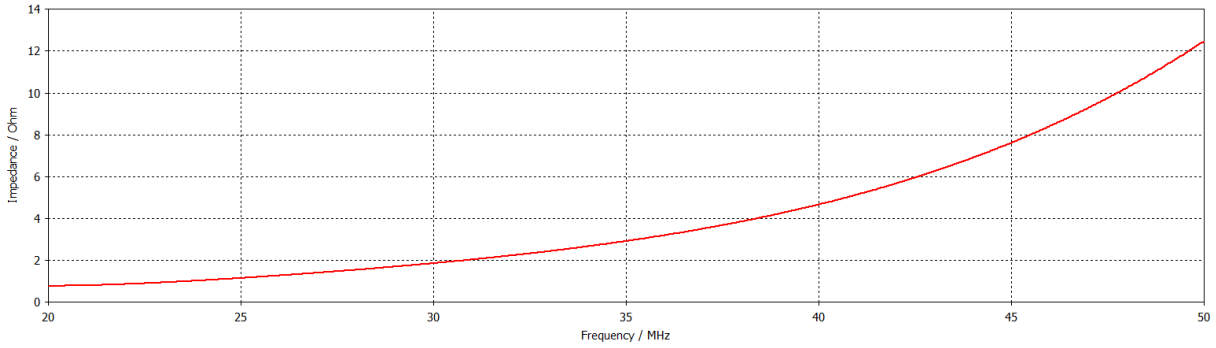

Figure 9. Tied fork dipole resistance

In the voltage sampling method, the voltage induced in passive radiators is transferred to the circuit over a high impedance. Electrically short dipole structures can be modeled with a capacitive impedance, as shown in Figure 4. In such circuits, Field-Effect Transistors (FETs) are often preferred as the first element. When condition (7) is met, a capacitive divider is formed between the input capacitance of the FET elements and the capacitance of the passive radiator structure. In this case, an increase in the capacitance of the passive radiator leads to higher voltage levels being transferred to the circuit. Figures 10 and 11 show the reactance values of the Inverted-V and Tied-Fork structures, respectively.

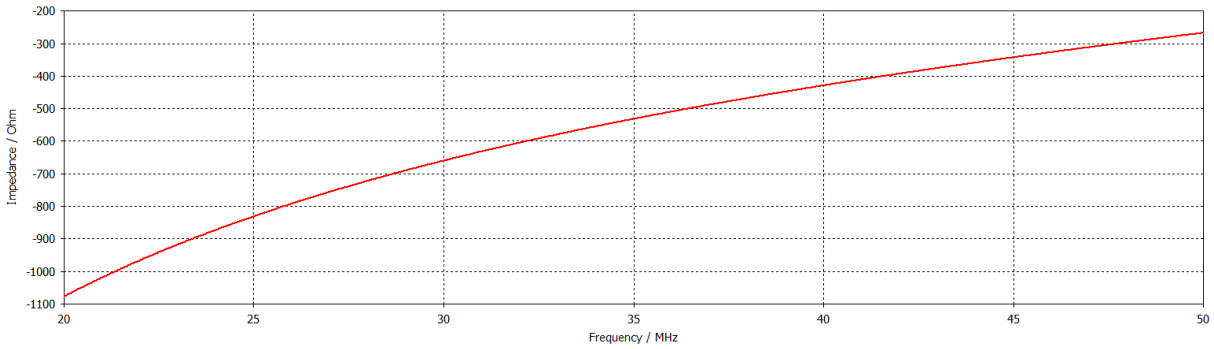

Figure 10. Inverted-V dipole reactance

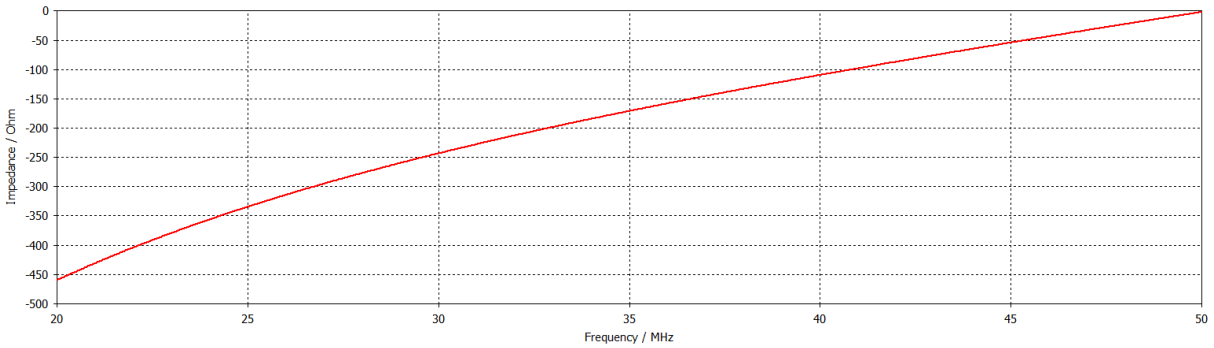

Figure 11. Tied fork dipole reactance

4 CONCLUSION

In this study, the Inverted-V passive radiator structure used in the LOFAR antenna array and the Tied-Fork passive radiator structure used in the LWA antenna array examined in terms of active antenna design methods. It found that when the power matching method is used, the Tied-Fork structure allows for higher power levels to be received at the terminals of the active circuit. In the case of using the voltage sampling method, it found that the voltage values induced in the Inverted-V and Tied-Fork structures designed with equal dimensions are almost equal, but the voltage level transmitted to the circuit is higher in the Tied-Fork antenna topology. According to equation (8), if the input capacitance of the active circuit is designed to be much smaller than the capacitance of the passive radiator, the Inverted-V passive radiator structure can be preferred for ease of installation and production.

Acknowledgments

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Analysing Eastern Anatolian Region Food Recipes with Graph Database

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Abstract

Networks are essential instruments for processing and analysis of large and complex data. They are useful for visualizing and identifying patterns and relationships among numerous phenomena. A network of recipes and ingredients was created to analyze local dishes from Turkiye's Eastern Anatolia Region. 71 ingredients used in the preparation of 42 different dishes and 10 desserts are analyzed in this study. A graph database management system was employed to facilitate the compilation, processing, and analysis of data. During the analysis process, algorithms for detecting centrality and communities were applied. Centrality algorithms were applied to determine which ingredients are most commonly present in recipes and which ingredients are most commonly combined together. Recipes with similar characteristics were paired together to identify local food groups using community detection algorithms. Analyzing recipes and ingredients from the Eastern Anatolia Region produced a comprehensive view of the cuisine. In addition, significant information about the region's food culture has been obtained by grouping recipes with similar characteristics.

Keywords: *Food network, Graph database, Centrality algorithms, Community detection algorithms*

1 INTRODUCTION

Data has become one of the most important concepts in the modern era. Information is ultimately accessed by processing a vast amount of data and giving it meaning. Databases have emerged for the purpose of processing and storing data, making processes easier. Nowadays, data is stored in databases with different structures, namely SQL (Relational) and NoSQL (Non-relational). ACID principles define SQL databases' fundamental characteristics. They preserve the properties of data, such as integrity, consistency, independence, and durability. Integrity is essential to ensure the effectiveness of transactional components. The consistency principle serves the purpose of ensuring correctness and validity by preventing conflicts between transactions. The independence principle is a fundamental concept that guarantees the non-interference of numerous transactions operating on the same data. The durability concept is designed to mitigate the risk of data loss under unforeseen circumstances [1].

Relational databases have been used for storing, accessing, and managing data for many years. However, as technology has advanced and data gathering tools have increased, the variety and quantity of gathered data has varied substantially. Storage and processing procedures have gotten more sophisticated as a result. To overcome data storage issues, distributed database systems have been created [2]. The CAP theorem is used in the construction of distributed databases. The principles of consistency, availability, and partition tolerance are used to express the CAP theorem. The capacity to access the same data across all databases at the same time is referred to as consistency. The availability idea indicates that databases provide uninterrupted service. Partition tolerance represents the system's capacity to function even if the network is partitioned. The CAP theorem underlines the benefits of NoSQL databases' scalability and partition tolerance while emphasizing the necessity to make a trade-off between consistency and availability [3].

The Big Data concept was developed due to the increasing volume and diversity of data. It refers to a rapidly increasing amount of data with various characteristics. Data such as images, videos, and social media posts cannot be efficiently processed by relational databases. To address the processing and storage of such data, NoSQL databases (non-relational databases) have emerged. NoSQL databases, unlike SQL databases, provide the capability to store different types of data. They enable the quick processing of data, especially in situations where the data size is substantial [4].

NoSQL databases were developed with the adoption of the BASE approach. The BASE approach includes the concepts of asynchrony, soft state, and eventual consistency. The concept of asynchrony indicates the system's inability to guarantee instant consistency after any query or operation. The concept of soft state acknowledges that

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the database may be in an inconsistent state after certain processes, but it is expected to return to a consistent state over time. The concept of eventual consistency acknowledges that there can be inconsistency among database copies, but over time, the database is expected to become consistent again [5].

NoSQL databases come in various types, with the most common being key-value databases, column-family databases, document databases, and graph databases. A type of NoSQL database, the graph database, stores data where nodes represent entities and edges represent relationships between nodes [6]. Graph databases are commonly preferred in fields where relationships between data are prominent, such as social media platforms, transportation planning, biological analyses, and more. In the context of recipe platforms, it can be said that they exhibit a graph-like structure concerning recipes and the ingredients they contain.

2 MATERIAL AND METHOD

For the analysis of traditional dishes from the Eastern Anatolia region, two different analysis methods, namely centrality and community detection algorithms, have been employed.

2.1 Centrality Algorithms

Centrality algorithms are utilized to determine the levels of impact of nodes in a graph through various mathematical approaches [7]. In this study, to identify the most crucial food products used in the Eastern Anatolia region, three different centrality algorithms have been employed;

Betweenness centrality: It is used to identify other nodes that act as bridges between pairs of nodes. The importance level of a node is highest when it lies on the shortest path between node pairs. In a graph, multiple shortest path scenarios may arise, leading to computational challenges. The betweenness centrality value is the ratio of how many times a node is found on the shortest paths that different node pairs, not directly connected to each other, would use to communicate the total number of shortest paths for that node pair. Equation 1 shows the formula used in the calculation of betweenness centrality [8].

$$g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}} \tag{1}$$

g(v) → The betweenness centrality value of node v
σ_{st} (v) → The number of times node v appears in the shortest paths between nodes s and t
σ_{st} → The sum of the shortest path counts between nodes s and t

Degree centrality: It is determined by identifying the number of adjacent nodes within a graph for a given node. Nodes with a higher number of adjacent nodes are considered more important. Equation 2 presents the formula used to calculate degree centrality [9, 10].

$$D_s = \sum_{t=1(t \neq s)}^{v} I_{st} \tag{2}$$

D_s →The degree centrality value of node s.
v → The total number of nodes in the graph
I_{st} → Adjacency matrix

Closeness centrality: It is used to determine the distance or closeness of a node to other nodes. The centrality of a node is associated with its proximity to other nodes in the network. Equation 3 specifies the formula used to calculate closeness centrality [11, 12].

$$C(v) = \frac{N-1}{\sum_u d(u,v)} \tag{3}$$

C(v) → The closeness centrality value of node v.
N → The total number of nodes in the graph
d(u, v) → The length of the shortest path between nodes u and v

2.2 Community Detection Algorithms

Community detection algorithms measure the clustering tendencies of nodes in a graph. The clustering tendencies of nodes are measured by examining the relationship between densities. There are different community detection algorithms. The algorithms utilized in this study are as follows:

Louvain algorithm: It measures the membership status of nodes to communities based on the concept of modularity. Initially, each node is represented as a separate community. Modularity is calculated to assess the membership status of nodes to communities. Modularity can have a value between -0.5 and 1. A node completely outside the community takes the value of -0.5, while a node entirely belonging to the community takes the value of 1. The Louvain algorithm calculates modularity using Equation 4 [13].

$$Q = \frac{1}{2m} \sum_{ij} \left[Aij - \frac{kikj}{2m} \right] \delta(ci, cj) \tag{4}$$

Q → Modularity
m → The total weight value of relationships in the graph
A_{ij} → The weight value of the relationship between nodes i and j
k_i → The total weight of relationships in node i
kj → The total weight of relationships in node j
$\delta(c_i , c_j)$ → The community membership value of nodes i and j

Triangle counting algorithm: It identifies the number of triangles formed by nodes in a graph. The concept of a triangle here refers to a situation where 3 nodes are interconnected, and the nodes constitute the corners of the triangle. An abundance of triangles in a node indicates that the node is involved in strong relationships. In Figure 1, there is a view of a graph with 6 nodes. When looking at the edges highlighted in red, it can be observed that there are 2 triangles in the graph [14].

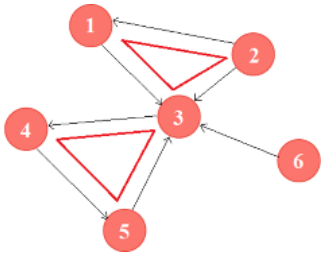

Figure 1. Detecting the number of triangles in a graph

2.3 Dataset and Pre-Processing

A dataset has been compiled, encompassing regional dishes and desserts from the Eastern Anatolia Region along with their respective ingredients. The dataset comprises 52 recipes, comprising 42 main dish recipes and 10 dessert recipes. A total of 87 ingredients are used in these recipes. Two different node types, namely 'Recipes' and 'Ingredients,' have been created. A directional relationship named 'Contains' is defined from the 'Recipes' node to the 'Ingredients' node, representing the inclusion of ingredients in recipes. In the graph illustrated in Figure 2, nodes coloured in purple represent 'Recipes,' while nodes in yellow represent 'Ingredients.' The edges between the nodes depict the relationships between them.

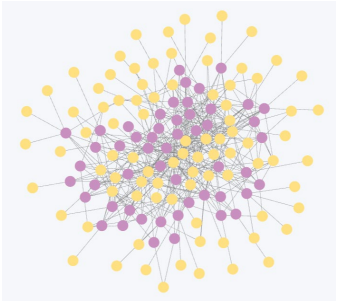

Figure 2. Graph representation of the database

The database consists of two different node types. However, for centrality and community analyses to be applicable, a homogeneous graph is required, where nodes are associated with nodes of their own types. To achieve this, a bidirectional relationship named 'Together' has been defined between the 'Ingredients' node types. The number of recipes in which two ingredients are jointly present is determined by the relationship weight. In Figure 3, the blue colour represents the 'Recipes' node type, and the orange colour represents the 'Ingredients' node type. While only a graph like the one on the left can be obtained in the initial state with only the 'Contains' relationship, the addition of the 'Together' relationship enables the creation of a homogeneous graph as shown on the right. The analyses will be conducted based on this newly established homogeneous graph [15].

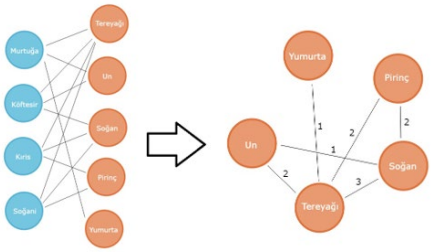

Figure 3. Transforming the graph into a graph with a single node type

There are 87 ingredients in the 52 recipes in the data. Salt, black pepper, and other spices, which are usually present in almost all recipes and do not contribute to the analysis, have been removed from the database. As a result, analysis was conducted based on the remaining 71 ingredients.

3 RESULTS

Three different centrality algorithms have been applied to the prepared data. The goal is to identify the ingredients that are heavily used in the recipes.

3.1 Results of Betweenness Centrality Algorithm

When calculating betweenness centrality, the number of relationships between nodes was considered as a weight. The top 20 ingredients with the highest betweenness centrality values used in recipes, along with the algorithm results, are shown in Table 1. Upon examination of the results, butter, onion, and sugar were found to be the top 3 ingredients with the highest betweenness centrality values in the recipes.

Table 1. Results of Betweenness centrality algorithm

Ingredients	Betweenness Centrality
Butter	641.898
Onion	573.341
Sugar	293.914
Egg	290.143
Tomato Paste	262.846
Olive Oil	168.286
Sunflower Oil	167.938
Yogurt	154.097
Rice	153.994
Parsley	152.117
Flour	150.249
Lemon	144.675
Wheat	139.221
Ground Meat	129.604
Milk	119.718
Chickpea	97.981
Tomato	70.797
Ground Wheat	69.750
Fresh Mint	50.565
Walnut	41.565

3.2 Results of Degree Centrality Algorithm

Degree centrality represents the number of adjacent nodes for each node. The top 20 ingredients with the highest degree centrality values used in recipes, along with the algorithm results, are shown in Table 2. Upon examination of the results, butter, onion, and tomato paste were found to be the top 3 ingredients with the highest degree centrality in the recipes.

Table 2. Results of Degree centrality algorithm

Ingredients	Degree centrality
Butter	53
Onion	53
Tomato Paste	43
Egg	40
Sugar	36
Flour	36
Ground Meat	35
Yogurt	34
Parsley	34
Olive Oil	33
Rice	33
Sunflower Oil	32
Ground Wheat	28
Lemon	28
Tomato	28
Wheat	28
Chickpea	27
Milk	26
Garlic	24
Walnut	21

3.3 Results of Closeness Centrality Algorithm

Closeness centrality is calculated based on the distance between nodes and other nodes. The top 20 ingredients with the highest closeness centrality values used in recipes, along with the algorithm results, are shown in Table 3. Upon examination of the results, it is observed that the top 3 ingredients with the highest closeness centrality values are butter, onion, and tomato paste.

Table 3. Results of Closeness centrality algorithm

Ingredients	Closeness centrality
Butter	0.805
Onion	0.805
Tomato Paste	0.722
Egg	0.700
Sugar	0.673
Flour	0.673
Ground Meat	0.667
Parsley	0.660
Yogurt	0.660
Olive Oil	0.654
Rice	0.654
Sunflower Oil	0.648
Ground Wheat	0.625
Lemon	0.625
Tomato	0.625
Wheat	0.625
Chickpea	0.619
Milk	0.614
Garlic	0.603
Walnut	0.588

3.4 Results of the Louvain Algorithm

According to the Louvain algorithm, nodes in the dataset are partitioned into four distinct communities. The results, shown in Table 4, display the community colours and the respective number of ingredients. Figure 4 visually represents the outcomes.

Table 4. Results of the Louvain algorithm

Ingredients	Number of Ingredients
Purple	32
Yellow	16
Orange	13
Blue	10

Figure 4. Graph representation of the results of Louvain algorithm

3.5 Results of the Triangle Counting Algorithm

According to the triangle counting algorithm, a total of 2374 triangular node triplets have been calculated in the dataset. Figure 5 visually presents the outcome of the triangle counting algorithm. It shows that there are a large number of relationships between nodes.

Figure 5. Graph representation of the results of triangle counting algorithm

The results of the triangle counting algorithm for the top 20 ingredients are presented in Table 5. Upon examination, it is observed that the top three ingredients with the highest triangle counts are, in order, onion, butter, and tomato paste.

Table 5. Results of the Triangle counting algorithm

Ingredients	Triangle Counts
Onion	425
Butter	421
Tomato Paste	354
Egg	307
Flour	298
Ground Meat	274
Yogurt	265
Parsley	263
Olive Oil	245
Sugar	236
Sunflower Oil	230
Rice	225
Ground Wheat	202
Tomato	199
Wheat	176
Lemon	176
Chickpea	175
Milk	166
Garlic	165

4 CONCLUSION

In today's world, the advancement of technology has led to an increase in data volume, giving rise to the concept of big data. Traditional SQL databases have proven insufficient for the analysis of these vast and heterogeneous data, leading to the emergence of NoSQL databases. In this study, a graph database containing recipes from the Eastern Anatolia Region was created, and various graph algorithms were applied for analysis. The dataset includes 52 recipes and 71 ingredients from the Eastern Anatolia Region, a region known for its unique culinary traditions. Three different centrality algorithms were used for the analysis: Closeness, Degree, and Betweenness. When the Closeness centrality results are analyzed, the top three ingredients are butter, onion, and sugar. In Degree centrality, the highest-ranked components are butter, onion, and tomato paste. Similarly, in Betweenness centrality, butter, onion, and tomato paste emerged as the most favorable three ingredients in the region. It is noteworthy that butter and onion are consistently ranked in the results of top two of all centrality algorithms. In addition, clustering algorithms, in particular the Louvain algorithm and triangle counting algorithms, were applied. According to the Louvain algorithm, the dataset revealed the existence of four different communities. The results of the triangle counting algorithm emphasized the dense relationships between pairs of components. In conclusion, these findings provide valuable information about the centrality and clustering tendencies of ingredients in recipes in Eastern Anatolia. Adding more recipes and ingredients to the dataset opens up new research opportunities and applications.

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Motion Prediction Classification for Wall-Following Robot Navigation

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Abstract

Robot navigation is an important feature for mobile robots to roam freely in the environment. The aim of robot navigation is to drive from a origin to a target point, but in accordance with the desired constraints. In this study, motion classification estimation and visualization were performed using the data set of the wall-following robot navigation. The class labels are forward movement, a slight turn to the right, a sharp turn to the right and a slight turn to the left. The model achieved 86.07 percent accuracy with an RMSLE score of 13.97.

Keywords: *Classification, Mobile robot, Navigation*

1 INTRODUCTION

Mobile robots are used in many areas such as transport, guidance, exploration and inspection. It is important that they move freely while fulfilling these tasks. Robot navigation is a necessity in providing these free movements. Thanks to robot navigation, mobile robots can reach the target from the starting point in a certain environment. With the sensors and classification methods used, obstacle avoidance function can be added to these robots. Classification methods facilitate the classification of various data sets as well as robot navigation.

Tripathy et al. designed a mobile robot navigation scheme in their study in 2021. The team used radio frequency-based identification to locate, a hybrid approach to plan the route and a predefined decision table to navigate. The algorithms underwent testing in four different situations involving two steps: creating a virtual environment and generating the shortest path. The efficacy of the proposed method was successfully demonstrated through the testing process. [1].

Pandey and his colleagues proposed using an Adaptive Neuro-Fuzzy Inference System (ANFIS) controller, which adjusts to navigate robots and avoid obstacles in unfamiliar environments. Distance information obtained from different sensors provides steering angle information with the help of the controller. The study, which was tested on a real mobile robot, showed its effectiveness and efficiency [2].

Er and Atasoy used Random Forest Algorithm, K Nearest Neighbourhood and Support Vector Machines algorithms to classify wine type and quality. As a result of the study, red and white wine were classified with an accuracy of approximately 99.5%. In addition, Random Forest Algorithm was found to be the most effective algorithm in the study where wine qualities were classified [3].

Gul, Rahiman and Alhady compared the techniques used for robot navigation and examined various methods such as neural networks, fuzzy logic, particle swarm optimisation. As a result of the study in which 133 papers were analysed in total, the methods used were compared according to certain metrics and their strengths and weaknesses were given [4].

In another study proposing a mobile robot navigation with lifelong learning capability, a robot navigation is designed that improves its behaviour in different environments and does not forget the environments it has learned before. The study was tested on a mobile robot. Experiments in three different environments showed that the proposed method gave better results [5].

Crespo et al. conducted a review on techniques for the use of semantic information with navigation systems. Human-assisted and autonomous semantic knowledge acquisition techniques were analysed [6].

Wang and colleagues suggested self-governing navigation of mobile robots in rough and unstructured indoor surroundings. The system combines sensing and navigation capabilities and provides a 2D map of the environment

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as input to the navigation function. The effectiveness of the system tested in simulation environment and in reality has been demonstrated [7].

In their research, Madi and Baba-Ali compared different ways of categorising methods for guiding robots along walls. They improved the K nearest neighbour algorithm, a type of method, to reduce the long time it takes to complete. As a result, it was observed that the improved version of the algorithm ran for a shorter time [8].

In their study on the application of Deep Reinforcement Learning to robot navigation, Zhu and Zhang analysed the proposed system for four different application scenarios. The article outlines the development of robot navigation using Deep Reinforcement Learning and discusses potential problems and their solutions [9].

Alenzi et al. used semantic information based on LIDAR data to create a representation of the environment. The system they proposed is low cost and requires low memory. They obtained a classification accuracy of 97.21% [10].

Faisal et al. compared four different navigation systems for a mobile robot. The controller parameters of the four fuzzy logic controller based navigation systems were defined in four different ways. These are respectively; inexperienced human, Genetic Algorithm, Particle Swarm Optimisation and expert human. As a result of the study, it was observed that the system tuned by the expert gave better results [11].

Rani and Jyothi examined different comparison techniques for different datasets in their study. As a result of the study, values such as the accuracy of the comparison methods for each dataset and their running times are presented in tables [12].

Wang and colleagues devised methods for improving the accuracy of detecting infrared maritime targets. These included Local Peak Singularity Measurement Based Image Enhancement and Grayscale Scatter Curve Shift Binarisation Based Target Segmentation. To validate their study, they conducted experiments comparing their algorithm with five others and found it performed robustly under different conditions [13].

Freire and colleagues conducted a study in 2009 that examined how the short-term storage mechanism affects the performance of neural classifiers for robotic navigation. Four different neural classifiers were tested in four action categories. As a result of the study, the multilayer perceptron method was found to be more effective [14].

In this study, we utilise the wall-following robot navigation dataset to categorise the robot movements with neural classifiers. Section 2 covers robot navigation and Section 3 describes the wall-following robot navigation dataset. The outcomes of the experiments are presented in Section 4, and the conclusions of the study are provided in the final section.

2 ROBOT NAVIGATION

Robot navigation produces a set of motion directives to transport a robot from an initial position s to a final position g in environment E. If this movement command is identified as $A^* = \{a_0, a_1, a_2, \dots\}$;

$$A^* = argminJ(E, s, g), A \in \mathcal{A} \quad (1)$$

Here, $\mathcal{A}$ represents the set of all conceivable motion instructions, while $J(.)$ denotes the aim function to be minimized by the navigation system. In the case of differential motion robots, linear and angular speed could be variables, while steering angle is pivotal for Ackermann steering cars and quad-rotor vehicle motions are based on propeller thrust. Navigation in two- and three-dimensional environments is facilitated by utilizing data from sensors or pre-existing environmental maps. The cost function J is determined in accordance with the system requirements such as the shortest path or time, obstacle avoidance, and movement constraints [15]. Robot navigation involves two basic tasks. These are point-to-point movement and obstacle avoidance. For point-to-point movement, methods such as GPS or perspective view can be used. For obstacle avoidance, methods with sensors such as laser range finding and ultrasonic detection are used. With the information received from these sensors, obstacles are identified and new movement commands are generated for obstacle avoidance [9]. A hierarchical path is followed to reach the target. A representative path is created from the start to the goal and this path is shaped with sensor information. Tasks and obstacles at certain points are identified and movement commands are shaped accordingly [15].

3 DATASET

The data used in this study are readily available data collected by Freire et al. The dataset containing the wall following robot navigation data was obtained with the SCITOS G5 robot using 24 ultrasonic sensors. The robot navigated clockwise in a room following a wall. A multilayer perceptron network was used for obstacle avoidance. There are 24 numerical features from 24 ultrasonic sensors. Simplified distances were calculated for front, back, right and left with the help of sensor groups that together cover an angle of 60 degrees. The distances taken are the shortest distances. The collected data are sensor reading, (x,y) coordinates and angular position, instantaneous translation and rotation speed of the robot, distance information and the tag number of the motion. A database was created from a collection of 5456 samples, gathered at a rate of 9 samples per second [14].

4 SIMULATION RESULTS

4.1 Root Mean Square Logarithmic Error (RMSLE)

Root Mean Square Logarithmic Error (RMSLE) is obtained by taking the logarithm of the actual and predicted values and finding the difference between them. This technique is not biased towards small or large errors, and it is not affected by outliers. The model incurs greater penalty when the predicted value greatly deviates from the true value. Conversely, less penalty is applied when the predicted value is much larger than the true value. Logarithms do not penalise high errors, which makes this method more accurate. The model consequently incurs a greater penalty for under-predicting than for over-predicting. The Equation (2) provides the calculation of this penalty. This characteristic can prove useful in situations where overestimation can be disregarded, while underestimation is unacceptable.

$$\text{RMSLE} = \sqrt{\frac{1}{N}\sum_{i=0}^{N}(\log(y_i + 1) - \log(\hat{y}_i + 1))^2} \tag{2}$$

Where N represents the total number of samples, y_i denotes the actual value, and $\hat{y}_i$ signifies the predicted value. The RMSLE value will solely focus on the relative error between the predicted and actual value, disregarding the data scale. However, if the error scale increases, the RMSLE value will increase in magnitude. The closer the RMSLE is to 0, the more accurate the model is [16].

Robot Navigation Importance Estimation: The wall-following robot navigation dataset used to estimate and visualise the importance of robot navigation was simulated via Google Colab. Four classes of information were used in the simulation, each representing different information. Here, class one represents forward movement, class two represents a slight right turn, class three represents a sharp right turn, and class four represents a slight left turn.

According to the simulation result of the predicted and actual training classes as given in Fig. 1, it is seen that the training actual class value is between three and four in the training prediction class for the fourth class, the prediction for the second actual class information is between one and three and a half, the prediction for the first actual class value is between one and three, and the prediction for the third actual class value is between one and three. The RMSLE value of the model was 0.1393 with an accuracy of 86.07%.

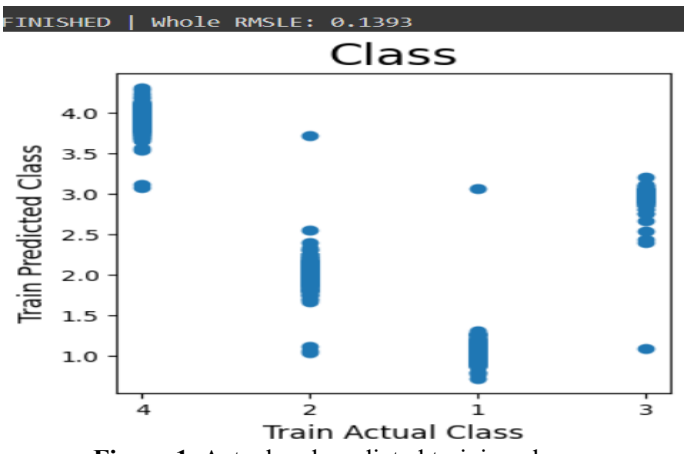

Figure 1. Actual and predicted training classes

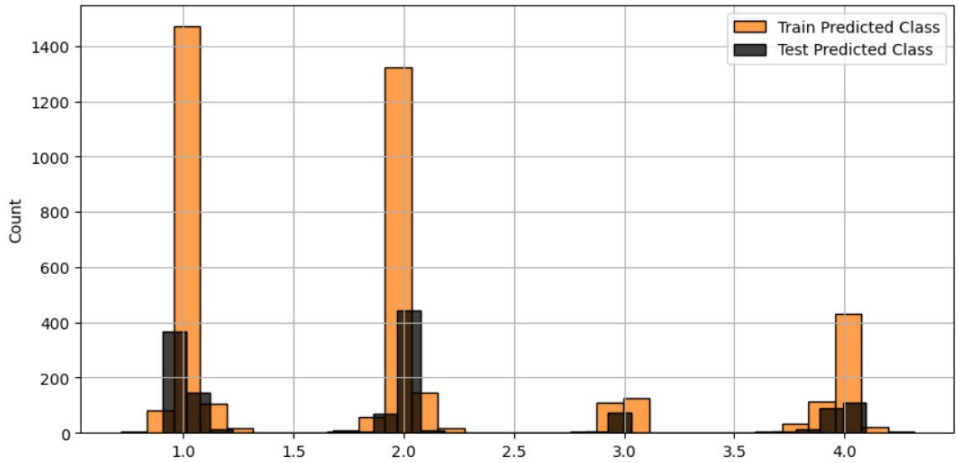

Figure 2. Training and test prediction classes graph

Fig. 2 shows the numerical graph of training and test prediction values. According to the graph, the training prediction value for the first class variable is one thousand five hundred while the test prediction value is three hundred ninety, the training prediction value for the second class variable is one thousand three hundred while the test value is four hundred ten, the training prediction value for the third class variable is one hundred while the test prediction value is eighty, the training prediction value for the fourth class variable is four hundred ten while the test prediction value is less than one hundred.

5 CONCLUSION

Data pertaining to the navigation of a wall-following robot was collected utilizing ultrasound sensors and the SCITOS G5 robot, as it navigated the room clockwise on four instances. The sensors, arranged in a circular pattern around the "waist" of the robot, employs 24 ultrasound sensors [17]. The file herein includes the raw data in relation to all 24 ultrasound sensors' measurements coupled with the corresponding class label. The measurements are taken at a rate of 9 samples per second. The study conducted motion classification prediction and visualisation on the wall-following robot navigation dataset. The dataset contains four groupings: moving in a straight line, turning slightly to the right, turning sharply to the right, and turning slightly to the left. The model achieved 86.07% accuracy with an RMSLE score of 13.97.

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Fixed Point Results of Generalized (ϕ,ψ)–Contractive Mappings in Ordered Non-Newtonian Metric Spaces

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Abstract

Grossman and Katz (1972) began studying non-Newtonian calculi. The fixed point theory has been introduced by Binbaşıoglu, Demiriz, and Turkoglu (2016) in non-Newtonian metric space. In this work, some fixed point, coincidence and common fixed point results are given for generalized (ϕ,ψ)-contraction mappings in complete partially ordered non-Newtonian metric spaces.

Keywords: *Non-Newtonian calculi, Fixed point theorems, Contraction mapping*

1 INTRODUCTION

In many spaces, fixed point theory has been the subject of far too many researches [1-8]. Lately, fixed point theorems have been used to demonstrate the existence and uniqueness of differential equation solutions. There are numerous applications of the theory and mappings that satisfy particular contraction requirements and have been an important topic of numerous research works.

An alternative to the traditional calculi is the non-Newtonian calculi [9]. Cakmak and Başar first described the non-Newtonian metric notion in 2002 [10]. Then, in 2016, Binbaşıoğlu, Demiriz, Türkoğlu provided non-Newtonian metric spaces and some of their qualities compared to topological ones [11]. Also, they introduced the fixed point theory in non-Newtonian metric spaces.

Bhaskar and Lakshmikantham [12] first established the idea of linked fixed points for specific mappings in ordered spaces and used their findings to investigate the existence and uniqueness of solutions for boundary value problems. Whereas Lakshmikantham and Ciric [13] were the first to introduce the notion of linked coincidence and coupled common fixed point theorems for nonlinear contractive mappings possessing monotone quality in partially ordered complete metric spaces. Since then, various writers have found results for generalized contraction mappings in partially ordered metric spaces and partially ordered b-metric spaces using fixed point, common fixed point, coupled coincidence point, and coupled fixed point methods. Some other researchers have given some results regarding fixed points, coincidences, coupled coincidences and coupled common fixed points for mappings obeying generalized (ϕ, ψ) -contractions and other generalized contractions in full partially ordered b-metric spaces and partial metric spaces [14-18]. The conclusions of several other analogous findings in the literature are expanded and generalized by these results.

In this work, some fixed point, coincidence and common fixed point results are given for generalized (ϕ, ψ)-contraction mappings in complete partially ordered non-Newtonian metric spaces.

2 PRELIMINARIES

We mention some fundamental information on the structure of non-Newtonian calculi. Let known the non-Newtonian real area together with its attributes.

Definition 2.1. An injective function is given to a generator from $\mathbb{R}$ and to the subset of $\mathbb{R}$ [10].

Remark 2.2. Every generator produces an arithmetic. A generator produces each arithmetic [10].

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Definition 2.3. Let we get the function $\beta: \mathbb{R} \to \mathbb{R}^+$, $\varsigma \to \beta(\varsigma) = e^{\varsigma} = \eta$. If $\beta = \exp$, following that, the function produces the geometric arithmetic. Also, the set $\mathbb{R}(N) = \{\beta(\varsigma): \varsigma \in \mathbb{R}\}$, is defined as the non-Newtonian real numbers set [10].

Remark 2.4. Consider the function β to be a generator, that is if $\beta = I$, then β generates the standard arithmetic, with I being an identity mapping.

The other notions of β- arithmetic are analogous to the traditional ones [10].

Definition 2.5. The following is how the β-integers are produced:

β-zero, β-one and therefore, all β-integers are displayed as ..., $\beta(-1)$, $\beta(0)$, $\beta(1)$, ...
Get a generator β with a range A. Then the operations β-addition, β-substraction, β-multiplication, β-division and β-order as described in the following,

$$\begin{aligned} \varsigma \dot{+} \eta &= \beta\{\beta^{-1}(\varsigma) + \beta^{-1}(\eta)\}, \\ \varsigma \dot{-} \eta &= \beta\{\beta^{-1}(\varsigma) - \beta^{-1}(\eta)\}, \\ \varsigma \dot{\times} \eta &= \beta\{\beta^{-1}(\varsigma) \times \beta^{-1}(\eta)\}, \\ \varsigma \dot{/} \eta &= \beta\{\beta^{-1}(\varsigma) \div \beta^{-1}(\eta)\}, \\ \varsigma \dot{<} \eta &= \beta(\varsigma) < \beta(\eta) \end{aligned}$$

for $\varsigma, \eta \in \mathbb{R}(N)$.

The β −absolute value of a number $\varsigma \in A \subset \mathbb{R}(N)$ specified by $\beta(|\beta^{-1}(\varsigma)|)$ is represented as $|\varsigma|_N$.

Also,

$$\sqrt{\varsigma^{2N}}^{N} = |\varsigma|_N = \beta(|\beta^{-1}(\varsigma)|).$$

So,

$$|\varsigma|_N = \beta(|\beta^{-1}(\varsigma)|) = \begin{cases} \varsigma, & \beta(0) \dot{<} \varsigma, \\ \beta(0), & \beta(0) = \varsigma, \\ \beta(0) \dot{-} \varsigma, & \beta(0) \dot{>} \varsigma. \end{cases}$$

For $\varsigma_1, \varsigma_2 \in A \subset \mathbb{R}(N)$, the non-Newtonian distance $|.|_N$ is described with

$$|\varsigma_1 \dot{-} \varsigma_2|_N = \beta\{|\beta^{-1}(\varsigma_1) - \beta^{-1}(\varsigma_2)|\}.$$

Where the distance has the commutative property that is $|\varsigma_1 \dot{-} \varsigma_2|_N = |\varsigma_2 \dot{-} \varsigma_1|_N$ [10].

Let we get any $\mu \in \mathbb{R}(N)$. μ is named as an *unsigned non-Newtonian real number,* if $\mu = \beta(0)$. μ is named as a *non-Newtonian negative real number,* if $\mu \dot{<} \beta(0)$ and μ is named as a *positive non-Newtonian real number,* if $\mu \dot{>} \beta(0)$. The sets of above numbers are showed by $\mathbb{R}^-(N)$ and $\mathbb{R}^+(N)$, respectively [9].

Definition 2.6. Let we take $X \neq \emptyset$ and $d_N: X \times X \to \mathbb{R}^+(N)$ meets the conditions listed below;

(NM1) $d_N(\varsigma, \eta) = \beta(0)$ iff $\varsigma = \eta$,
(NM2) $d_N(\varsigma, \eta) = d_N(\eta, \varsigma)$,
(NM3) $d_N(\varsigma, \eta) \dot{<} d_N(\varsigma, \mu) \dot{+} d_N(\mu, \eta)$.

for all $\varsigma, \eta, \mu \in$ X.

The pair (X, d_N) is then referred to as a non-Newtonian metric space and is called a non-Newtonian metric on X [10].

Definition 2.7. A sequence (ς_n) in a non-Newtonian metric space $X = (X, d_N)$ is claimed to be non-Newtonian convergent if for every given $\varepsilon \dot{>} \beta(0)$ there exists an $n_0 = n_0(\varepsilon) \in \mathbb{N}$ and $\varsigma \in X$ such that $d_N(\varsigma_n, \varsigma) \dot{<} \varepsilon$ for all $n > n_0$ and it is indicated by

$$\lim_{n\to\infty} \varsigma_n = \varsigma \text{ or } \varsigma_n \overset{N}{\to} \varsigma, \text{ as } n \to \infty \text{ [11].}$$

Definition 2.8. A sequence (ς_n) in a non-Newtonian metric space $X = (X, d_N)$ is claimed to be non-Newtonian Cauchy if for every given $\varepsilon > \beta(0)$ there exists an $n_0 = n_0(\varepsilon) \in \mathbb{N}$ such that $d_N(\varsigma_n, \varsigma_m) < \varepsilon$ for all $m, n > n_0$.

If for every non-Newtonian open ball $B_\varepsilon^N(\varsigma)$, there exists a natural number n_0 such that $n > n_0$, $\varsigma_n \in B_\varepsilon^N(\varsigma)$, then the sequence (ς_n) is claimed to be non-Newtonian convergent to ς.

The space X is said to be non-Newtonian complete if every non-Newtonian Cauchy sequence in X converges [11].

3. MAIN RESULTS

Definition 3.1. $(X, d_N, \preccurlyeq)$ is referred to be a partially ordered non- Newtonian metric if (X, d_N) is a non-Newtonian metric space and $(X, \preccurlyeq)$ is still a partially ordered set.

Definition 3.2. If the non-Newtonian metric d_N is non-Newtonian complete then $(X, d_N, \preccurlyeq)$ is defined complete partially ordered non-Newtonian metric.

Definition 3.3. Let $(X, d_N, \preccurlyeq)$ be a partially ordered non-Newtonian metric space, $T, K: X \to X$ are two mappings.

Then

i) K is called a monotone nondecreasing, if $K(\varsigma) \preccurlyeq K(\eta)$ for $\varsigma, \eta \in X$ with $\varsigma \preccurlyeq \eta$.
ii) An element $\varsigma \in X$ is called a coincidence point of T and K, if $T(\varsigma) = K(\varsigma)$.
iii) An element $\varsigma \in X$ is called a common fixed point of T and K, if $T(\varsigma) = K(\varsigma) = \varsigma$.
iv) T and K are called commuting, if $K\,T(\varsigma) = T\,K(\varsigma)$ for all $\varsigma \in X$.
v) T and K are called compatible, if any sequence $\{\varsigma_n\}$ with $\lim_{n\to\infty} T(\varsigma_n) = \lim_{n\to\infty} K(\varsigma_n) = \mu$, for $\mu \in X$ then $\lim_{n\to\infty} d_N(K\,T(\varsigma_n), T\,K(\varsigma_n)) = 0$.
vi) T and K are called weakly compatible, if $K\,T(\varsigma) = T\,K(\varsigma)$, when $K(\varsigma) = T(\varsigma)$ for some $\varsigma \in X$.
vii) K is called monotone T-nondecreasing, if $T(\varsigma) \preccurlyeq T(\eta) \Rightarrow K(\varsigma) \preccurlyeq K(\eta)$, for any $\varsigma, \eta \in X$.
viii) $X \neq \emptyset$ is called well ordered set, if every two elements of it are comparable i.e. $\varsigma \preccurlyeq \eta$ or $\eta \preccurlyeq \varsigma$, for $\varsigma, \eta \in X$.

Definition 3.4. Let $(X, d_N, \preccurlyeq)$ be a partially ordered non-Newtonian metric space, $K: XxX \to X$ and $T: X \to X$ be two mappings. Then, for $\varsigma, \eta, \varsigma_1, \varsigma_2, \eta_1, \eta_2 \in X$

i) K has the mixed T-monotone property, if K is non-decreasing T-monotone in its first argument and is non increasing T-monotone in its second argument, that is for any $\varsigma, \eta \in X$

$$T(\varsigma_1) \preccurlyeq T(\varsigma_2) \Rightarrow K(\varsigma_1, \eta) \preccurlyeq K(\varsigma_2, \eta)$$

and

$$T(\eta_1) \preccurlyeq T(\eta_2) \Rightarrow K(\varsigma, \eta_1) \succcurlyeq K(\varsigma, \eta_2).$$

Note that, if take T is an identity mapping then K has the mixed monotone property.

ii) If $K(\varsigma, \eta) = T(\varsigma)$ and $K(\eta, \varsigma) = T(\eta)$ then the pair $(\varsigma, \eta) \in X \times X$ is called as a coupled coincidence point of K and T.

Note that, if take T is an identity mapping then (ς, η) is a coupled fixed point of K.

iii) If $K(\varsigma, \varsigma) = T(\varsigma) = \varsigma$, then $\varsigma \in X$ is called as a common fixed point of K and T.
iv) If $K(T(\varsigma), T(\eta)) = T(K(\varsigma, \eta))$, then K and T are commutative.
v) T and K are called compatible, if

$$\lim_{n\to\infty} d_N(T(K(\varsigma_n, \eta_n)), K(T(\varsigma_n), T(\eta_n))) = 0$$

and

$$\lim_{n\to\infty} d_N(T(K(\eta_n, \varsigma_n)), K(T(\eta_n), T(\varsigma_n))) = 0,$$

whenever two sequences $\{\varsigma_n\}$ and $\{\eta_n\}$ in X such that

$$\lim_{n\to\infty} K(\varsigma_n, \eta_n) = \lim_{n\to\infty} T(\varsigma_n) = \varsigma \text{ and } \lim_{n\to\infty} K(\eta_n, \varsigma_n) = \lim_{n\to\infty} T(\eta_n) = \eta.$$

Definition 3.5. A mapping $\phi: \mathbb{R}^+(N) \cup \{\beta(0)\} \to \mathbb{R}^+(N) \cup \{\beta(0)\}$ is an altering distance function, if ϕ is continuous, non decreasing and $\phi(t) = \beta(0) \Leftrightarrow t = \beta(0)$. Also, we will denote by Φ the set of ϕ functions satisfying above conditions.

Furthermore, we will denote by Ψ the set of all functions $\psi: \mathbb{R}^+(N) \cup \{\beta(0)\} \to \mathbb{R}^+(N) \cup \{\beta(0)\}$ satisfying two conditions: ψ is lower semi-continuous, $\psi(t) = \beta(0) \Leftrightarrow t = \beta(0)$.

Let $(X, d_N, \preccurlyeq)$ be a partially ordered non-Newtonian metric space, $k \in \mathbb{R}^+(N)$, $\mathrm{k} \dot{>} \beta(1)$ and $K: X \to X$ be a mapping. Then we will get

$$N(\varsigma,\eta) = max\{\frac{d_N(\eta,K\eta) \dot{\times}[\beta(1) \dot{+} d_N(\varsigma,K\varsigma)]}{\beta(1) \dot{+} d_N(\varsigma,\eta)}, \frac{d_N(\varsigma,K\varsigma) \dot{\times} d_N(\eta,K\eta)}{\beta(1) \dot{+} d_N(K\varsigma,K\eta)}, \frac{d_N(\varsigma,K\varsigma) \dot{\times} d_N(\varsigma,K\eta)}{\beta(1) \dot{+} d_N(\varsigma,K\eta) \dot{+} d_N(\eta,K\varsigma)}, d_N(\varsigma,\eta)\} \dots (1)$$

And

$$M(\varsigma,\eta) = max\left\{\frac{d_N(\eta,K\eta) \dot{\times}[\beta(1) \dot{+} d_N(\varsigma,K\varsigma)]}{\beta(1) \dot{+} d_N(\varsigma,\eta)}, d_N(\varsigma,\eta)\right\} \dots (2)$$

Definition 3.6. Let $(X, d_N, \preccurlyeq)$ be a partially ordered non-Newtonian metric space, $k \in \mathbb{R}^+(N)$, $\mathrm{k} \dot{>} \beta(1)$ and $\phi \in \Phi$, $\psi \in \Psi$. This mapping $K: X \to X$ is called as a generalized (ϕ,ψ) −contractive mapping if it satisfies

$$\phi(\mathrm{k} \dot{\times} d_N(K\varsigma,K\eta)) \dot{\leq} \phi(N(\varsigma,\eta)) \dot{-} \psi(M(\varsigma,\eta)) \dots (3)$$

for any $\varsigma, \eta \in X$ with $\varsigma \preccurlyeq \eta$.

Theorem 3.7. Let $(X, d_N, \preccurlyeq)$ be a complete partially ordered non-Newtonian metric space, $k \in \mathbb{R}^+(N)$, $\mathrm{k} \dot{>} \beta(1)$ and $K: X \to X$ be an almost generalized (ϕ,ψ) −contractive mapping, continuous, nondecreasing mapping. If there exists $\varsigma_0 \in X$, $\varsigma_0 \preccurlyeq K\varsigma_0$, then K has a fixed point in X.

Proof. Let we take $\varsigma_0 \in X$, $K\varsigma_0 = \varsigma_0$, then K has a fixed point in X.
Now, we suppose that $\varsigma_0 \prec K\varsigma_0$, then establish a sequence $\{\varsigma_n\} \subset X$ by $\varsigma_{n+1} = K\varsigma_n$, for $n \geq 0$. Because K is non-decreasing, we get

$$\varsigma_0 \prec K\varsigma_0 = \varsigma_1 \preccurlyeq \dots \preccurlyeq \varsigma_n \preccurlyeq K\varsigma_n = \varsigma_{n+1} \preccurlyeq \dots (4)$$

If for some $n_0 \in \mathbb{N}$, such that $\varsigma_{n_0} = \varsigma_{n_0+1}$ then from above inequality, ς_{n_0} is a fixed point of K. Assume that, $\varsigma_{n+1} \neq \varsigma_n$, for all $n \geq 1$. Since $\varsigma_n \succ \varsigma_{n-1}$ and from the condition (3), then

$$\begin{aligned}\phi(d_N(\varsigma_n,\varsigma_{n+1})) &\dot{=} \phi(d_N(K\varsigma_{n-1},K\varsigma_n)) \\ &\dot{\leq} \phi(\mathrm{k} \dot{\times} d_N(K\varsigma_{n-1},K\varsigma_n)) \\ &\dot{\leq} \phi\big(N(\varsigma_{n-1},\varsigma_n)\big) \dot{-} \psi\big(M(\varsigma_{n-1},\varsigma_n)\big) \dots (5)\end{aligned}$$

So, we obtain

$$d_N(\varsigma_n,\varsigma_{n+1}) \dot{=} d_N(K\varsigma_{n-1},K\varsigma_n)) \dot{\leq} \frac{\beta(1)}{\mathrm{k}} \dot{\times} N(\varsigma_{n-1},\varsigma_n) \dots (6),$$

Where

$$\begin{aligned}N(\varsigma_{n-1},\varsigma_n) &= max\{\frac{d_N(\varsigma_n,K\varsigma_n) \dot{\times}[\beta(1) \dot{+} d_N(\varsigma_{n-1},K\varsigma_{n-1})]}{\beta(1) \dot{+} d_N(\varsigma_{n-1},\varsigma_n)}, \frac{d_N(\varsigma_{n-1},K\varsigma_{n-1}) \dot{\times} d_N(\varsigma_n,K\varsigma_n)}{\beta(1) \dot{+} d_N(K\varsigma_{n-1},K\varsigma_n)}, \\ &\quad \frac{d_N(\varsigma_{n-1},K\varsigma_{n-1}) \dot{\times} d_N(\varsigma_{n-1},K\varsigma_n)}{\beta(1) \dot{+} d_N(\varsigma_{n-1},K\varsigma_n) \dot{+} d_N(\varsigma_n,K\varsigma_{n-1})}, d_N(\varsigma_{n-1},\varsigma_n)\} \\ &= max\{\frac{d_N(\varsigma_n,\varsigma_{n+1}) \dot{\times}[\beta(1) \dot{+} d_N(\varsigma_{n-1},\varsigma_n)]}{\beta(1) \dot{+} d_N(\varsigma_{n-1},\varsigma_n)}, \frac{d_N(\varsigma_{n-1},\varsigma_n) \dot{\times} d_N(\varsigma_n,\varsigma_{n+1})}{\beta(1) \dot{+} d_N(\varsigma_n,\varsigma_{n+1})}, \\ &\quad \frac{d_N(\varsigma_{n-1},\varsigma_n) \dot{\times} d_N(\varsigma_{n-1},\varsigma_{n+1})}{\beta(1) \dot{+} d_N(\varsigma_{n-1},\varsigma_{n+1}) \dot{+} d_N(\varsigma_n,\varsigma_n)}, d_N(\varsigma_{n-1},\varsigma_n)\} \\ &\dot{\leq} max\{d_N(\varsigma_n,\varsigma_{n+1}), d_N(\varsigma_{n-1},\varsigma_n)\} \dots (7).\end{aligned}$$

If $max\{d_N(\varsigma_n,\varsigma_{n+1}), d_N(\varsigma_{n-1},\varsigma_n)\} = d_N(\varsigma_n,\varsigma_{n+1})$ for some $n \geq 1$, then from (6) follows

$$d_N(\varsigma_n,\varsigma_{n+1}) \dot{\leq} \frac{\beta(1)}{\mathrm{k}} \dot{\times} d_N(\varsigma_n,\varsigma_{n+1}) \dots (8)$$

which is a contradiction. That is, $max\{d_N(\varsigma_n, \varsigma_{n+1}), d_N(\varsigma_{n-1}, \varsigma_n)\} = d_N(\varsigma_{n-1}, \varsigma_n)$ for $n \geq 1$.

We get from (6),

$$d_N(\varsigma_n, \varsigma_{n+1}) \dot{\leq} \frac{\beta(1)}{\mathrm{k}} \dot{\times} d_N(\varsigma_{n-1}, \varsigma_n) \dots (9).$$

As $\beta(0) \dot{<} \frac{\beta(1)}{\mathrm{k}} \dot{<} \beta(1)$, the sequence $\{\varsigma_n\}$ is a Cauchy sequence and from X is complete, then there exists some $\mu \in X$ such that $\varsigma_n \overset{N}{\to} \mu$. Since K is continuous,

$$K\mu = K(\lim_{n\to+\infty} \varsigma_n) = \lim_{n\to+\infty} K\varsigma_n = \lim_{n\to+\infty} \varsigma_{n+1} = \mu \dots (10).$$

Therefore, μ is a fixed point of K.

Theorem 3.8. Let $(X, d_N, \preccurlyeq)$ be a complete partially ordered non-Newtonian metric space, $\mathrm{k} \dot{>} \beta(1)$. Assume that X satisfies, if a nondecreasing sequence $\varsigma_n \overset{N}{\to} \mu$ in X, then $\varsigma_n \preccurlyeq \mu$ for all $n \in \mathbb{N}$, and $\mu = sup\varsigma_n$. Let $K: X \to X$ be a nondecreasing mapping such that the contraction condition (3) is satisfied. If there exists $\varsigma_0 \in X$, $\varsigma_0 \preccurlyeq K\varsigma_0$, then K has a fixed point in X.

Proof. From the proof of above theorem, we take a nondecreasing Cauchy sequence $\{\varsigma_n\}$, which converges to μ in X. Therefore we have $\varsigma_n \preccurlyeq \mu$ for any $n \in \mathbb{N}$, implies that $\mu = sup\varsigma_n$.

We assume that $K\mu \neq \mu$. Let

$$N(\varsigma_n, \mu) = max\{\frac{d_N(\mu, K\mu) \dot{\times} [\beta(1) \dot{+} d_N(\varsigma_n, K\varsigma_n)]}{\beta(1) \dot{+} d_N(\varsigma_n, \mu)}, \frac{d_N(\varsigma_n, K\varsigma_n) \dot{\times} d_N(\mu, K\mu)}{\beta(1) \dot{+} d_N(K\varsigma_n, K\mu)}, \frac{d_N(\varsigma_n, K\varsigma_n) \dot{\times} d_N(\varsigma_n, K\mu)}{\beta(1) \dot{+} d_N(\varsigma_n, K\mu) \dot{+} d_N(\mu, K\varsigma_n)}, d_N(\varsigma_n, \mu)\} \dots (11)$$

and

$$M(\varsigma_n, \mu) = max\left\{\frac{d_N(\mu, K\mu) \dot{\times} [\beta(1) \dot{+} d_N(\varsigma_n, K\varsigma_n)]}{\beta(1) \dot{+} d_N(\varsigma_n, \mu)}, d_N(\varsigma_n, \mu)\right\} \dots (12)$$

Letting $n \to +\infty$ and from $\lim_{n\to+\infty} \varsigma_n = \mu$,

$$\lim_{n\to+\infty} N(\varsigma_n, \mu) = max\{d_N(\mu, K\mu), \beta(0), \beta(0), \beta(0)\} = d_N(\mu, K\mu) \dots (13)$$

and

$$\lim_{n\to+\infty} M(\varsigma_n, \mu) = max\{d_N(\mu, K\mu), \beta(0)\} = d_N(\mu, K\mu) \dots (14).$$

As $\varsigma_n \preccurlyeq \mu$ for all $n \in \mathbb{N}$, we obtain that

$$\begin{aligned} \phi(d_N(\varsigma_{n+1}, K\mu)) &= \phi(d_N(K\varsigma_n, K\mu)) \\ &\dot{\leq} \phi(k \dot{\times} d_N(K\varsigma_n, K\mu)) \\ &\dot{\leq} \phi(N(\varsigma_n, \mu)) \dot{-} \psi(M(\varsigma_n, \mu)) \dots (15) \end{aligned}$$

Therefore,

$$\phi(d_N(\mu, K\mu)) \dot{\leq} \phi(d_N(\mu, K\mu)) \dot{-} \psi(d_N(\mu, K\mu)) \dot{<} \phi(d_N(\mu, K\mu)) \dots (16)$$

This is a contradiction. In this case $\mu = K\mu$, i.e. K has a fixed point.

Theorem 3.9. Let $(X, d_N, \preccurlyeq)$ be a complete partially ordered non-Newtonian metric space, $\mathrm{k} \dot{>} \beta(1)$ and $K: X \to X$ be an almost generalized (ϕ, ψ) −contractive mapping, continuous, nondecreasing mapping and every pair of elements has a lower bound or an upper bound. If there exists $\varsigma_0 \in X$, $\varsigma_0 \preccurlyeq K\varsigma_0$, then K has a unique fixed point in X.

Proof. From the proof of above two theorems, we conclude that K has a nonempty set of fixed points. Assume that ς^* and η^* be two fixed points of K then, we claim that $\varsigma^* = \eta^*$. Suppose that $\varsigma^* \neq \eta^*$, then from the hypothesis we have

$$\phi(d_N(K\varsigma^*, K\eta^*)) \dot{\leq} \phi(k \dot{\times} d_N(K\varsigma^*, K\eta^*)) \dot{\leq} \phi(N(\varsigma^*, \eta^*)) \dot{-} \psi(M(\varsigma^*, \eta^*)) \dots (17)$$

Consequently, we get

$$d_N(\varsigma^*, \eta^*) = d_N(K\varsigma^*, K\eta^*) \dot{\leq} \frac{\beta(1)}{k} \dot{\times} N(\varsigma^*, \eta^*) \dots (18)$$

where

$$\begin{aligned} N(\varsigma^*, \eta^*) = max\{&\frac{d_N(\eta^*, K\eta^*) \dot{\times} [\beta(1) \dot{+} d_N(\varsigma^*, K\varsigma^*)]}{\beta(1) \dot{+} d_N(\varsigma^*, \eta^*)}, \frac{d_N(\varsigma^*, K\varsigma^*) \dot{\times} d_N(\eta^*, K\eta^*)}{\beta(1) \dot{+} d_N(K\varsigma^*, K\eta^*)}, \\ &\frac{d_N(\varsigma^*, K\varsigma^*) \dot{\times} d_N(\varsigma^*, K\eta^*)}{\beta(1) \dot{+} d_N(\varsigma^*, K\eta^*) \dot{+} d_N(\eta^*, K\varsigma^*)}, d_N(\varsigma^*, \eta^*)\} \\ = max\{&\frac{d_N(\eta^*, \eta^*) \dot{\times} [\beta(1) \dot{+} d_N(\varsigma^*, \varsigma^*)]}{\beta(1) \dot{+} d_N(\varsigma^*, \eta^*)}, \frac{d_N(\varsigma^*, \varsigma^*) \dot{\times} d_N(\eta^*, \eta^*)}{\beta(1) \dot{+} d_N(\varsigma^*, \eta^*)}, \\ &\frac{d_N(\varsigma^*, \varsigma^*) \dot{\times} d_N(\varsigma^*, \eta^*)}{\beta(1) \dot{+} d_N(\varsigma^*, \eta^*) \dot{+} d_N(\eta^*, \varsigma^*)}, d_N(\varsigma^*, \eta^*)\} \\ = max\{&0,0,0, d_N(\varsigma^*, \eta^*)\} \\ = &d_N(\varsigma^*, \eta^*) \dots (19) \end{aligned}$$

From (19), we get

$$d_N(\varsigma^*, \eta^*) \dot{\leq} \frac{\beta(1)}{k} \dot{\times} d_N(\varsigma^*, \eta^*) \dot{<} d_N(\varsigma^*, \eta^*) \dots (20)$$

which is a contradiction. Hence $\varsigma^* = \eta^*$. This completes the proof.

Let $(X, d_N, \preccurlyeq)$ be a complete partially ordered non-Newtonian metric space, $k \dot{>} \beta(1)$ and the $K, T: X \to X$ be two mappings. Set

$$\begin{aligned} N_T(\varsigma, \eta) = max\{&\frac{d_N(T\eta, K\eta) \dot{\times} [\beta(1) \dot{+} d_N(T\varsigma, K\varsigma)]}{\beta(1) \dot{+} d_N(T\varsigma, T\eta)}, \frac{d_N(T\varsigma, K\varsigma) \dot{\times} d_N(T\eta, K\eta)}{\beta(1) \dot{+} d_N(K\varsigma, K\eta)}, \\ &\frac{d_N(T\varsigma, K\varsigma) \dot{\times} d_N(T\varsigma, K\eta)}{\beta(1) \dot{+} d_N(T\varsigma, K\eta) \dot{+} d_N(T\eta, K\varsigma)}, d_N(T\varsigma, T\eta)\} \dots (21) \end{aligned}$$

and

$$M_T(\varsigma, \eta) = max\left\{\frac{d_N(T\eta, K\eta) \dot{\times} [\beta(1) \dot{+} d_N(T\varsigma, K\varsigma)]}{\beta(1) \dot{+} d_N(T\eta, T\varsigma)}, d_N(T\varsigma, T\eta)\right\} \dots (22).$$

Definition 3.10. Let $(X, d_N, \preccurlyeq)$ be a partially ordered non-Newtonian metric space with $k \dot{>} \beta(1)$. The mapping $K: X \to X$ is called a generalized (ϕ, ψ) −contraction mapping with respect to $T: X \to X$ for some $\phi \in \Phi$ and $\psi \in \Psi$, if

$$\phi(k \dot{\times} d_N(K\varsigma, K\eta)) \dot{\leq} \phi(N_T(\varsigma, \eta)) \dot{-} \psi(M_T(\varsigma, \eta)) \dots (23)$$

for any $\varsigma, \eta \in X$ with $T\varsigma \preccurlyeq T\eta$, where $N_T(\varsigma, \eta)$ and $M_T(\varsigma, \eta)$ are given by (21) and (22), respectively.

Theorem 3.11. Let $(X, d_N, \preccurlyeq)$ be a complete partially ordered non-Newtonian metric space with $k \dot{>} \beta(1)$ and the $K: X \to X$ be an almost generalized (ϕ, ψ) −contractive mapping with respect to $T: X \to X$, K and T are continuous such that K is a monotone T non decreasing mapping, compatible with T and $KX \subseteq TX$. If for some $\varsigma_0 \in X$ such that $T\varsigma_0 \preccurlyeq K\varsigma_0$, then K and T have a coincidence point in X.

Proof. We construct two sequences $\{\varsigma_n\}$ and $\{\eta_n\}$ in X such that

$$\eta_n = K\varsigma_n = T\varsigma_{n+1} \dots (24)$$

for all $n \in \mathbb{N}$, for which

$$T\varsigma_0 \preccurlyeq T\varsigma_1 \preccurlyeq T\varsigma_2 \preccurlyeq \dots \preccurlyeq T\varsigma_n \preccurlyeq T\varsigma_{n+1} \preccurlyeq \dots \quad \dots (25)$$

We have to show that

$$d_N(\eta_n, \eta_{n+1}) \dot{\leq} \gamma \dot{\times} d_N(\eta_{n-1}, \eta_n), \dots (26)$$

for all $n \geq 1$, $\gamma \in \mathbb{R}^+(N)$ and $\beta(0) \dot{<} \gamma \dot{<} \frac{\beta(1)}{\mathrm{k}}$. Therefore, we have

$$\phi\left(k \dot{\times} d_N(\eta_n, \eta_{n+1})\right) = \phi\left(k \dot{\times} d_N(K\varsigma_n, K\varsigma_{n+1})\right)$$

$$\dot{\leq} \phi(N_T(\varsigma_n, \varsigma_{n+1})) \dot{-} \psi(M_T(\varsigma_n, \varsigma_{n+1})) \dots (27)$$

where $\lim_{n\to+\infty} K\varsigma_n = \lim_{n\to+\infty} T\varsigma_{n+1} = \eta$.

$$N_T(\varsigma_n, \varsigma_{n+1}) = max\{\frac{d_N(T\varsigma_{n+1}, K\varsigma_{n+1})[\beta(1) \dot{+} d_N(T\varsigma_n, K\varsigma_n)]}{\beta(1) \dot{+} d_N(T\varsigma_n, T\varsigma_{n+1})},$$
$$\frac{d_N(T\varsigma_n, K\varsigma_n) \dot{\times} d_N(T\varsigma_{n+1}, K\varsigma_{n+1})}{\beta(1) \dot{+} d_N(K\varsigma_n, K\varsigma_{n+1})}, \frac{d_N(T\varsigma_n, K\varsigma_n) \dot{\times} d_N(T\varsigma_n, K\varsigma_{n+1})}{\beta(1) \dot{+} d_N(T\varsigma_n, K\varsigma_{n+1}) \dot{+} d_N(T\varsigma_{n+1}, K\varsigma_n)}, d_N(T\varsigma_n, T\varsigma_{n+1})\}$$
$$= max\{\frac{d_N(\eta_n, \eta_{n+1}) \dot{\times} [\beta(1) \dot{+} d_N(\eta_{n-1}, \eta_n)]}{\beta(1) \dot{+} d_N(\eta_{n-1}, \eta_n)},$$
$$\frac{d_N(\eta_{n-1}, \eta_n) \dot{\times} d_N(\eta_n, \eta_{n+1})}{\beta(1) \dot{+} d_N(\eta_n, \eta_{n+1})}, \frac{d_N(\eta_{n-1}, \eta_n) \dot{\times} d_N(\eta_{n-1}, \eta_{n+1})}{\beta(1) \dot{+} d_N(\eta_{n-1}, \eta_{n+1}) \dot{+} d_N(\eta_n, \eta_n)}, d_N(\eta_{n-1}, \eta_n)\}$$

$$\dot{\leq} max\{d_N(\eta_{n-1}, \eta_n), d_N(\eta_n, \eta_{n+1})\}$$

and

$$M_T(\varsigma_n, \varsigma_{n+1}) = max\{\frac{d_N(T\varsigma_{n+1}, K\varsigma_{n+1}) \dot{\times} [\beta(1) \dot{+} d_N(T\varsigma_n, K\varsigma_n)]}{\beta(1) \dot{+} d_N(T\varsigma_n, T\varsigma_{n+1})}, d_N(T\varsigma_n, T\varsigma_{n+1})\}$$
$$= max\{\frac{d_N(\eta_n, \eta_{n+1}) \dot{\times} [\beta(1) \dot{+} d_N(\eta_{n-1}, \eta_n)]}{\beta(1) \dot{+} d_N(T\eta_{n-1}, T\eta_n)}, d_N(\eta_{n-1}, \eta_n = max\{d_N(\eta_{n-1}, \eta_n), d_N(\eta_n, \eta_{n+1})\}$$

Therefore we get

$$\phi\left(k \dot{\times} d_N(\eta_n, \eta_{n+1})\right) \dot{\leq} \phi(\max\{d_N(\eta_{n-1}, \eta_n), d_N(\eta_n, \eta_{n+1})\})$$
$$\dot{-} \psi(max\{d_N(\eta_{n-1}, \eta_n), d_N(\eta_n, \eta_{n+1})\}) \dots . (28)$$

If $\beta(0) \dot{<} d_N(\eta_{n-1}, \eta_n) \dot{\leq} d_N(\eta_n, \eta_{n+1})$ for some $n \in \mathbb{N}$, then we obtain

$$\phi\left(k \dot{\times} d_N(\eta_n, \eta_{n+1})\right) \dot{\leq} \phi\left(d_N(\eta_n, \eta_{n+1})\right) \dot{-} \psi(d_N(\eta_n, \eta_{n+1}) \dot{<} \phi\left(d_N(\eta_n, \eta_{n+1})\right) \dots (29)$$

and thus

$$k \dot{\times} d_N(\eta_n, \eta_{n+1}) \dot{\leq} d_N(\eta_n, \eta_{n+1}) \dots (30).$$

This is a contradiction so that

$$k \dot{\times} d_N(\eta_n, \eta_{n+1}) \dot{\leq} d_N(\eta_{n-1}, \eta_n) \dots (31)$$

is found. Consequently, $\{\eta_n\} = \{K\varsigma_n\} = \{T\varsigma_{n+1}\}$ is a non-Newtonian Cauchy sequence and so non-Newtonian converges to a η in X as X is complete such that

$$\lim_{n\to+\infty} K\varsigma_n = \lim_{n\to+\infty} T\varsigma_{n+1} = \eta.$$

Thus by the compatibility of K and T, we obtain that

$$\lim_{n\to+\infty} d_N(TK\varsigma_n, KT\varsigma_n) = \beta(0)\dots (32)$$

and from the continuity of K and T, we have

$$\lim_{n\to+\infty} TK\varsigma_n = T\eta,\ \lim_{n\to+\infty} KT\varsigma_n = K\eta. \dots(33)$$

From the triangle inequality,

$$\frac{\beta(1)}{k} \dot{\times} d_N(K\eta, T\eta) \dot{\leq} d_N(K\eta, KT\varsigma_n) \dot{+} \mathrm{k} \dot{\times} d_N(KT\varsigma_n, TK\varsigma_n) \dot{+} k \dot{\times} d_N(TK\varsigma_n, T\eta) \dots (34)$$

Thus, $d_N(K\varsigma, T\varsigma) = \beta(0), n \to \infty$ and ς is a non-Newtonian coincidence point of K and T.

Theorem 3.12. Let $(X, d_N, \preccurlyeq)$ be a complete partially ordered non-Newtonian metric space with $k \dot{>} \beta(1)$ and the $K: X \to X$ be an almost generalized (ϕ, ψ) −contractive mapping with respect to $T: X \to X$, X satisfies for any nondecreasing sequence $\{T\varsigma_n\} \subset X$ with $\lim_{n\to+\infty} T\varsigma_n = T\varsigma$ in TX, where TX is a closed subset of X implies that $T\varsigma_n \dot{\preccurlyeq} T\varsigma$, $T\varsigma \dot{\preccurlyeq} T(T\varsigma)$ for $n \in \mathbb{N}$. If there exists $\varsigma_0 \in X$, $T\varsigma_0 \dot{\preccurlyeq} K\varsigma_0$, then the weakly compatible mappings T and K have a coincidence point in X. Moreover, T and K have a common fixed point, if T and K commute at their coincidence points.

Proof. The sequence, $\{\eta_n\} = \{K\varsigma_n\} = \{T\varsigma_{n+1}\}$ is a non-Newtonian Cauchy sequence from the proof of Theorem 3.11. Because TX is closed, then there is some $\eta \in X$ such that

$$\lim_{n\to+\infty} K\varsigma_n = \lim_{n\to+\infty} T\varsigma_{n+1} = T\eta.$$

From hypotheses, $T\varsigma_n \preccurlyeq T\eta$ for all $n \in \mathbb{N}$.

Now, we have to prove that η is a coincidence point of T and K. From equation (23), we have

$$\phi\big(k \dot{\times} d_N(K\varsigma_n, K\varsigma)\big) \dot{\leq} \phi\big(N_T(\varsigma_n, \varsigma)\big) \dot{-} \psi(M_T(\varsigma_n, \varsigma)), \dots (35)$$

where

$$N_T(\varsigma_n, \eta) = max\{\frac{d_N(T\eta, K\eta) \dot{\times} [\beta(1) \dot{+} d_N(T\varsigma_n, K\varsigma_n)]}{\beta(1) \dot{+} d_N(T\varsigma_n, T\eta)},$$
$$\frac{d_N(T\varsigma_n, K\varsigma_n) d_N(T\eta, K\eta)}{\beta(1) \dot{+} d_N(K\varsigma_n, K\eta)}, \frac{d_N(T\varsigma_n, K\varsigma_n) d_N(T\varsigma_n, K\eta)}{\beta(1) \dot{+} d_N(T\varsigma_n, K\eta) \dot{+} d_N(T\eta, K\varsigma_n)}, d_N(T\varsigma_n, T\eta)\}$$
$$\overset{N}{\to} max\{d_N(T\eta, K\eta), \beta(0), \beta(0), \beta(0)\}$$
$$= d_N(T\eta, K\eta) \text{ as } n \to \infty,$$

and

$$M_T(\varsigma_n, \eta) = max\{\frac{d_N(T\eta, K\eta) \dot{\times} [\beta(1) \dot{+} d_N(T\varsigma_n, K\varsigma_n)]}{\beta(1) \dot{+} d_N(T\varsigma_n, T\eta)}, d_N(T\varsigma_n, T\eta)\}$$
$$\overset{N}{\to} max\{d_N(T\eta, K\eta), \beta(0)\} = d_N(T\eta, K\eta)$$

as $n \to \infty$.

Therefore (35) we obtain

$$\phi(k \dot{\times} \lim_{n\to+\infty} d_N(K\varsigma_n, K\varsigma)) \dot{\leq} \phi\big(d_N(T\eta, K\eta)\big) \dot{-} \psi(d_N(T\eta, K\eta)) \dot{<} \phi\big(d_N(T\eta, K\eta)\big) \dots (36)$$

Consequently, we get

$$\lim_{n\to+\infty} d_N(K\varsigma_n, K\varsigma) \dot{<} \frac{\beta(1)}{k} \dot{\times} d_N(T\eta, K\eta). \dots (37)$$

Further by triangular inequality, we have

$$\frac{\beta(1)}{k} \dot{\times} d_N(T\eta, K\eta) \dot{\leq} d_N(T\eta, K\varsigma_n) \dot{+} d_N(K\varsigma_n, K\eta) \ldots (38)$$

then (37) and (38) lead to contradiction, if $T\eta \neq K\eta$. Hence, $T\eta = K\eta$.

Let $T\eta = K\eta = \omega$, that is T and K commute at ω, then $K\omega = K(T\eta) = T(K\eta) = T\omega$. Since $T\eta = T(T\eta) = T\omega$, then by equation (35) with $T\eta = K\eta$ and $T\omega = K\omega$, we get

$$\phi\big(k \dot{\times} d_N(K\eta, K\omega)\big) \dot{\leq} \phi(N_T(\eta, \omega))) \dot{-} \psi(M_T(\eta, \omega)) \dot{\leq} \phi((K\eta, K\omega)) \ldots (39)$$

or equivalently,

$$k \dot{\times} d_N(K\eta, K\omega) \dot{\leq} d_N(K\eta, K\omega),$$

which is a contradiction, if $T\eta \neq K\omega$. Thus, K$\eta = K\omega = \omega$. Hence, K$\eta = T\omega = \omega$, that is, ω is a common fixed point of K and T.

3 CONCLUSION

In this work, some fixed point, coincidence point theorems for mappings satisfying generalized (φ, ψ)-contraction conditions in complete partially ordered non-Newtonian metric spaces are demonstrated. These theorems generalize some known results from the literature to non-Newtonian metric spaces.

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Activated Carbon-Based Adsorbent for Hydrogen Purification

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Abstract

Fossil fuels have dominated today's energy landscape, providing over 65% of global electricity generation. However, their finite nature, depletion risks, and their harmful effects on the environment call for a shift to sustainable energy sources. Hydrogen is one of the prominent alternative energy sources, with a focus on materials for hydrogen storage. Among these, ammonia stands out for its high hydrogen capacity, low storage pressure, and stability during long-term storage. To use hydrogen effectively, it must be purified by separating the ammonia generated during hydrogen production such as NH_3 cracking or NH_3BH_3 thermolysis. Activated carbon, renowned for its porous structures, which can be manufactured from a variety of carbonaceous raw materials, is utilized for this purpose because of its exceptional adsorption capabilities in capturing, storing molecules and ions from solutions.

In this study, the activated carbon (AC) based adsorbents investigated for the hydrogen purification applications. In this aim, experimental setups based on several activated carbons in the different types (granular and powdered) have been tested for the adsorption ability over ammonia gas. Granular and powdered are supplied from marked.

The results showed that the adsorption performance of the materials was affected from the morphological structure. Based on the shape of the carbon based material the capability versus water and ammonia were drastically effected and granular activated carbon found best for purification application not only with its practical usage but also with its high capacity up to 5 wt.% and 14 wt.% for ammonia and humidity capacity, respectively.

Keywords: *Ammonia, Hydrogen, Activated carbon, Adsorption*

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Finding the Density of a Closed or Open System at Time *t* with Eigenvalues and Eigenvectors

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Abstract

Eigenvalues and eigenvectors have an important function in both the control of a system and damage detection in engineering disciplines, as in mathematics. Therefore, in this study, the system density at any moment $t \geq 0$ of a mechanism with a closed or open system is found with the help of eigenvalues and eigenvectors, and the cases of eigenvalues being real, real and multiple and finally complex are discussed. Then, the mathematical relationships between these situations are given. Finally, examples are given to demonstrate the practical applications of relevant theoretical situations in the engineering discipline.

Keywords: *Eigenvalues, Eigenvectors, Mathematic, Engineering*

1 INTRODUCTION

In this section, the definitions of eigenvalues and eigenvectors of matrices that we will use in the future are given [1-6]. Again, the eigenvalue and eigenvector of the solution of a system of equations were defined separately [7, 8].

Definition 1.1: For a square matrix A of type nxn,

$$|A-\lambda I|=0 \tag{1}$$

The nonzero number λ that satisfies the equation is called the eigenvalue of matrix A. Corresponding to a non-zero number λ

$$\begin{aligned} &Av=\lambda v \\ &(A-\lambda I)v=0 \end{aligned} \tag{2}$$

the non-zero vector v is called the eigenvector [2-4]. Located in Definition 1.1,

$$|A-\lambda I|=\begin{vmatrix} a_{11}-\lambda & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22}-\lambda & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n1} & \cdots & a_{nn}-\lambda \end{vmatrix}=0 \tag{3}$$

equation (3) is called the characteristic equation of matrix A. The roots of this equation are called the eigenvalues of the matrix. We can easily see with the help of the type of matrix,

$$b_n\lambda^n+b_{n-1}\lambda^{n-1}+...+b_1\lambda+b_0=0 \tag{4}$$

n. returns the degree polynomial. According to the fundamental theory of algebra, this polynomial has at most n roots that differ from each other. This shows us that it can have n eigenvalues. These roots can be real numbers, multiple real numbers and complex numbers [1, 7].

Let us give a definition of how to find the solution of a homogeneous, linear and constant-coefficient system of equations of order 1 using eigenvalues.

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Definition 1.2: For $\frac{dx}{dt} = x'$

$$\begin{aligned} x'_1 &= a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n \\ x'_2 &= a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n \\ &\vdots \\ x'_n &= a_{n1}x_1 + a_{n2}x_2 + \cdots + a_{nn}x_n \end{aligned} \tag{5}$$

The solution of the equation system is found by using the elimination method of n linearly independent $x_1, x_2, \cdots, x_n$ solutions and the general solution of this equation is written as

$$x(t) = c_1x_1 + c_2x_2 + \cdots + c_nx_n \tag{6}$$

the linear combination of $x_i = \lambda_i e^{\lambda t}$ solutions for $c_i \in \mathbb{R}$ [9].

Let's find this solution with the help of matrices.

Definition 1.3: If we take $x_i = v_i e^{\lambda t}$, $x'_i = \lambda v_i e^{\lambda t}$ where $\lambda, v_1, v_2, \cdots, v_n$ are constant numbers, we can write equation (5) as

$$X' = Ax \tag{7}$$

with the help of matrices. Equation (7) is called the matrix representation of the system of equations.

If we replace the $x_i = v_i e^{\lambda t}$ and $x'_i = \lambda v_i e^{\lambda t}$ values in equation (7), it will be $\lambda v e^{\lambda t} = Ave^{\lambda t}$ and if the $e^{\lambda t}$ value is simplified and arranged,

$$\begin{aligned} Av &= \lambda v \\ |A - \lambda I| &= 0 \end{aligned} \tag{8}$$

the equation is obtained. Here, where v is a non-zero vector and λ is a constant number, we can write the solution of equation (8) in $(A - \lambda I)v = 0$ form and find it with the help of the polynomial we defined in equation (4). The name of this method we will use comes from the definition of eigenvalue and eigenvector [7]. Moreover, for the system of equations (7) to have a non-trivial solution, a necessary and sufficient condition is that the determinant of the matrix of coefficients A is not zero.

Theorem 1.1: If the eigenvalue of the coefficient matrix A of the first-order linear $\frac{dx}{dt} = Ax$ system is λ and v is an eigenvector corresponding to the eigenvalue of λ, then the $x(t) = ve^{\lambda t}$ system has a nontrivial solution [1, 7-9].

So, in the second part, let's consider the situations we may encounter in solving equation (4).

2 MATERIAL AND METHOD

Eigenvalue method: In this section, we will discuss the situations of the eigenvalues of λ_i in equation (6), which is the solution of the equation system given by equation (7).

2.1 Case of Different Real Eigenvalues

With the help of the solution of equation (4), if each of the λ_i eigenvalues is different and real, we can find the v_i eigenvectors that satisfy equation (2) for each λ_i value. Thus, we find the general solution we expressed in (6) [1]. Let's examine this situation with an example.

Example 2.1: Find the general solution of the system of equations given below.

$$\begin{aligned} x'_1 &= 4x_1 - 2x_2 \\ x'_2 &= x_1 + x_2 \end{aligned} \tag{9}$$

Solution: The matrix form of the system given by equation (9)

$$X'_i = \begin{bmatrix} 4 & -2 \\ 1 & 1 \end{bmatrix} x \tag{10}$$

and the characteristic equation of the coefficients matrix of this system is

$$\begin{vmatrix} 4-\lambda & -2 \\ 1 & 1-\lambda \end{vmatrix} = (4-\lambda)(1-\lambda)+2$$
$$= \lambda^2 - 5\lambda + 6 = (\lambda-2)(\lambda-3) = 0$$

Find the different eigenvalues of $\lambda_1 = 2$ and $\lambda_2 = 3$. Now, let's find the $v_i = \begin{bmatrix} a_i & b_i \end{bmatrix}^T$ eigenvectors for each λ_i value with the help of $(A-\lambda I)v = 0$ eigenvector equations for the A matrix given in equation (10).

$$(A-\lambda_i I)v_i = \begin{bmatrix} 4-\lambda_i & -2 \\ 1 & 1-\lambda_i \end{bmatrix} \begin{bmatrix} a_i \\ b_i \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \tag{11}$$

If we solve equation (11) for $\lambda_1 = 2$

$$\begin{bmatrix} 2 & -2 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} a_1 \\ b_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

from the equation

$$\begin{aligned} 2a_1 - 2b_1 &= 0 \\ a_1 - b_1 &= 0 \end{aligned} \tag{12}$$

an identical system of equations is obtained. If $b_1 = 1$ is taken in this system of equations, $a_1 = 1$ is obtained. In this case, $v_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ is the eigenvector corresponding to the eigenvalue of $\lambda_1 = 2$. Thus we find solution $x_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix} e^{2t}$.

Likewise, if we solve equation (11) for the eigenvalue of $\lambda_2 = 3$,

$$\begin{bmatrix} 1 & -2 \\ 1 & -2 \end{bmatrix} \begin{bmatrix} a_2 \\ b_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

from the equation

$$\begin{aligned} a_2 - 2b_2 &= 0 \\ a_2 - 2b_2 &= 0 \end{aligned}$$

an identical system of equations is obtained. If $b_2 = 1$ is taken in this system of equations, $a_2 = 2$ is obtained. In this case, $v_2 = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$ is the eigenvector corresponding to the eigenvalue of $\lambda_2 = 3$. Thus we find solution

$x_2 = \begin{bmatrix} 2 \\ 1 \end{bmatrix} e^{3t}$. The v_1 and v_2 eigenvectors corresponding to these two eigenvalues are linearly independent and the general solution of the system of equations (9) is

$$x(t) = c_1 x_1 + c_2 x_2 = c_1 \begin{bmatrix} 1 \\ 1 \end{bmatrix} e^{2t} + c_2 \begin{bmatrix} 2 \\ 1 \end{bmatrix} e^{3t}$$

obtained. If we write the general solution separately, component by component,

$$x_1 = c_1 e^{2t} + 2c_2 e^{3t}$$
$$x_2 = c_1 e^{2t} + c_2 e^{3t}$$

The solution curves of this solution system we have obtained are seen as two hyperbola families with the same asymptote pair, as in Figure 1. Moreover, it is clearly seen that from the general solution, line $x_2 = -2x_1$ is obtained for $c_1 = 0$ and line $x_2 = x_1$ is obtained for $c_2 = 0$.

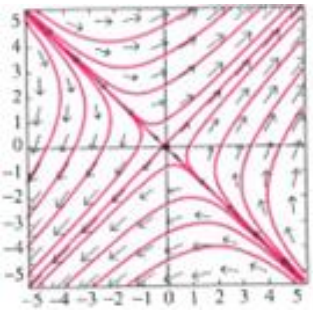

Figure 1. Solution curves

2.2 The Case of Real and Multiple Eigenvalues

In this case, eigenvectors with multiple eigenvalues are found, and if possible, eigenvectors are chosen to be linearly independent from each other. Here, it is sufficient to choose as many linearly independent eigenvectors as the eigenvalue has. Situations where this selection cannot be made are outside our study [8, 9].

2.3 The Case of Complex Eigenvalue

We expressed a system of equations given by equation (5) as a matrix with the help of (8). The eigenvalue roots of the characteristic equation of this system of equations, which we express in (4), may be in complex numbers. Even in this case, the system of equations has n number of linearly independent solutions that differ from each other [1, 7]. In this study, non-existence situations were not addressed.

There are eigenvectors corresponding to each of these eigenvalue solutions. However, the only thing that is different here is that the conjugate of the eigenvalue found as a complex number is also an eigenvalue, and the eigenvectors corresponding to the eigenvalues that are complex numbers are complex numbers. That is, if $\lambda_1 = a + bi$ in equation (8) is an eigenvalue, $\lambda_2 = \overline{\lambda_1} = a - bi$ is also an eigenvalue. Again, if $v_1 = v + ui$, is an eigenvector for $\lambda_1 = a + bi$ eigenvalue, $v_2 = \overline{v_1} = v - ui$, eigenvector is an eigenvector corresponding to $\lambda_2 = a - bi$ eigenvalue. These equations can be easily seen with the help of equation (8). We can write the general solution consisting of these eigenvectors as follows, with the help of Euler's formula. The eigenvalues are $\lambda_1 = a + bi$, $\lambda_2 = a - bi$ and the eigenvectors are $v_1 = v + ui$, $v_2 = v - ui$

$$\begin{aligned} x(t) &= v_1 e^{\lambda_1 t} = (v + ui) e^{(a+bi)t} = (v + ui) e^{at} e^{i(bt)} \\ &= (v + ui) e^{at} (\cos(bt) + i \sin(bt)) \\ &= e^{at} (v \cos(bt) - u \sin(bt)) + i e^{at} (u \cos(bt) + v \sin(bt)) \end{aligned} \tag{13}$$

the solution is obtained. Since there is a solution in the real and imaginary parts of complex solutions, the local general solution is found as equation (14) [7, 9].

$$x_1(t) = \text{Rel}(x(t)) = e^{at}\left(v\cos(bt) - u\sin(bt)\right)$$
$$x_2(t) = \text{Im}(x(t)) = e^{at}\left(u\cos(bt) + v\sin(bt)\right) \quad (14)$$

3 RESULTS

In this section, first of all, the definition of an open or closed system will be given and we will establish the system of equations that gives the density of this system at any moment $t \geq 0$. We will find the general solution of this system of equations with the help of eigenvalues and eigenvectors.

Figure 2 shows two tanks containing V_1 and V_2 gallons of brine, respectively. Pure water flowing into the 1 nd tank mixes with the salt water in the tank and flows into the 2 nd tank, and then out of the 2 nd tank. Since the system is open. Let $x_i(t)$, define the amount of salt (in pounds) in tanks $i = 1,2$ at time t. It is defined by the system of equation (15) where each flow rate is equal per minute and the salt rate is calculated as r gallon [7].

$k_i = \frac{r}{V_i}, i = 1,2$ to be

$$x'_1 = -k_1 x_1$$
$$x'_2 = k_1 x_1 - k_2 x_2 \quad (15)$$

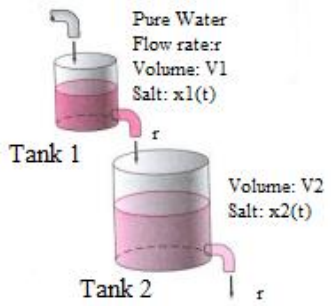

Figure 2. A two-stage open system

As a result, the density of a product (salt) in the tanks of an open system as shown in Figure 2 decreases rapidly and reaches zero thanks to the pure water flowing into Tank 1. If another tank is added to the other tank or to the system, the salt concentration in the tanks first increases to a certain point and then decreases rapidly to zero.

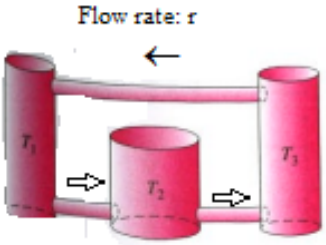

Figure 3. A 3-stage closed system

Figure 3 shows a closed system consisting of 3 tanks containing gallons of brine, respectively. The difference of this system from the open system in Figure 3.1 is that there is water flow from the 3 nd tank to the 1 nd tank. Similar to the equation system (15) for $k_i = \frac{r}{V_i}, i = 1,2,3$, the equation system giving the amount of salt in the tanks is found as follows [7].

$$\begin{aligned} x'_1 &= -k_1 x_1 + k_3 x_3 \\ x'_2 &= k_1 x_1 - k_2 x_2 \\ x'_3 &= k_2 x_2 - k_3 x_3 \end{aligned} \tag{16}$$

It is easily seen from here that the systems of equations (15) and (16), which give the densities of an open or closed system at time $t \geq 0$, are exactly the same as the systems of equation (9) that we discussed in Chapter 2 In other words, the eigenvalues and eigenvectors that give the solutions of these systems of equations, including the volume of the tanks (V_i) and the flow rate per minute (r), can be real numbers, multiple real numbers and complex numbers. In the last part of our study, let us give examples of the systems we obtained with equations (15). In the last part of our study, let us give examples of the systems we obtained with equations (15). For more problems, you can look at [7].

Example 3.1: Let $V_1 = 40, V_2 = 80, V_3 = 100$ and $r = 20$ (gal/min.) be a system with 3 tanks as in Figure 3. Also, find the initial amount of salt in the salt water tanks in pounds, the amount of salt in the tank at time $t \geq 0$ for $x_1(t) = 30,\ x_2(t) = 0$ and $x_3(t) = 50$.

Solution: If the given values are substituted in equation (15),

$$\begin{aligned} x'_1 &= -0.5x_1 \\ x'_2 &= 0.5x_1 - 0.25x_2 \\ x'_3 &= 0.25x_2 - 0.2x_3 \end{aligned}$$

and if we write this system of equations in matrix format

$$x'_i = \begin{bmatrix} -0.5 & 0 & 0 \\ 0.5 & -0.25 & 0 \\ 0 & 0.25 & -0.2 \end{bmatrix} x,\ x(0) = \begin{bmatrix} 20 \\ 10 \\ 0 \end{bmatrix}$$

the initial value problem is obtained. From here, with the help of equation (8)

$$A - \lambda I = \begin{bmatrix} -0.5 - \lambda & 0 & 0 \\ 0.5 & 0.25 - \lambda & 0 \\ 0 & 0.25 & -0.2 - \lambda \end{bmatrix}$$

matrix is obtained. It is easily found that the matrix A has eigenvalues $\lambda_1 = -0.5,\ \lambda_2 = -0.25$ and $\lambda_3 = -0.2$ from the solution of the characteristic equation $|A - \lambda I| = (0.5 + \lambda)(0.25 + \lambda)(0.2 + \lambda)$.

Let's find the eigenvector $v_1 = \begin{bmatrix} a_1 \\ b_1 \\ c_1 \end{bmatrix}$ for the eigenvalue $\lambda_1 = -0.5$ with the help of (2).

$$(A - \lambda_1 I)v_1 = \begin{bmatrix} 0 & 0 & 0 \\ 0.5 & 0.25 & 0 \\ 0 & 0.25 & 0.3 \end{bmatrix} \begin{bmatrix} a_1 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

from the system of equations

$$\begin{aligned} 2a_1 + b_1 &= 0 \\ 5b_1 + 6c_1 &= 0 \end{aligned}$$

equations are obtained. $a_1 = 3$ is obtained for $b_1 = -6$ and $c_1 = 5$ that satisfy the second equation. Thus, the eigenvector $v_1 = \begin{bmatrix} 3 \\ -6 \\ 5 \end{bmatrix}$ is found. With a similar calculation, the eigenvector $v_2 = \begin{bmatrix} 0 \\ 1 \\ -5 \end{bmatrix}$ is found corresponding to the eigenvalue of $\lambda_2 = -0.25$, and the eigenvector $v_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$ is found corresponding to the eigenvalue of $\lambda_3 = -0.2$. Thus, with the help of equation (6), we can write the general solution of the system as follows.

$$x(t) = c_1x_1 + c_2x_2 + c_3x_3 = c_1v_1e^{\lambda_1 t} + c_2v_2e^{\lambda_2 t} + c_3v_3e^{\lambda_3 t}$$
$$= c_1\begin{bmatrix} 3 \\ -6 \\ 5 \end{bmatrix}e^{-0.5t} + c_2\begin{bmatrix} 0 \\ 1 \\ -5 \end{bmatrix}e^{-0.25t} + c_3\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}e^{-0.2t}$$

As a result, separate scalar equations are

$$x_1(t) = 3c_1e^{-0.5t}$$
$$x_2(t) = -6c_1e^{-0.5t} + c_2e^{-0.25t}$$
$$x_3(t) = 5c_1e^{-0.5t} - 5c_2e^{-0.25t} + c_3e^{-0.2t}$$

obtained. If the initial conditions $x_1(t) = 30,\ x_2(t) = 0$ and $x_3(t) = 50$ are written into the equations, $c_1 = 10, c_2 = 60$ and $c_3 = 300$ values are found. As a result, the amount of salt in the three brine tanks at time t is

$$x_1(t) = 30e^{-0.5t}$$
$$x_2(t) = -60e^{-0.5t} + 60e^{-0.25t}$$
$$x_3(t) = 50e^{-0.5t} - 300e^{-0.25t} + 300e^{-0.2t}$$

found by equations. As can be seen from these solution equations, in this system, while the amount of salt in the 1nd tank decreases rapidly, the amount of salt in the 2nd and 3nd tanks first increases and then decreases rapidly, reaching zero.

4 CONCLUSION

Whether the result is an open or closed system, we find the density of the system as in equation (6). These solutions can be examined for $t \to \infty$ to find their equilibrium states, or how they change can be visually examined with the help of graphs. Studies can also be done on systems with different speeds.

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The Use of Eye-tracking Technology in Education

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Abstract

The accessibility and affordability of eye-tracking technology have increased significantly in recent years. This technology, measuring various eye movement parameters such as fixation duration, count, saccades, and pupil size, has an essential role in educational research. It enables the analysis of both teacher and student behaviors, offering insights into cognitive processes during lessons or applications. Visualizations, such as heatmaps and gaze plots, help in understanding attention patterns, contributing to the enhancement of teaching methods and learning environments. This study presents the findings from a literature review focused on the intersection of education and eye-tracking technology. By employing a systematic literature review, this study identifies relevant articles published between 2019 and 2023. The distribution of publications over the years highlights sustained interest in the field. Furthermore, this study explores global participation in eye-tracking research, with the United States, China, and Germany leading in contributions. The distribution of research topics emphasizes the diverse applications, with self-regulated learning, language education, and science education being predominant areas of focus. In conclusion, this study underscores the dual role of eye-tracking technology in education – as a tool for precise data collection and an interactive device to enhance learning environments. It emphasizes the importance of collaborative efforts among teachers, researchers, and technology experts to optimize the use of eye-tracking technology in education, ultimately benefiting students across various schools and learning settings.

Keywords: *Eye-tracking technology, Educational research, Human-computer interaction*

1 INTRODUCTION

Eye tracking technology, when it first emerged, was limited to use due to its high costs. However, over time, technological advancements and increased demand have made it more affordable and widely available in educational research [1]. This technology operates by emitting near-infrared light towards the eyes, which is then reflected back, capturing crucial data on gaze movements [2]. The eye-tracking device with cameras processes these reflections, creating a detailed representation of eye position and fixation points. Filtering and calculations are then applied to point to the coordinates of visual focus.

In the realm of eye-tracking technology, two main types of devices have emerged: screen-based and glasses-type eye trackers. Screen-based trackers are placed below a computer screen, capturing eye movements as individuals interact with on-screen content. Integrated into eyeglass frames, Glass-type trackers offer a more mobile alternative, suitable for studying natural behaviors in real-world environments.

Eye-tracking data provides valuable parameters such as fixation duration, fixation count, fixation positions, visit count, saccades, time to first fixation, and pupil size [3]. These metrics offer insights into visual attention and cognitive processing. In educational contexts, this technology proves invaluable for analyzing students' visual attention, generating heatmaps and gaze plots to understand attention patterns in the classroom. For instance, visualizations can help teachers identify elements that capture attention, potential distractions, or overlooked stimuli.

This study explores the utility of eye tracking in educational research, emphasizing its impact on understanding how students learn. By highlighting various applications in educational studies, this study aims to underscore its importance in uncovering details about cognitive processes, attention, and learning behaviors. The goal is to raise awareness among teachers, researchers, and policymakers about the value of integrating eye-tracking technology into educational research. This technology, measuring eye movements such as fixation duration and pupil size, offers valuable insights for improving teaching methods and creating better learning environments.

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2 METHODOLOGY

This study employed a systematic literature review by focusing on studies conducted over the past five years, from 2019 to 2023, and sourced from the Web of Science database. The chosen keywords for this review include "education", "learning", "eye-tracking", "eye movements", "gaze tracking", and "gaze movements". The objective is to identify and analyze recent academic publications that explore the intersection of education, learning, and eye-tracking technology. By systematically reviewing research within this timeframe, this study aims to distill current trends, emerging themes, and notable findings in utilizing eye-tracking technology to understand and improve educational practices. This review contributes to the ongoing discourse on integrating eye-tracking technology in education and seeks to inform future research directions and applications within the field. The inclusion and exclusion criteria for this systematic literature review were defined based on the PRISMA guideline [4]. The specified criteria included the articles published in academic journals, written in English, and available in full text, specifically focusing on educational research conducted between 2019 and 2023, as seen in Table 1.

Table 1. Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Published in an academic journal	Review or meta-analysis
Written in English	Not written in English
Available in full-text	Not available in full text
Educational research	Medical or engineering research

Following the PRISMA guideline, the inquiry and selection process involved the identification, screening, eligibility assessment, and inclusion of articles [5, 6]. In the identification phase, a comprehensive search on the Web of Science (WoS) yielded a total of 2,285 articles. Subsequently, during the screening stage, titles, abstracts, and keywords were meticulously examined, leading to the exclusion of 1,918 articles that did not align with the predetermined criteria. Following this, in the eligibility assessment phase, 367 articles underwent further examination, resulting in the exclusion of an additional 131 articles. Ultimately, 236 articles met the inclusion and exclusion criteria and were deemed suitable for the review. This systematic process ensures a rigorous and transparent approach to selecting relevant literature, contributing to the robustness and reliability of the forthcoming review on the intersection of eye-tracking technology and education.

3 RESULTS

The distribution of publications obtained from the literature review, as shown in Figure 1, highlights the yearly output of research in the field. In 2019, there were thirty-eight publications, followed by fifty-nine in 2020, forty-two in 2021, and fifty-five in 2022. The trend continued with forty-two publications in 2023. The consistent output over these years, derived exclusively from the Web of Science source, signifies a sustained interest and relevance in the utilization of eye-tracking technology within the realm of educational research. This trend underscores the enduring significance of eye-tracking technology in contributing to a deeper understanding of learning processes and educational dynamics.

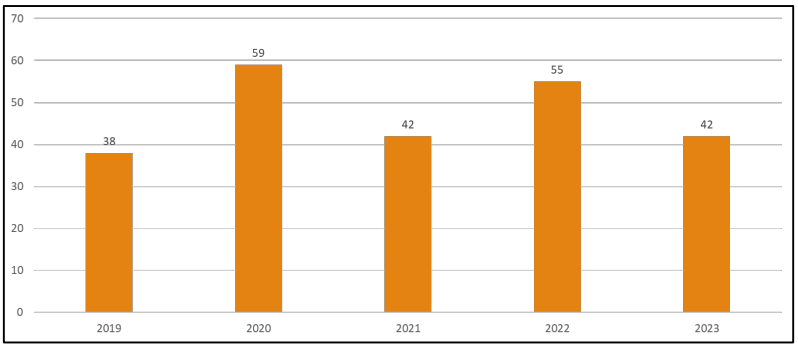

Figure 1. Number of articles by years

A comprehensive examination of the journals featuring the published articles reveals that Frontiers in Education leads with the highest number of publications, boasting seventeen articles, as seen in Table 2. Following closely are Computers & Education and Journal of Computer Assisted Learning, each contributing thirteen publications. The distribution across these prominent journals underscores the diverse and expansive scope of studies on the utilization of eye-tracking technology in education. This pattern suggests that research in this domain spans a wide array of disciplines, as evidenced by the inclusion of studies in various journals indexed in the Web of Science.

The broad dissemination of these findings across different journals underscores the interdisciplinary nature and widespread interest in applying eye-tracking technology in educational research.

Table 2. Host journals

Journal Name	Number of Publications
Frontiers in Education	17
Computers & Education	13
Journal of Computer Assisted Learning	13
Sensors	10
Instructional Science	9
Journal of Educational Psychology	8
British Journal of Educational Technology	7
Education and Information Technologies	7
Physical Review Physics Education Research	6
Others (85 Different Journals)	152

The distribution of publications by country reveals that the United States (USA) has the highest contribution, with 51 publications, followed by the People's Republic of China with 48 publications and Germany with 35 publications (see Figure 2). Notably, there are also six publications from Turkey. This data underscores the global participation in research on applying eye-tracking technology in education, with numerous countries making valuable contributions to the field.

Figure 2. Countries of articles (>5)

As seen in Figure 3, the distribution of research topics indicates that self-regulated learning holds the highest share with 25% of the publications, followed by language education at 22%. Science education and teacher education contribute 8% and 7%, respectively. Special education constitutes 5% of the publications, while numerical cognition and augmented reality each represent 4%. The remaining 25% encompasses various other research topics within the field of eye-tracking technology in education. This diverse array of research topics reflects the multifaceted applications and interests within the broader scope of educational research utilizing eye-tracking technology.

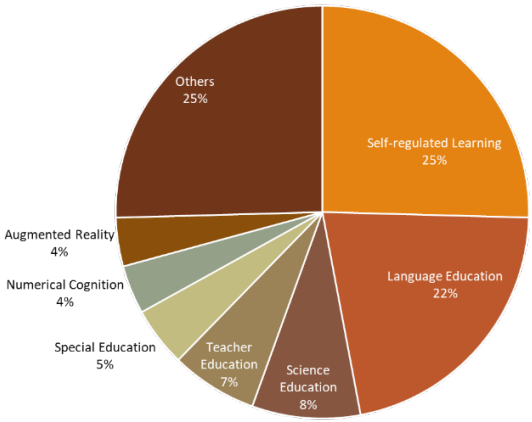

Figure 3. Topics of articles

4 CONCLUSION

Eye-tracking technology serves two main purposes in education. Firstly, it helps collect precise eye movement data from students and teachers, offering insights into how people engage with educational content. Secondly, it acts as an interactive tool to improve learning environments. Besides, eye-tracking technology is valuable, helping educators understand their teaching methods better and providing personalized feedback for improvement in teacher training and professional development. Moreover, using eye-tracking technology in Special Education is crucial. It helps us understand how students with special needs see and process information. By paying extra attention to this field, customized teaching methods can be created to support these students effectively. In simple terms, it is about making education work better for everyone, no matter their learning needs. Finally, teamwork among teachers, researchers, and technology experts is essential. When we work together, we can improve and utilize eye-tracking technology in the best way for education. This collaboration helps create new tools and methods that can benefit students in different schools and learning environments.

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Linguistic Summarization for Higher Education Institutions in the Context of Sustainable Development Goals: Analysis of THE Impact Ranking Results

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Abstract

The United Nations published 17 Sustainable Development Goals in 2015 to eradicate poverty in all its forms and ensure the common welfare of humanity by 2030. Higher Education Institutions play a crucial role in attaining these objectives through their education, research, and social contributions. These essential functions have contributed to the popularity of ranking systems that disclose universities' efforts to achieve Sustainable Development Goals. The Times Higher Education Impact Ranking is one of the most significant global method for measuring universities' performance concerning the United Nations Sustainable Development Goals. 1591 universities participated in the 2022 evaluation of this Ranking, which included 768 universities worldwide in 2020. The objective of this study was to assess universities, countries, and continents using the linguistic summarization technique, with a focus on the universities listed in the 2022 Times Higher Education Impact Rankings based on the Sustainable Development Goals. Linguistic summarization is a data mining technique that generates natural language summaries to assist decision-makers who lack specialist expertise. This study has made a notable contribution to the advancement of universities and countries by identifying specific sustainable development goals that can be enhanced to attain the overall Sustainable Development Goals.

Keywords: *Linguistic summarization, Data mining, Sustainable development goals, University ranking, Sustainability*

1 INTRODUCTION

Universities play a crucial role in attaining Sustainable Development Goals (SDGs) and serve a fundamental role in providing the necessary skills, information, and comprehension for upcoming generations to effectively tackle the challenges and possibilities related to sustainability [1]. As part of this role, it is necessary to integrate sustainability principles into the academic curriculum and foster a sustainable mindset among both students and staff [2]. Moreover, universities facilitate sustainable development collaborations, offering training and programs to local stakeholders such as government entities, institutions, industry participants, and Non-governmental Organizations, fostering partnerships for sustainable development [3]. By incorporating sustainability principles into academic courses and research programs, universities guarantee the active involvement of faculty and students in their efforts to achieve SDGs [2]. The principle of higher education for sustainable development underscores the incorporation of sustainability within education, research, university endeavors, and community service initiatives. This comprehensive strategy guarantees that sustainability is essential to the university's values and actions. Universities play a crucial role in advancing the global agenda for sustainable development by fostering a culture of sustainability, imparting students with essential information and skills, and facilitating collaborations for sustainable development. Multiple rating methods are available within this framework to assess universities' contributions towards achieving SDGs. The Times Higher Education (THE) Impact Ranking is one of the significant rankings that assess universities' environmental, societal, and economic influence following the SDGs set by the United Nations (UN) [4]. The Impact's methodology facilitates the assessment and comparison of universities' contributions towards the attainment of the Sustainable Development Goals. Consequently, it emphasizes higher education institutions' societal significance and influence [5, 6]. The rankings catalyze higher education reforms, guiding the assessment of international excellence and motivating universities to vie for global competitiveness [7].

THE Impact Rankings represent significant value for universities as they profoundly influence diverse stakeholders within higher education. These rankings are utilized by students who are looking for university admissions, academics who are searching for job prospects, university administrators who aim to maintain a competitive edge in student recruitment, and governments who want to ensure that public funds invested in

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universities contribute to a top-notch higher education system [8]. Rankings significantly influence national policymaking, institutional behavior, and the restructuring of higher education systems. They also impact the worldwide competitiveness of universities and the geopolitical standing of nations and universities [7, 9]. Therefore, it is crucial to assess universities based on their effect ranking. This study employed the linguistic summarization method to evaluate the universities and nations featured in the 2022 THE Impact Rankings regarding their alignment with the SDGs. Following sections are organized as follows. Section 2 explains the linguistic summarization method, and its implementation to THE Impact Rankings. Section 3 analyzes the results in detail. Section 4 concludes the paper.

2 MATERIAL AND METHOD

2.1 Preliminaries of Linguistic Summarization

Data mining is a procedure used to extract knowledge from large databases. Descriptive approaches are needed to summarise, assess, and identify patterns and relationships in the data [10]. Statistical summarizing is a simple descriptive task for data mining. Natural language summaries are often chosen over statistical summaries, even though the former may be less accurate due to their better comprehension. References [11, 12] first introduced fuzzy quantifiers, widely used in linguistic summarization to manage the ambiguous meanings of linguistic labels like "most". Reference [13] proposed linguistic summarization research as a descriptive technique for extracting concise and easily comprehensible information from databases. The main objective of linguistic summarizing is to produce brief and intelligible data summaries.

Basically, linguistic summarization studies use two types of quantified sentence structures based on the type of quantifier (e.g., absolute or relative), developed by Reference [14]. Relative quantifiers are defined as possibility distributions in the unit interval [0,1], whereas absolute quantifiers are defined as possibility distributions over non-negative integers. The quantified sentence structures are defined as follows: i) Type-I quantified sentence: "$Q\ Y\ A$" $[TD]$, and ii) Type-II quantified sentence: "$Q\ B\ Y\ A$" $[TD]$. In quantified sentence structures, Q is a linguistic quantifier, Y is the object, A is a linguistic summarizer for any attributes about objects of Y, B is a linguistic pre-summarizer for any attributes about objects of Y, and TD is the truth degree of the generated linguistic summary. For example, "Most SDG1 High University had overall point high" [0.96] is a linguistic summary about THE Impact Rankings of High Education Institutes. Here, "most" is a relative quantifier, "university" is the object, "SDG1 high" is a linguistic pre-summarizer about SDG1 attribute of the universities, "overall point high" is a linguistic summarizer about the overall point attribute of the universities, and "0.96" is the truth degree of the linguistic summary. Type-I quantified sentence structure is a particular case of type-II sentence structure in which the pre-summarizer covers all the objects.

Evaluating the generated sentences is the most crucial phase in the linguistic summarization process. The relevant truth degrees are computed to evaluate quantified sentences. The resulting summaries will not accurately represent the dataset if the truth degree is not consistently reached. Reference [12] scalar cardinality-based truth degree is given in Eq. (1) for type-II quantified sentence structure.

$$TD = \mu_Q\left(\frac{\sum_{m=1}^{M}(\mu_A(v_{k_1}^m) \otimes \mu_B(v_{k_2}^m))}{\sum_{m=1}^{M}\mu_B(v_{k_2}^m)}\right) \quad (1)$$

Since there is a summarizer and a pre-summarizer (A and B) in type-II sentence structures, there are two related attributes as k_1 and k_2. $v_{k_1}^m$ is the value for k_1^{th} attribute of m^{th} object and $v_{k_2}^m$ is the value for k_2^{th} attribute of m^{th} object, and μ_Q is the membership function of linguistic quantifier Q. $\otimes$ is a t-norm operator that is used for the intersection of two fuzzy sets.

Evaluation techniques can be broadly classified into fuzzy and scalar-cardinality-based techniques [15]. While scalar cardinality-based techniques, like Zadeh's method, are widely used, easy to use, and quick to obtain truth degrees, they contain flaws that might lead to inconsistent results in some situations. Because they rely on counting the occurrences of elements, they cannot discriminate between large numbers of low membership degrees and small amounts of high membership degrees. Fuzzy cardinality-based techniques like the GD method and ZS method are suggested to solve this inconsistency [16]. Additional fuzzy cardinality-based techniques are also suggested for linguistic evaluation, including the restriction level-based approach [17], the gradual number-based method [18], and the semi-fuzzy quantifier-based method [19].

Reference [20] has contributed to the fusion of linguistics and logic by proposing semi-fuzzy quantifiers, which are the generalised version of fuzzy linguistic quantifiers. A semi-fuzzy quantifier combines the characteristics of both classical and fuzzy quantifiers, accepting crisp arguments like a classical quantifier and generating a TD in unit interval like a fuzzy quantifier [19]. Semi-fuzzy quantifiers are easier to define than fuzzy quantifiers, but they are more difficult to evaluate. For example, "Around 80% of universities provided data for SDG3", can be evaluated using semi-fuzzy quantifiers; however, "Around 80% of universities have SDG3 high scores" cannot be evaluated using semi-fuzzy quantifiers unless a Quantifier Fuzzification Mechanism (QFM) is used. “Providing data for SDG3” is a clear fact in the first sentence, whereas “high score of SDG3” in second sentence is a fuzzy phenomenon.

A probabilistic QFM, F^I, for discrete α-cuts on $X_1, \dots, X_S$, is proposed as in Eq. (2) by Reference [21].

$$F^I(Q)(X_1, \dots, X_S) = \sum_{i_1=0}^{m_1} \dots \sum_{i_S=0}^{m_S} Q\left((X_1)_{\geq \alpha_{1,i_1}}, \dots, (X_S)_{\geq \alpha_{S,i_S}}\right) \mathfrak{m}(\alpha_{1,i_1}) \dots \mathfrak{m}(\alpha_{S,i_S}) \quad (2)$$

where X_s is a fuzzy property for $s = 1, \dots, S$, $(X_s)_{\geq \alpha_s}$ is α-cut of X_s, and Q is a semi-fuzzy quantifier of arity S, $0 = \alpha_{s,m_s+1} < \alpha_{s,m_s} < \dots < \alpha_{s,1}, \alpha_{s,0} = 1, 1 \leq s \leq S$, and $\mathfrak{m}(\alpha_{s,j}) = \alpha_{s,j} - \alpha_{s,j+1}$, $j = 0,1, \dots, m_s$.

2.2 Implementation

This study employs the semi-fuzzy quantifier based linguistic summarization method (See Eq.(2)) to thoroughly examine the data from THE Impact Ranking published in 2022 [22]. All UN SDGs that are included in this study are given in Figure 1.

Figure 1. The UN SDGs

The THE Impact Ranking webpage provides information and data regarding the universities involved in the evaluation according to the SDGs. The ranking technique involves the voluntary participation of universities and includes a separate examination of universities’ rankings for each SDG as well as an overall point assessment. The overall point analysis encompasses the assessment of the top three SDGs that have achieved the highest scores in the total score, together with SDG17. Although colleges are obligated to complete SDG17, they can offer data from remaning SDGs. This study considered the university’s score for each SDG and total scores from the most recent results, which were announced in 2022, and covered the review of data from 2021. This list encompassed 1591 universities, representing 112 distinct nations and 9 diverse continents. The study encompasses the countries and continents listed in Table 1.

Table 1. Countries and continents

Countries	Continents
Australia, United Kingdom, Canada, Malaysia, United States, Denmark, New Zealand, South Korea, Thailand, Indonesia, Japan, Italy, Taiwan, Portugal, Mexico, Ireland, South Africa, Sweden, India, Turkey, Hong Kong, China, Bahrain, Jordan, United Arab Emirates, Chile, Egypt, Spain, Netherlands, Germany, Israel, France, Saudi Arabia, Ghana, Finland, Latvia, Belgium, Brazil, Nigeria, Lebanon, Palestine, Philippines, Romania, Czech Republic, Pakistan, Northern Cyprus, Cyprus, Iran, Russian Federation, Argentina, Colombia, Qatar, Tunisia, Bangladesh, Hungary, Ecuador, Iceland, Greece, Switzerland, Sri Lanka, Croatia, Ukraine, Costa Rica, Vietnam, Kuwait, Iraq, Poland, Morocco, Serbia, Peru, Puerto Rico, Fiji, Uzbekistan, Slovakia, Austria, Kazakhstan, Azerbaijan, Uganda, Bulgaria, Uruguay, Macao, Jamaica, Zimbabwe, Lithuania, Slovenia, Algeria, Georgia, Norway, Kosovo, Venezuela, Armenia, Afghanistan, Belarus, Turks and Caicos Islands, Tanzania, Panama, Mongolia, Curaçao, Turkmenistan, Bosnia and Herzegovina, Brunei Darussalam, Kenya, Kyrgyzstan, Sudan, Mauritius, Zambia, Paraguay, Oman, Cambodia, Haiti, Moldova, Dominican Republic.	Australia, Europe, North America, Asia, Africa, Asia/Europe, South America, Europe/Asia, Oceania.

3 RESULTS

The linguistic summaries for every feasible combination of quantifiers, pre-summarizers and summarizers were constructed using MATLAB. The algorithmic applications were used to generate all possible combinations of quantifiers and summarizers. The evaluation of summaries is the pivotal stage in linguistic summarization [15]. The Truth Degree (TD) was utilized as a standard to selectively enhance the summaries obtained during the modelling phase. Typically, summaries are evaluated by assessing their correctness. Only summaries that had a specified TD value equal to or greater than this number were assessed.

The first evaluation was conducted to analyze which SDG-related data universities provided. Although 214 summaries were obtained as a result of the analysis, the number of summaries with an TD above 0.50 was 5. The summaries obtained are given in Table 2. According to the results, it is seen that universities provided the most data for SDG4 (Quality Education) and the least data for SDG14 (Life Below Water). It was deemed necessary for universities to do more work to achieve SDG14. Additionally, SDG15 (Life on Land) turned out to be an underrated target. SDG3 and SDG5, to which universities made the most significant contribution, were the second and third SDGs, respectively.

Table 2. Generated linguistic summaries for SDGs

Summaries	*TD*
Most universities provided data for SDG4	1.00
Most universities provided data for SDG3	0.96
Most universities did not provide data for SDG14	0.74
Most universities provided data for SDG5	0.67
Most universities did not provide data for SDG15	0.54

Total 1917 summaries were produced in the analysis to see the status of the continents in the SDGs. 42 of these summaries have a TD above 0.9. The summaries obtained are given in Table 3, Table 4 and Table 5. Australia was the country that provided data for the most SDGs, with 6 different SDGs. While SDG4 stood out in the European and Asian continents, SDG3, SDG4, and SDG5 stood out in Africa. While North America point to SDG3 and SDG5, South America point to SDG3 and SDG4. To achieve the SDGs, countries need to do more work on the ones not included in Table 3.

Table 3. Continents providing data for SDGs

Summaries	***TD***
Most universities in Australia provided data for SDG3	1.00
Most universities in Australia provided data for SDG5	1.00
Most universities in Australia provided data for SDG8	1.00
Most universities in Australia provided data for SDG10	1.00
Most universities in Australia provided data for SDG16	1.00
Most universities in Australia provided data for SDG17	1.00
Most universities in Europe provided data for SDG4	0.99
Most universities in North America provided data for SDG3	1.00
Most universities in North America provided data for SDG5	0.91
Most universities in Asia provided data for SDG4	1.00
Most universities in Africa provided data for SDG3	1.00
Most universities in Africa provided data for SDG4	1.00
Most universities in Africa provided data for SDG5	1.00
Most universities in Asia-Europe provided data for SDG3	1.00
Most universities in Asia-Europe provided data for SDG4	1.00
Most universities in South America provided data for SDG3	1.00
Most universities in South America provided data for SDG4	1.00
Most universities in Europe-Asia provided data for SDG4	1.00
Most universities in Oceania provided data for SDG4	1.00
Most universities in Oceania provided data for SDG8	1.00
Most universities in Oceania provided data for SDG13	1.00

Another analysis for continents includes SDGs for which continents did not provide data. The results obtained are given in Table 4. While SDG16 and SDG17 stood out for the Europa-Asia continent, it were observed that the Oceania continent did not provide data for eight SDGs.

Table 4. Continents not providing data for SDGs

Summaries	***TD***
Most universities in Europe-Asia did not provide data for SDG16	1.00
Most universities in Europe-Asia did not provide data for SDG17	1.00
Most universities in Oceania did not provide data for SDG1	1.00
Most universities in Oceania did not provide data for SDG2	1.00
Most universities in Oceania did not provide data for SDG5	1.00
Most universities in Oceania did not provide data for SDG6	1.00
Most universities in Oceania did not provide data for SDG9	1.00
Most universities in Oceania did not provide data for SDG10	1.00
Most universities in Oceania did not provide data for SDG11	1.00
Most universities in Oceania did not provide data for SDG12	1.00

In the final analysis, summaries of the continents' overall ranking points were obtained and given in Table 5.

Table 5. Linguistic summaries on continent ranking points

Summaries	***TD***
Most universities in Australia ranked high in overall ranking	1.00
Most universities in Australia ranked in the first 600	1.00
Most universities in Australia ranked in the first 1000	1.00
Most universities in Australia ranked in the first 400	1.00
Most universities in Europe ranked in the first 1000	1.00
Most universities in North America ranked in the first 1000	1.00
Most universities in Oceania ranked in the first 1000	1.00

A total of 85 summaries were obtained to compare the overall point with each SDG. These summaries are given in Table 6. Universities with high scores in SDG13 and SDG14 also had high overall points. However, it can be seen that the high scores of SDG3 and SDG4 contribute to the high scores of the overall points less than the others.

Table 6. Linguistic summaries on SDGs over overall point high universities

Summaries	***TD***
Most SDG1 high universities had an overall point high	0.96
Most SDG2 high universities had an overall point high	0.99
Most SDG5 high universities had an overall point high	0.97
Most SDG6 high universities had an overall point high	0.99
Most SDG7 high universities had an overall point high	0.97
Most SDG8 high universities had an overall point high	0.94
Most SDG9 high universities had an overall point high	0.94
Most SDG10 high universities had an overall point high	0.98
Most SDG11 high universities had an overall point high	0.99
Most SDG12 high universities had an overall point high	0.99
Most SDG13 high universities had an overall point high	1.00
Most SDG14 high universities had an overall point high	1.00
Most SDG15 high universities had an overall point high	0.99
Most SDG16 high universities had an overall point high	0.95
Most SDG17 high universities had an overall point high	0.95

A total of 170 summaries were prepared regarding the evaluation of universities in the Top 100 for each SDG. The TD of 18 of them was higher than 0.9. The summaries obtained are given in Table 7. It was observed that the universities in the top 100 had high scores in SDG11, SDG12, SDG16, and SDG17.

Table 7. Linguistic summaries for the first 100 and overall point high universities

Summaries	***TD***
Most universities in the first 100 provided data for SDG3	1.00
Most universities in the first 100 provided data for SDG5	1.00
Most universities in the first 100 provided data for SDG6	0.92
Most universities in the first 100 provided data for SDG8	1.00
Most universities in the first 100 provided data for SDG9	1.00
Most universities in the first 100 provided data for SDG10	1.00
Most universities in the first 100 provided data for SDG11	1.00
Most universities in the first 100 provided data for SDG12	1.00
Most universities in the first 100 provided data for SDG13	1.00
Most universities in the first 100 provided data for SDG15	1.00
Most universities in the first 100 provided data for SDG16	1.00
Most universities in the first 100 provided data for SDG17	1.00
Most universities in the first 100 had a high point for SDG11	0.99
Most universities in the first 100 had a high point for SDG12	0.99
Most universities in the first 100 had a high point for SDG16	0.95
Most universities in the first 100 had a high point for SDG17	0.95
Most universities with overall point high provided data for SDG3	1.00
Most universities with overall point high provided data for SDG4	0.97

In the analysis of the countries' overall points (high, medium, low, and empty) in THE impact ranking, 448 summaries were obtained. The resulting summaries are given in Table 8. A total of 23 summaries with an TD value of 0.9 and above were obtained. All summaries were obtained for high-score classification. It was observed that 23 of 133 countries had high overall points.

Table 8. Generated Linguistic Summaries for Countries

Summaries	***TD***
Most Australian universities had an overall point high	1.00
Most United Kingdom universities had an overall point high	1.00
Most Canadian universities had an overall point high	1.00
Most Denmark universities had an overall point high	1.00
Most New Zealand universities had an overall point high	1.00
Most South Korean universities had an overall point high	0.94
Most Italy universities had an overall point high	0.90
Most Ireland universities had an overall point high	1.00
Most South African universities had an overall point high	0.90
Most Sweden universities had an overall point high	1.00
Most Hong Kong universities had an overall point high	1.00
Most Bahrain universities had an overall point high	1.00
Most United Arab Emirates universities had an overall point high	0.98
Most Spain universities had an overall point high	0.91
Most Netherlands universities had an overall point high	1.00
Most German universities had an overall point high	0.90
Most Israel universities had an overall point high	0.90
Most Finland universities had an overall point high	0.93
Most Belgium universities had an overall point high	1.00
Most Argentina universities had an overall point high	0.90
Most Qatar universities had an overall point high	1.00
Most Serbia universities had an overall point high	0.90
Most Puerto Rico universities had an overall point high	0.90

By evaluating the countries specifically for each SDG, 9520 summaries were obtained. 1167 of these summaries had a TD above 0.9. Of these, only the SDGs for which countries have high scores are given in Table 9. It were revealed that countries need to work for other SDGs to achieve the SDGs.

Table 9. Generated Linguistic Summaries for Countries and SDGs

Summaries	***TD***
Most Australian universities had high points for SDG3	1.00
Most United Kingdom universities had high points for SDG10	0.92
Most Canadian universities had high points for SDG11	0.98
Most Denmark universities had high points for SDG3	0.95
Most Denmark universities had high points for SDG9	1.00
Most Denmark universities had high points for SDG10	1.00
Most Denmark universities had high points for SDG12	0.99
Most Denmark universities had high points for SDG16	1.00
Most Denmark universities had high points for SDG17	1.00
Most New Zealand universities had high points for SDG11	1.00
Most New Zealand universities had high points for SDG15	1.00
Most South Korean universities had high points for SDG9	0.95
Most Hong Kong universities had high points for SDG4	1.00
Most Chinese universities had high points for SDG9	0.97
Most Bahrain universities had high points for SDG4	1.00
Most Israel universities had high points for SDG16	1.00
Most Israel universities had high points for SDG17	1.00
Most Belgium universities had high points for SDG9	1.00
Most Argentina universities had high points for SDG4	0.90
Most Qatar universities had high points for SDG4	1.00
Most Qatar universities had high points for SDG8	1.00
Most Qatar universities had high points for SDG9	1.00
Most Qatar universities had high points for SDG10	1.00
Most Qatar universities had high points for SDG11	0.98
Most Qatar universities had high points for SDG12	0.99
Most Qatar universities had high points for SDG14	1.00
Most Qatar universities had high points for SDG15	1.00
Most Qatar universities had high points for SDG16	1.00
Most Qatar universities had high points for SDG17	1.00
Most Serbia universities had high points for SDG3	0.95
Most Zimbabwe universities had high points for SDG9	1.00
Most Slovenia universities had high points for SDG9	1.00
Most Georgia universities had high points for SDG3	0.95

4 CONCLUSION

In this study, THE Impact ranking results, based on the studies carried out by universities to achieve the SDGs, were analyzed with the linguistic summarization method, a descriptive data mining method. Both the scores for each SDG and the overall points announced by THE Impact Ranking were included in the analysis. In addition, the countries and continents where the universities participating in the ranking were located were included in the study.

The results revealed which SDGs need more work, which countries and continents are good at which SDGs, and which SDGs need more work. Future studies may include analyzing the results with different data mining methods and monitoring change by having results for more than one year.

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Play to Earn Web 3.0: The Future of Gaming and Marketing

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Abstract

The revolutionary "Play to Earn" (P2E) model, created by blockchain technology and the gaming industry, has transformed the gaming economy. This research explores the complex Web 3.0 game ecology, where users actively create and regulate virtual worlds, moving from passive consumers to active producers. In this dynamic ecology, marketing tactics must adapt to new paradigms. The paper evaluates literature and suggests future game marketing strategies, notably for P2E applications. Several key studies illuminate P2E ventures' economic and governance frameworks, highlight blockchain technology's benefits, and analyse risks including deflationary reward currencies and unequal reward systems. Integrating Web 3.0 technology and marketing methods emphasizes transparency, fair play, and consumer protection. Additionally, digital marketing, game design patterns, and social media marketing are examined in advertising virtual items and computer games. Case studies in the paper feature P2E games "Big-Time" and "Meta Theft Auto", showing how gamers can make money from their interest and how reliable blockchain technology is. Games with diverse gameplay attract a wider audience, making them good marketing assets. As blockchain technology improves trust and security, P2E gaming allows gamers to monetize their interest. The possibilities for industrial expansion and diverse games attract more players. Marketing should emphasize responsible gaming and financial issues to attract varied players. P2E systems, blockchain, and different in-game vocations make "Big-Time" and "Meta Theft Auto" interesting games. These games' marketing should stress potential earnings, safety, gameplay variety, industry development, and responsible gaming, asking players to be cautious and study before playing.

Keywords: *Play-to-earn, Web 3.0 gaming, Marketing strategies, Consumer behaviour*

1 INTRODUCTION

The convergence of blockchain technology and the gaming industry has given rise to the "Play to Earn" model, which is radically redefining the gaming economy. The primary objective of this study is to investigate the various intricate features of the developing Web 3.0 gaming ecosystem. In this ecosystem, players are not merely consumers, but rather they actively engage in the creation and control of virtual worlds. This event serves as a platform for the convergence of industry professionals, game developers, pioneers in blockchain technology, and enthusiasts to engage in comprehensive discussions regarding the potential, obstacles, and prospects of this revolutionary synthesis of technology and entertainment. In this context, maintaining the marketing status quo is of utmost significance. This study seeks to examine the above topics in literature, while also offering insights into the future marketing strategies and practices within the gaming industry while exploring current play-to-earn (P2E) applications.

Yu et al. [1] examines the economic and governance frameworks used by P2E initiatives. The author emphasizes the potential advantages offered by blockchain technology in terms of system resilience, transparency, composability, and decentralized governance. In the study conducted by Delfabbro et al. [2], an analysis is undertaken on the mechanics and business model of P2E games. The focus of the study is placed on the potential hazards that arise from deflationary reward currencies and the presence of asymmetric reward structures, which tend to provide advantages to early investors. The objective of Pimentel and Melo [3] is to examine and elucidate the misunderstandings and potential problems that are often connected with NFT-based P2E games. The study seeks to enhance understanding and awareness among both game creators and players about these issues. In Torralba [4]'s study, an examination is conducted on the many aspects that contribute to the incentive for economic gain among gamers in P2E games. These characteristics include problematic gaming behaviour, gender, the quantity of games played, and individual learning styles. In brief, these studies together provide insights into the mechanics, advantages, drawbacks, and difficulties associated with P2E gaming. These studies underscore the need of consumer awareness, transparency in commercial frameworks, and safeguarding measures for susceptible participants.

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The studies collectively discuss the integration of Web 3.0 technologies and marketing strategies, specifically in the context of P2E and web-based marketing. Delfabbro et al. [2] underscores the need for consumers to possess a comprehensive understanding of the operational mechanisms and potential hazards inherent in play-to-earn gaming. The author places particular emphasis on the significance of transparency, fair game results, and safeguarding measures for those who may be susceptible to harm. Singh and Pillai [5] examines the influence of digital marketing methods on the gaming business, acknowledging the substantial financial prospects and professional pathways available within the gaming sector. According to Hamari and Lehdonvirta [6], the use of game design patterns and mechanics may be seen as marketing strategies aimed at promoting the sale of virtual products. This serves to establish a connection between game creators and marketers, therefore bridging the gap between the two entities. In the study [7], an examination is undertaken to investigate the use of social media marketing strategies in the promotion of computer games, using The Witcher game as a specific case study. In brief, the papers together underscore the need of consumer awareness, the influence of digital marketing tactics, the amalgamation of game design and marketing, and the use of social media marketing in P2E gaming. Additionally, Akkaya et al. [8] presents a case study on a mobile game that combines a decentralized ecosystem with a web component to provide players with a seamless P2E experience. Gatomatis et al. [9] explores the impact of Web 3.0 on marketing, highlighting the potential for personalized and behavioural marketing in a semantic web environment. Weidong [10] focuses on the application of Web 3.0 in hotel marketing, emphasizing the importance of intelligence and individualization in meeting tourists' demands. Almeida et al. [11] discusses the transformative potential of Web 3.0 and semantic technologies in creating new business models, including those related to e-commerce. Overall, these papers suggest that the integration of Web 3.0 technologies in marketing, particularly in the P2E context, can enhance user experiences, enable personalized and behavioural marketing approaches, improve efficiency in hotel marketing, and create new business opportunities.

2 METHODOLOGY

Based on data published by Statista [12], it is projected that the games industry would undergo substantial expansion, resulting in a revenue of $406.20 billion by 2023 and an anticipated market volume of $584.60 billion by 2027. China is expected to generate the highest revenue, with an estimated $1122,000.00m in 2023. The market is expected to reach 4.3 billion users by 2027, with user penetration expected to increase from 48.9% in 2023 to 54.5% by 2027. The average revenue per user is expected to be $312.80. The United States remains the dominant player in the global games market due to high consumer spending and the presence of major game development companies. The Play to Earn gaming industry is anticipated to experience substantial growth in the forthcoming years, as projections suggest a notable 21.3% surge from 2022 to 2028. The growth is primarily propelled by the expansion of player bases, the introduction of innovative games, and the incorporation of blockchain technology.

This research examines the video material produced by Mindblow [13] on the YouTube platform. The transcriptions of these videos are used to investigate two specific P2E gaming situations, with the aim of comprehending the underlying mechanics and identifying possible marketing prospects. The first case study pertains to the game titled “Big-Time”, while the subsequent case study focuses on “Meta Theft Auto”.

2.1 Big-Time Case

The game “Big Time” not only captivated my attention, but also demonstrated remarkable profitability. Based on a social media post authored by a user identified as Bang Boy, it has come to light that on October 15, 2023, proficient participants in the game known as Big Time were able to amass a noteworthy amount of $148 over a duration of 6 hours of active engagement, punctuated by intermittent periods of respite. This corresponds to an estimated rate of $25 per hour of gameplay.

The subsequent section will analyse the mechanics that underlie this phenomenon. To participate in the Big-Time experience, players are required to acquire an invitation code. Nevertheless, it is important to acknowledge that this game exhibits certain similarities to massively multiplayer online games (MMOGs), providing players with captivating raid-like encounters. The native token of the game, known as Big Time, is an ERC-20 token that operates on the Ethereum network. It is readily accessible on multiple centralized exchanges. The game's economic structure is currently undergoing development, characterized by an increase in the circulation of Big-Time tokens. However, this expansion is accompanied by a growing number of players seeking to accumulate these tokens for various purposes. To participate in the Big-Time game and commence the process of generating income, it is necessary to possess an invitation code. These codes can be obtained from sources such as the official Discord server of the game or through Twitch streamers. After obtaining a code, one may commence their expedition. To optimize one's financial gains, it is advisable to acquire a scarce celestial body and enlist the services of an individual with temporal guardianship, commonly referred to as a Time Warden. These objects serve as tools for

the construction of hourglasses, which play a crucial role in acquiring Big Time tokens during gameplay. Although Big Time's prices may initially increase, they could subsequently undergo inevitable declines due to an influx of new participants, resulting in an increased supply of tokens. To generate a daily income exceeding $100, it is imperative to enhance the efficiency of one's in-game avatar through the acquisition of additional hourglasses, prolonging the duration of gameplay sessions, and engaging in the production of items that contribute to the economic dynamics within the game. It is anticipated that a robust economy driven by non-fungible tokens (NFTs) will develop, thereby establishing a sustainable and enduring gaming environment.

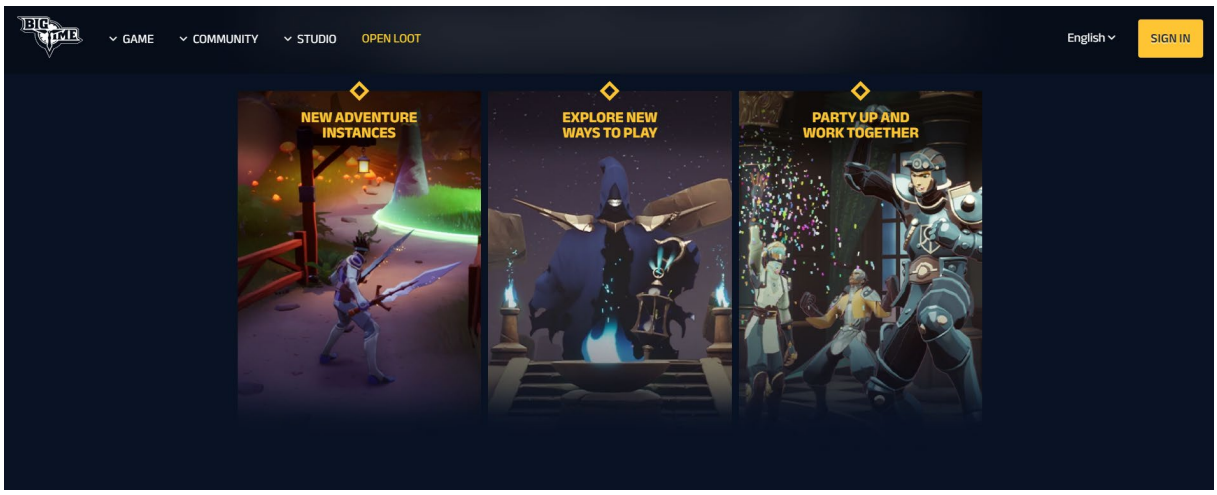

Figure 1. Big-time webpage [14]

The realm of "Play to Earn" within the context of Web 3.0, as demonstrated by Big Time, presents enticing prospects for gamers to generate tangible monetary rewards while engaging in immersive gameplay experiences. Although it is premature to make definitive projections regarding the future trajectory of the game's economy, there is clear evidence of the potential for significant profits and a prosperous in-game economic system.

2.2 Meta Theft Auto Case

Within the context of a rapidly evolving digital landscape, the convergence of traditional gaming and the transformative capabilities of Web 3.0 has given rise to a novel paradigm. Consider envisioning a game that surpasses the realm of mere amusement, presenting a virtual universe wherein one can acquire knowledge and rewards in tandem. The transformation of the popular video game Grand Theft Auto (GTA) into Meta Theft Auto (MTA) is anticipated to have a significant impact on the realm of P2E gaming.

Meta Theft Auto is an innovative online video game that effectively encapsulates the core elements of the popular Grand Theft Auto (GTA) franchise, while simultaneously introducing novel gameplay mechanics that revolve around the concept of P2E. This implies that individuals can pursue a wide range of virtual professions, encompassing occupations such as truck driver, mechanic, pilot, farmer, or even taxi driver. The game provides players with the option to assume the role of a law-abiding citizen by enlisting in the police force, or alternatively, to engage in the exhilarating experience of embodying a criminal. One notable aspect? All these activities provide tangible benefits in the real world.

In contrast to conventional games, MTA does not depend on the established game economy. The system functions on a blockchain infrastructure, utilizing a proprietary cryptocurrency known as MTA, or Meta Theft Auto tokens. The utilization of blockchain technology guarantees both transparency and security, thereby generating novel prospects for gamers to accrue tangible earnings. Participants can engage in a multitude of activities and challenges within the game, thereby accruing MTA tokens. The MTA is a dynamic interactive gaming experience that requires the utilization of Grand Theft Auto to commence this virtual expedition. After completing the steps, users can proceed to the official Rockstar website to acquire the Rockstar Games launcher. Subsequently, they can initiate the download process and subsequently install the San Andreas game. Following this, users have the option to download the MTA software and subsequently initiate it to commence their virtual journey. Within the context of the Metropolitan Transportation Authority (MTA), there exists a diverse range of available choices or alternatives. Individuals have the option to pursue conventional occupations such as taxi driving, trucking, or engaging in agricultural activities. Nevertheless, for those inclined towards audacity, one may choose to explore the realm of criminal activities. In this virtual environment, users have the option to either join existing factions or establish their own groups, participating in a range of missions. Alternatively, users may choose to align themselves with

the law enforcement task force, working towards apprehending and prosecuting individuals involved in criminal activities.

Figure 2. MTA income illustration [15]

The Metropolitan Transportation Authority (MTA) provides a diverse range of community events that present an opportunity to earn significant MTA token rewards. The weekly events encompass a variety of gaming activities, including team deathmatches, hide and seek, Mario Kart races, cops and robbers, and the glass floor game. These events offer players a wide range of gaming experiences. Additionally, there exists a lottery system that caters to individuals who possess a sense of optimism and fortune, affording them an opportunity to potentially acquire substantial winnings. The fundamental objective of MTA is to provide gamers with the opportunity to generate income from their in-game pursuits. This technology has the potential to significantly transform the gaming industry. The ability to exchange or sell virtual items and assets obtained within the game for actual currency provides players with an opportunity to generate supplementary financial resources.

The Metropolitan Transportation Authority (MTA) provides a range of income opportunities, including both passive and active sources of revenue. Passive income can be derived through the acquisition and exchange of virtual assets, which possess the potential to increase in value over a period. Conversely, individuals could engage in income-generating endeavours within the game, such as high-risk races and heists, which yield substantial financial rewards. Virtual trading and speculation offer opportunities for optimizing financial gains.

The game Meta Theft Auto serves as a prime example of the limitless possibilities inherent in the Play to Earn gaming model. With tangible incentives and a multifaceted gaming encounter, this innovation has the potential to revolutionize our perception of internet-based gaming. However, it is crucial to emphasize the importance of conducting comprehensive research and exercising due diligence prior to engaging in any activity.

3 RESULTS

3.1 Game Dynamics

The P2E concept is gaining popularity in the realm of online gaming. Games like “Big Time” and “Meta Theft Auto” both use the P2E concept to get people to join their communities. This is a significant shift from previous gaming, in which the value of in-game progress and successes was almost never, if ever, monetary. Participating in these games may earn players money in the real world, which constitutes a significant divergence from traditional gaming. Integration of blockchain technology and cryptocurrencies big time and meta theft auto both use blockchain technology and have their own in-game currencies, which are referred to as “Big Time” and “MTA” respectively. This link ensures transparency and security and provides participants with the opportunity to gain digital assets that may be sold for value in the physical world. There is a diverse selection of work that may be done online. Players in both games have access to a diverse range of virtual occupations and activities, providing them with the freedom to choose their own positions inside the game and tailor the rewards they get accordingly. Players have access to a broad variety of in-game vocations, such as truck driving, farming, working in law enforcement, and even partaking in illegal activities. In any of the two possible outcomes, players have the chance to convert their in-game achievements and assets into tangible, real-world benefits that may be used to improve their financial situation. Both passive income, which can be gained via the appreciation of assets, and active

income, which can be earned by involvement in in-game events such as tournaments and heists, are possibilities inside these games. Passive income can be acquired through the appreciation of assets.

3.2 Play to Earn Market

Both games leverage on the growing demand for different ways to make money while playing them, which means that they both have the potential for monetary benefit from a business perspective. They illustrate that it is feasible for gamers to develop their hobby into a source of revenue, which may be an effective marketing point that brings in a wider audience. Additionally, they demonstrate that it is possible for players to turn their pastime into a source of cash. The reliability of distributed ledger technology These games get an extra measure of legitimacy and confidence because of the use of blockchain technology and cryptocurrency betting options. It is conceivable to market this platform to gamers as a marketplace that is not only trustworthy but also risk-free for the purchase and sale of digital goods. Diversified game plays these games may be pushed to cater to the preferences of a broad range of players by giving a choice of virtual occupations and hobbies for players to pick from. This allows the games to appeal to a greater number of people. This idea not only broadens the attractiveness of the games to a bigger number of individuals overall, but it also has the potential to be applied as a marketing strategy to attract a broader range of gaming audiences. The possibility of growth in scope or scale of the potential for growth in the P2E segment of the gaming industry, as is mentioned in both cases, may be a strong selling element for the firm. It is feasible that players and investors will be interested in these games because of the apparent success of the industry that they are a part of. Both “big time” and “meta theft auto” are examples of innovative approaches to gaming since they mix aspects like P2E mechanisms, blockchain technology, and a broad number of professions that are accessible inside the game itself. Both games are available on a variety of platforms. It’s possible that the marketing approach for these games will place an emphasis on the potential profits, the safety of blockchain technology, the many types of gameplays, the growth of the industry, and responsible gaming, while simultaneously drawing attention to the demand that players exercise care and perform research.

4 CONCLUSION

The gaming business is undergoing a fast transformation, with a notable shift towards immersive virtual worlds that are attracting a growing number of users. In addition to the existing capability of preceding gaming applications to facilitate the purchase and sale of in-game products, the emergence of Web3.0 has significantly increased the prevalence of such transactions among users, hence contributing to the fast growth of the gaming economy. These advancements hold significant interest for a wide range of scientific disciplines, including computer science, engineering, marketing, consumer behaviour, psychology, and the domains of tourism and recreation.

The importance of future studies pertaining to the efficient marketing of real-world businesses in virtual worlds, or vice versa, is growing. Future research might investigate the behavioural patterns shown by gamers as consumers inside the gaming environment and beyond, including both the gameplay experience and the subsequent post-game period. Lastly, future research to examine the possible use of certain in-game and off-game items in marketing applications is also crucial. Additionally, it is crucial to explore the behaviour of individual gamers when they participate as members of in-game groups in various scenarios.

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Artificial Intelligence in Marketing: Content Analysis of Web of Science Indexed Papers

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Abstract

Artificial intelligence (AI) plays a substantial and myriad role in technology across various disciplines and industries by allowing for automation, data analysis based on data-driven decision-making, machine learning, speech recognition, autonomous systems, healthcare diagnosis, cybersecurity, and virtual reality. AI represents a revolution in marketing by automating tasks, providing data-driven insights, and delivering highly personalised customer experiences. Marketers are increasingly leveraging AI to stay competitive and meet the evolving demands of the digital age. It provides companies with personalisation, customer services with chatbots or virtual assistants, effective content creation, dynamic pricing and customer relationship management. On the other hand, researchers attempt to guide industry by investigating how AI can be adopted by firms, accepted by consumers and managed by practitioners. Many scientific studies on the subject of AI exist in the literature. However, a structural review is needed to distinguish studies in terms of what conceptual frameworks or methodologies were used and what the shortcomings and requirements are. The study endeavours to respond to this call by conducting a theoretical and methodological content analysis on papers about AI in marketing published in scientific journals. Web of Science index was embraced since it is a highly reputable and qualified database. Papers published from 2020 to 2023 were included in the analysis since the COVID-19 pandemic is an influential milestone in transforming macro environment factors. After the content analysis process, the implications and suggestions were made to guide theoreticians and practitioners.

Keywords: *Marketing, Consumer behaviour, Artificial intelligence, Content analysis*

1 INTRODUCTION

Artificial intelligence (AI) has gained popularity in marketing due to its ability to provide automation, data analysis based on data-driven decision-making, machine learning, speech recognition, autonomous systems, healthcare diagnosis, cybersecurity, and virtual reality [1]. Companies are able to acquire a competitive advantage in markets by benefitting from AI technologies. Marketing studies have started to focus on how AI can be implemented in marketing strategies and how consumers can adopt products or services using AI technology. Therefore, the quantity of AI research has been rising in marketing literature [2].

Marketing studies have subjected AI to several aspects. They examined AI in terms of what it means theoretically and how conceptual frameworks can be built in the context of AI. On the other hand, others attempt to investigate AI quantitatively to reveal how AI technologies influence, shape and forecast consumer behaviour. However, quantitative studies embraced different theoretical backgrounds and methodological approaches. It may cause diverse findings regarding equivalent purposes, provoking contradictions in understanding consumer behaviour with AI. Therefore, analyzing past studies on AI should help picture existing situations in the literature and provide a deep knowledge of conceptual and methodological approaches.

The study aims to examine the studies subjected to AI regarding which theoretical framework and methodological process is embraced. It also suggests which subjects or methods are needed in future AI studies that theoreticians, researchers and practitioners can conduct.

2 MATERIAL AND METHOD

The study embraced a qualitative approach to reveal associations among phenomenons. Content analysis is sufficient to shed light on grounded themes in relevant studies [3]. According to the research aims, several criteria were determined as below.

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- Database: Web of Science.
- Index: Social Science Citation Index (SSCI).
- Keywords: “marketing” + “artificial intelligence”, “consumer behaviour” + “artificial intelligence”
- Categories: Management, business or management, business.
- Document type: Article.
- Years: 2020-2023.
- Language: English.

There are 45 papers were detected to include the analysis, however, some exclusions exist in the research. Specifically, six papers irrelevant to AI and marketing were excluded. Additionally, two papers were excluded because one could not be accessed, and one was an editorial. After reviewing the literature regarding the criteria, 37 papers were included in the content analysis process.

First, 37 papers were entirely read and reviewed by the author. Then, a theme list was created parallel with the research aims. The theme list guides the author on coding papers during the content analysis. The components included in the list are below.

1. Authors
2. Year
3. Research type
4. Context
5. Framework
6. Variables
7. Sample size
8. Data collection tools
9. Analysis

Papers were examined by theme list and coded manually since the relevancy of the themes and codes is essential. Content analysis was accomplished when the last paper was coded and added. Table 1, representing the findings of the content analysis, is below.

Table 1. Findings of Content Analysis

Source	Year	Research Type	Context	Framework	Variables	Sample	Data Collection	Analysis
[4]	2020	Conceptual	artificial intelligence and the future of marketing					
[5]	2020	Research (quantitative)	Clustering consumers’ mobile shopping journeys	Customer journeys		14 participants, aged 18–34 years old	two fashion retailers’ websites on smartphones	SMI BeGaze 3.7 software used data obtained from eye-tracking technology
[6]	2020	Research (qualitative)	motivations and human values about consumer restraint	Anti-consumption, Consumer resistance		5,603 English tweets containing the term “Buy Nothing Day”	Twitter data set in 2016, 2017, 2018	computerized and manuel content analysis
[7]	2020	Conceptual	Consumer Adoption to Autonomous Shopping Systems					
[8]	2020	Research (qualitative)	The role of AI and voice bots in service marketing	consumer decision-making process		41 academic and 57 managerial focal articles	searching specific articles in EBSCO Host, Science Direct and Google Scholar databases	manual content analysis

[9]	2021	Research (quantitative)	consumers' evaluations of product consumption values, purchase intentions and willingness to pay for fashion products designed using generative adversarial network (GAN), an artificial intelligence technology	theory of consumption value	Consumption values (functional, social, emotional and epistemic), Use of GAN technology	163 members of Generation Y	experimental conditions	Regression analysis, ANOVA
[10]	2021	Research (quantitative)	the influence of consumer trust, interaction, perceived risk, and novelty value on brand loyalty for AI supported devices	Psychographic characteristics of adopters	trust, interaction, perceived risk, novelty value, brand loyalty	675 Apple iPhone-using respondents	survey via MTurk platform	PLS-based SEM
[11]	2021	Conceptual	online customer engagement behavior via artificial intelligence	Stimulus-Organism-Response theory				
[12]	2021	Research (quantitative)	Consumers' reasons and perceived value co-creation of using artificial intelligence-enabled travel service agents	behavioral reasoning theory, Service-Dominant logic	Value, Perceived personalization, Superior functionality, Ubiquitous, Tradition barrier, Privacy concerns, Technology anxiety, Need for personal interaction, Perceived value co-creation, Behavioral intentions	99 graduate and undergraduate students		SEM, fuzzyset qualitative comparative analysis (fsQCA)
[13]	2021	Research (quantitative)	automated digital assistance for online consumers based on an AI	anthropomorphism, reactance theory, digital service assistance	asistant type, asistant initiation, reactance, choice difficulty, choice confidence, perceived performance, choice satisfaction	400 participants	a between-subjects experimental design	sequential moderated mediation model
[14]	2021	Research (quantitative)	relationship among voice assistant personality, consumers' attitudes and behaviors	flow theory	Functional Intelligence, Sincerity, Creativity, Consumers' Perceived Control, Flow Experience, Consumers'	275 consumers,	questionnaire	exploratory factor analysis, multiple-group comparison test, PLS-SEM, Multi-Group Analysis

					Exploratory Behavior, Satisfaction, Willingness to Continue Using			
[15]	2021	Research (quantitative)	AI powered voice assistants and consumer brand engagement	social presence theory, technology acceptance theories	AI voice asisstant attributes (social presence, perceived intelligence, social attraction), technology attributes (perceived ease of use, perceived usefulness), situation attributes (utilitarian benefits, hedonic benefits, distrust), consumer brand engagement (cognitive processing, affection, activation), purchase intention, brand usage intention	21 and 724 respondents	in-depth interviews, survey	thematic codes, Exploratory Factor Analysis, SEM
[16]	2021	Research (quantitative)	human nature's role in consumers' shopping channel choices in the AI era	theory of planned behaviour, accessibility-diagnosticity theory, Xunzi's humanity hypothesis	Unrestrained pursuit of personal interests, Desires of the ears and eyes, Hedonic and Utilitarian orientation, Subjective norms, Online and offline purchase intention, Perceived AI usefulness	206 and 192 students, 46 employee	questionnaire, interviews, focus groups and expert judgements	EFA, SEM, Hierarchical regression analysis
[17]	2021	Research (quantitative)	AI-enabled checkouts and consumer judgements	Self-efficacy	Checkout Type (Self-service vs. AI-enabled), consumers' callousness, self-efficiacy, perceived shopping convenience, consumer patronage intent	222, 509 and 368 participants	focal retailers having self-checkout systems or AI-enabled checkout type, Amazon Mturk	correlational, regression, moderating, moderated mediation analysis
[18]	2021	Research (quantitative)	consumer–voice assistant (VA) interaction in	(not mentioned)	high vs. low involvement, Higher (vs. lower)	296, 226 and 241 VA users	Amazon Mechanical Turk	t-test, ANOVA

			food and beverage purchase		perceived power, willingness to purchase			
[19]	2021	Research (quantitative)	Machine Learning Algorithm for the Prediction of Online Purchase Conversion	conversion funnel model	consumer engagement behavior, conversion (duration time, page view, search depth, …)	374,749 online consumer behavior data	Google Merchandise Store	Machine learning technology, eXtreme Gradient Boosting model
[20]	2021	Research (quantitative)	examining the adoption of robo-advisors vs human financial advisors with different expertise levels	Self service technology adoption	trust, performance expectancy, intention to hire human financial advisors or AI-based robo-advisor	USA, 188, 189, and 185 respondent	Amazon Mechanical Turk and Prolific	MANCOVA
[21]	2021	Research (quantitative)	consumers' acceptance of automated technologies in service encounters	Service Robot Acceptance Model	p. ease of use, p. Usefulness, subjective social norms, p. Humanness, p. Social interactivity, p. Social presence, trust, rapport, acceptance of digital voice assistants	238 young digital voice assistant users		PLS-SEM
[22]	2021	Conceptual	Digital servitization value co-creation framework for AI services	Service-dominant logic				
[23]	2021	Research (quantitative)	a chatbot's initial message and foster consumer–brand connections	Stereotype Content Model	chatbot message (warm vs. competent), brand-self distance, brand engagement, brand affiliation	80, 126 and 184 Mturk participants, 82 university students,	Amazon Mechanical Turk	automated text analysis, independent-samples t-test, ANOVA, mediation analysis, moderation-of-process approach
[24]	2021	Research (quantitative)	Use of AI Influencers As Brand Endorsers	celebrity endorsement	AI influencer similarity, Celebrity endorser similarity, New AI transgression likelihood, New celebrity transgression likelihood, Attitudes toward the brand, Purchase intentions, Attitudes toward the endorser, Transgression appropriateness, Perceptions of responsibility	53, 184, 157	between-subjects design experiment, Amazon Mturk	ANOVA, mediation analysis, paired-samples t-test

[25]	2021	Research (quantitative)	robots' perceived human-likeness and consumers' behavioral intentions	social categorization	human-likeness, competence, warmth, need for social interaction, functional value, social value, monetary value, emotional value, loyalty	526 customers	a market research agency.	PLS-SEM
[26]	2021	Research (quantitative)	Impact of auditory sense on trust and brand affect	social cognition theory	p. Auditory sense, p. Auditory social interaction, p. Auditory control, trust invoice asistant, brand affect, surprise	127 young consumers, 116 adults,	Lab experiment in a university in USA, questionnaire	ANOVA, exploratory factor analysis, PLS-SEM
[27]	2022	Conceptual	consumption process shaped by attachment to anthropomorphized AI	anthropomorphism				
[28]	2022	Research (quantitative)	the influence of consumer goals on artificial intelligence (AI) driven interactive recommendation agents	goal frame	gain goals, hedonic goals, normative goals, attitude, IRA (interactive recommendation agents) value, IRAs usage duration, intention to use.	321 AI-driven IRAs users, Twenty-eight college students	survey from AI-driven IRAs users of Stitch Fix, focus group interviews	PLS-SEM
[29]	2022	Research (quantitative)	predicting the purchase intention of e-commerce website users via machine learning	Big Data Analytics	consumers' purchase intention	online shoppers' 12,330 sessions	dataset obtained from public domain	Machine Learning models
[30]	2022	Research (quantitative)	investigating the matching efect of brand personality and customer service provision type on brand attitudes and purchase intentions	brand personality and authenticity theory	brand personality, customer service provision, consumer involvement, perceived brand authenticity, brand attitudes, purchase intentions	246, 250, and 240 participants	scenario-based online surveys	ANOVA, Independent t-test, mediation analyses
[31]	2022	Research (quantitative)	the role of (AI) agents in nonprofit charity marketers	Anthropomorphism and construal level theories	smile existence, AI agent type (humanlike, machinelike), psychological closeness, donation intention	240 adults, 127 under-graduate business students	Amazon Mechanical Turk platform	moderated mediation analysis

[32]	2022	Research (quantitative)	determining consumer purchase decisions using artificial intelligence in the fashion industry in social commerce platforms	Engel-Kollat-Blackwell (EKB) theory	Instagrammars' purchase decision, perceived eWOM, perceived emotional value, perceived quality, perceived risk and perceived price	202 instagram users	Semi-structured in-depth interviews, questionnaire	SEM, importance performance matrix analysis
[33]	2022	Conceptual	proposing an updated view of consumer choice based on voice platforms with AI	AI-influenced decision-making (AIDM) processes		53 academic and 65 managerial focal articles	Science Direct, EBSCO Host, and Google Scholar	literature review
[34]	2022	Research (qualitative)	firms' different SM engagements with respect to artificial intelligence (AI)	relationship marketing theory		15 participants	semi-structured in-depth interviews	NVivo qualitative data analysis software
[35]	2022	Research (quantitative)	unravelling the dynamic reciprocal relationship between review helpfulness and unhelpfulness	social learning theory	review helpfulness, review unhelpfulness	35,246 product reviews	dataset obtained from amazon.com	LCS modeling technique
[36]	2022	Research (quantitative)	The relationship among AI quality, customer experience and brand relationship	flow theorysocial identity theory	AI information quality (accuracy, currency), AI system quality (reliability, flexibility, timeliness), employee responsiveness, flow, brand identification, customer advocacy	350 guests	paper-based survey from four hotels that used AI	SEM, mediation analysis, moderation analysis
[37]	2022	Research (quantitative)	examining users' affective relationships with smart voice assistants	relational cohesion theory	interaction frequency, pleasure-based satisfaction, interest, relational cohesion, user purchases, user knowledge, user reference	717 smart voice asisstant users	panel data obtained from an international market research company	SEM
[38]	2023	Research (quantitative)	Optimization of consumer engagement with artificial intelligence elements	Stimulus-Organism-Response theory	chatbot, image search, recommendation system, automated after sales services, psychological engagement, attention to social comparison-consumption, behavioral engagement	464 responses	online questionnaire	PLS-SEM, Mediation and moderation analysis

[39]	2023	Research (quantitative)	the impact of voice AI service failure on customer complaint behavior	service failure-customer reaction relationship	Call Length, Customer Complaint, AI service result, age, gender, Location, Open time, Customer emotion	252,938 voice AI service records	dataset obtained via a call center of a telecommunications company in China	Logit regression analysis, Rosenbaum bounds sensitivity analysis (Rosenbaum, 2004), Regression of linear probability model
[40]	2023	Research (quantitative)	integrating the AI technology within a corporate brand management strategy	computer-mediated communication (CMC) theory	problem-solving ability, accuracy, and customization of AI, Anthropomorphism, Interaction, customer equity (value equity, brand equity, and relationship equity), brand image, brand familiarity.	210 responses	survey	SEM
[41]	2023	Research (quantitative)	the effects of AI-powered digital assistance toward customers' luxury brand online shopping experience	SOR model, TRAM (Technology Readiness and Acceptance Model)	AI-powered digital assistance, digital multisensory cues, customer engagement, luxury brand online shopping experience.	25 interviewers, 273 respondent	semistructured interviews, survey	PLS-SEM, fuzzy-set qualitative comparative analysis (fsQCA)

3 RESULTS

Papers were examined regarding the theme list created in line with research aims. Table 2 represents which research types were embraced in papers on AI in marketing. According to Table 2, the majority of the investigations are quantitative. Conceptual and qualitative studies are limited in the literature, signalling theoretical and exploratory research are needed to understand AI and consumer behaviour associations.

Table 2. Research types

Research Type	Frequency
Conceptual	5
Research (qualitative)	3
Research (quantitative)	29
Total	37

Papers on AI in marketing and consumer behaviour were built on various theoretical frameworks, producing diverse variables, as seen in Table 1. Conceptual backgrounds included psychological theories (i.e. anthropomorphism, flow theory, self-efficacy), social theories (i.e. social cognition theory, social categorization, social learning theory) and others (i.e. computer-mediated communication (CMC) theory, authenticity theory, accessibility-diagnosticity theory, Service-dominant logic). Researchers embrace different frameworks despite investigating similar phenomena. It may diversify the variables used by researchers; however, it should cause future conceptual contradictions, so a theoretical consensus is needed in studying AI in marketing to comprehend consumer behaviour.

According to the findings, qualitative studies used a more miniature sample size, as small samples are expected to be sufficient exploratory research like interviews or focus groups. Likewise, qualitative investigations on AI in marketing were conducted with 15 to 57 interviewers, as demonstrated in Table 1. The findings show that the

sample size of quantitative examinations included 99 to 749 respondents, as seen in Table 1. It differs due to the studies' audiences and the number of used variables. To achieve congruity in the sample size determination, researchers should embrace parallel sampling procedures to avoid potential measurement errors and improve the representation of samples.

The research revealed that various data collection sources were used in previous attempts. The sources were databases (i.e. ScienceDirect, Google Scholar), tweets, a fashion retailer's website, datasets, interviews, and online offline surveys. The questionnaire technique was predominantly used in past studies since it is a time-saving method to collect large samples quickly and relieve and accelerate the data collection process.

Analysis techniques were examined in the research to reveal which statistical or subjective methods were performed by previous studies. Table 3 briefly displays the frequency of the techniques. According to that, Structural Equation Modeling (SEM) was mainly employed in quantitative studies on AI in marketing. Then, mediation analysis and dissimilarity tests (ANOVA, t-test) were frequently utilised by researchers. However, novel techniques such as machine learning and neuromarketing (e.g. eye-tracking) were restricted in past investigations, which can be shown in Table 3. Using new methods should provide new insights and critical evidence to comprehend the role of AI in consumer behaviour.

Table 3. Analysis techniques

Technique	Frequency
Structural Equation Modeling	10
Others	7
Mediation	6
ANOVA	5
t-test	4
Content analysis	3
Exploratory factor analysis	3
Regression	3
Machine learning	2
Moderated mediation	2
Moderation	2
Literature review	1
Neuromarketing	1

4 CONCLUSION

The study aims to reveal theoretical and methodological patterns in papers subjected to AI in marketing and consumer behaviour published in the Web of Science database in 2020-2023. Few criteria were determined in the literature review, and 37 papers were detected regarding the criteria. Then, a theme list was created to conduct content analysis aligned with research objectives. Finally, the relevant studies were examined and distinguished according to their research type, context, framework, variables, sample, data collection method and analysis technique. The findings of the research provide particular insights for future endeavours.

First, additional introspection is needed to reveal the role of AI in marketing and consumer behaviour since only 37 papers have been published in the Web of Science Core Collection (SSCI) in the last three years. More attempts should provide a deeper understanding of the function of AI in creating and managing marketing strategies.
Second, a theoretical and methodological consensus should be needed to avoid potential contradictions in understanding the AI concept and examining AI empirically in marketing research. Which framework should be better for building research on AI can be discussed by researchers in scientific journals or activities. Additionally, the sampling process may be standardized by the scientific community to achieve similar measurement procedures and minimize errors.

Third, as a multivariate analysis technique, researchers predominantly operated on SEM to empirically investigate AI and consumer behaviour associations. However, novel methods provide unexpected relationships among variables, which can help comprehend AI's function in marketing. Setting sail for new techniques may also offer extraordinary discoveries.

There are a few limitations in the research. The content analysis included only the Web of Science (SSCI) database since it is a world-leading and qualified scientific portal. However, other indexes may provide additional knowledge to reveal the role of AI in marketing and consumer behaviour research. The research embraced a qualitative approach to explore the associations among the phenomenon, yet future attempts may utilise quantitative methods such as bibliographic analysis, big data analytics, or meta-mining.

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Entrepreneurship and Management Roles in Wealth Creation

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Abstract

In simplifying entrepreneurship and management role for wealth creation, we will expand the role of entrepreneurship on wealth creation which is stated as employment generation, training and human resource development, innovation, maintenance of population density, wealth creation, education and mentorship. In addition to this, we will also expand qualities to cultivate for intending Entrepreneurs which is stated as risk taking, passion, knowledge, leadership, building and managing an effective team.

Keywords: *Entrepreneurship, Management and wealth*

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Analysis of Occupational Accidents in the Electricity Generation, Transmission, and Distribution Sector in Turkey

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Abstract

In Turkey, the energy sector plays a vital role in economic growth and sustainable development. Among the key components of this sector, occupational health and safety are of significant importance for those involved in the processes of electricity generation, transmission, and distribution. After providing a general overview of the electricity generation, transmission, and distribution sectors in Turkey, this study aims to analyze data on work-related accidents resulting in temporary disability or fatalities that occurred during the five-year period from 2018 to 2022. The data were extracted from the Social Security Institution (abbreviation for Turkish: SGK) Statistical Yearbooks. The findings reveal that a total of 20,702 work-related accidents occurred in the electricity generation, transmission, and distribution sector in Turkey during the 2018-2022 period. These accidents resulted in the loss of 117 lives, and 18 workers contracted occupational diseases. Additionally, there were 143,486 days of temporary disability with workers spending 8,350 days in hospitalization, leading to a total of 151,836 days of temporary work incapacity. The study indicates a consistent increase in the frequency rate of work accidents over the years. It is observed that this sector falls into the category of high-risk occupations, and the majority of accidents are attributed to factors such as human error, equipment malfunction, and violations of safety procedures. In light of these findings, it is concluded that providing more effective training for workers in this sector and continuously updating safety protocols can reduce work-related accidents and elevate safety standards.

Keywords: *Occupational health, Occupational safety, Occupational accident, Electric energy*

1 INTRODUCTION

In today's world, electrical energy is considered an indispensable element of economic and social life, playing a vital role in various areas such as heating, lighting, communication, transportation, industry, and agriculture. Therefore, electrical energy holds a critically important position in terms of a country's economy and energy policies. The production of electrical energy typically involves the use of fossil fuels (coal, natural gas, oil) or renewable energy sources (hydropower, solar, wind). Electricity, being advantageous in providing ease of transmission and control, has reduced costs and increased efficiency in the transportation sector. Due to the ease of installation and relatively low costs of transmission lines, the necessity of establishing facilities near energy sources has been eliminated, allowing businesses to settle in more efficient locations. Electricity has supported the development of mass transportation vehicles such as trains and trams, positively influencing urbanization [1].

In Turkey, the management of electricity production, transmission, and distribution was initially centralized under the Turkish Electricity Authority (abbreviation for Turkish: TEK) until changes were made in 1994. The structure of TEK was reorganized into two separate state economic enterprises: Turkey Electricity Generation Transmission Corporation (abbreviation for Turkish: TEAS) and Turkey Electricity Distribution Corporation (abbreviation for Turkish: TEDAS). Subsequently, in 2001, TEAŞ was further restructured into three separate joint-stock companies under the names of Electricity Generation Inc. (abbreviation for Turkish: EUAS), Turkey Electricity Transmission Inc. (abbreviation for Turkish: TEIAS), and Turkey Electricity Trade and Contract Inc. (abbreviation for Turkish: TETAS) [2].

The production of electrical energy takes place in various types of plants depending on the energy source and fuel type, including hydropower, thermal, nuclear, gas turbine, geothermal, wind, tidal, and solar power plants. In Turkey, a significant portion of electricity generation comes from hydropower and thermal power plants. The choice of power plant type is dependent on investment, operation, and maintenance costs. For example, the installation costs of thermal power plants are lower than those of hydropower plants, but operational expenses are higher. Hydropower plants have lower operating costs [3].

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EUAS, responsible for operating public plants and electricity production, plays a significant role in meeting a substantial portion of Turkey's total electricity production. EUAS conducts rehabilitation projects to increase the efficiency of thermal and hydropower plants. Transmission and distribution networks, including high-voltage lines, transformer centers, and other units, are used to transport electricity from the places of generation to consumption regions. The energy transmission lines in Turkey are operated by TEIAS and have a total length of 73,947 km. The distribution of electrical energy is carried out by TEDAS and private companies. High-voltage electricity reaches distribution centers, where it is reduced to medium voltage values before being conveyed to industrial and residential areas. Before reaching the end consumer, the voltage is further reduced to 220 V using small transformers mounted on poles. Electrical energy is utilized by consumers for various purposes such as heating, lighting, and mechanical energy production [4-6].

According to the Hazard Classes List Notification related to Occupational Health and Safety published by the Ministry of Labor and Social Security, workplaces are classified into three categories: low-risk, risky, and highly risky. According to this classification, workplaces engaged in Electric Energy Production with NACE Code 35.11.19, Electricity Transmission (operating transmission systems that transfer electricity from the production source to the distribution system) with NACE Code 35.12.13, and Electricity Distribution (operating the distribution system that transmits electricity from the production source or transmission system to the end user) with NACE Code 35.13.01 are categorized as 'highly risky workplaces.' The main objective of this study is to analyze the occupational health and safety situation in the "Electric Energy Production, Transmission, and Distribution" sector for the 5-year period between 2018 and 2022. This involves examining statistics on workplace accidents, occupational diseases, related fatalities, and workday losses, with a focus on emphasizing the importance of sector-specific occupational health and safety measures and contributing to the literature [7].

2 MATERIAL AND METHOD

The data for this study were obtained from the Social Security Institution Statistical Yearbooks, aiming to assess the current situation regarding occupational health and safety in the Electricity Energy Production, Transmission, and Distribution sector in our country. The study further aims to present the accident and mortality statistics for the last five years (2018-2022), propose solutions related to the subject, and contribute to future research. The accident and mortality statistics for the specified period were extracted from SGK records, focusing on registered insured employees. It should be noted that this study only covers statistics for insured employees registered with SGK in our country. The inability to determine the number of workplace accidents and the associated loss of workdays and deaths due to undeclared employment in the country is a limitation of this study.

3 RESULTS

The development of the Electricity Energy Production, Transmission, and Distribution sector in Turkey significantly contributes to the country's economic growth. However, like any other industry, this sector also experiences workplace accidents leading to injuries, occupational diseases, workday losses, and, in some cases, fatalities. Table 1 presents statistics for insured employees in the Electricity Energy Production, Transmission, and Distribution sector in Turkey from 2018 to 2022 [8-12].

Table 1. Workplace and insured employee numbers in the production, transmission, and distribution of electricity, gas, steam, and air conditioning systems by years

Years	Workplace Count	Insured Employee Count
2022	9,843	123,476
2021	10,024	116,618
2020	10,096	109,439
2019	12,893	111,754
2018	13,417	103,221

According to Table 1, the number of workplaces in the Electricity Energy Production, Transmission, and Distribution sector decreased by 26.6% compared to 2018, while the number of insured employees increased by 19.6% over the same period.

Table 2 shows the number of workplace accidents that occurred in the Electricity Energy Production, Transmission, and Distribution sector from 2018 to 2022, and Table 3 provides statistics on fatal workplace accidents during the same period [8-12].

Table 2. Number of workplace accidents in the electricity energy production, transmission, and distribution sector by years

Years	Electricity Energy Production	Electricity Energy Transmission	Electricity Energy Distribution	Electricity Energy Trade
2022	2,900	198	2,440	47
2021	2,290	207	1,959	71
2020	1,485	302	1,681	98
2019	1,298	361	1,937	64
2018	1,095	321	1,861	87

According to the data shown in Table 2, workplace accidents in the Electricity Energy Production, Transmission, and Distribution sector increased over the years from 2018 to 2022. While the highest number of workplace accidents occurred in the Electricity Energy Distribution sector in 2018, 2019, and 2020, in 2021 and 2022, the Electricity Energy Production sector experienced the highest number of workplace accidents [8-12].

Table 3. Number of fatal workplace accidents in the electricity energy production, transmission, and distribution sector by years

Years	Electricity Energy Production	Electricity Energy Transmission	Electricity Energy Distribution	Electricity Energy Trade
2022	8	1	14	0
2021	15	1	13	0
2020	10	1	14	0
2019	2	2	16	0
2018	8	1	10	1

Examining fatal workplace accidents in Table 3, the total number of fatal workplace accidents was 20 in 2018 and 2019, increased by 25% to reach 25 in 2020, continued to rise to 29 in 2021, and then decreased by 20.6% to 23 in 2022. In 2018, 2019, and 2020, the Electricity Energy Distribution sector experienced the highest number of fatal workplace accidents, while in 2021, the Electricity Energy Production sector had the highest number, followed by a return to the highest number of fatal workplace accidents in the Electricity Energy Distribution sector in 2022 [8-12].

Table 4 provides statistics on occupational diseases that occurred in the sector from 2018 to 2022.

Table 4. Number of occupational diseases in the electricity energy production, transmission, and distribution sector by years

Years	Electricity Energy Production	Electricity Energy Transmission	Electricity Energy Distribution	Electricity Energy Trade
2022	5	0	0	0
2021	4	0	1	1
2020	1	0	0	0
2019	5	0	1	0
2018	0	0	0	0

According to the data shown in Table 4, the total number of occupational diseases in the Electricity Energy Production, Transmission, and Distribution sector from 2018 to 2022 is 18. While the highest number of occupational diseases occurred in the Electricity Energy Production sector, no occupational diseases were reported in the Electricity Energy Transmission sector during the five-year period. Moreover, no deaths were reported due to these occupational diseases during the same period [8-12].

Table 5 presents the number of days of disability due to hospitalization or outpatient treatment in the Electricity Energy Production, Transmission, and Distribution sector for the 5-year period from 2018 to 2022 [8-12].

Table 5. Number of disability days in the electricity energy production, transmission, and distribution sector

Years	Electrıcıty Energy Productıon			Electrıcıty Energy Transmıssıon			Electrıcıty Energy Dıstrıbutıon			Electrıcıty Energy Trade		
	Inpatient	Outpatient	Total	Inpatient	Outpatient	Total	Inpatient	Outpatient	Total	Inpatient	Outpatient	Total
2022	618	22.959	23.577	212	2.135	2.347	936	12.463	13.399	0	61	61
2021	594	20.158	20.752	156	1.499	1.655	562	10.891	11.453	4	152	156
2020	634	13.628	14.262	170	2.300	2.470	1.009	12.051	13.060	85	1041	1126
2019	451	11.935	12.386	270	2.923	3.193	1.117	11.314	12.431	9	641	650
2018	366	5.995	6.361	100	1.014	1.114	975	9.680	10.655	82	646	728

According to the data presented in Table 5, the number of workdays lost due to both inpatient and outpatient treatment consistently increased over the years in the Electricity Energy Production sector. However, in the Electricity Energy Transmission, Distribution, and Trade sectors, there has been a decreasing trend in workday losses in recent years. Nevertheless, the total workday loss for the entire sector during the 5-year period from 2018 to 2022 reached 151,836 days, with 8,350 days spent in hospitalization and 143,486 days through outpatient treatment [8-12]

4 CONCLUSION

The electricity energy sector plays a significant role in national economies; however, when evaluating the occupational health and safety performance in this study, several crucial findings emerge. Firstly, the observed decline in the number of workplaces may indicate the sector's adaptation to technological advancements and increased efficiency. However, it could also signify that businesses in the sector have become larger and more complex, leading to an increased workload per employee. In this case, occupational safety measures should be meticulously reviewed. The increasing trend in workplace accidents suggests ongoing challenges in managing risks within the sector. The variation in workplace accidents across different subcategories over time emphasizes the need for continuous revision and improvement of safety measures within the sector. The increase in accidents in the Electricity Energy Distribution sector indicates the urgent need for specific measures in this subsector. Fluctuations in fatal workplace accidents are crucial for assessing the effectiveness of measures taken in the sector. A decrease in fatal accidents indicates an improvement in safety awareness, while rising numbers underscore the need to identify and develop targeted solutions for priority risks. Particularly, the high numbers of fatal accidents in the Electricity Energy Production and Distribution sectors signal the necessity for a more detailed analysis of risks in these subsectors. Since occupational diseases encompass long-term risks for employees, more effective preventive measures and regular health screenings are mandatory to combat occupational diseases in the sector. Lastly, the increase in workday losses indicates that the effects of accidents in the sector are not limited to physical health alone but also have a significant impact on workforce productivity. Therefore, occupational health and safety measures should not only focus on accident prevention but also on the continuity and productivity of employees. Despite the decrease observed in fatal workplace accidents, occupational health and safety measures in the Electricity Energy sector still pose serious challenges in terms of accidents and workday losses. The variations among different subcategories within the sector highlight the necessity for tailoring specific safety measures to different areas of the sector. In conclusion, more efforts and a focus on reducing risks are needed in the Occupational Health and Safety aspects of the Electricity Energy Production, Transmission, and Distribution sector. This will be a crucial step in enhancing the safety of employees in the sector and establishing a sustainable work environment.

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The Mediating Role of Trust in Social Media in the Effect of Influencers on Consumers' Purchasing Actions

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Abstract

Social media is one of the most effective tools to achieve goals. It is online and consists of resources that individuals use to share content, such as videos, photos, images, texts, ideas, gossip, news, blogs, and vlogs. The branch of science that examines all the actions of consumers before, during, and after purchase and investigates their reasons is called consumer behavior. With the rapid development of the internet in the digital market it has made shopping easier by creating new consumer categories through online shopping. An influencer is someone who has the right to influence people's decisions through their authority, knowledge, status, or relationships. Influencers are individuals who have active followers and motivate followers. Influencers represent third-party advocates who shape the attitude of audiences. Establishing a relationship of trust with the target audience is very important for brands, and the fastest way to lose trust is to offer things that are not personally used or are not suitable for the target audience and do not express value. As it is known, issues such as data protection and feelings of insecurity are effective in shopping via social media. The aim of this study is to see whether the trust in social media, where participants make purchases from social media by being influenced by influencers has a mediating role. As a result of the testing conducted with the SPSS26 package program, it was concluded that trust in social media has a mediating role in the influence of influencers on consumers' purchasing actions.

Keywords: *Social media, Influencers, Brand trust*

1 INTRODUCTION

With social media, an online environment, brands can communicate with their customers effectively and efficiently. Thanks to this communication, various content created by brands can be shared [1]. With consumer behavior, how individuals will act and the reasons behind these actions are investigated [2]. Consumers used to engage in purchasing behavior in traditional markets, but now, with the developing electronic environments, they have started to engage in online purchasing behavior, and thus, shopping has become easier [3]. Thanks to this developing new media, the application of influencers has emerged. Influencers are individuals who affect consumers' purchasing behavior and push them to shop [4]. Therefore, influencers are an important source of motivation for their followers to shop [5]. It is very important that communication with customers is built on the concept of "trust". For this, brands must deliver products that meet the expectations, needs, and wishes of consumers [6].

Brand trust; It can be defined as the strong belief of consumers that their expectations about the brand will be met and that the brand will not disappoint by fulfilling its promises. It is, therefore based on customers' expectation that the trusted party will take some significant action [7]. Therefore, brand trust is becoming the most important factor in the buyer and seller relationship, especially on social media. It is also considered one of the reasons for not buying online [8].

The aim of this study is to see whether the trust in social media, where participants make purchases from social media by being influenced by influencers has a mediating role. In addition to the studies examining the direct effect of influencers on the purchasing behavior of their followers, this research tries to contribute to the literature in a different way by examining whether the reliability of the social media platform has a mediating effect.

2 MATERIAL AND METHOD

The aim of this study is to see whether trust in social media, where participants make purchases from social media by being influenced by influencers, plays a mediating role. The study has been conducted using the "convenience

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sampling method" with 244 participants so far. A 6-point Likert scale was used in the study (1: Strongly Disagree; 2: Disagree; 3: Partially Disagree; 4: Partially Agree; 5: Agree, 6: Strongly Agree). Tests were carried out with SPSS26.

2.1 Research Hypotheses

The hypotheses of the research are as follows;

H_1: Influencers have a positive effect on consumers' purchasing actions.
H_2: Influencers have a positive effect on trust in social media.
H_3: Trust in social media has a mediating role in the positive effect of influencers on consumers' purchasing actions.

2.2 Research Reliability and Validity

In terms of the reliability of the research, Cronbach's Alpha coefficient for the 39 items tested is 0.915, which is quite reliable. The test result is presented in Table 1.

Table 1. Research reliability

Cronbach's Alpha	Items
0.915	39

KMO and Bartlett test were checked for the validity of the study. The KMO value of the test is 0.901, Bartlett's Test of Sphericity is 5709.280, and p = 0.000. Test results are shown in Table 2.

Table 2. Research validity

KMO and Bartlett Test		
KMO		0.901
Bartlett's Test of Sphericity	Approx. Chi-Square	5709.280
	df	741
	Sig.	0.000

3 RESULTS

3.1 Demographic Findings

Information about the participants is as follows, and Table 3 explains this situation;

- 43.9% are women; 56.1% are male.
- 32.4% are married; 67.6% are single.
- 6.1% primary school; 20.5% secondary school; 23.8% high school; 41.4% have associate degree and bachelor's degree; 8.2% have postgraduate education.
- 25.4% are 18-24; 40.6% are 25-34; 28.7% are between the ages of 35-44 and 45-54%. No one selected the +55 age option, which is another option.
- 12.8% are unemployed; 13.1% are students; 19.8% are private; 21.1% are in the public sector.
- 20.7% is below 11402₺; 30.7% is 11402₺; 25.4% 11403-17500₺; 11.1% is 17501-25000₺; 5.7% have an income of 25001-35000₺ and 6.4% have an income above 35001₺.

Table 3. Demographic characteristics of participants

Variables	Groups	N	%
Gender	Female	107	43.9
	Male	137	56.1
Marital Status	Married	79	32.4
	Single	165	67.6
Age	18-24	62	25.4
	25-34	99	40.6
	35-44	70	28.7
	45-54	13	5.3
Education Level	Primary School	15	6.1
	Secondary School	50	20.5
	High School	58	23.8
	Vocational/ Bachelor's Degree	101	41.4
	Graduate	20	8.2
Occupation	Unemployed	80	12.8
	Student	32	13.1
	Housewife	26	10.7
	Private Sector Employee	24	19.8
	Public Officer	27	21.1
	Merchant	20	8.2
	Retired	16	6.6
	Other	11	7.8
Household Income (₺)	Less than 11402	50	20.7
	11402 (minimum wage)	75	30.7
	11403-17500	62	25.4
	17501-25000	27	11.1
	25001-35000	14	5.7
	35001 and above	16	6.4

3.2 Mean of Dimensions

In order to interpret the mean of the scale dimensions of the research, the following widely used formula was taken into account;

Score Range = (Highest Value-Lowest Value)/Total Value = (6-1)/6= 5/6 = 0.83

Based on this, the 6-point Likert scale ranges are formed as follows, and as seen in Table 4, the mean of all dimensions is within the "Partially Agree: 3.51-4.33" option coded with 4:

1) Strongly Disagree: 1.00-1.83
2) Disagree: 1.84- 2.66
3) Partially Disagree: 2.67-3.50
4) Partially Agree: 3.51-4.33
5) I agree: 4.34-5.17
6) Strongly Agree: 5.18-6.00

Table 4. Mean of dimensions

	Minimum	Maximum	**Mean**	Std. Deviation
Influencers	1.00	6.00	**3.7582**	1.59827
Trust in Social Media	1.00	6.00	**3.6762**	1.56534
Consumers' Purchasing Actions	1.00	6.00	**3.6148**	1.62515

3.3 Hayes' Process Analysis Results

Hayes' Process Analysis Results regarding whether trust in social media has a mediating role in the positive effect of influencers on consumers' purchasing actions are given in Table 5.

Table 5. Regression analysis results in Hayes' process

Independent Variable	Dependent Variable	R	P (R)	β	P (β)	Hypothesis	Decision
Influencers	Consumers' Purchasing Actions	0.648	0.000	0.659	0.000	H_1	✓
	Trust in Social Media	0.753	0.000	0.738	0.000	H_2	✓

*Decision; ✓: Accepted - X: Rejected

As stated in Table 5, the H_1 and H_2 hypotheses of the research are accepted. Table 6 presents the test results of the H_3 hypothesis, and this hypothesis is accepted. Trust in social media partially mediates the positive impact of influencers on consumers' purchasing actions.

Table 6. Mediation results in Hayes' process

Variables	R	P (R)	β	P (β)	Hypothesis	Decision
Influencers	0.664	0.000	0.494	0.000	H_3	✓
Trust in Social Media			0.224	0.004		

Total Effect of Influencers on Purchase Actions						
β	SE	t	p	LLCI	ULCI	R^2
0.659	0.050	13.250	0.000	0.561	0.757	0.648

Direct Effect of Influencers on Purchase Actions						
β	SE	t	p	LLCI	ULCI	R^2
0.494	0.074	6.636	0.000	0.341	0.641	0.486

Indirect Effect of Influencers on Purchase Actions			
β	BootSE	BootLLCI	BootULCI
0.165	0.056	0.060	0.281

*Decision; ✓: Accepted, X: Rejected

4 CONCLUSION

Social media is a very useful tool for brands to achieve their marketing communication goals in accordance with the requirements of the digital age. Influencer; They are people who have active followers and direct their followers, and can influence them thanks to their competence, knowledge transfer, position, recognition (such as fame, fame), and connections. It is very important for brands to provide communication with customers built on trust. Because lost trust can lead to the formation of a cynical consumer group. What needs to be done to prevent this from happening is; It is to supply goods and services that fulfill the promises made to customers, thus meeting or even exceeding customer expectations. Thus, that brand and its products can become an element that can "express value" in the eyes of the customer.

As a result of the testing conducted in the research, it was concluded that trust in social media has a mediating role in the influence of influencers on consumers' purchasing actions. Since the hypotheses of the study are accepted, what brands must fulfill is; It is the process of using influencers who have the ability to influence marketing communications and choosing reliable social media tools and platforms as communication channels. With this aspect of the study, it is thought that it can provide guidance to the sector, brands, influencers and be a source for new research.

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The Effect of Advergame (Game Advertising) Applications on Social Networks on Hedonic Consumption

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Abstract

Today, communication channels have shifted to social networks, which can appeal to larger audiences at the same time and are a more social medium. Since social media allows instant sharing very quickly, it has created the opportunity for people to share all their positive and negative experiences with everyone. While this sharing increases people's freedom of communication and information, it has also become remarkable for businesses. This situation has created a great chance for businesses' brands, products and services to be found remarkable by people, that is, social media visitors, and to become their customers. At this point, the most important point remaining is to design marketing strategies accordingly. For this reason, it is important to find an answer to the question of what the target audience wants among the visitor audience. At this point, offering customers what attracts attention by taking advantage of all the opportunities provided by technology is an important step to differentiate.

While the target audience of young people comes to mind when it comes to games, it has been determined that visitors of all ages are interested, especially in recent years. Because the visitor, who has a pleasant time by finding entertainment along with the game, develops a positive feeling towards the brand's product and service. In our research, what we pursue in terms of marketing; The aim is to determine how this positive emotion directs the consumer to hedonic consumption behaviors through advergame applications that combine games and advertising.

In this context, a semi-experimental study is planned to measure the hedonic consumption effect of the advergame application played on social networks on the players. According to the statistical results obtained from this study, it is predicted that those who play game advertisements will increase hedonic consumption due to the effect of these advertisements.

Keywords: *Advergame, Game advertising, Digital games, Social media, Hedonic consumption*

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The Relationship Between Personal Branding and Leadership Metaphor in Digital Innovation

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Abstract

Digital innovation is to bring innovative solutions in the application of business models and organizational processes of businesses to the digital platform. Information technology-based innovations such as big data, artificial intelligence, electronic information systems and mobile applications are the reasons that drive businesses towards digitalization. Organizations have to produce their own solutions to keep up with the digital age. Therefore, there is a significant need for employees specialized in digital innovation. Since leadership is the activity of the person who carries the organization in achieving organizational goals, digital leadership is leading the organization to achieve digital transformation goals. Digital leaders are the ones who ensure the alignment of organizational processes with information technologies and the interaction of business models and customer requirements. University education programs seem to be an attractive option for both students and employees who want to develop themselves in this field. This study uses the metaphor of leadership to understand digital innovation. Metaphor is the use of other concepts to understand a concept and to try to explain it with similar characteristics. In this study, the metaphors related to leadership metaphor are discussed. In addition, the literature on personal branding is discussed and its connection with leadership theory is examined. The aim of personal branding is to create a positive image and stand out in a competitive environment. Branding is one of the important career stages for those who will lead the digital innovation processes of organizations.

Keywords: *Digital innovation, Leadership metaphor, Personal branding*

1 INTRODUCTION

Today, managing the digitalization phenomenon brought by technology has become a special expertise for organizations. For this reason, organizations carry out digital innovations in order not to lag behind the age and to be in an effort to exist in the competitive market by bringing digital leaders to work [1]. Digital innovation is defined as significant changes in the products, processes or business models of businesses using information technologies and perceived as new [2]. Digital innovation in organizations brings about productivity gains, cost reductions and sustainable innovation. This innovative perception is important in terms of increasing customer satisfaction, renewal in the business processes of the organization and production of high value-added products [3]. In order for organizations to survive in the competitive market, they need to integrate digital innovation into their own structure, and achieving this depends on the presence of digital leaders who have the capacity and equipment to manage this transformation. It is possible to say that personal branding has an important role in this process. Personal branding is a strategy that enables a leader to promote his/her thoughts, vision and mission, in short, to promote himself/herself and gain a positive image [4]. In this context, the study aims to examine the link between leadership metaphor and personal branding in the digital innovation process.

2 MATERIAL AND METHOD

Conceptual analysis technique is used in this study. Accordingly, the study first explains the leadership metaphor with examples and then discusses the role of personal branding in digital innovation leadership.

3 LEADERSHIP METAPHOR

Metaphor is explained with words such as figure of speech, symbol and simile. Metaphor facilitates expression in daily speech, improves the aesthetic aspect in literary works and provides versatility in teaching concepts [5]. In this context, the use of metaphor in explaining leadership is quite common in the literature. Because leadership is

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a concept that needs to be understood with its multifaceted dimensions in accordance with the purpose of using metaphor. In practice, behaviours, interactions, outcomes and social phenomena are associated with leadership. However, different sources approach leadership in different ways. These theories include those that explain leadership in terms of personal characteristics (charismatic, perfect person), those that explain leadership in terms of situational conditions (selecting specific people for specific situations), those that explain leadership in terms of behaviour (actions can be measured and evaluated accordingly), those that explain leadership in terms of probabilities (dealing with the probability between personal characteristics and situational conditions), and those that explain leadership in terms of position and experience (dealing with role attribution by followers) [6]. Leadership can be evaluated in many ways, such as its vision, qualities and ability to bring people together. Associating leadership with metaphors can be used to understand the ways in which each metaphorical concept differs from the others. For example, it is easier to understand how a traffic policeman differs from a clock, a mountain climber or a bridge [7]. When the literature is examined, it is seen that there are explanations and examples related to leadership metaphor by many researchers. These are summarized in Table 1.

Table 1. Leadership metaphors and examples (Source: This table was created by the authors based on the relevant literature)

Source	Concept	Explanation	Metaphor Example
Fennel (1996) [8]	Power router	The leader is not the one who holds the power but the one who directs it in the right direction. The leader transfers power to where it should be directed.	River, steering wheel, shepherd, conductor, erupting volcano
Fennel (1996) [8]	Spiritual caregiver	The leader supports those around him/her. She/He provides an environment for teamwork and helps everyone to fulfill their duties.	Teacher, parent
Mayer-Schoenberger and Oberlechner (2002) [6]	Mobilizer	A leader is a high performer. She/He turns ideas into reality through discipline, strategies and experience.	Warrior, actor, conductor, religious leader, machine operator
Bolman and Deal (2003) [9]	Visionary	Leaders design appropriate responses to changes in the environment, culture or market. They accurately anticipate and respond to developments in the environment.	Architect, lawyer
Mullen et al. (2005) [10]	Able to manage different roles	It enables people in different roles to inform each other. It dominates the nature of the work and ensures cohesion.	Two climbers climbing at the same time, ocean wave, architect and engineer on a construction project
Forest (2007) [11]	Inspiring	A competent leader is someone who has the ability to tell a story convincingly.	Storyteller, writer, orator, speaker
Alvesson and Spicer (2010) [12]	With a distinct personality	Leaders stand out with their personality traits. They have charismatic and transformative characteristics. It is the nature of their personalities to see and develop this potential. They gain charisma by pushing the limits.	Saint, gardener, cyborg, friend, commander, bully
Avidov-Ungar vd. (2022) [13]	Guide and guide	They ensure that the organization completes its journey safely. The digital leader finds creative solutions despite challenges. She/He makes friends easily even in unfamiliar places.	The captain of the ship, the prophet Moses
Avidov-Ungar vd. (2022) [13]	Creative, explorer and seeker	The digital leader is able to do things that others cannot see, dare or connect with. Her/His flexibility allows it to relate to everyone at the right level.	Discoverer of new islands, artist, puzzle maker, space explorer team member, octopus
Avidov-Ungar vd. (2022) [13]	Showing the way and moving forward	A digital leader is someone who sees the organization in a broad perspective. She/He prevents the organization from staying on the road by bringing continuous innovations to the organization. She/He teaches innovations to the organization and applies them together with others.	Drone, lighthouse, motor, first moving wheel of a gear, road signs, dance instructor

When Table 1 is examined, it is seen that leadership is characterized by many concepts such as inspiring, directing power, visionary, mobilizing, guiding and directing, and there are many examples of metaphors related to leadership. Some of them are shepherd, teacher, conductor, architect, ship captain, commander, octopus, lighthouse, gardener, volcano, parent, artist, dance instructor and actor.

4 THE ROLE OF PERSONAL BRANDING IN DIGITAL INNOVATION LEADERSHIP

The share of the internet economy, which covers electronic commercial transactions, has an important place in the general economy. It is important for organizations to adapt to new technologies in the development of the Internet economy. Managers have a great role in the adaptation of new technologies to their managerial processes. Managers can overcome the resistance of employees to new technologies in the organization with their leadership qualities. New technologies are not only simple systems such as e-mail systems or messages. They are also complex systems such as knowledge management systems, management information systems, customer relationship management prompts and supply chain management systems [14]. Digital leadership helps organizations transform their traditional processes by providing digital solutions and leads with its capabilities. The most important feature of digital leadership that distinguishes it from traditional leadership is to ensure that the organization understands new technologies and is more collaborative [15]. Another role of digital leadership is the need to deal with the new challenges that come with digitalization. Information security and protection of personal data is one of the challenges that leaders need to overcome [16]. At the same time, teamwork in an online environment without going to work and without geographical boundaries also makes the virtual leadership role relevant. In virtual leadership, there are differences such as the ability to bring experts to teamwork without any boundaries, the reduction of hierarchical authority between employees and managers, and the closer cooperation of employees with leaders [17].

A trademark is a name, term, design or symbol used to distinguish goods or services from others. In this context, personal branding is a practice that enables individuals to distinguish themselves from others. Personal branding is the design and creation of one's image, influence and impressions of oneself to one's followers [18]. Personal branding enables leaders to gain global prestige and power, to stand out within the organization, to have a psychological impact on the business world or the community within their sphere of influence, and to increase their recognition [19]. In addition, leaders with a digital leadership brand image influence employees' digital innovation performance. Therefore, there is a significant and positive relationship between leadership style and innovative work in organizations using digital technology [20]. In this context, it is possible to ensure digital innovation in organizations with leadership behaviours in this direction [21]. Based on the related literature, a model in Figure 1 can be drawn showing the relationships between digital leadership, personal branding and digital innovation

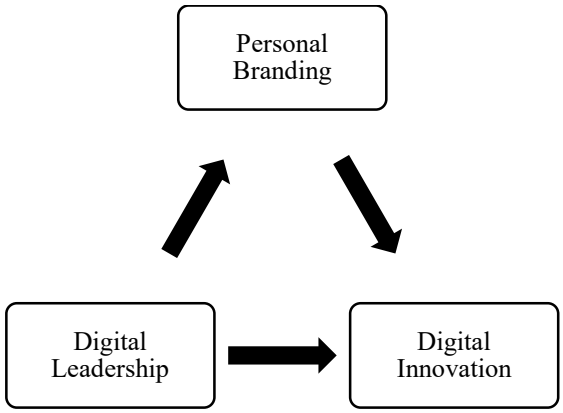

Figure 1. Digital leadership, personal branding and digital innovation model (Source: Created by the authors based on the relevant literature)

According to the model in Figure 1, it is predicted that digital leaders can increase digital innovation performance in organizations through personal branding. Because digital innovation requires an effective leadership behaviour [22]. For an effective leadership behaviour, it can be said that an effective strategy such as personal branding is needed. However, leadership metaphor can be utilized in the process of implementing personal branding strategy.

5 CONCLUSION

Leadership is the activity of the person who leads the organization in the process of achieving organizational goals. Digital leadership is leading the organization to achieve digital transformation goals. In order for organizations to adapt to the digital age, digital innovation should be given importance and encouraged in organizations. For this, effective digital leaders are needed. In this study, the relationship between leadership metaphor and personal branding in the digital innovation process was examined conceptually. As a result of the analysis, a model was developed based on the relevant literature. The model shows that digital leaders can increase digital innovation performance in organizations through personal branding. By making leadership more effective through personal branding, digital innovation in the organization can be brought to higher levels. In this context, it is possible to say that personal branding is a mediating variable in the relationship between digital leadership and digital innovation. As a result, it can be said that this theoretically developed model should be supported by an empirical study. For this reason, it is important to conduct a research in line with this model in future studies.

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Transition to the Circular Economy in the European Union: Is It Really Ready?

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Abstract

In recent years, the transition to a circular economy has shaped the EU policies and has also become a focal point of them. The EU offers a variety of funding programs to achieve the goals related to the circular economy. Therefore, the purpose of the study is to determine the relative circular economy performances of the EU countries. Hence, this will detect whether they are ready to the transition to a circular economy and show similarities with each other in terms of circular economy performance. The analysis was conducted for the EU-27 countries and included a total of 19 variables existing in the Eurostat database. In the study, the Ward's method, which is one of the hierarchical clustering analyses, was employed to determine the circular economy performance of the EU countries. Considering the distribution of countries according to clusters, the results show that the countries are not clustered in line with their level of economic development. In Cluster 1, Finland and Sweden, which are among the advanced economies of the EU, are located together with countries whose development level is relatively below the EU average. However, we cannot draw the same conclusions for Cluster 2 and Cluster 3. The reason for this is that the countries in these two clusters have exhibited a clustering tendency parallel to their economic development levels. In sum, the results of the statistical analysis show that the EU countries have three different levels of development in terms of the circular economy.

Keywords: *Circular economy, European union, Cluster analysis, Ward's method*

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Notes Concerning 2x2 Type Quaternion Matrices

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Abstract

Quaternions, which consist of quadruple components, attract attention with their unique equations and the fact that they do not provide many algebraic properties existing in mathematics. Again, in engineering science, it is more useful to work with matrices whose components are quaternions, especially in high-dimensional matrices. In this context, in the first part of this study, the quaternion field consisting of $q = a + bi + cj + dk;\ a,b,c,d \in \mathbb{R}$ and $i^2 = j^2 = k^2 = -1,\ ijk = -1$ shaped quadruple components were defined and information about its important properties was given. In the second part, matrices whose elements consist of quaternions are defined and their general properties are given. In the last part, which is the purpose of the study, unitary and orthogonal quaternion matrix forms of 2x2 type matrices obtained from quaternions were investigated.

Keywords: *Quaternions, Quaternionic matrices, Mathematic, Engineering*

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Digital Entrepreneurship Training: E-Learning Platforms and Training Programs for University Students

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Abstract

Today, the digital economy has become an important part of business life. Especially in the 2000s, developments accelerated the development of the digital economy. Social media has adapted digital-based communication to social life at a dazzling speed. People develop their relationships by sharing their pictures, photographs and writings in cyberspace. On the other hand, multilateral electronic commerce platforms have enabled new business models to become operational in retailing. New ones such as O2O, Clicks and Morter, OmniChannel have been added to the known B2B, B2C, C2C business models. In addition, the market for digital products that can only be held in the virtual environment in the form of software, code and data has become a serious industry. The industrialization triggered by the sale of music tracks through the Apple Store is now evolving into giant companies such as Netflix, Spotify and Microsoft that sell only digital products. Young people are the biggest entrepreneurs of the digital economy, especially since they need to be able to use technology well. Other incentives are that the digital economy offers young entrepreneurs the opportunity to grow very fast, high profitability and the ability to do more with less infrastructure. Although the digital economy offers opportunities for young entrepreneurs, the number of successful ventures can be increased with the right training. For this reason, the number of training programs for university students is relatively high compared to other segments of society, both to encourage young entrepreneurs and to increase their success rates. This study examines training programs, courses, learning platforms, consultancies and government support programs on digital entrepreneurship. Content analyses of these programs are conducted and evaluations are made by comparing the support services they offer to young entrepreneurs.

Keywords: *Digital entrepreneurship, E-learning, E-training, University students*

1 INTRODUCTION

Entrepreneurship is one of the most important building blocks of a country's economy and young entrepreneurs need to be encouraged and supported in terms of economic growth, development, employment and development. For this reason, it is of great importance that young people are subjected to entrepreneurship training in order to bring them into the business world as entrepreneurs [1]. Entrepreneurship training is a unique concept for the development of entrepreneurial attitudes and skills along with personal development and training to support new ventures rather than directly creating new ventures. Entrepreneurship training includes explaining the factual essence of entrepreneurship to those who receive entrepreneurship-related training and providing personal development and professional orientation. Entrepreneurship teaching, on the other hand, involves transferring knowledge about the types and dimensions of entrepreneurship. However, entrepreneurship programs should include both training and training concepts [2]. The aim of entrepreneurship training is to change students' thinking about innovative and risky business activities [3]. Digital entrepreneurship training is a new approach to entrepreneurship training that aims to prepare students for technological changes in the digital transformation process [4].

The purpose of this study is to examine training programs, courses, learning platforms, consultancies and government-sponsored programs related to digital entrepreneurship.

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2 MATERIAL AND METHOD

In line with the purpose of the study, content analysis technique was used in the research. In this context, the study first provides information about digital entrepreneurship training, then the digital entrepreneurship trainings/courses of the institutions are presented in the form of tables and explanations are made.

3 DIGITAL ENTREPRENEURSHIP TRAINING

Digital entrepreneurship training is a training model that intensively includes case studies of successful entrepreneurs due to its experience-based learning approach [3]. The focus of the training is to increase awareness and consciousness about digital entrepreneurship as a career choice. With these entrepreneurship trainings in the programs of universities, it is aimed that graduates not only learn a job but also contribute to employment by establishing new businesses [4]. On the other hand, entrepreneurship courses are also organized to teach basic skills. In a normal entrepreneurship course, skills such as decision-making, leadership, motivation, interpersonal relationship management are offered. In digital entrepreneurship training, digital skills such as social media marketing and content marketing gain importance [5]. In addition, entrepreneurial intuition and social media usage increase digital entrepreneurship in these trainings [6]. Jardim [7] lists the skills that digital entrepreneurs should have in the era of globalization and digital transformation as *"creativity and innovation, initiative, self-efficacy and resilience, strategic planning and evaluation, problem solving, transformational leadership, clear and visual communication, teamwork, networking and digital communication."*

In addition to the development of attitudes and skills, environmental factors should also be taken into account in the preparation of digital entrepreneurship program content. In this context, environmental challenges related to entrepreneurship training include cultural differences, adaptation to digital technologies, teaching new skills according to different work trends, new lifestyles intertwined with technology and the use of critical thinking skills [3]. The performance of entrepreneurship training is influenced by the digital economy (economic development index), entrepreneurship course (training content), entrepreneurial trainer (quality of trainer), entrepreneurial competition (professionalism of projects), entrepreneurial practice (practice environment), entrepreneurial policy (incentives and supports) [8]. Lubis [9] lists the issues to be considered for university students to be successful in digital entrepreneurship as follows:

- Digital infrastructure (internet, technological devices, etc.) is affordable, reliable and highly fast,
- Effective university-industry cooperation,
- Increasing local and regional cooperation,
- Providing R&D grants and support for student projects,
- Creating crowdfunding for student initiatives,
- Providing incentives such as tax breaks for student initiatives,
- Raising awareness among students about new technologies and business models.

4 DIGITAL ENTREPRENEURSHIP TRAINING PLATFORMS

The number of digital entrepreneurship training platforms has increased, especially during the COVID-19 pandemic. Massive online courses (MOOCs) are among the most popular online systems for open access learning and teaching in the digital environment. Some MOOCs are free while others are paid. MOOCs are distance learning and open training resource platforms mostly developed by universities. Leading universities such as Stanford and MIT, but also companies such as Microsoft and Accenture have online platforms. Popular MOOC platforms include edX, Coursera and Udacity. Even online master programs are organized on these platforms [10]. Table 1 shows the digital entrepreneurship courses in the world.

When Table 1 is examined, it is seen that a large number of entrepreneurship courses of minimum 4 weeks and maximum 8 months are organized by many institutions in the world. It is understood that most of these courses are offered by universities.

Table 1. Digital entrepreneurship courses in the world [11]

Name of Institution	Name of Course	Duration
Babson	The Entrepreneurial Mindset	6 weeks
Babson	Entrepreneurial Operations: Launching a Startup	4 weeks
Babson	Business Principles and Entrepreneurial Thought	7 months
Berkeley	Entrepreneurship for All (Part I): The UC Berkeley Startup Guide for students by Silicon Valley Insiders	6 weeks
Berkeley	Entrepreneurship for All (Part II): The UC Berkeley Startup Guide for students by Silicon Valley Insiders	8 weeks
Berkeley	The Silicon Valley Insiders' Guide to Entrepreneurship: Launch, Fund, Scale Your Startup.	4 months
Berklee	Creativity & Entrepreneurship	4 weeks
Curtin	Disciplined Approach to Social Entrepreneurship	7 weeks
Davidson	Building A Lean Startup	4 weeks
Delft	Entrepreneurship for Engineers	8 weeks
Delft	Entrepreneurship for Global Challenges in Emerging Markets	6 weeks
Harvard	Entrepreneurship in Emerging Economies	6 weeks
Harvard	Technology Entrepreneurship: Lab to Market	5 weeks
Harvard	Food Systems Live!: Entrepreneurship in Emerging Economies	9 weeks
IIMB	Develop, Organize and Manage Your Own Business	8 ay
IIMB	Do Your Venture: Entrepreneurship for Everyone	6 weeks
IsraelX	Introduction to Innovation and Entrepreneurship	13 weeks
KAUST	Entrepreneurship Adventure	10 weeks
Maryland	Financing Innovative Ventures	4 weeks
Maryland	Innovation and Entrepreneurship	4 ay
MIT	Becoming an Entrepreneur	6 weeks
MIT	Entrepreneurship 101: Quién Es Tu Cliente?	8 weeks
MIT	Entrepreneurship 102: Qué Puedes Hacer Por Tu Cliente?	6 weeks
MIT	Cultivating Entrepreneurship and Antifragility to Thrive in A Fast-Paced World	4 weeks
Seakademie	Social Entrepreneurship-Von Der Idee Zur Umsetzung	12 weeks
TecdeMonterrey	Fundamentals of Entrepreneurship in the Family Business	5 weeks
TecdeMonterrey	Corporate Entrepreneurship	4 weeks
TecdeMonterrey	Innovation and Entrepreneurship	7 months
TecdeMonterrey	Family Businesses: Entrepreneurship and Leadership to Transcend	3 months
TecdeMonterrey	Entrepreneurial Mindset	4 weeks
The Hong Kong Polytechnic	Product Design for Entrepreneurship	8 weeks
UPValencia	Boosting Innovation and Entrepreneurship in the Food Sector	4 weeks

Table 2 shows the entrepreneurship training platforms and trainings of the institutions that can be accessed online in Turkey.

Table 2. Entrepreneurship training programs in Turkey (Source: Created by the authors)

Name of Institution-Training Platform	Name of Training Program	Duration
Anadolu University- Akadema	Starting Entrepreneurship	5 courses
Ataturk University- Atademix	-	-
Istanbul University Graduate School of Business - Iienstitu	Digital Entrepreneurship Training	5 courses
KOSGEB-e-Academy	New Entrepreneur Program -Traditional Entrepreneurship Training -Advanced Entrepreneurship Training	3 months
Middle East Technical University Bilgeiş	Entrepreneurial Women with Information	10 modules
The Banks Association of Türkiye-Finance and Banking Training Portal	Entrepreneurship Video Trainings	Indefinite
Yeditepe Universty, Istanbul Technical University Bogazici University-Universiteplus	Entrepreneurship and Leadership Training	3 courses

When Table 2 is examined, it is seen that entrepreneurship training programs are organized by a small number of institutions in Türkiye, but most of them are carried out by universities. On the other hand, it is understood that some institutions such as Atatürk University do not organize entrepreneurship training programs although they have e-learning platforms.

5 EVALUATION AND CONCLUSION

Digital entrepreneurship is the realization of entrepreneurial activities in virtual environments such as the internet. Digital entrepreneurship, also called internet entrepreneurship or e-entrepreneurship, ensures customer satisfaction by offering advantages such as flexibility, speed, price and quality. Therefore, digital entrepreneurship, which is a new type of entrepreneurship, is a tool for producers to earn money by offering their products to customers easily and is one of the most preferred types of entrepreneurship today [12]. For this reason, it is important to educate young people about digital entrepreneurship, and it is of great importance to organize training programs on digital entrepreneurship during the university training process, which has an important role in the training lives of young people. Because there is a need for training centers that will provide consultancy and training services to students who want to become entrepreneurs in the digital transformation process [13]. In this study, digital entrepreneurship training programs of institutions for university students were examined. It was determined that entrepreneurship training programs are organized by many institutions such as TecdeMonterrey, Babson, Berkeley, Harvard and MIT in the world. In Turkey, few institutions have entrepreneurship training programs, some of them (Anadolu University, Boğaziçi University, KOSGEB, The Banks Association of Türkiye, etc.) focus on general entrepreneurship training, while others (Middle East Technical University and Istanbul University) focus on digital entrepreneurship training. On the other hand, some institutions (Atatürk University) do not have entrepreneurship training programs despite having e-learning platforms. As a result, it can be said that e-learning platforms are needed in teaching digital entrepreneurship to university students, the number of platforms should be increased and it is important for universities to be pioneers in this regard.

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The Effect of the Freudian Subconscious on Purchasing Behavior towards Materialistic Values

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Abstract

The concept of the subconscious developed with the pioneering of Sigmund Freud and became a widely used theme in behavioral sciences such as psychology and psychoanalysis. The subconscious consists of a number of psychological effects that have been dragged out of the field of consciousness and have the possibility of constantly reappearing. The subconscious literally describes the inaccessible parts of the psychological universe of all people. This study was conducted on the effect of the Freudian subconscious on materialist values and it was conducted to reveal the degree to which consumers are affected by Freudian Subconscious attitudes during their behavior towards the effect of materialist values at the point of purchase. The study was conducted on Bayburt University students using the online survey method. The data obtained from the research were analyzed with the SPSS 26 package program. According to the research results; of the 12 hypotheses established, 9 were accepted and 3 were rejected. Among the independent variables among the hypotheses accepted in the study, the dimension of "Unplanned Purchasing" had the highest effect on the dimension of "Centrality", one of the dependent variables; It was found that the "Purchasing Wisdom" dimension had the least effect on the "Happiness" dimension.

Keywords: *Freudian subconscious, Materialist values, Consumer behavior*

1 INTRODUCTION

Rational purchasing motivations are based on rational criteria or evaluation of a situation. It is compared to emotional purchasing motivations that are based on emotions. Nowadays, as the consumption culture changes, the shopping behavior of consumers also changes [1]. Nowadays, people consume to satisfy their emotions as well as their material needs [2]. In other words, consumers make purchases, which are referred to as unplanned purchases, for reasons such as bad mood, pleasure, and identity formation [3]. Psychological factors such as perception, attitude, motivation and personality that affect consumers' purchasing behavior need to be investigated. Impulsive buying, one of these psychological factors, is a purchasing process that consumers do not need but cannot resist [4]. At this point, individuals cannot act wisely in their purchasing decisions. Purchasing wisdom is a cognitive issue and is about thoughts and questions about the purchases made. It is also when a person realizes during or after the purchasing process that the consumer does not need the product or may not have chosen the appropriate one [5].

Today, many theories discuss the materialist tendency, which is considered a common concept in psychology and sociology. When the common points of these theories are considered, three elements that form the basis of the materialist tendency stand out: Centrality, happiness and success [6]. An individual's tendency towards money and purchasing material goods is known as materialism. Materialists measure themselves and others by what they have and believe that they can find happiness and joy by consuming expensive goods [7].

With the current study, it was tried to understand the Purchasing Behavior of Bayburt University students regarding both the Freudian Subconscious and Materialist Values, and the Effect of the Freudian Subconscious on the Purchasing Behavior towards Materialist Values. In this respect, the research will be able to contribute to the literature as a source for new research to the scientific community examining the relationship between unconscious attitudes and materialistic behavior.

2 MATERIAL AND METHOD

2.1 Purpose of the Research

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The aim of the study is to see the effect of the Freudian subconscious on purchasing behavior towards materialist values consisting of success, happiness and centrality dimensions. The study is carried out on Bayburt University students. Accordingly, a survey form was prepared in the study and applied to 221 people via www.surveey.com.

2.2 Research Hypotheses

The hypotheses of the study were determined as follows;

H_1: Rational Purchasing dimension has an effect on the Achievement dimension.
H_2: Impulsive Buying dimension has an effect on the Achievement dimension.
H_3: Purchasing Wisdom dimension has an effect on the Success dimension.
H_4: The dimension of Inability to Resist Purchasing has an effect on the Success dimension.
H_5: Rational Purchasing dimension has an effect on the Centrality dimension.
H_6: Unplanned Purchasing dimension has an effect on the Centrality dimension.
H_7: Purchasing Wisdom dimension has an effect on the Centrality dimension.
H_8: The dimension of Inability to Resist Acquisition has an effect on the Centrality dimension.
H_9: Rational Purchasing dimension has an effect on the Happiness dimension.
H_{10}: Impulsive Buying dimension has an effect on the Happiness dimension.
H_{11}: Purchasing Wisdom dimension has an effect on the Happiness dimension.
H_{12}: The dimension of Inability to Resist Purchasing has an effect on the Happiness dimension.

2.3 Research Reliability

The reliability analysis of the scales in the study was tested and the Cronbach Alpha coefficient was examined. As a result of the reliability analysis regarding the Freudian Subconscious, the Cronbach's Alpha Coefficient of the scale was calculated as = 0.611 and Cronbach's Alpha Coefficient of the Materialist Values scale was found to be = 0.615. The test result is presented in Table 1.

Table 1. Research reliability

Scale	Cronbach's Alpha	Items
Freudian Subconscious	0.611	20
Materialist Values	0.615	18

2.4 Research Validity

The KMO value for the "Freudian Subconscious" scale was 0.822; for the "Materialist Values" scale, the KMO value was 0.700. In this test, p: 0.000 and it is significant for both scales.

Table 2. Research validity

Scale	KMO	p
Freudian Subconscious	0.822	0.000
Materialist Values	0.700	0.000

As a result of the evaluation of 20 scale items regarding the Freudian Subconscious scale, 4 factors were formed. These 4 factors explain 53.555% of the total variance. Three factors were formed regarding the Materialist Values scale. These 3 factors constitute 58.433% of the total variance.

Factors related to the Freudian Subconscious scale are;

- Rational Purchasing
- Unplanned Purchasing
- Purchasing Wisdom
- Inability to Resist Purchasing

Factors related to the Materialist Values scale are;

- Success
- Centrality
- Happiness

3 RESULTS

3.1 Demographic Characteristics of the Sample

Findings on the demographic characteristics of the participants are given in Table 3. As seen in Table 3, the findings regarding the sample are as follows;

- Considering the age distribution of the participants in the research, 11.2% is the ages of +24, 76.1% is between the ages of 21-24, and 12.7% is between the ages of 17-20.
- Considering the gender distribution; 48.4% are men and 51.6% are women.
- Considering marital status; 6.3% are married, 93.7% are single.
- Considering the educational status; It was determined that 33% had a vocational school, 62.4% had a bachelor's degree, and 4.6% had a graduate degree.

Table 3. Demographic characteristics

Variables	Groups	N	%
Age	17-20	28	12.7
	21-24	168	76.1
	+24	25	11.2
Gender	Female	114	51.6
	Male	107	48.4
Marital Status	Married	14	6.3
	Single	207	93.7
Education	Vocational School	73	33
	Bachelor's Degree	138	62.4
	Graduate Degree	10	4.6

3.2 Simple Linear Regression Analysis

Simple linear regression analysis was used to test the hypotheses established for the research. The 12 hypotheses presented here as the hypotheses of the research will be tested with regression testing. There are 4 independent variables and 3 dependent variables in the research, and 12 basic models were created based on this. The test results are presented in Table 4.

Table 4. Regression analysis results

Model	Independent Variable	Dependent Variable	R	F	P (R)	ß	T	P (ß)
1	Rational Purchasing	Success	0,315	22,280	0,000	0,304	4,720	0,000
2	Unplanned Purchasing		0,152	5,158	0,002	0,227	2,271	0,004
3	Purchasing Wisdom		0,063	0,862	0,213	0,087	0,928	**0,354**
4	Inability to Resist Purchasing		0,211	10,209	0,000	0,261	3,195	0,000
5	Rational Purchasing	Centrality	0,264	15,867	0,000	0,260	3,983	0,002
6	Unplanned Purchasing		0,252	14,835	0,000	0,426	3,852	0,000
7	Purchasing Wisdom		0,052	0,585	0,324	0,052	0,765	**0,445**
8	Inability to Resist Purchasing		0,247	14,182	0,000	0,344	3,766	0,000
9	Rational Purchasing	Happiness	0,364	33,376	0,000	0,372	8,935	0,000
10	Unplanned Purchasing		0,069	1,740	0,188	0,089	1,319	**0,123**
11	Purchasing Wisdom		0,164	6,064	0,000	0,169	2,463	0,015
12	Inability to Resist Purchasing		0,128	8,371	0,014	0,171	1,836	0,014

When Table 3 is examined; it is seen that the independent variables do not have any effect on the dependent variables for model 3, model 7 and model 10. However, it is found that there is an effect in the other 9 models. The results regarding whether the research hypotheses are supported or not are presented in Table 5. As seen in Table 5, 9 of the 12 hypotheses are accepted and 3 are rejected.

Table 5. Results related to the hypotheses of the research

Hypothesis	Result
H_1	👍
H_2	👍
H_3	👎
H_4	👍
H_5	👍
H_6	👍
H_7	👎
H_8	👍
H_9	👍
H_{10}	👎
H_{11}	👍
H_{12}	👍

👍: Supported, 👎: Not supported

4 CONCLUSION

The subject of this article is the Effect of the Freudian Subconscious on Consumer Behavior towards Materialist Values. The survey on Freudian approach and Materialist Values was conducted for Bayburt University students. Customers face many purchasing emotions and compare alternatives when or before purchasing a product. This situation is more related to the subconscious. Another purchasing emotion is when an individual buys something in order to show that person to have a certain position or status. This situation is explained by materialist values. The Freudian approach is the reflection of the teachings of Sigmund Freud, the neurologist and founder of psychoanalysis, in marketing science. In marketing studies implemented in line with the Freudian approach, a number of messages are sent that will activate the subconscious (unconscious), the repressed part of the human mind, and the consumer's purchasing behavior is tried to be controlled. With the current study, it was tried to understand the Purchasing Behavior of Bayburt University students regarding both the Freudian Subconscious and Materialist Values, and the Effect of the Freudian Subconscious on the Purchasing Behavior towards Materialist Values. In the study, findings for 221 participants were presented and the survey is still ongoing. It is thought that the results of the research can make important contributions to the literature.

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Postmodern Language and Discourse: The Example of Ekşi Sözlük

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Abstract

People use language to communicate with those around them and to express themselves. Communication becomes more efficient with the correct and effective use of language. While the concept of living together is strengthened thanks to language, cultural exchange is also carried out. While language is expressed through a number of indicators, it also becomes effective when used in a context, and thus an evaluation is made by the recipients regarding the situation in which it is expressed. The use of language is carried out through the discourse dimension. In its simplest form, discourse shows how the language is conveyed and with what style of expression. The concept of language and discourse has transformed from past to present. In this context, when evaluating the understanding of language and discourse in the period of modernism and postmodernism, it is seen that the perspective has changed because these two processes are different. While the modern period mainly creates a limited and formal structure, there are evaluations that there are no borders and a freer form of discourse has developed in the postmodern period. Although it is criticized in various ways, there are studies showing that postmodern discourse also contains a different perspective within itself.

Keywords: *Postmodern language, Postmodern discourse, Ekşi Sözlük*

1 INTRODUCTION

Language in the Turkish Language Association Dictionary; "Language is the agreement people make with words or signs to communicate what they think and hear." It is defined as [1]. As can be understood from here, language is how people communicate and express themselves with certain signs and words. Apart from creating cultural and social unity, it is not possible to communicate between people without using language. Language is a tool through which culture, knowledge and sharing are carried. Because, according to Vardar [2], the main function of language is to communicate between people and socialize the individual.

When individuals use language, they develop a way of saying things in a context, that is, in relation to the subject they express. With this concept called discourse, individuals convey to their environment through their own cultural structures, perspectives and the form of expression they create. When viewed in this context, people organize and shape all their actions within a discourse. Therefore, discourse expresses a phenomenon that permeates every aspect of life [3].

Since language is a structure consisting of signs and discourse is the way expressions are uttered, it can be said that it is highly affected by the social structure or, when viewed from the opposite perspective, changes society. From this point of view, it can be accepted as a natural situation that with the development and transformation of society and the development of technology, the language and discourse characteristics of individuals also change. "Every discourse has an ideology, and every ideology has a discourse. (Discourse) is the struggle to determine social meanings" [3]. Accordingly, for example, it can be said that the language and discourse used in the 19th and 20th centuries were influenced by modernism and the structural characteristics of that day, and that, starting from the last quarter of the 20th century, it entered a process of evolution according to the characteristics of the period called the postmodern period.

1.1 Language and Discourse Features of the Postmodernist Era

Language and Discourse Characteristics of the Postmodernist Period Modernism "refers to a process of breaking away from tradition and embodying a form of thought and behavior that involves the subordination of the old to the new, and prioritizing rationality, functionality and reason (rationality) while affirming and accepting the new in every field" [4]. However, the negativities experienced in the social sphere have led to the basic principles of

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modernism being opened to discussion. Thus, the belief in rationalism was shaken and the philosophy of modernism began to be discussed.

Postmodernism emerged as a reaction to the criticism of modernism. This criticism and reaction has developed as a radical opposition in almost every field, from cultural to science. In this context, according to [5] evaluation, postmodernism "first started to be used among artists and critics in New York in the 1960s, and then moved to Europe in the 1970s and was developed by European theorists". Thus, postmodernism has shown its influence in all social areas, from architecture to music, from music to literature, from science to philosophy, as well as in the field of language.

At this point, it is possible to determine some points regarding the change in language and discourse features between modernism and postmodernism as follows [4].

While form is important in modernism, formlessness, distinctiveness and openness come to the fore in postmodernism. In modernism there is hierarchy and order, in postmodernism there is anarchy and chaos. While semantics comes to the fore in modernism, rhetoric (beautiful speech, art of words) comes to the fore in postmodernism. In modernism, general (main) language features are at the forefront, while in postmodernism, individual language (a language structure specific to the individual) is at the forefront. In modernism, images and objects are meaningful, while in postmodernism, the meanings attributed to images and objects are taken into consideration. While narrative narrative is valid in modernism, it is assumed that grand narratives have come to an end in postmodernism. While in modernism there is certainty in all areas, including language and discourse, in postmodernism uncertainty prevails.

In the light of these evaluations, it is possible to say that postmodern language and discourse have changed and transformed according to the modernism period. Because the postmodern period also points to the development of technology and the formation of a society described as a network society. Castells' (2013) characterization of postmodern society as a "network society" indicates that with the development of technology, especially information technologies, the internet environment is rapidly changing the direction of humanity [6]. In Castells' seminal work, the postmodern period as the information age; It has been discussed in detail as the rise of the network society in the context of economy, society and culture.

The rapidly rising network society with the development of computer technology in the postmodern period has also been a factor in the transformation of language. In this context, Ekşi Sözlük, which publishes in the digital environment, can be given as an example reflecting postmodern language and discourse.

1.2 Ekşi Sözlük as a Postmodern Communication Tool

Ekşi Sözlük, a platform that is especially popular among university students, was created by Sedat Kapanoğlu in 1999. The slogan of the site is "sacred source of information". In 2017, Ekşi Mobile application started to be used on phones. As of 2020, dictionary authors can add up to 10 images to the entries they enter [7].

When we look at the Turkish language used in Ekşi Sözlük, it is seen that the writers can use letters inspired by English and even letters that are not used in the Turkish writing language on the English keyboard. In this context, it can be said that this platform, which the young generation is interested in, displays features such as uncertainty, comfort, the end of grand narratives, and intertextuality in postmodern language and discourse.

When the concept of "discourse" is searched in Ekşi Sözlük, the expressions seen on the page are as follows:

"which does not consist of words, style, or manner of speaking; Perhaps it is the sum of all the words spoken in a certain style, their connotations and meanings, what they said and did not say, the genealogy of each word and all its relatives, the dowry chest and the photo albums.

And your clothes, your notebooks... your words.

"serendipity"

"eng. discourse

purplehaze

“Not every word that comes out of your mouth is equal. (see: saying a discourse)

“serendipity”

“It is a system of producing information that is controlled within certain restrictions.

hemingway

“saying, pronunciation

“keri”

It refers to all the ways and possibilities that operate through processes related to the production of the text*, its circulation, and its reception by people*, necessary for the language to convey the meaning (especially the ideology) at the conscious or subconscious level.

“poturgilinpotur”

“The concept that Foucault uses frequently and very complexly to understand the power-knowledge relationship. Discourse, Foucault's primary unit of analysis, can most appropriately be understood as a system of possibilities for knowledge.

astrocracy”

“A set of linguistic equivalents of realities that, when parodied, can create a veiled fascistic tone with the concern of going beyond the codes of "distributed-acquired social roles" that it may cause in the individual.

drunk”

As can be seen from the quotes above, it is seen that individuals express themselves with fewer words and abbreviations, which is one of the main features of today’s social media platforms, thus causing the language-thought relationship to fall into very weak points. In addition, it is noteworthy that since the use of English keyboards is common among young people, the letter “ü”, which does not exist in English on such platforms, is given with the letter “u” in some quotations. It should be underlined that the authors also created a unique pseudonym and were able to write with this freedom. It is also possible to see an example of intertextuality in the second quote (see: saying discourse).

2 RESULTS

The concept of postmodernism, which was put forward as a reaction to modernism, is based on the assumption that there was a “libertarian” period in which irregularities, uncertainties and ambiguity were prioritized. The phenomenon of postmodernism affects culture and language and discourse, which are the basic elements that make up culture, as well as in every area of society. In this sense, the basis of the significant transformation lies in the developments in communication technology.

With the rise of the network society, the introduction of new communication tools plays an important role in this change and transformation. However, it should be considered natural that postmodernism, which was put forward with criticisms about the rational perspective of modernism and the orderly use of everything, was also subjected to negative criticism in the context of language and discourse, as in many areas. As examined in this study, it is seen that digital platforms such as Ekşi Sözlük not only display a free perspective to writers and readers, but also cause significant misuse of language, which is the cornerstone of culture.

3 CONCLUSION

It seems inevitable that Ekşi Sözlük type platforms, where it is assumed that free discourses take place, should be rethought in terms of the use of Turkish, sourceless information flow, and environments where almost everyone can enter data as they wish, and therefore postmodern language and discourse should be discussed in detail.

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Measuring the Industry 4.0 Awareness Level of Students in the Field of Engineering and Information Systems

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Abstract

Within the scope of this study, an Industry 4.0 awareness survey was applied to students in the field of engineering and information systems at a university in Turkey, and the Industry 4.0 awareness levels of these students were tried to be determined by examining the survey results. The number of students participating in the survey is 271. SPSS program was used to interpret the survey results. As a result of the analysis, it was seen that the data showed a normal distribution. It was observed that the Industry 4.0 awareness levels of the students who participated in the research were below the medium level. T-test and ANOVA analysis were performed on demographic questions. Kaiser-Meyer-Olkin (KMO) test, Bartlett's Test and Cronbach's Alpha test were applied to the awareness scale.

Keywords: *Industry 4.0, SPSS, ANOVA*

1 INTRODUCTION

Industry 4.0 is a constantly developed technology tool to provide production and marketing services to businesses focused on efficiency, effectiveness, speed, flexibility, cost and satisfaction. It is aimed to obtain the best and quality products by establishing a connection between Industry 4.0 and production processes, obtaining information from the previous stage, establishing communication and ensuring continuity. The term Industry 4.0 was used for the first time at the Hannover Fair [1]. Industry 4.0 plays a very important role in the globalizing world. In addition to providing instant communication all over the world, countries should use Industry 4.0 at the highest level for security, software, production, transportation, fast and flexible response to customer requests, and ensuring competition. Countries that use Industry 4.0 effectively have the authority to reverse the situation in the world. The usage areas of Industry 4.0 are quite wide. Some concepts within the framework of Industry 4.0 are autonomous vehicles, cyber security, simulation technologies, horizontal and vertical system integration, internet of things, cloud computing, 3D printers and augmented reality. Industry 4.0 is used in many areas such as medicine, military and civil space and aviation technologies, textile applications, construction and architectural technologies, and education.

2 INDUSTRY 4.0

2.1 Industrial Revolutions

The first industrial revolution started with the invention of the steam engine in 1712. Weaving looms were also built in the same century. After these great revolutions, mechanical production was started with the construction of railways and the help of steam machines. As small workshops were replaced by factories, easier and faster production began. In the second industrial revolution, mass production was started by integrating electricity into production at the end of the 19th century. The second industrial revolution began with the use of electrical systems in the Ford Motor factory. Thanks to mass production, Ford Motor increased production volume and reduced costs and prices. The second industrial revolution is also called Fordism-Ford Age. The third industrial revolution began to emerge in 1968 with programmable machines developed in the light of scientific knowledge. With the use of computers in the production stage, the need for labour force has decreased. Industry 4.0, expressed as the Fourth Industrial Revolution, ensures that production is carried out in the most effective, flexible, high-quality and fast way, thanks to the smart factories approach [2].

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2.2 Fundamentals of Industry 4.0

The main features of Industry 4.0 can be listed as follows [1]:

- Interoperability: Smart factories work interconnectedly by communicating with people.
- Virtualization: Copying the data of the smart factory and meeting customer needs by using simulation models with sensor data.
- Decentralization: Switching to production with 3D printing technologies, with cyber-physical systems being able to make their own decisions.
- Real-Time Capability: It means instantly eliminating errors that may occur by collecting data and performing analysis instantly.
- Platform-Oriented Services: It is the coexistence of people and cyber-physical systems of smart factories in service provider platforms. Production should be customer-focused and service provider platforms should be connected to respond flexibly to customer requests immediately.
- Modularity: It aims to instantly adapt to changing customer demands.

Some concepts related to Industry 4.0 are listed below [1]:

- Internet of Things: All objects on our planet are connected to the internet and communicate.
- Cyber – Physical systems: It is the production of machines that organize production independently of people.
- Artificial Intelligence: It is the process of developing computer systems that will understand human thought structure and reveal similar ones.
- Simulation Technologies: It is creating virtual models of the next stages by creating a virtual environment using real data.
- Augmented Reality: It is the combination of the real environment with the virtual environment.

3 LITERATURE REVIEW

When the literature is examined, it is seen that various studies have been carried out on Industry 4.0. In the study conducted by Kaygisiz and Sipahi, the concept of generation, generation classes and the impact of Industry 4.0 on generations were examined. The purpose of the study is to measure the knowledge levels of generation Y about individual innovation and Industry 4.0 and to examine the relationship between individual innovation and Industry 4.0. A survey was administered to 321 students studying at Giresun University Business Administration department to measure their individual innovation and Industry 4.0 knowledge levels. The survey results were evaluated with the help of SPSS program. As a result of the statistical evaluations, it was concluded that the relationship between gender, individual innovativeness, education levels and awareness of the Industry 4.0 concept is independent [3].

In the study conducted by Kamber and Sonmezturk Bolatan, the current technological situation of the Turkish production industry and its perspective on Industry 4.0 were examined. The purpose of the study is to measure the Industry 4.0 awareness level of employees in the production sector. An Industry 4.0 awareness survey was administered to 202 participants working in the manufacturing industry. Sectoral Industry 4.0 knowledge levels of 202 participants were measured. It has been observed that the sector-based Industry 4.0 perspective is different. It has been observed that the awareness of Industry 4.0 varies depending on whether the participants' company carries out studies on Industry 4.0 or not [4].

In the study conducted by Yildiz and Firat, it was aimed to measure the young generation's perspective and knowledge level on the fourth industrial revolution. For this purpose, a survey was prepared and applied to university students in Turkey. Factors affecting Industry 4.0 knowledge levels were determined by applying factor analysis and structural equation modeling methods. As a result of the study, it was revealed that university students mostly use technology to perform banking transactions [5].

In the study conducted by Torun and Cengiz, the perspectives of Faculty of Economics and Administrative Sciences students on Industry 4.0 were examined. A survey consisting of demographic questions, 15 statements and technological acceptance model questions was applied to students in the Business Administration, Management Information Systems, Economics, Finance, Political Science and Public Administration departments. T-test and ANOVA Analysis methods were used to measure differences in survey responses. As a result of the t-test, it was concluded that gender difference did not make a difference. As a result of the ANOVA analysis, it was concluded that there was a difference due to the differences in the departments. As a result of the research, it was

concluded that the Industry 4.0 awareness level of Management Information Systems students is very high compared to other departments. It has been concluded that this is due to the curriculum [6].

In the study conducted by Yelkikalan, Ozcan, and Temel, students studying at the Faculty of Economics and Administrative Sciences and School of Social Sciences, their perspectives on Industry 4.0 were examined. A survey consisting of demographic questions, 15 statements and technological acceptance model questions were applied to students. Demographic questions in the survey were interpreted with descriptive statistics and factor analyzes were performed according to the scale. T-test and ANOVA analysis methods were used to measure differences in survey responses. Students' perceived benefit levels of Industry 4.0 technologies, perceived ease of use, and intentions to use these technologies differ according to their gender. It was determined that usage behaviors did not differ according to gender. It has been determined that students' perceived benefit levels of Industry 4.0 technologies and their intentions to use these technologies differ significantly depending on the departments they study in; It was determined that perceived ease of use and usage behaviors did not show a significant difference [7].

In the study conducted by Demiral, the effect of Industry 4.0 and the application of the prominent technological concepts of Industry 4.0 on human resources management were examined. A survey was administered to white-collar employees of a food business that operates as a corporate entity and has technology applications. 44 survey data obtained as a result of the survey were analyzed with SPSS 23 program. As a result of the regression analysis conducted on the participants in the research, it was concluded that new technologies will affect human resources. Another result is that there is no positive thought towards Industry 4.0 and its technologies [8].

The study conducted by Ozcelik, Erkollar, and Cebeci was conducted to measure the level of digitalization of the business while responding to customer requests. Nine criteria were considered to measure the digitalization index. Questions were prepared based on the criteria considered. The prepared questions were applied to a machinery manufacturing company in Sakarya province. Considering that the effects of the criteria may be different, the weights of the criteria were found by using the Analytic Hierarchy Process. As a result of the survey conducted on experts in the business, it was concluded that the digitalization index of the company was 3 [9].

In the study conducted by Sertel, Buruk Sahin, and Islier, the perspective of Industrial Engineering students on Industry 4.0 was examined. A survey was administered to 118 students studying at Eskisehir Osmangazi University Industrial Engineering Department. SPSS program was used to evaluate the survey results. The results of the survey applied to the students were collected under 3 headings. These are the thoughts that software education should be increased, unemployment will increase and the curriculum is insufficient [10].

In the study conducted by Metin and Turkoglu, it was investigated whether the enterprises producing in Elazig had sufficient knowledge and equipment to implement the production method introduced by the Industry 4.0 revolution. A total of 49 people from 10 companies in different sectors were surveyed. It was determined that 28.60% of the company owners and 42.90% of the managers participating in the research were knowledgeable about this technology [11].

In the study conducted by Bulut and Akcaci, it was aimed to explain Industry 4.0 and its basic concepts. Industry 4.0 studies in Turkey were examined and what needed to be done to catch up with other countries was investigated. According to the study, a commission should be established for the Turkish economy as we move towards Industry 4.0. This commission should determine the measures to be taken for Industry 4.0, R&D expenditures and the direction of innovation [12].

In the study conducted by Sener and Elevli, the qualifications required to move to Industry 4.0 were examined and an academy was proposed. As a result of the study, it was reported that the education system should be renewed and it should be adapted faster instead of waiting for the adaptation process [13].

In the study conducted by Ozbek, Yildiz, and Alan, the Industry 4.0 adaptation of textile companies operating in Turkey was examined. The aim of the study is to examine the perspectives, usage potentials and expectations of textile companies in Turkey on Industry 4.0 technologies. A survey was applied to 67 textile enterprises that managed to enter the Istanbul Chamber of Industry's (ISO) 500 largest enterprises list in 2018. As a result of the survey, it was seen that the Industry 4.0 technology that businesses use most is Enterprise Resource Planning (ERP), and 54% of the businesses participating in the survey do not use Industry 4.0 technologies due to the high investment cost. Businesses using Industry 4.0 technologies stated the reasons for their use as increasing efficiency and quality and reducing the number of workforce and costs [14].

The study conducted by Batibay aimed to measure the Industry 4.0 awareness levels of Electrical and Electronics engineers working in different enterprises in Diyarbakır. In order to measure Industry 4.0 awareness levels in the study, A survey was administered to 64 Electrical and Electronics Engineers. As a result of the survey, it was determined that Industry 4.0 was very well known by 69.21%, well known by 16.25%, slightly known by 11.01%, and not known at all by 3.51% [15].

The study conducted by Tas and Alagoz aimed to measure the Industry 4.0 awareness levels of companies operating in the logistics sector in Konya. The survey results were evaluated with the help of SPSS program. The analysis results show that the relevant companies have Industry 4.0 awareness. On the other hand, they are not at a sufficient level in the implementation of Industry 4.0 in businesses. [16].

In the study conducted by Karakadilar, it was aimed to develop a unique scale by considering Industry 4.0 and economic factors together. For this purpose, a survey was prepared and it was applied to 36 participants. As a result, Industry 4.0 and economic factors are grouped under three subheadings. These topics are “sustainable logistics”, “smart production operations”, and “obstacles to transformation” [17].

The aim of the study conducted by Selim, Dogan and Dogan was to determine the Industry 4.0 susceptibility levels of medium and large-scale companies operating in Manisa and Izmir Organized Industrial Zones and to determine the factors affecting their susceptibility levels. It was determined that large-scale companies were more likely to participate. However, it has been revealed that the factor affecting susceptibility levels is intention [18].

In the study conducted by Dogan and Asan, Industry 4.0 awareness levels of Health Institutions Management department students were measured. It has been observed that female students' Industry 4.0 awareness levels are higher than male students, and second-year students' Industry 4.0 awareness levels are higher than first-year students [19].

4 APPLICATION

Table 1. Demographic findings

Variable	Category	Frequency	Ratio
Gender	Female	75	0.277
	Male	196	0.723
Age	18-21	61	0.225
	22-26	182	0.672
	27-35	21	0.077
	36-49	5	0.018
	50 and above	2	0.007
Place of residence	Village	34	0.125
	City	237	0.875
City of residence	İstanbul	41	0.151
	Ankara	9	0.033
	İzmir	6	0.022
	Bursa	7	0.026
	Other	208	0.768
Number of siblings	1	10	0.037
	2	70	0.258
	3	74	0.273
	4	38	0.14
	5 and above	79	0.292

Within the scope of the study, it was aimed to examine the Industry 4.0 awareness of undergraduate students of a university in Turkey. Therefore, A survey consisting of Industry 4.0 conceptual awareness scale and demographic questions was prepared. The prepared survey was applied to Industrial Engineering, Mechanical Engineering, Civil Engineering, Food Engineering and Management Information Systems students. A 5-point Likert scale was used in the survey. The survey was converted to electronic form using "Google Forms" and shared via e-mail. There were 271 survey returns. Survey results were interpreted using the SPSS program. The answers to demographic questions such as gender, department and age in the first part of the survey are given below.

5 RESULTS AND DISCUSSION

KMO test whether the sample size is suitable for analysis. KMO value is between 0 and 1. The closer it is to 1, the more reliable it is. The Bartlett test decides whether the data forms the identity matrix and whether the correlation between the variables is sufficient. KMO and Bartlett test results are given in Table 2.

Table 2. KMO and Bartlett's test results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.962
Bartlett's Test of Sphericity	Approx. Chi-Square	7126.673
	Df	528
	Sig.	0

As seen in Table 2, the KMO value is 0.962. The number of samples is suitable for factor analysis. Since $p < 0.05$ as a result of the Bartlett test, the data set is suitable for factor analysis. The results of the factor analysis conducted to determine how many factors the Industry 4.0 awareness scale consists of are given in Table 3.

Table 3. Factor analysis results

Factor	Eigen Value	Variance Explanation Ratio (%)	Cumulative Variance Explanation Ratio (%)
1	17.495	53.014	53.014

As seen in Table 3, it was revealed that the 33 item Industry 4.0 conceptual awareness scale had a unidimensional scale structure since its variance level was 53.014. Reliability analysis measures the consistency between responses to questions in the survey. In order to perform a reliability analysis, Cronbach's Alpha (α) value must be found. The α value can be found for each question. If the α value obtained for all questions is greater than 0.7, it is reliable and consistent.

Table 4. Cronbach's alpha reliability test results

Cronbach's Alpha	N of Items
0.972	33

Cronbach's Alpha (α) value was found to be 0.972. This shows that the answers given by survey participants are consistent. The results regarding whether the participants showed a significant difference according to gender in the survey were examined with a t-test. Analysis results are seen in Table 5.

Table 5. T-test results by gender

Scale	Gender	N	X	Homogeneity Situation	F	SİG.	t	SİG. (2-Tailed)
Industry 4.0 Awareness	Female	75	2.50465	Variances are homogeneous	1.139	0.465	2.764	0.544
	Male	196	2.56107	Variances are not homogeneous			-3.511	0.538

According to Table 5, Sig. values greater than 0.05 indicate that the variances are homogeneous. In this case Sig. (2-tailed) considering the values, it was determined that the Industry 4.0 awareness of the students did not show a significant difference in terms of gender. Findings regarding whether there was a significant difference in terms

of the department in which the survey participants studied were tested with ANOVA. Analysis results are seen in Table 6.

Table 6. ANOVA results in terms of department studied

Scale	Department	N	X	F	SİG.
Industry 4.0 Awareness	Industrial Engineering	39	2.818	1.84	0.324
	Civil Engineering	157	2.474		
	Food Engineering	2	2.348		
	Mechanical Engineering	30	2.391		
	Management Information Systems	43	2.674		

When the data in Table 6 was examined, it was seen that the Industry 4.0 awareness level of the students showed a significant difference based on the department. In this case, when the averages are examined, it is seen that the Industrial Engineering students who participated in the survey have more Industry 4.0 awareness than other students.

6 CONCLUSION

Today, the concept of Industry 4.0 appears in many areas of life. One of the areas it affects is undoubtedly the field of education. Especially students in the field of engineering and information systems may encounter the concept of Industry 4.0 both in their courses and in their research. The main purpose of the study is to measure the Industry 4.0 awareness levels of these students. In this context, a survey was designed to be presented to related students. The designed survey was applied to the students and the results were analysed through the SPSS program. Analysis results showed that students' Industry 4.0 awareness levels are concentrated below the middle level and this awareness level varies according to departments.

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Cyprus Issue and Its Effect on Turkey–European Relations

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Abstract

The strategic importance of the "Cyprus Problem", which is put forward by the Union as a prerequisite for Turkey's European Union membership process, for Turkey, Greece, the European Union and other countries, is discussed in this study and examined whether this problem plays a role as an obstacle for Turkey. The segregating policies of the European Union between Greeks and Turks living together in Cyprus have completely separated the two peoples, and this situation prevents the problem from becoming inextricable with each passing day and preventing the problem from being resolved in the short term. In addition, the different perspectives of the governments in Turkey to the Cyprus problem, and even the perspectives of some of them in the understanding of give and get rid of Cyprus, what they lost to Turkey are discussed and their reflections on Turkey are explained.

Keywords: *Cyprus, Management, European union, Membership*

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Temperature Analysis with MATLAB PDE Toolbox

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Abstract

With the development of the computer and the development of software programs that make it easier for people to create and understand a system, the effective use of computers has increased, especially in the field of engineering. In this study, the temperature analysis of a rectangular geometry positioned on the x and y axis and with an extension on the z axis was carried out with MATLAB's Partial Differential Equation (PDE) Toolbox. According to the problem geometry, the lower, right, left and upper surfaces of the rectangular geometry are insulated as desired or heated to the desired level. Necessary adjustments and adjustments were made in PDE Toolbox for heat transfer. After the PDE Specification and mesh mode, heat transfer was interpreted by taking the two-dimensional distribution and directional change of temperature. Additionally, the deformations occurring in the model due to the effect of temperature were also examined.

Keywords: *MATLAB PDE Toolbox, Heat transfer*

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Researching the Appropriate Connection Type in the Tower Crane System with Finite Element Analysis

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Abstract

In this study, structural analysis of the tower crane system used in both lifting and transportation operations was made. ANSYS finite element program was used for structural analysis and the analysis was carried out using the finite element method under certain boundary conditions. Stresses and deformations were examined under the best mesh values and as a result, the connections were evaluated comparatively for the most suitable connection in the system.

Keywords: *Finite element method, ANSYS, Connection type*

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World Energy Efficiency: Current Status and Strategic Approaches for the Future

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Abstract

The increase in energy demand and sustainability concerns around the world have made emphasizing energy efficiency a necessity. This study aims to evaluate the current situation in energy efficiency worldwide and consider strategic approaches for a more sustainable energy use in the future. Therefore, the study focused on energy efficiency indices and evaluation methodologies, energy efficiency in the industrial sector, urban planning and transportation, investment in energy efficient technology development, energy efficiency education and awareness. This study aims to reveal strategic approaches to sustainable energy use by discussing the current situation and future steps in energy efficiency worldwide. Increasing energy efficiency will not only reduce energy consumption, but will also bring economic and social benefits by supporting environmental sustainability.

Keywords: *Energy efficiency, World, Approaches for the future*

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Wind Energy, Research on Wind Potential in the World and Tunisia

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Abstract

Due to the damage caused by fossil-based fuels to the environment and the limited resources, research studies on new energy sources have been initiated. It has caused mankind to start working on using wind energy, which they have used since the earliest ages, first in moving vehicles on water, and then in windmills, in the production of electrical energy, which is the most widely used type of energy in our era. Wind energy applications, which provide economical solutions to meet the energy needs especially in remote regions where installing electricity grid lines is expensive, also promise a future in supplying energy to the grid in regions where the wind regime is suitable throughout the year. In this study, the potential of wind energy, the World and Algeria, is emphasized and attention is tried to draw attention to its potential in Algeria.

Keywords: *Wind power, Wind potential, World, Algeria*

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Energy Solutions for a Sustainable Future: Geothermal Energy

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Abstract

Geothermal energy is a technology that offers important solutions for a clean and sustainable energy future. Geothermal is the general name given to the heat accumulated at various depths of the earth's crust. Geothermal fluid is hot water, steam and gases containing many different elements and other substances. Geothermal energy is the name of the energy created by the enthalpy and heat of these fluids. In this study, numerical information will be given about geothermal energy resources in the world and information will be given about the potential of geothermal energy. In addition, in geothermal energy, which is an important step in terms of both environmental sustainability and energy security; Issues such as investment and financing, management of environmental impacts, education and awareness will also be addressed.

Keywords: *Geothermal energy, Geothermal energy in the world*

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Renewable Energy Sources: Global Situation and Future Potentials

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Abstract

Developments in technology and industrialization, the continuous increase in energy demand worldwide and climate change concerns emphasize the importance of renewable energy sources. This study aims to assess the current status of global renewable energy resources and address their future potential. Therefore, in this study, the current applications and potential of solar energy, wind energy, hydroelectric energy, biomass energy, sea wave and tidal energy, and geothermal energy in the world were investigated and the data were graphed. Afterwards, suggestions were made about potential future applications. Renewable energy sources play a critical role in energy security, environmental sustainability and combating climate change. Implementing these recommendations would represent important steps towards a more sustainable energy future on a global level.

Keywords: *Renewable energy sources, World potential, Suggestions*

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Development of Management Strategy in Universities

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Abstract

In this study, the strategic management practices of Universities operating in Nigeria and Citiedge University were discussed and the effects of these practices on the corporate performance of universities were examined. In this regard, models that will affect the performance of Citiedge University have been determined through environmental analysis and data that will make a positive contribution to the development process of the University have been extracted. In addition, strategies have been developed for the University's flexibility to easily adapt to new situations in the face of positive or negative developments in the external environment.

Keywords: *Strategic management, Suggestion, Plan*

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Urban, Rural, and Regional Economy: Recommendations for Integration and Sustainable Development

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Abstract

The balance between urban, rural and regional economies is of critical importance for sustainable development and social well-being.

- In urban economy; innovation and technology centres, sustainable transport infrastructure and education and skills development,
- In rural economy; agriculture and sustainability, strengthening local markets and promoting tourism,
- In the regional economy; infrastructure investments, cooperation and clustering and public-private cooperation

about the proposals were presented in order to support a fair and effective integration between these three economic areas. A healthy balance between urban, rural and regional economies is the key to sustainable development. These recommendations aim to achieve fair integration and increase social welfare in these areas.

Keywords: *Economy, Integration, Sustainable development*

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Managing the Conflicts in International Joint Ventures: Prevent or Resolve Them

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Abstract

While the question of the determinants (why) of conflicts in international joint ventures has been widely discussed in the literature dedicated to strategic management, few studies have studied their occurrence, evolution and resolution (how). The purpose of this paper is to study the mechanisms of managing conflicts in international joint ventures by distinguishing between two approaches: a proactive approach that prevents the emergence of conflicts and a reactive approach that resolves them. The analysis of some cases of international joint ventures reveals the coexistence and complementarity of the two approaches, based on distinct mechanisms, with, on the one hand, preventive tools (contract, communication, cultural adaptation) and on the other hand curative mechanisms (renegotiation, mediation, arbitration). Together, these mechanisms make it possible to avoid escalation of conflict situations that could paralyze the operation of the joint venture or lead to its failure.

Keywords: *International joint ventures, Conflicts, Management, Prevention, Resolution*

1 INTRODUCTION

Recent studies reveal a growing interest in the study of conflict management mechanisms in International Strategic Alliances (ISA) [1, 2]. Two currents dealing with conflict management have thus developed. The first trend, the most striking in the literature, concerns mechanisms for preventing conflicts a priori such as contracts [3]; communication [2] and shared vision [4]. The second current, the least studied empirically [5], rather concerns the mechanisms for dealing with conflicts after their occurrence such as meetings between managers, negotiations, external mediations and legal arbitration procedures.

Observation of conflict management practices in the context of ISA shows that these two mechanisms coexist and are often mobilized in a differentiated manner by one of the partners or by the managers of the alliance. A priori preventive actions are completed ad hoc when a conflict situation arises. However, to our knowledge, few works have combined the two streams to present to ASI partners complete mechanisms (based on both proactive and reactive approaches) that can help them prevent and manage conflicts. In this perspective, the work of [5] and [6] proposed a theoretical approach to conflict prevention and management tools in the context of international joint ventures (IJV).

2 DETERMINANTS AND DYNAMICS OF CONFLICTS IN INTERNATIONAL JOINT VENTURES

Inter-organizational conflicts are a major issue in examining the outcomes of International strategic alliances, potentially leading to their failure and disappearance as an inter-organizational entity of cooperation between partners, especially those of different national cultures. They can develop throughout the life cycle of an international joint venture, from the pre-formation stage to the termination stage of the relationship.

The conflicts are linked to endogenous factors such as:

- Lack of confidence;
- The ambiguity of contracts and
- The heterogeneity of objectives;
- The adoption of opportunistic behaviors;
- The relational context or

Exogenous factors such as:

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- Cultural differences;
- The complexity and uncertainty of the environment.

2.1 Conflicts

Conflict is understood as a dynamic process, between two or more parties, made up of 5 phases, namely:

- Latent conflict (the conditions likely to trigger a conflict between partners),
- Perceived conflict (partners become aware of the existence of a conflict),
- Felt conflict (partners develop feelings of stress and tension),
- Manifest conflict (partners express their disagreement by adopting conflictual behavior expressed through action or speech), and finally
- The repercussions of the conflict (the conflict may or may not be overcome by the partners). The majority of research studying conflict in IJV focuses on the manifest conflict phase.

2.2 Determinants and Dynamics

Some authors distinguish conflicts emerging during the formation phase of a JVI from conflicts that develop during the operational phase.

During the formation phase of a joint venture, conflicts are potentially linked to endogenous factors such as:

- The lack of trust between the parties,
- The homogeneity of the partners' resources,
- The ambiguity of contracts and
- The heterogeneity of partners' objectives.

To this we could add the partner's need for rare resources possessed by the other party.

During the operational phase of a JVI, researchers argue that:

- The adoption of opportunistic behaviors by one or both partners,
- Differences in operational policies,
- Changes in objectives and strategic plans

Can lead to conflicts preventing the creation of the expected synergies. Also,

- The increased formalization and monitoring of relationships

Can give rise to disagreements between parties struggling to maintain their autonomy in the face of increasing interdependence.

From the same perspective, several authors emphasize the role of control and the desire for autonomy in the emergence of conflicts between partners. When the meaning of contribution and control is changed in an unconcerted, unilateral (or even hidden) way, conflicts between partners are more likely to occur. In addition, the increase in the number of transactions over time is likely to reduce their complementarity and thus increase territorial conflicts, competition and the risks of alliance failure.

Cultural differences between partners constitute another potential determinant of the emergence of conflicts. In fact, the diversity of the organizational and strategic contexts of the two partners generates disagreements and creates contradictory points of view likely to favor conflict situations. Likewise, some researchers have shown that conflicts between IJV partners are caused by the managerial complexity of the partnership relations, most often associated with high agency and coordination costs.

On the other hand, the characteristics of the external environment have a real impact on the development of conflicts within IJVs. Thus, the authors emphasize that conflicts between partners are most likely linked to inter-organizational relationships exposed to strong environmental uncertainty. Likewise, some researchers have highlighted that characteristics of the external environment, such as:

- Unanticipated political and economic changes,

- Changes in industry structure and competition patterns, or
- Reorientations of parent companies' strategies,

Influence the political behavior adopted by the partners and have an impact on the disappearance of the joint venture.

For their part, others have stressed that:

- The volatility of the environment,
- The structural instability,
- The unverifiable nature of information and
- The inapplicability of the laws characterizing these countries

Are likely to increase the opportunism of partners and therefore encourage conflict situations.

Overall, the researchers emphasize that the effect of the uncertainty of the partners' motivations on the failure of the JVI (internal factors) is more important than that of the uncertainty of the external environment.

3 CONFLICT MANAGEMENT IN INTERNATIONAL JOINT VENTURES

In the theoretical works devoted to conflict management in IJVs, we distinguish prevention mechanisms from conflict resolution mechanisms encountered by partners. The first are "designed" by the partners during the formation of the alliance, with adjustments throughout its life cycle, while the latter most often intervene in an "emergency" to resolve already exacerbated conflicting situations.

3.1 Prevention

According to some authors, most previous studies have focused on the mechanisms for avoiding conflicts rather than on the processes of their resolution.

In this sense, we can consider the governance mechanisms of joint ventures:

- Building trust,
- Contractual clarifications,
- Adjustment of clauses, etc.

Identified in the literature as conflict prevention tools. As such, the contract makes it possible to clarify the division of labor, establish clear power relations, formalize the procedures for interaction between partners, provide structural assurance if one of the parties does not meet the criteria performance, prevent opportunistic behavior and specify, in advance, the conditions and procedures relating to the resolution of conflicts and the termination of the relationship.

When starting the alliance, all the strategic partners draw up a contract which will set the normative framework of the relationship in terms of contributions, extent of cooperation, methods of knowledge transfer, but also protection against behavior opportunistic, legal constraints to be respected by the different parties, conflict resolution and terms of exit and termination of the agreement.

According to the results, two types of contract can be distinguished, namely: the succinct contract, called "start-up contract" or "progressive contract", and the very detailed contract called "complete contract". These two types of contract serve as a basis for preventing the emergence of opportunistic behavior likely to trigger conflicts, but cannot, on their own, prevent their development and proliferation. Indeed, the first category of contract (start-up contract) does not make it possible to foresee all the developments in the collaboration, nor the changes in the objectives and behavior of the partners, thus leading to confusion and misinterpretations. For its part, the complete contract details all the processes, objectives, resources of the partners and above all anticipates the scenario in the event of conflicts, but does not allow it to be up to date with the evolution and requirements of the cooperation or to take into account all possible changes and developments in the relationship.

In the same perspective, social mechanisms such as:

- Shared vision,

- Trust and
- Communication

Play an important role in minimizing the opportunism of partners, developing strong relationships and closer ties between the parties with a view to preventing conflict situations.

Concerning IJV in particular, cultural adaptation approaches (multicultural practices, development of corporate culture, etc.) between partners is another tool that plays an important role in conflict prevention.

All the IJVs studied bring together partners whose cultures and origins are different, business processes and managerial practices sometimes distant. Partners of distinct nationalities, even from the same continent, have heterogeneous values, dissimilar language and "jargon", histories, understandings and expectations. This is an underlying element of the alliance, a factor in possible tensions and conflict situations. This is how the partners equip themselves with a set of mechanisms complementary to the contract, such as cultural adaptation tools, in order to better prevent conflicts. However, the cultural adaptation process implemented differs from one case to another depending on the nature of the cultural differences encountered or the phase of the collaboration concerned as well as the cooperative or international experience of the partners. Thus, during the start-up phase of the alliance, the analysis of the results reveals the establishment of a common working language to better protect against national cultural differences. Indeed, linguistic differences are likely to trigger misunderstanding difficulties between the actors involved in the alliance. Harmonization of communication language is therefore essential to facilitate the implementation of partners' strategy and the conduct of joint activities.

By fostering similar values and a common cultural environment among all parties and allowing congruence of objectives, cultural adaptation encourages partners to refrain from opportunistic behavior. The success of IJVs depends on the cultural adaptation of partners based on:

- Intercultural awareness;
- Training programs and
- The encouragement of informal contacts.

From this perspective, cultural adaptation is considered as a preventive mechanism for conflict because it consists of ensuring the understanding, assimilation and integration of respective differences in order to develop common approaches and make heterogeneous organizational cultures coexist.

3.2 Resolution

If, despite these efforts at cultural adaptation and communication, prevention fails, the priority task of IJV managers consists of resolving the conflict through appropriate and specific mechanisms. Indeed, conflicts are likely to grow and become more serious due to the divergence in the partners' managerial practices. The diversity of organizational cultures increases the risks of ambiguity, complexity and confusion and consequently makes it difficult to converge directions and actions. These differences give rise to numerous conflicts between the two partners as indicated previously, but are also a source of conflicts on the choice of mechanisms to put in place to resolve the problems of differences of opinion and objectives... In other words, not only can these cultural differences lead to conflicting situations, but they can also hinder the identification of consensual resolution tools a posteriori.

As partners adopt a preventative approach, some conflicts will be reduced while others may emerge. To deal with them, partners can resort to several strategies recognized in the literature, namely resolving problems through:

- Compromise,
- Negotiating,
- Forcing the position or
- Adopting a legalistic strategy.

However, the cultural distance between the partners influences the choice between the four strategies cited above. For example, the "programming" at the start of an alliance of a conflict resolution process by one of the partners may offend the other party, who will perceive it as a lack of trust, likely to reduce the chances of resolution of the conflict and create new ones.

In this curative perspective, certain authors highlight the importance of mobilizing conflict resolution techniques, in an increasing manner depending on their intensity, starting with meetings between managers at the highest level of each parent internally until recourse to external mediations and legal arbitration procedures. While the mediator has no power to impose an agreement between the partners and must therefore demonstrate neutrality throughout the process by supporting them and advising them in a relevant manner, the arbitrator will take position and will propose a decision that will apply to all parties. Thus, arbitration should result in more restrictive mechanisms than mediation.

For their part, others propose a model of process composed of a set of actions to be implemented by partners in order to resolve conflicts, namely:

- The identification and evaluation of the problem;
- Strategy formation;
- The definition of the initial stages of the conflict resolution procedure;
- The formation of a mixed conflict negotiation team;
- Brainstorming sessions on possible strategies to resolve conflicts;
- The repetitions;
- Conflict transformation;
- The effective negotiation of conflicts between partners;
- Assessing and rebuilding trust, etc.

4 CONCLUSION

Conflict is dynamic and evolving. The tools to respond to them must combine prevention and reaction, without exclusivity. Then, the partner's vision and perception of the conflict (intensity, frequency and effects on the relationship) is often different from ours (because of differences in experience, national and organizational cultures). This involves the development of understanding and communication tools from the first phases of cooperation in order to detect early warning signs of the emergence of a potential conflict.

In short, IJV partners must choose between well-adapted and complementary mechanisms with a view to preventing a priori or resolving a posteriori the conflict situations encountered. They are in fact part of this dual proactive and reactive approach to conflict management.

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