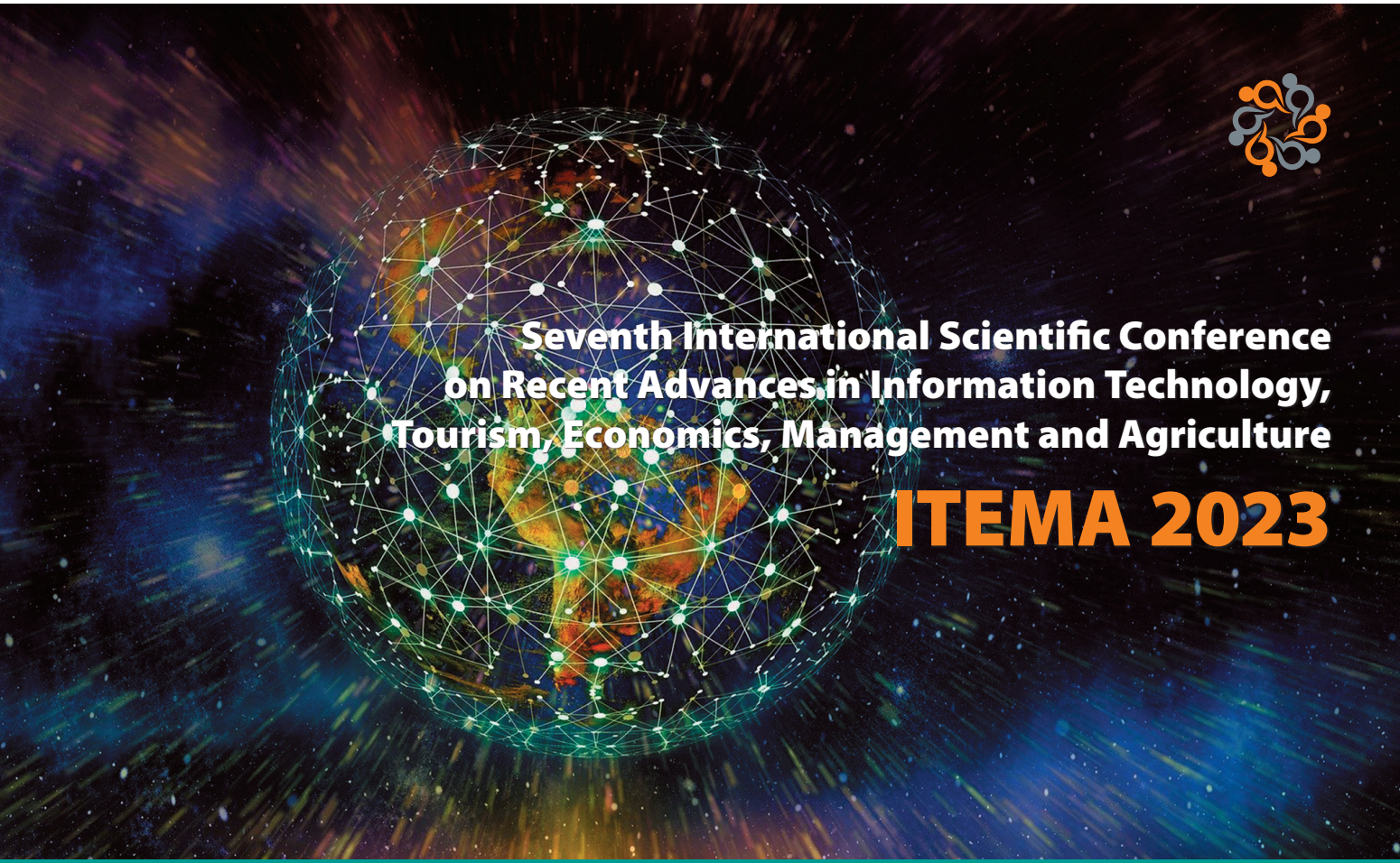

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on Recent Advances in Information Technology,
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Preface

The purpose of the annual ITEMA conference is to support the power of scientific research and dissemination of the research results with the objective to enhance society by advancing knowledge; policy-making change, lives, and ultimately, the world. Our objective is to continue to be the foremost annual conference on cutting-edge theory and practice of information technology, tourism, economics, management, and agriculture, encouraging advancement via excellence, and interaction.

ITEMA conference aims to bring together the international academic community (experts, scientists, engineers, researchers, students, and others) and enable interactive discussions and other forms of interpersonal exchange of experiences and popularization of science and personal and collective affirmation.

The annual ITEMA conference is committed to the highest standards of publishing integrity and academic honesty as ensuring ethics in all its publications. Conformance to standards of ethical behavior is therefore expected of all parties involved: authors, editors, reviewers, and the publisher. The conference organizer follows the Committee on Publication Ethics (COPE) guidelines on how to deal with potential acts of misconduct.

All received full papers prior peer review process are subject to plagiarism check with iThenticate by Turnitin software. Any identified plagiarism automatically disqualifies a paper. Afterward, all full papers are double-blind peer-reviewed by the reviewers drawn from the editorial committee or external reviewers depending on the topic, title, and the subject matter of the paper. Peer reviewers provide a critical assessment of the paper and may recommend improvements. Although the author may choose not to take this advice, we highly recommend that the author address any issues, explaining why their research process or conclusions are correct.

The conference program of the 7th International Scientific Conference on Recent Advances in Information Technology, Tourism, Economics, Management, and Agriculture - ITEMA 2023 held on October 26, 2023, at the Faculty of Organization and Informatics Varaždin University of Zagreb, Croatia; combined presentations of the latest scientific developments in the field of the emerging trend of wine tourism in Albania and the impacts of the COVID-19 pandemic on the U.S. housing market and ICT use in marketing in Montenegro. The studies also cover corporate governance in the energy sector, the influence of crises on Southeast Asian capital markets, and the efficiency of Croatia's banking sector. Additionally, the papers discuss the role of project teams in sustainable economies, engagement incentives for IT professionals in Bulgaria, and consumer responses to sustainable consumption, with insights gained from eye-tracking experiments. Furthermore, the ITEMA 2023 conference covered the positive and negative effects of digital content consumption, the potential of cryptocurrencies in risk management, and the experiential dimensions driving local producers, the impact of digitalization on HR performance in Morocco, AI adoption in Slovenia, and large language models in text mining are explored, alongside the analysis of cryptocurrencies in tourism and corporate governance's influence on financial performance in the energy sector, etc.

ITEMA 2023 keynote speaker was Ilijana Petrovska, Program Leader of Digital Marketing MSc at Northumbria in Qatar and Full-Time Professor at University American College Skopje, North Macedonia with the topic *Customer Empowerment in Digital Age*.

Within publications from the ITEMA 2023 conference:

- 24 double peer-reviewed papers have been published in the **ITEMA 2023 Selected Papers**,
- 44 double peer-reviewed papers have been published in the **ITEMA 2023 Conference Proceedings,**
- 47 abstracts have been published in the **ITEMA 2023 Book of Abstracts**.

Altogether ITEMA 2023 publications have more than 700 pages. All full papers have DOI numbers and ORCID iD integration.

Participation in the conference took more than **200 researchers** representing **25 different countries** from different universities, eminent faculties, scientific institutes, colleges, various ministries, local governments, public and private enterprises, multinational companies, associations, etc.

ITEMA 2023 Participants' Affiliation

Albania
- Canadian Institute of Technology, St. Xhanfize Keko, No. 12, Tirana
- Epoka University, Faculty of Economics and Business Administration, Department of Business Informatics, Autostrada Tirana-Rinas, km. 12, Tirana
- Fan S. Noli University, Economic Faculty, Korce
- Legal Department, One Communication Company, Tirana
- Mediterranean University of Albania, Bulevardi Gjergj Fishta 52, Tirana
- POLIS University, Rruga Bylis 12, Autostrada Tiranë-Durrës, Km 5, Kashar, SH2, 1051Tirana
- Tirana Prosecutor Office, General Jurisdiction, Road "Haxhi Hysen Dalliu", Tirana
- University "Aleksander Moisiu" Durrës, Faculty of Business, Department of Marketing, Street 15, Miqësia, 2001, Durres
- University of New York, Rruga e Kavajes, Ish-21 Dhjetori, Tirana
- University of Tirana, Faculty of Economics, Rruga Arben Broci 1, 1001Tirana
- University of Tirana, Faculty of Law, Criminal Department, Road "Milto Tutulani", Tirana

Austria
- University of Applied Sciences Kufstein Tirol, Finance, Accounting & Auditing, Andreas Hofer-Str. 7, 6330 Kufstein
- University of Applied Sciences, Burgenland Campus 1, A-7000 Eisenstadt

Bulgaria
- Agricultural University - Plovdiv, 12 Mendeleev str., 4000 Plovdiv
- NBU, Sofia
- Sofia University "St. Kliment Ohridski", Boul. Tsar Osvoboditel 15, Sofia
- South-West University 'Neofit Rilski', Faculty of Economics, Ivan Mihailov 60, 2700 Blagoevgrad
- Technical University of Varna, 1 Studentska str., 9000 Varna
- Trakia University, Faculty of Economics, Stara Zagora
- Tsenov Academy of Economics, Faculty of Economic Accounting, 2 Em. Chakarov Str., 5250, Svishtov
- University of Economics – Varna, Faculty of Informatics, 77 Knyaz Boris I blvd., 9002 Varna
- University of Economics – Varna, Faculty of Management, 77 Knyaz Boris I Blvd., 9002 Varna
- University of Economics – Varna, Marketing Department, 77 Knyaz Boris I Blvd., 9002 Varna
- University of National and World Economy UNWE, Studentsky Grad, 1700 Sofia

Croatia
- Adriatic Expert d.o.o, Put Supavla 1, 21000 Split
- Central State Office for Digital Society Development, Ivana Lučića 8, Zagreb
- Faculty of Tourism and Hospitality Management, Primorska, 46, 54410 Opatija
- Gulija Consulting and Smart Solutions d.o.o., Vinogradska cesta 74, Zagreb
- Hrvatska elektroprivreda, Viktora cara Emina, 2, 51000 Rijeka
- Institute for Development and International Relations (IRMO), Lj. F. Vukotinovića 2, 10000 Zagreb
- Libertas International University, Trg J. F. Kennedy 6b, 10 000 Zagreb
- Polytechnic of Rijeka, Vukovarska, 58, 51000 Rijeka
- Raiffeisen Bank Austria d.d., Petra Preradovića 17, 42 000 Varaždin
- University North, Jurja Križanića 31b, 42000 Varaždin
- University of Split, Faculty of Economics, Business and Tourism, Cvite Fiskovića 5, 21000 Split
- University of Zagreb, Faculty of Organization and Informatics, Pavlinska 2, 42000 Varaždin

Czech Republic
- Prague University of Economics and Business, W. Churchill Sq. 1938/4, 130 67 Prague 3 – Žižkov

Ethiopia
- Addis Ababa University, School of Commerce, Addis Ababa

Greece
- University of the Aegean, Department of Financial and Management Engineering, Kountouriotou, 41, 82100, Chios, Greece

Hungary
- Budapest Business University, Faculty of Finance and Accounting, Buzogány utca 11-13, 1149 Budapest
- Budapest Business University, Faculty of International Management and Business, Dióssy Lajos utca 22-24, 1164 Budapest
- Pázmány Péter Catholic University, Faculty of Law and Political Sciences, Szentkirályi utca 28, 1088 Budapest

- Széchenyi István University, Deák Ferenc Faculty of Law and Political Sciences, Department of International and European Law, Egyetem tér 1., Győr
- Széchenyi István University, Kautz Gyula Faculty, Department of Tourism and Hospitality, Egyetem tér 1., Győr

India
- School of Management Studies and Research at KLE Technological University Hubli Karnataka
- Vignana Jyothi Institute of Management, Hyderabad

Italy
- Magna Græcia University, Viale Europa, 88100 Catanzaro
- University of Bologna, Department of Management, Via Capo di Lucca 34, 40126 Bologna
- University of Florence, Viale delle Idee 30 Sesto Fiorentino, Florence
- University of Palermo, Department of Architecture, Viale delle Scienze Bld. 8-14, 90128 Palermo

Luxembourg
- Eurostat

Morocco
- ENSAM, Mohammed V University in Rabat, Avenue Mohammed Ben Abdellah Ragragui Madinat Al Irfane B.P, 6430 Rabat
- FSJES Ait Melloul, Ibn Zohr University Agadir
- FSJES Ait Melloul, Research Team In Economy And Organizational Management Erego, Ibn Zohr University Agadir
- FSJES-Souissi, Mohammed V University in Rabat, Avenue Mohammed Ben Abdellah Ragragui Madinat Al Irfane B.P, 6430 Rabat

Mozambique
- Smart Energy Initiatives
- Mediterranean University, Faculty of Economics and Business, Josipa Broza bb, 81000, Podgorica

Montenegro
- Adriatic University, Faculty of Mediterranean Studies Tivat; Faculty of Maritime and Trade Bar
- Instituto Nacional das Comunicações
- Autoridade Reguladora de Energia

North Macedonia
- Goce Delcev University Shtip, Krste Misirkov 10-A, 2000 Shtip
- Ss. Cyril and Methodius University in Skopje, Faculty of Economics, Bul. Goce Delcev 9V, 1000 Skopje

Poland
- Poznan University of Economics and Business, al. Niepodleglosci 10, 61-875 Poznan

Portugal
- Fin-Prisma Lda, Lisboa
- Lusófona University, ECEO, COPELABS, Campo Grande 376, 1749-024, Lisbon
- NOVA Information Management School (NOVA IMS), Lisbon
- Polytechnic Institute of Setúbal - ESCE, Setúbal
- Polytechnic Institute of Setúbal, Campus do IPS - Estefanilha, 2910-761 Setúbal

Romania
- Bucharest University of Economic Studies, The Economics and International Business Doctoral School, Street Piața Romană 6, 010374 Bucharest
- "Constantin Brancusi" University, Faculty of Engineering, Târgu-Jiu
- "Lucian Blaga" University of Sibiu
- Romanian American University, Bd. Expozitiei no. 1B district 1, Bucharest
- Technical University of Civil Engineering Bucharest, Bd. Lacul Tei 122-124, Bucharest
- Transilvania University of Brasov, B-dul Eroilor 29, 500036 Brasov
- University Babes-Bolyai of Cluj-Napoca, Avram Iancu Str. 11, 400089 Cluj-Napoca
- University of Craiova, Alexandru Ioan Cuza, no. 13, 200585, Craiova
- University of Oradea, Faculty of Economic Sciences, Universității Street 1, 410087 Oradea
- University of Petrosani, Doctoral School, Street Universității no. 20, 332006, Petroșani
- University of Petrosani, Faculty of Mechanical and Electrical Engineering, Street Universității no. 20, 332006, Petroșani
- West University of Timisoara , B-dul Vasile Pârvan 4, 300223, Timisoara

Russia
- Volgograd Institute of Management, Department of Accounting, Analysis and Audit, Branch of the Russian Presidential Academy of National Economy and Public Administration, Gagarina St, 8, 400131 Volgograd
- Volgograd State University, Department of Applied Informatics and Mathematical Methods in Economics, Prosp. Universitetsky, 100, 400062, Volgograd

Serbia
- Academy of Technical and Art Applied Studies Belgrade (ATUSS) – Department ICT College for vocational studies, Zdravka Čelara, 16, 11000 Belgrade
- Association of Economists and Managers of the Balkans - Udekom Balkan, Ustanička 179, Belgrade
- Belgrade Business and Arts Academy of Applied Studies, Belgrade
- Faculty of Engineering Management, Bulevar Vojvode Mišića 43, 11000 Belgrade
- Metropolitan University, Faculty of Applied Ecology Futura, Požeška 83a, 11000 Belgrade
- Novi Sad School of Business, Vladimira Perića Valtera 4, Novi Sad
- State University of Novi Pazar, Vuka Karadžića bb, 36300, Novi Pazar
- The Academy of Technical and Art Applied Studies Belgrade, Department School of Information and Communication Technologies, Starine Novaka 24, 11000 Belgrade
- University Business Academy in Novi Sad, Faculty of Social Sciences, Bulevar umetnosti 2a, Belgrade
- University of Belgrade, Faculty of Mining and Geology, Djusina 7, Belgrade
- University of Belgrade, Faculty of Organizational Sciences, Jove Ilića 154, 11000 Belgrade
- University of Belgrade, Faculty of Security Studies, Gospodara Vucica 50, Belgrade
- University of Novi Sad, Faculty of Economics, Segedinski put 9-11, 24000 Subotica

Slovakia
- Bratislava University of Economics and Management, Furdekova 16, 851 04 Bratislava
- Comenius University, Faculty of Management, Odbojarov 10, 820 05 Bratislava
- Slovak University of Agriculture in Nitra, Faculty of Economics and Management, Trieda Andreja Hlinku 2, 949 76 Nitra

Slovenia
- Higher Vocational College, Celje School of Economics, Mariborska 2, 3000 Celje
- Higher Vocational College, Professional Education Centre Brežice, Bizeljska cesta 45, 8250 Brežice
- Higher vocational college, School Center Šentjur, Cesta na kmetijsko šolo 9, 3230 Šentjur
- University of Ljubljana, Faculty of Public Administration, Gosarjeva ulica 5, Ljubljana
- University of Maribor, Faculty of Economics and Business, Maribor

Spain
- University of the Basque Country UPV/EHU, Lehendakari Aguirre 83 48015 Bilbao

Turkey
- Gaziantep University, Faculty of Economics and Administrative Sciences, Department on International Trade and Logistics, 27310-Sehitkamil-Gaziantep

UAE
- Higher Colleges of Technology, Faculty of Applied Media, FWC, Fujairah

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Benefits and Risks: Combined Literature Review on the Use of AI Models and Company Data Disclosure

Stojan Ivanišević[1]
Rajko Ivanišević[2]
Aleksandar Ivić[3]

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Abstract: *As the use of artificial intelligence (AI) language models in business operations becomes an everyday reality, the management of company data resources, including the prevention of loss, raises critical questions about data privacy, security, and ethical considerations become increasingly important. This study presents a comprehensive examination - literature review, as a foundation for further research on AI model usage and the effective management of company data resources. The literature review surveys current research, revealing key themes and trends related to the topic, and offering insights into the reality of AI model use. This study aims to provide a holistic understanding of the complex interaction between AI, data resource management, and corporate decision-making.*

1. INTRODUCTION

In the era of digital transformation, the interaction of artificial intelligence (AI) models and corporate data has ignited a discussion about the way businesses use their data. AI models, driven by advanced machine learning techniques, have emerged as formidable tools capable of processing vast amounts of data, extracting insights, and augmenting human capabilities. The urge to exploit these models to enhance productivity and use AI models as tools to gain competitive advantage is tempting. The public availability of AI models such as Chat GPT allows any employee to add part of the company data into a prompt and expose the company resource (data) to the AI model. This event could potentially have a double negative effect: not only as company data/know-how/resources loss/disclosure but also as a disclosure of the client's data that the company is obliged to protect.

While the integration of AI models into business processes offers unprecedented opportunities, it also creates challenges, none more pressing than the safeguarding and effective management of company data resources. As organizations now use AI in the everyday work of the average employee to drive growth, optimize operations, and enhance customer experiences, they simultaneously engage with the complexities of data privacy, security, and ethical considerations. The delicate balance between using the benefits of AI-driven insights and guarding against the loss of company data resources is a point that is worthy of scientific discussion.

[1] No Affiliation
[2] University of Novi Sad – Faculty of Economics, Segedinski put 9-11, 24000 Subotica, Serbia
[3] No Affiliation

2. AI MODELS – CONCEPTS

Artificial Intelligence (AI) has emerged as a transformative force in the world of technology and data science. At the heart of AI lies the concept of AI models—sophisticated algorithms and computational structures that enable machines to simulate human intelligence. To understand the broader concept and research background, it is important to show concepts of AI models, shedding light on their underlying principles, applications, and significance in today's data-driven world.

Concepts: At its core, an AI model is a mathematical representation of a real-world process. These models leverage statistical and computational techniques to make predictions, classify data, or perform other tasks without explicit programming. The primary concepts underpinning AI models include:

Machine Learning (ML): Machine learning is a subset of AI that focuses on enabling machines to learn from data. ML models can identify patterns and make predictions by analyzing large datasets. This learning process enables the model to improve its performance over time.

Deep Learning: Deep learning is a specialized branch of ML that uses artificial neural networks to model and solve complex problems. These neural networks consist of interconnected layers of nodes, mimicking the human brain's structure. Deep learning models have achieved remarkable success in image recognition, natural language processing, and other tasks.

Supervised Learning: In supervised learning, an AI model is trained on labeled data, where the input data is paired with corresponding target outcomes. The model learns to make predictions or classifications by identifying patterns in the data and adjusting its parameters to minimize errors.

Unsupervised Learning: Unsupervised learning deals with unlabeled data, where the model seeks to discover hidden patterns or structures within the data. Clustering and dimensionality reduction are common tasks in unsupervised learning.

Reinforcement Learning: Reinforcement learning is a framework where an agent interacts with an environment to achieve specific goals. The agent receives feedback in the form of rewards or penalties, enabling it to learn optimal actions over time. This approach is widely used in robotics and game playing.

3. COMPANY DATA RESOURCES - DEFINITION AND SIGNIFICANCE

Today data is the lifeblood of modern organizations. From multinational corporations to small startups, businesses across the spectrum are accumulating vast volumes of data. This data, often referred to as company data resources, is a wide array of information assets that are pivotal for decision-making, strategy formulation, and operational efficiency. For clarification purposes, the authors attempted a comprehensive exploration of company data resources, defining their scope and significance in contemporary business operations. These resources can range from structured database data to unstructured forms of communication, such as emails and social media interactions. Borges et al. (2021) stated "Huge volume of data in diverse formats being generated faster than ever has demanded the development of new technologies, resulting in

an acceleration of technological progress, which includes increasing the computational processing capacity and the development of new AI techniques. Many organizations are motivated to adopt AI technologies, mainly by their disruptive potential demonstrated by top digital corporations. The text also highlights the potential benefits, challenges, and opportunities of integrating AI into organizational strategy".

At its core, company data resources encompass the collective information assets that an organization collects, manages, and analyzes to facilitate its day-to-day operations, strategic planning, and competitive positioning. These resources span a spectrum of data types, each with its characteristics and relevance to business operations:

1. Structured Database Data: Structured data, stored in relational databases, represents the backbone of many company data resources. It includes organized information such as customer profiles, transaction records, and inventory levels. Structured data is amenable to traditional data analysis techniques and is foundational for business intelligence.
2. Unstructured Data: In contrast to structured data, unstructured data lacks a predefined format. This category includes textual documents, multimedia content, and social media posts. Unstructured data is abundant and valuable for extracting insights through natural language processing (NLP) and image analysis.
3. Semi-Structured Data: Semi-structured data bridges the gap between structured and unstructured data. It includes formats like XML or JSON, often used for data exchange and flexible data representation.
4. Email Communication: Email communication serves as a rich source of data resources within organizations. Email archives contain a historical record of interactions, negotiations, and decisions. These archives are critical for compliance, dispute resolution, and knowledge management.
5. Social Media Interactions: Social media platforms have evolved into potent channels for customer engagement and feedback. Analyzing social media data offers insights into market sentiment, brand perception, and consumer preferences.
6. Sensor and IoT Data: With the proliferation of sensors and the Internet of Things (IoT), organizations gather data from physical devices and sensors. This data informs predictive maintenance, supply chain optimization, and product performance monitoring.
7. Financial Data: Financial data resources encompass financial statements, income reports, and transaction histories. These data types are essential for financial analysis, budgeting, and regulatory compliance.

4. LEVERAGING COMPANY DATA RESOURCES AND AI MODELS FOR ENHANCED PRODUCTIVITY AND DECISION-MAKING

Wamba-Taguimdje et al. (2020) and Fountaine et al. (2019) focus on the business value of AI-based tools and how they can positively impact an organization's performance. However, their work also discusses the importance of culture, structure, and ways of working to support road AI tools adoption, and the need for businesses to align their culture and structure to support AI adoption.

In today's digitally interconnected business landscape, the effective utilization of company data resources, coupled with the integration of sophisticated AI models, has emerged as a mainstream practice for organizational success. Employees across diverse functions and hierarchies use AI language models to foster productivity gains and elevate decision-making to a new level of sophistication.

AI-Powered Efficiency and Innovation: Beyond the realm of traditional data analysis, AI models have revolutionized how employees interact with data. Machine learning algorithms, natural language processing (NLP), and predictive analytics are augmenting human capabilities. AI automates repetitive tasks, extracts meaningful insights from unstructured data like emails and social media interactions, and facilitates predictive analysis that was previously unattainable. Employees now wield AI tools to unlock operational efficiencies, explore innovative possibilities, and enhance their contributions to the organization.

The integration of AI models plays a pivotal role in decision-making processes. It brings about a transformation in decision-making by bolstering accuracy and speed. Employees, equipped with AI-augmented data resources, are not only able to process vast volumes of data swiftly but also with exceptional precision.

In essence, the synergy between company data resources and AI models represents a monumental shift in the way employees operate within organizations. It transcends traditional boundaries, creating a data-driven culture where employees leverage the power of data and AI to enhance productivity, drive innovation, and make decisions that propel their organizations toward success in an increasingly dynamic and competitive business environment.

However, the authors state that the use of AI models is not only limited to the IT department within the company but is available to all employees as an open-source online tool. This by default enables the employees to use them without sufficient understanding and proper training. This creates many challenges which are discussed in the next chapter.

5. CHALLENGES IN THE USE OF COMPANY DATA RESOURCES IN INTERACTION WITH AI MODELS

5.1. Data Exposure and the Risk of Loss to the Company

The integration of language models into company workflows has enabled transformative possibilities for natural language processing and communication. However, this integration also introduces a critical concern - data exposure. When sensitive company data, whether from databases or emails, is shared with a language model, it poses a significant risk that can lead to substantial loss for the organization. Exposing sensitive company data to a language model without proper safeguards can result in data security and confidentiality breaches. Language models are designed to process and generate text, and in doing so, they may inadvertently reveal sensitive information. Unauthorized access, data leaks, or even accidental disclosures through generated text can compromise confidential business data. Such breaches can lead to reputational damage, legal liabilities, and loss of customer trust.

5.2. Compliance Violations:

Many industries are subject to strict regulatory frameworks that mandate the protection of sensitive data. For example, healthcare organizations must comply with the Health Insurance Portability and Accountability Act (HIPAA), which governs the privacy and security of patient health information. Similarly, financial institutions are bound by the Sarbanes-Oxley Act (SOX) and other regulations. Exposing data to a language model without appropriate measures to maintain compliance can result in violations, leading to hefty fines and legal consequences.

5.3. Intellectual Property Risks:

Companies often store proprietary information and intellectual property in their databases and email systems. When such data is exposed to a language model, there is a risk that it may be inadvertently included in generated content. This could lead to the unintentional sharing of intellectual property or trade secrets, potentially benefiting competitors or exposing the company to litigation.

5.4. Data Leakage through Generated Content:

Language models generate text based on patterns learned from the data they have been trained on. In some cases, this means that the model may generate text that unintentionally contains sensitive or confidential information from the data it has been exposed to. This text could be used in various ways, such as in customer communications, reports, or public-facing content, inadvertently exposing sensitive data to external parties.

5.5. Ethical and Privacy Concerns:

Exposing sensitive data to a language model raises ethical and privacy concerns, particularly when it comes to personal data about employees, customers, or partners. Mishandling such data can lead to breaches of trust and damage to the company's reputation.

5.6. Loss of Competitive Advantage:

Companies often rely on their data resources as a competitive advantage. Data exposure, especially if it leads to intellectual property theft or the leaking of sensitive business strategies, can erode this advantage and compromise the company's market position.

6. LITERATURE REVIEW

In this chapter, the authors explore what various scientific studies have to say about how companies use their data with AI models. This article looks at the most widely discussed research papers and what they reveal on this topic. The authors aim to distill the main ideas and challenges presented in scientific literature. By doing this, we aim to provide you with a clear overview of the findings from multiple studies, shedding light on how businesses are leveraging data and AI use benefits. This review should offer valuable insights drawn from existing scientific research, which can inform further inquiry and practical applications in the ever-evolving landscape of modern business and technology.

Methodology: This systematic literature review was put together using Kitchenham's (2004) methodology for doing so. Kitchenham (2004) claims that a systematic literature review may be broken down into three key stages: planning, carrying out, and reporting. A list of research questions, as well as inclusion and exclusion standards, are the main topics of the literature review.

Planning: In the planning stage of the systematic literature review, it is important to acknowledge the need for writing the review itself for a certain topic. The need for a systematic literature review can be established by evaluating already existing scientific literature reviews in the chosen

subject area. To the author's best knowledge, no systematic review of the literature has been found that summarizes the challenges and potential risks of exposing company data to open AI Models. Therefore, this systematic literature review is the first one to be written on the defined topic.

According to the chosen methodology, the following research questions were established:

RQ1: Are there any studies that discuss the use of company data in the interaction with open AI models?

RQ2: What are the main possible risks of data exposure to the AI models according to these studies?

RQ3: Can these risks be avoided or mitigated?

The Scopus database was searched for this literature review. Search terms defined for search in this database are:

- the paper has to be in the area of AI, AI data models, Company Data Use,
- the paper is written in English,
- the paper is written between 2019-2023.,
- the paper is a scientific article,
- the paper must represent a study in which challenges or opportunities of using AI models with company or organization data.

Conducting the review: The researchers carefully examined 64 scientific papers that matched the defined criteria. Out of those 15 papers were selected as insightful and helpful for the study related to the abovementioned research questions.

6.1. Reporting the review

The authors selected relevant papers and created summaries of the parts that are relevant to the research questions.

Lee et al. (2019) discuss the potential benefits of using AI models to analyze company data, such as improving performance and innovation. However, the author also acknowledges that there are challenges associated with data use, such as data quantity and uncertainty, and that companies may lack the internal expertise to effectively implement AI technology. Additionally, the author notes that there may be ethical concerns related to data privacy and security that need to be addressed.

The study by Di Vaio et al. (2020) consider intellectual property, data privacy, liability, and compliance with evolving laws and standards. They state "AI relies heavily on data, and ensuring the quality, integrity, and security of data used in SBMs is crucial. Data governance and data management become critical aspects of AI adoption".

"AI models can be transformative for businesses but also highlight potential risks and challenges associated with data use. These include issues related to data exposure to AI models, data loss, and the need for clear processes towards consent. The author suggests that future research should investigate these factors and their implications for the strategic business value of digital transformation. Additionally, the author emphasizes the importance of full disclosure and

transparency about the intelligent agent or hybrid systems to clarify the roles of humans and machines" according to Akter et al. (2022).

Cheatham et al. (2019) warn that "ingesting, sorting, linking, and properly using data has become increasingly difficult as the amount of unstructured data being ingested from sources such as the web, social media, mobile devices, sensors, and the Internet of Things has increased. As a result, it's easy to fall prey to pitfalls such as inadvertently using or revealing sensitive information hidden among anonymized data." The authors also mention that technology and process issues across the entire operating landscape can negatively impact the performance of AI systems and that security snags are another emerging issue. The author emphasizes that leaders need to be aware of these issues as they work to stay in line with privacy rules and otherwise manage reputation risk".

Reddy et al. (2020) emphasize the importance of protecting patient confidentiality and obtaining informed consent for the usage of personal health data in AI systems. The author also highlights the risks of privacy breaches and data loss associated with sharing patient data with AI developers. The author recommends seeking fully informed consent from patients and anonymizing data to minimize the risks of analysing confidential and sensitive data. The author also suggests using public datasets to develop AI software to minimize privacy breaches. Overall, the author stresses the need for ethical and transparent practices in the use of company data with AI models to prevent potential issues related to data exposure and loss.

Campbell et al. (2020) note that there are concerns about data exposure and loss, particularly considering recent data breaches and harvesting of data without consumer consent. The author suggests that firms need to be aware of the increasingly important challenges of privacy and regulation and that consumers are growing more concerned about what data is being collected from them and how it is being used by marketers.

Loureiro et al. (2021) discuss the potential benefits of using AI to gain insights from vast amounts of data that organizations produce or have access to. Additionally, the author mentions that there is a risk of data loss when using AI models, as the models may not be able to accurately interpret complex data.

Enholm et al. (2022) present a balanced view of the potential benefits and challenges of using AI in company data analysis.

Bharadiya (2023) emphasizes the importance of ethical considerations in AI development and deployment, particularly in terms of protecting user privacy and ensuring compliance with data protection regulations. The use of vast amounts of data, often including sensitive and personal information, requires organizations to implement robust security measures, data anonymization techniques, and secure data handling practices to safeguard user information. Additionally, the author highlights the potential risks associated with biased data and unintended consequences and stresses the need for transparency and accountability frameworks to detect errors, biases, or unethical behaviour and facilitate remedial actions.

Rudin and Radin (2019) discuss the potential issues with using black box models in AI, particularly in terms of data exposure and data loss. They argue that trusting a black box model means trusting not only the model's equations but also the entire database it was built from, which can contain imperfections and errors. The author suggests that using interpretable models can help

mitigate these issues and improve transparency and accountability in industries such as finance and healthcare.

Gregory et al. (2021) emphasize the importance of treating data as a strategic asset and carefully managing it to reap the benefits of data network effects. The author suggests that developing or acquiring a superior platform AI capability is not enough, and that attention must be paid to three key mechanisms of data network effects: (1) data stewardship, (2) user-centric design, and (3) platform legitimation. The author also discusses the need for responsible use of personal data collected from users, implementing principles of privacy-by-design and security-by-design, and ensuring the explainability of predictions generated by AI on the platform. The author does not specifically address issues of data exposure to AI models or data loss.

Overgoor et al. (2019) discuss the use of AI to support marketing decisions and provide a process for managers to use when executing a Marketing AI project. The authors note that while AI has proven to be useful in many applications, many firms lack a process by which to execute a Marketing AI project. The article also discusses issues that might arise, such as data exposure to the AI models and data loss. The authors suggest that companies should be transparent about their use of AI and ensure that their data is secure. The authors mention two issues related to data in the context of using AI for marketing: data exposure to the AI models and data loss. Data exposure refers to the possibility that sensitive or confidential data may be exposed to the AI models, which could lead to privacy violations or other negative consequences. Data loss refers to the possibility that data may be lost or corrupted during the process of using AI for marketing, which could lead to inaccurate or incomplete results. The authors suggest that companies should be aware of these issues and take steps to mitigate them.

Jöhnk et al. (2021) suggest that change management can help employees understand and cope with AI-induced organizational change and that data security and privacy concerns should be addressed to prevent data exposure and loss. Yes, the authors suggest that data security and privacy concerns should be addressed to prevent data exposure and loss. They note that data breaches can lead to significant financial and reputational damage to organizations and that AI-based systems can be vulnerable to cyber-attacks. Therefore, they recommend that organizations implement appropriate security measures, such as encryption, access control, and monitoring, to protect their data from unauthorized access and misuse. Additionally, they suggest that organizations should comply with relevant data protection regulations, such as the General Data Protection Regulation (GDPR), to ensure that personal data is processed lawfully and transparently.

Loureiro et al. (2021) discuss the increasing need for companies to integrate Big Data information to better serve the consumer and improve production efficiency. However, the use of AI models to analyze this data raises concerns about data exposure and loss. The author notes that deep learning models are often black boxes, making it difficult to understand how they arrive at their predictions. To address this issue, the author suggests the use of eXplainable AI (XAI) algorithms, which can provide more transparency and accountability in AI applications. Additionally, the author emphasizes the importance of ethical and legal issues regarding the data protection of citizens and the new role of robots in society.

According to Benbya et al. (2021), "Researchers should explore potential unintended consequences that arise as AI is increasingly integrated into decision-making practices, including data exposure to AI models and data loss".

7. CONCLUSION

The authors think that without any doubt there are substantial benefits from the use of AI models in day-to-day business activities. However, this new opportunity brings new dangers and security pitfalls. Business organizations should make adjustments in their strategy and policies to harness the power of AI Models while minimizing the potential risks. To mitigate the risk of data exposure when using language models, organizations should implement strict data access controls, encryption mechanisms, and data anonymization techniques. Additionally, they should carefully review and redact sensitive information from data before it is exposed to the model. Employee training and awareness programs can also play a vital role in preventing unintentional data exposure.

In conclusion, data exposure from databases or other data sources to language models presents a real risk to companies, encompassing data security breaches, compliance violations, intellectual property risks, and ethical concerns. Recognizing and mitigating this risk is essential for organizations seeking to leverage language models while safeguarding their data assets and reputation. Proper data protection measures and adherence to regulatory requirements are indispensable to achieve benefits and minimize the risk.

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Linear Statistical Features for the Purposes of Computer Network Automation

Milan Milivojević[1]
Milan Pavlović[2]
Marija Zajeganović[3]

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Abstract: *The development of artificial intelligence finds applications in various practical areas, such as computer networks. The primary goal of introducing automated methods is the efficient optimization of computer network operations. As input data for each algorithm, parameters that best describe the computer network are defined. Therefore, it is essential to define which parameters are relevant to ensure the significant use of automation methods. Parameters like Round-Trip Time delay resulting from ping commands can be used as the basis for defining input parameters for the automation system. This approach can help detect anomalies in network operation due to topology disruptions and increased load on specific links within the network. These anomalies can be mitigated by adjusting routing protocol parameters and activating redundant links. The authors describe basic features that can be extracted from time series data containing information about delay times. Special emphasis is placed on the characteristics that result from linear statistical analysis using the Python programming language.*

1. INTRODUCTION

In recent times, there has been evident development of artificial intelligence tools in various spheres of human activity. It is not necessary to further emphasize the significance of artificial intelligence in terms of increasing the efficiency of various processes and systems while reducing costs, ensuring their further development. In the field of computer networks, automation is increasingly prevalent. Computer networks are complex systems consisting of various elements. Primarily present are network elements such as routers and switches, which have their predefined configurations. Since the conditions in the operation of computer networks are not static, it is necessary to make occasional changes in the configuration to ensure smooth operation. Computer networks are susceptible to faults in the elements themselves, congestion on certain links within the network, as well as external links. The intensity of disturbances can vary from minor faults to failures of individual parts of the network. On the other hand, malicious attacks can also cause problems in the network's operation. In this case, it is necessary to make certain modifications within the network to successfully carry out the defense and return to normalcy with minimal degradation (Yaibuates & Chaisricharoen, 2020).

The time to restore normal functioning must be as short as possible. The automation system can react by disabling certain parts, forming appropriate isolated area, disconnecting specific links, creating new routes, etc. To make all of the above possible, it is necessary to automatically change configurations, primarily of network elements. In the case of routers, this may

[1] Academy of Technical and Art Applied Studies Belgrade (ATUSS) – Department ICT College for vocational studies, Zdravka Čelara, 16, 11000, Belgrade, Republic of Serbia
[2] Academy of Technical and Art Applied Studies Belgrade (ATUSS) – Department ICT College for vocational studies, Zdravka Čelara, 16, 11000, Belgrade, Republic of Serbia
[3] Academy of Technical and Art Applied Studies Belgrade (ATUSS) – Department ICT College for vocational studies, Zdravka Čelara, 16, 11000, Belgrade, Republic of Serbia

involve changes to interface configurations, modifications to routing protocol parameters, adjustments to the costs of individual links, and traffic balancing to redirect traffic along alternative paths and methods.

The automation system operates with specific scripts that gather all the necessary information for the implementation of the automation procedure. First and foremost, it is essential to collect information about the network's status, and this process occurs in cycles. After gathering all the necessary information, the computer network automation system optimizes the network, undertaking urgent procedures in the case of unforeseen situations (Ahuja et al., 2021).

This paper presents linear statistical characteristics that can serve as a starting point when the automation system assesses the performance of a computer network. The advantage of applying these features lies in their simplicity of calculation. By using the well-known 'ping' command, information about the availability of specific hosts in the network and latency time can be obtained. Basic statistical analysis was then performed on this data to extract certain features, in this case, moments up to the fourth order. Additionally, the possibility of a more in-depth analysis using the linear regression procedure was demonstrated. Based on these extracted features, the automation system can make certain modifications to the computer network to ensure smooth operation. The Python programming language was used to implement specific simulations.

The paper is organized into five chapters. The first chapter serves as an introduction. The second and third chapters define the Round-Trip Time (RTT) and the acquisition of that time. The fourth and fifth chapters are dedicated to linear statistical analysis and modeling of the RTT time series. The sixth chapter provides a conclusion.

2. ROUND TRIP TIME

The Round-Trip Time (RTT) represents a fundamental parameter that quantitatively describes the performance of networks in general, particularly in the context of computer networks. The content transmitted through computer networks can vary significantly in its characteristics, making the RTT parameter directly related to user experience. In the case of video content streaming, it is directly correlated with the quality of the user's video experience (video QoE). On the other hand, it directly affects the page load time of a website. Any change in RTT statistics indicates a degradation in user experience. The cause of this degradation primarily lies in issues within the computer network itself, such as problems with network elements of hardware and/or software nature, inappropriate network protocol settings, interruptions in individual links, etc. Secondly, problems may arise from malicious activities, such as various types of network attacks aiming to intercept traffic and ultimately make the service unavailable. Therefore, sudden and significant variations in the RTT parameter indicate issues such as network congestion or that the network is under attack from remote entities. Hence, monitoring the RTT parameter is of great importance for overseeing a computer network to react promptly and eliminate adverse effects within the shortest possible time frame.

The most commonly used tool for evaluating the Round-Trip Time (RTT) parameter is the application of ICMP (Internet Control Message Protocol), which is based on the exchange of request/reply messages between two nodes in the network. Nodes in the network refer to any host (computer, corresponding serial/Ethernet interface of routers or switches). The ICMP

protocol, in synergy with the IP protocol, provides the capability to report potential errors that occurred during the transmission of IP packets on the path from the source computer to any host (Gezer, 2019).

There are various types of ICMP, but the use of the ping option is crucial for us. Ping is another term for sending ICMP Echo messages. In this case, the header size is 8 bytes, where the corresponding type field is used to differentiate between requests and response messages. The value 8 represents a request (Echo request message), while 0 is reserved for a response (Echo reply message). This is illustrated in Figure 1.

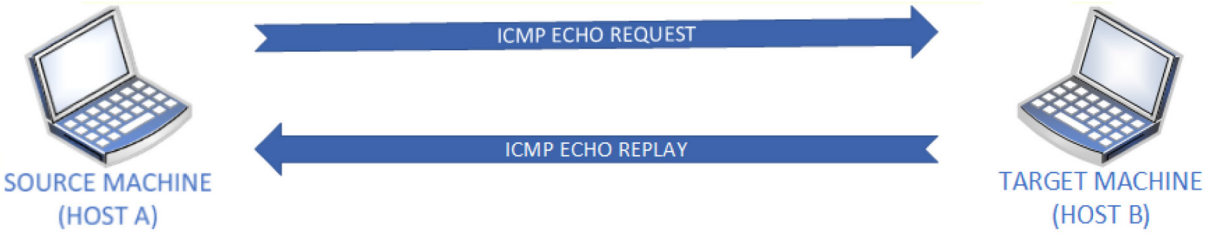

Figure 1. Ping through ICMP messages

Source: Own processing

In general, two points are observed (source and destination). The first point is usually within the computer network, while the second point can be a remote node outside the boundaries of the observed network. The connections between nodes represent links. Links can be direct, or there may be hidden routers serving as links between individual segments that are not explicitly visible. When measuring RTT, it is assumed that there is no change in topology, and the routing table has an unchanged content.

The evaluation of RTT time is based on the exchange of ICMP request/echo messages between two nodes. The result of the operation can be that the host in node B is unreachable, or an echo message containing information about the RTT time, usually expressed in milliseconds (ms).

The Round-Trip Time (RTT) represents the total time required for a message to propagate from node A to node B and back. This time includes all delays originating from the link, processing, and waiting times. In this way, it is possible to answer whether the host is available and what time is required for packets to propagate to the host and back. If the host is unavailable, then the value of this parameter is infinite.

One drawback of estimating the RTT parameter based on ICMP requests is that Internet Service Providers (ISPs) often block or limit the flow of ICMP traffic. ICMP traffic has lower priority on routers (Guo & Heidemann, 2018). However, as a fundamental measure of network connectivity, it remains the primary choice for estimating RTT traffic. If certain problems are detected, more precise methods for estimating RTT time, available in the literature, can be considered in a second iteration (Sengupta et al., 2022).

3. ACQUISITION OF ROUND-TRIP TIME DATA

The process of acquiring the Round-Trip Time (RTT) data typically involves sending a series of ICMP requests to a specific node, measuring the time between sending the request and receiving the response for each ICMP request and recording these values in an array. These data can

then be analyzed to gain insights into the performance characteristics of the network, as well as to monitor changes over time (Matcharashvili et al., 2020).

During the acquisition of the RTT data, it is important to consider factors such as network conditions, network load, and potential communication issues with the remote node. This information can be crucial for maintaining and optimizing the performance of a computer network.

The core part of the Python script consists of the ping command from the pythonping Python library, which takes the following input parameters: the destination IP address, packet size in bytes, and the number of packets sent to the destination. For the destination host's IP address, you can choose a host belonging to the same local computer network as the source host or a host belonging to a different remote computer network. A packet size of 32 bytes and a packet count of 200 have been chosen empirically, and these values directly affect the time required to collect the resulting RTT array. Therefore, the selection of these values is crucial.

As a result of the ping command, data is printed, and it needs to be parsed to extract only the numeric data related to the RTT parameter expressed in milliseconds. For this purpose, a specific script has been written in the Python programming language.

Computer Code

```
import numpy as np
from pythonping import ping
def prikupi _ ping(ip _ adresa,broj,velicina):
    odgovori = ping(ip _ adresa,verbose=False,count=broj,size=velicina)
    RTT=[]
    for odgovor in odgovori. _ responses:
        x = str(odgovor)
        x = x.partition('in ')[-1][0:-2]
        RTT.append(x)
    RTT = np.array(RTT, dtype = float)
    return RTT
```

The extracted array with RTT data is stored in a separate file suitable for working with data processing programs and the Python programming language. In case the destination host is unreachable or for some reason, it is not possible to estimate the delay time, a non-numeric NaN-type value is stored in the file. The total number of values must correspond to the number of sent packets. In Figure 2, the dependence of the delay time expressed in milliseconds on the sequential number of sent packets is shown. It is observed that there is a pronounced explosiveness in the response, considering the occurrence of pronounced local maxima and minima.

In practical applications, it is often convenient to observe time series with certain averaging within a defined time frame. For this reason, moving averaging is used according to formula 1.1.

$$RTT^{*}[k] = \frac{1}{W}\sum_{n=k}^{W+k-1} RTT[n] \tag{1.1}$$

In this equation, W represents the length of the time frame over which averaging is performed, RTT is the original array with estimated delays, and RTT* is the averaged array with estimated delays.

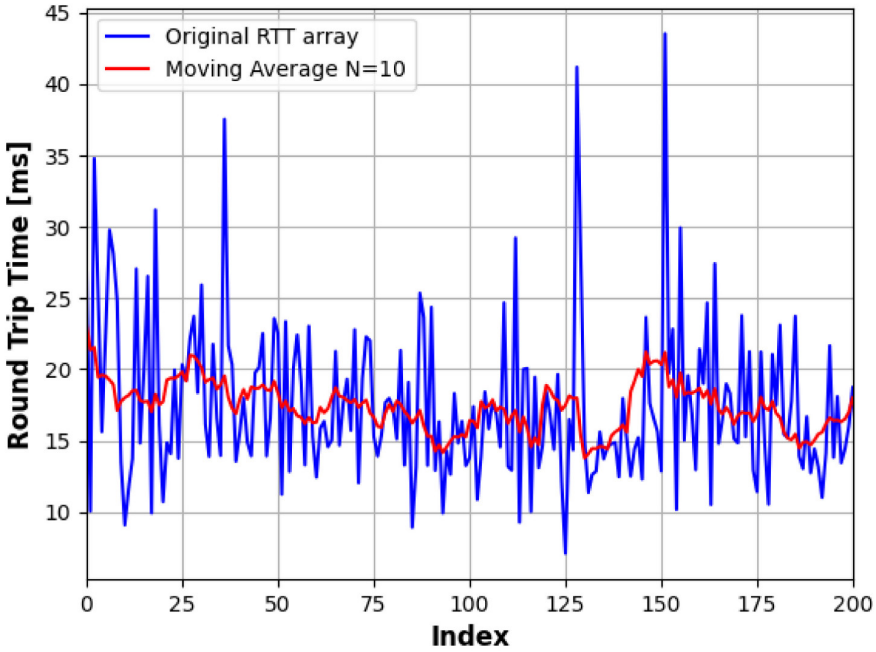

Figure 2. The original and moving averaged RTT time series

Source: Own calculations

The sample value at time k is obtained as the mean of the W previous samples, corresponding to the length of the time frame. For small values of this parameter, information about changes in delay values near the observed moment is retained. For larger values of the time frame length, information about local changes is lost in favor of a global picture of delay behavior. Figure 2 illustrates the averaged data (red line) alongside the original data (blue line) with a time frame length value of W=10. Explosive changes in delay values are no longer visible, while information about the data trend is preserved. The automation system for computer networks controlled by artificial intelligence, through variations in the time frame length parameter, influences the nature of the required delay data in the network. Any irregularity in the operation of the computer network will directly reflect in the appearance of the time series and can be easily detected.

4. LINEAR STATISTICAL ANALYSIS OF THE RTT ARRAY

Statistical analysis of Round-Trip Time (RTT) delays is crucial for analyzing and testing the functionality of computer networks. A broad categorization of statistical analyses is based on the use of linear or nonlinear methods and models on the time series. Basic analysis involves the application of linear methods, with the linear regression model being the most commonly used. Among the fundamental parameters calculated for each time series, moments up to the fourth order are typically employed, including mean, standard deviation, skewness and kurtosis (Gupta & Kapoor, 2018).

The mean, or the first-order moment, represents the arithmetic average of all values within a set or time series. All weights assigned to the values within the set have equal value.

$$\overline{RTT} = \frac{1}{N}\sum_{n=1}^{N} RTT[n] \tag{1.2}$$

The standard deviation, or the second-order moment of a time series, represents the square root of the arithmetic mean of the squared deviations of values in the series from their mean. The square in the formula for calculating the standard deviation ignores the sign of the deviations.

Standard deviation is one of the measures of data dispersion and is highly sensitive to the presence of extreme values within the series.

$$\sigma(RTT)=\sqrt{\frac{1}{N-1}\sum_{n=1}^{N}\left(RTT[n]-\overline{RTT}\right)^2} \quad (1.3)$$

Skewness is the third-order moment and represents the lack of symmetry in the distribution of time series values. An example of a symmetric distribution is the normal or Gaussian distribution. The sign of the third-order moment indicates asymmetry, which is pronounced on the right or left side of the distribution.

$$s=\frac{1}{N-1}\cdot\frac{1}{\sigma^3(RTT)}\sum_{n=1}^{N}\left(RTT[n]-\overline{RTT}\right)^3 \quad (1.5)$$

Knowing measures of central tendency such as skewness and dispersion still may not provide a complete understanding of the behavior of a time series distribution. Pearson introduced the concept of kurtosis (convexity of a curve), or the fourth-order moment. Kurtosis enables us to understand the flatness or peakedness of the curve. A curve flatter than the normal curve is known as platykurtic, while a curve more peaked than the normal curve is called leptokurtic.

$$k(RTT)=\frac{\frac{1}{N}\sum_{n=1}^{N}\left(RTT[n]-\overline{RTT}\right)^4}{\sigma^4(RTT)} \quad (1.6)$$

The discrete distribution or relative histogram of the observed RTT array has been estimated for graphical representation. In Figure 3, the relative histogram is displayed, with the bin frequency value set to 0.5 ms. The relative histogram is fitted using a Gaussian distribution, indicated by the red color. The parameters of the fitted Gaussian distribution correspond to the first and second-order moments. The values of all calculated moments are also shown on the same graph.

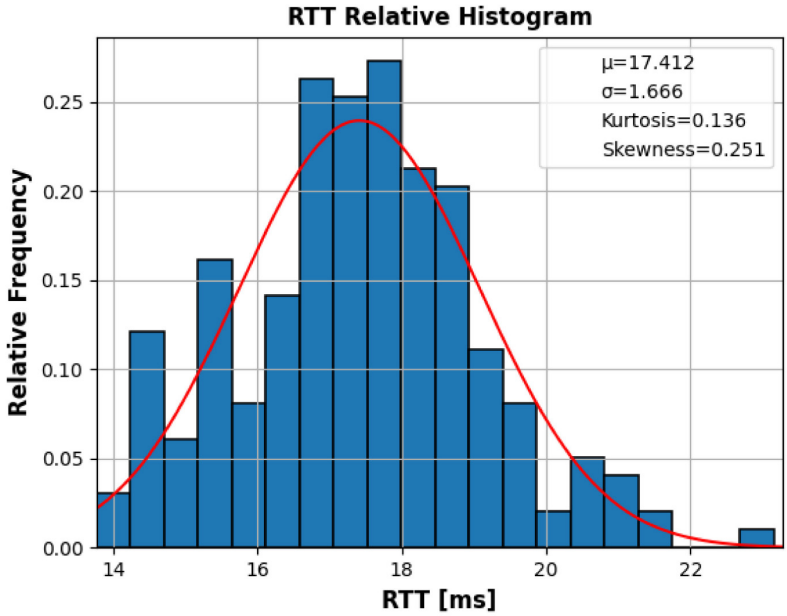

Figure 3. The relative and fitted histogram for RTT time series

Source: Own calculations

The relative histogram together with the moments provides a fundamental set of information about the state of the computer network when observing two nodes in the network. This information

must be periodically collected in the computer network automation system to prevent or effectively mitigate the negative effects during incident situations, such as various types of faults and failures. By observing two measurements of these parameters, it is possible to define specific thresholds that indicate which changes in parameter values may indicate certain performance degradations or impending attacks within the computer network. This allows for a more comprehensive investigation into the nature of the degradation when such changes are detected.

5. LINEAR MODELING OF RTT TIME SERIES

It has already been mentioned that the ping command used to assess RTT delay values takes multiple input parameters, such as the number of sent packets (count) and the size of the packets. In order to better analyze the nature of the RTT time series, a simulation was performed by varying one of the parameters. The simulation was conducted in multiple iterations, where each iteration involved an increase in the number of sent packets in the range from 40 to 100 with a step size of 5. For each value of sent packets, the corresponding RTT array was obtained. The first moment value was calculated for each of these RTT arrays. This process resulted in a set of points representing ordered pairs of the number of sent packets and the mean value of the RTT array. Linear regression was then applied to this set of points, obtaining parameters corresponding to the slope and intercept. These parameters define the line that fits the data and is shown in Figure 4.

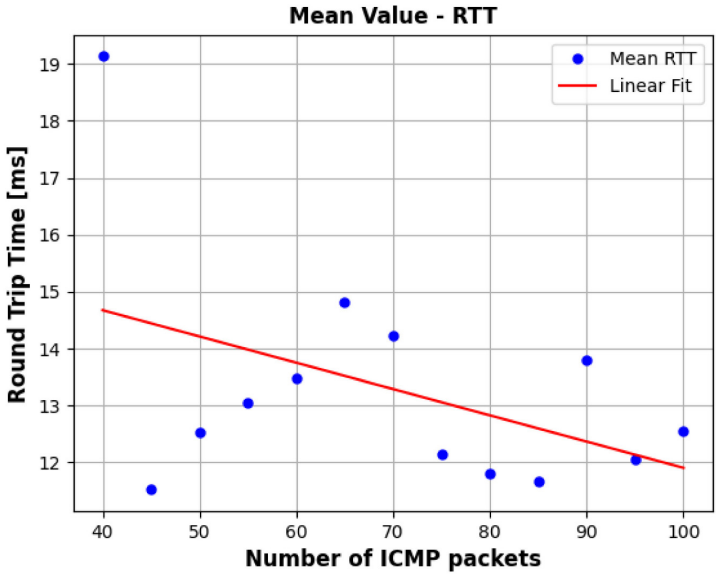

Figure 4. An example of linear fit for mean RTT values

Source: Own calculations

The parameter values of the linear model can be calculated based on the following equations (Lauritzen, 2023):

$$k = \frac{\sum_{i=1}^{N}\left(X[i]-\overline{X}\right)\cdot\left(Y[i]-\overline{Y}\right)}{\sum_{i=1}^{N}\left(X[i]-\overline{X}\right)^{2}}, n = \overline{Y} - k\cdot\overline{X} \tag{1.7}$$

where: $\overline{Y}$ is the mean of the dependent variable (mean RTT), $\overline{X}$ is the mean of the independent variable (mean number of sent packets), X_i and Y_i are individual data points and N is the number of data points. Calculated values for the slope coefficient and the intercept are: k= -0.044 and n=16.4.

Changes in these parameters depending on the moment when a specific test is conducted in the network serve as an additional indicator that can aid in network performance analysis. Any significant change indicates a potential issue in the network operations.

6. CONCLUSION

Automation in computer networks brings numerous benefits and facilitates administration, optimization, and configuration. All of this aims at detecting and resolving issues that may arise due to various external and internal factors. A prerequisite for any automation is defining a set of features that best reflect the state of the computer network. By activating specific scripts, data on the values of these features is collected. Based on the gathered features, the automation system, which may be controlled by artificial intelligence in the future, makes decisions about changing the configuration of the computer network in conditions that correspond to potential incident situations. This paper explores the possibilities of using linear statistical features for the automation of computer networks. The used features include moments up to the fourth order. The use of a linear regression model for automation purposes is demonstrated. For further research, it is necessary to apply nonlinear statistical approaches and methods. Linear statistical features are significant for rough examinations, while the application of nonlinear models is inevitable for a more detailed analysis.

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Implementation of Next-Generation Firewalls in Modern Networks

Milan Pavlović[1]
Marija Zajeganović[2]
Milan Milivojević[3]

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Network security;
IoT

Abstract: *The primary function of any firewall is to assist in protecting against unwanted or malicious traffic entering or leaving a network. However, as threats evolve and become increasingly challenging to detect, network security must remain equally sophisticated. In addition to access control, Next-Generation Firewalls can block modern threats such as advanced malware and application-layer attacks. This paper will present the fundamental characteristics of Next-Generation Firewalls and their implementation in modern networks, particularly their use in IoT. First, the concept of Next-Generation Firewalls will be explained, highlighting significant improvements they have over previous generations of firewalls, and the reasons for implementing them. Next, the authors will provide an overview of Next-Generation Firewall architectures. Special attention will be given to the use of Next-Generation Firewalls in the context of IoT.*

1. INTRODUCTION

Without a doubt, a notable challenge in the realm of network security involves guaranteeing access to data, secure transactions, data integrity, and privacy, among several other considerations. An essential protective measure in the modern Internet network is the firewall. In the computing network, a firewall serves as a device that segregates a potentially dangerous external network from the local network. However, it must possess a level of sophistication to regulate both incoming and outgoing network traffic based on specific rules, ensuring security against undesired and perilous network activities. So, network security is one of the important things that need to be implemented in computer networks. The primary function of any firewall is to assist in protecting against unwanted or malicious traffic entering or leaving a network. Firewalls are divided into hardware and software firewalls.

A hardware firewall is a physical device that is typically placed between your internal network and the Internet. It acts as a barrier, inspecting all incoming and outgoing network traffic to protect your network from unauthorized access, malware, and other threats. Hardware firewalls are more expensive and somewhat more challenging to use, but they offer better protection. Compared to software firewalls, hardware firewalls have a higher data throughput and processing power, depending on the quality and performance of the firewall hardware. They are suitable for larger organizations, allowing the installation of multiple devices in the same network to increase data processing speed, flow, and protect various servers. Different departments within a company can be separated, and distinct rules can be created for each. The main advantage lies in speed and enhanced security. Since hardware firewalls have their operating system, they are

[1] The Academy of Technical and Art Applied Studies Belgrade, Department School of Information and Communication Technologies, Zdravka Čelara 16, Belgrade, 11000, Republic of Serbia
[2] The Academy of Technical and Art Applied Studies Belgrade, Department School of Information and Communication Technologies, Zdravka Čelara 16, Belgrade, 11000, Republic of Serbia
[3] The Academy of Technical and Art Applied Studies Belgrade, Department School of Information and Communication Technologies, Zdravka Čelara 16, Belgrade, 11000, Republic of Serbia

less susceptible to attacks, offer advanced security features, and various configuration options. With proper centralized management and maintenance by a qualified individual, the security level is significantly higher compared to software firewalls. The main drawback remains the high purchase cost and the need for proper configuration.

A software firewall, on the other hand, is a program or application that runs on an individual computer or device. It monitors and controls network traffic on that specific device, allowing or blocking data based on predefined security rules. Its job is to control every entry point through which network traffic passes on a computer. Software firewalls maintain a list of all applications with network access and control entry points through which communication occurs. If the firewall detects malicious traffic, it blocks it and alerts the user to unauthorized activity. Software firewalls are affordable and cheaper than physical or hardware firewalls. They are easy to use, and suitable even for individuals with general computer knowledge. Settings of the software firewall can be quickly and easily changed to adapt to our needs. The firewall automatically monitors active applications on the computer and adjusts filtering settings accordingly.

A drawback of software firewalls is vulnerability at the physical level of the OSI reference model. All network traffic from external networks reaches the computer before the firewall thoroughly scans it. It is more efficient in filtering outbound traffic, blocking any unauthorized traffic immediately. Software firewalls are susceptible to DoS attacks as they overload the firewall and, consequently, the computer on which it is installed. Another drawback is that they protect only the computers on which they are installed, not other devices in the local network. With an informed user and an updated application version, a software firewall is a relatively powerful means of protecting personal computers.

However, as threats evolve and become increasingly challenging to detect, network security must remain equally sophisticated. In addition to access control, Next-Generation Firewalls can block modern threats such as advanced malware and application-layer attacks. There are numerous manufacturers and various versions of next-generation firewalls. To make the right choice for the implementation of a next-generation firewall, it is necessary to accurately define the requirements based on the organization's needs.

In this paper, it will be explained the various implementations of firewall devices in modern networks. After a brief review of the main Next-Generation firewall characteristics given in Chapter 2, Chapter 3 will provide an overview of the Next-Generation firewall architecture. The use of Next-Generation Firewalls in the context of IoT will be emphasized in Chapter 4, while the specific case studies analyzed are described in Chapter 5.

2. FIREWALL TECHNOLOGY GENERATIONS

Since the first attacks on computer networks, firewall technologies have been continuously developed and improved. Historically, there have been multiple generations of firewall devices. Specifically, they are classified into three generations based on their characteristics and capabilities, as well as the latest fourth generation – a new generation of firewall technology (Liang & Kim, 2022).

Packet filtering was the first method by which firewalls checked incoming and outgoing traffic. It operates at the network layer. This is an extremely simple and accessible form of firewall

protection. With this protection, each incoming and outgoing packet of information is examined. The firewall can allow the packet to pass or reject it based on pre-defined rules set by the user. The firewall examines each packet based on the following criteria: Source IP address, Destination IP address, TCP/UDP source port, TCP/UDP destination port.

Such a simple system has its drawbacks. Packet filtering is susceptible to many attacks, including IP spoofing, where an attacker attempts to gain unauthorized access to a computer by sending messages to the computer with an IP address that indicates the message is coming from a trusted host. Packet filtering firewalls do not put data into context, analyze each one individually, and therefore are quite slow, also not providing a high level of security. They are very susceptible to IP spoofing attacks.

The second generation of firewalls has introduced packet filtering based not only on the source but also on content (Mukkamala & Rajendran, 2020). These firewalls incorporate stateful packet inspection, known as dynamic packet filtering, operating at the network layer. They constantly monitor the network's state, allowing decisions to be made not just according to user-defined rules but also based on the context of packets established during the successful passage of previous packets. This method enables the inspection of packet content rather than just their filtering. A key advantage of stateful inspection is dynamic filtering, facilitating faster data processing and the ability to track packets throughout a network session. However, while this type of firewall establishes a direct connection between two points in the network, configuring it and establishing effective security policies present challenges.

An application firewall is the third generation which can detect malicious traffic that packet filtering cannot. This is achieved through detailed packet inspection (DPI). A more in-depth understanding of data flow allows better monitoring and control of applications, improved traffic optimization, and enhanced security. To achieve this, it's necessary to look beyond just the layer 4 OSI model of the packet. Packets are examined at a specific moment, from level 2 up to level 7.

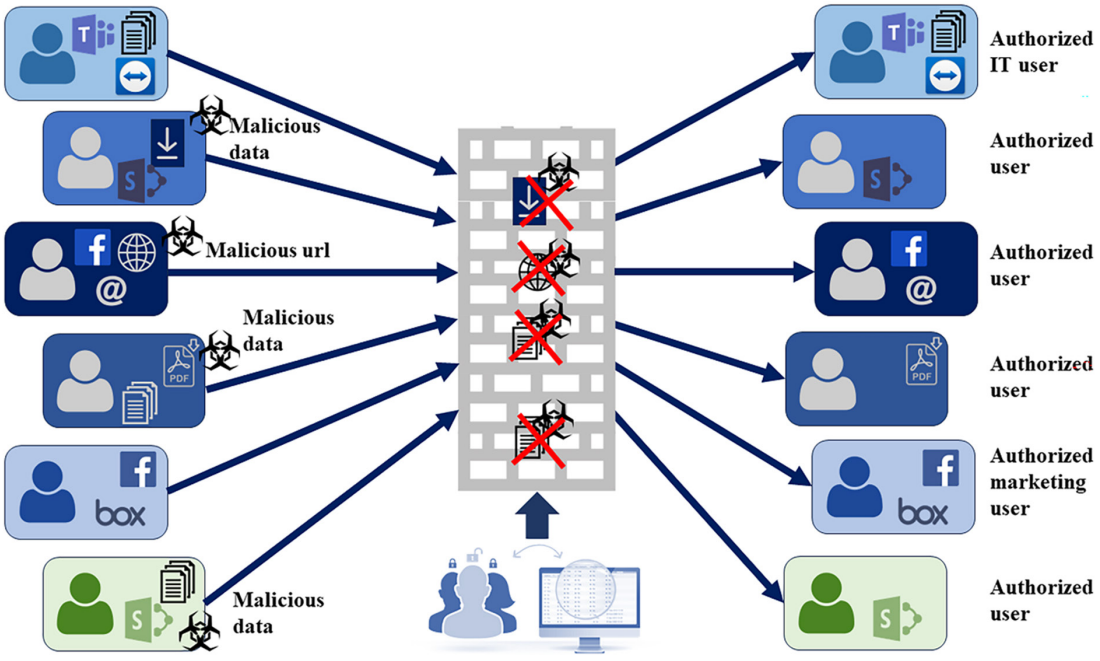

Figure 1. Packet inspection and filtering on application level 7 OSI model

Source: Own research

Based on packet inspection, the firewall classifies the packet, allowing it to enforce a specific security policy in the event of an attack. Such devices offer a wide range of functions. In addition to traditional analysis, they must identify applications without relying on basic criteria (Freet & Agrawal, 2016). They filter connections not only based on the port used but also based on the processes through which an application wants to connect to the web, see Figure 1. They provide much greater security than their predecessors, but as a result, they are more complex and require more than basic firewall knowledge to manage them. However, they are unable to create advanced security rules or perform traffic classification based on application, content, or user, which led to the development of a new generation of firewalls. These shortcomings are implemented in the fourth-generation firewall technology, i.e. next-generation firewalls.

3. NEXT-GENERATION FIREWALLS

Next-generation firewalls (NGFWs) are security walls with deep scanning of network packets, going beyond scanning only at the port and protocol levels. They can examine packets at the application layer of the OSI model and are capable of preventing intrusions. NGFWs are, therefore, independent devices whose main purpose is comprehensive protection between the local network and the external network, along with controlling local network traffic. The essence of the NGFWs is to have all the capabilities of previous versions of firewalls, as well as incorporate new technologies such as packet control, application control, and user control. The basic functional requirements for effective NGFWs include numerous capabilities like:

1. application identification regardless of port, protocol, operation technique, or use of SSL encryption;
2. support for traffic prioritization using traffic shaping and traffic policing mechanisms;
3. providing better visibility and granular control of applications;
4. accurate identification of users and using user identity as an attribute for security control;
5. ensuring traditional system protection against various threats, including application layer threats;
6. integration instead of combining traditional firewalls with IPS systems, antivirus solutions, and web filters;
7. support for processing large traffic volumes on the order of several gigabits per second without compromising system performance.

In addition to these requirements, support for traditional firewall functions is needed, including support for packet filtering, state inspection, NAT, deep packet inspection, VPN, IPS and IDS capabilities (Santos, 2020).

A key characteristic of next-generation firewalls is that they can do everything a traditional firewall can do, but with additional advanced capabilities that include new technologies, high performance, and additional functionalities depending on system requirements. NGFWs are adaptable, available in different setups, and can scale from small branch offices to carrier-grade data centers. They include centralized management that facilitates the easy administration of events and policies for network security solutions, dynamic protection, ensuring continuous visibility and policy enforcement for applications across networks and workloads. They offer administrators to monitor hosts, users, mobile devices, applications, virtual environments, threats, and vulnerabilities in the network. It is possible threat management in real-time, to control network access, monitor application usage, and defend against known attacks. NGFWs implement scalable log management combined with behavioral analysis for real-time threat detection and

response. This type of traffic analysis will later help in more detailed preparation of defense against future attacks. Furthermore, NGFWs automatically correlate security events with vulnerabilities in the network, prioritize attacks and suggest security policies for implementation.

NGFWs come in various types, each with specific features and capabilities to meet different security needs (Santos, 2020). Here are some common types of NGFWs along with their definitions.

First, there are Hardware-based NGFWs, physical devices that combine traditional firewall features with advanced security functionalities like intrusion prevention, application control, and content filtering. These appliances are deployed at the network perimeter to protect an organization's internal network from external threats. Then, NGFW software-based applications or software packages can be installed on standard servers or virtual machines. They offer NGFW capabilities on existing hardware and are often used for virtualized or cloud environments.

In cloud environments, cloud-based NGFW are delivered as a service and are hosted in the cloud. They protect traffic to and from cloud-based resources, making them well-suited for organizations that rely heavily on cloud services and need to secure their connections. Integrated NGFWs are part of a broader security appliance or platform, such as Unified Threat Management (UTM) devices. These devices incorporate multiple security features, including NGFW capabilities, in a single hardware appliance.

NGFW can be offered as a managed NGFW service which are outsourced NGFW solution where a third-party provider manages and maintains the NGFW on behalf of an organization. This is often used by companies looking to offload the responsibility of firewall management.

There are also virtual NGFWs, designed to run within virtualized environments. They offer the same NGFW capabilities as hardware-based appliances but are optimized for use in virtual machines or cloud environments. Then, container-based NGFWs, are designed to provide security for containerized applications and microservices. They are specifically built to secure containerized workloads and orchestration platforms.

Each type of NGFW has its advantages and may be better suited for specific use cases, depending on an organization's requirements, infrastructure, and security goals. The common thread among these types is their focus on providing advanced security features and capabilities beyond basic firewall functions.

4. NEXT-GENERATION FIREWALL ARCHITECTURE

There are several different firewall architectures in terms of their positions in a computer network where their implementation is possible. One architecture is known as the dual-homed architecture, where the firewall device has two network interfaces. One interface accepts traffic from the external network, and the other interface connects to the internal network. All traffic into the network enters through one interface, and necessary traffic control is then performed. When implementing this architecture, hosts from the internal network can communicate with the firewall device just like hosts from the external network, but a direct connection between the external and internal networks is disabled, providing a high level of control. The advantage of this architecture is a single entry point into the network, which allows excellent control. The

disadvantage of this architecture is the high-performance load on the firewall and the issue of a single point of failure because, in the event of a firewall device failure, an attacker gains direct access to the internal network.

The screened host architecture offers some additional options for providing new, unreliable, or inbound services. A screened host represents a type of firewall located at the edge of the network behind the edge router. Traffic coming from the Internet is first filtered at the router, and then the traffic is forwarded to the firewall device that performs additional traffic control. After the control, the traffic is forwarded to the internal network. This model represents the basic architecture of multi-layered network protection, the so-called defense in depth because if the firewall fails, a large part of the traffic will be filtered at the edge router. In this architecture, primary security is ensured by packet filtering. Packet filtering configuration in the screening router can do one of the following:

1. Allow other internal hosts to open connections to hosts on the Internet for certain services (allowing access to these services through packet filtering).
2. Disallow all connections from internal hosts (forcing those hosts to use proxy services through a bastion host).

The screened subnet architecture adds a layer of security to the screened host architecture by adding a perimeter network that further isolates the internal network from the Internet. With the simplest type of screened subnet architecture, there are two screening routers, each connected to the perimeter network. One is located between the perimeter network and the internal network, and the other is between the perimeter network and the external network (usually the Internet). To break into the internal network with this type of architecture, an attacker would have to pass both routers. Even if the attacker somehow breaks through to the bastion, they would still have to pass the internal router. This architecture is a true example of multi-layered protection because, for an attacker to gain access to the internal network, they must hack three devices.

There are more complex implementations of this architecture that use several different demilitarized zones, as well as multiple firewalls, including proxy firewalls for controlling access to a specific application, as shown in the image below. Placing a next-generation firewall in the right location within the system is a key factor in system design.

Designing systems that implement next-generation firewalls is based on the concept of segmentation. There are many ways to segment networks. Next-generation firewalls use a unique combination of hardware and software segmentation capabilities to allow an organization to isolate key parts of the network. Next-generation firewalls use the concept of security zones for network segmentation and isolation of key parts of information and communication systems. A security zone is a logical container for physical interfaces, VLANs, a set of IP addresses, or a combination of the above. Interfaces assigned to a specific security zone can be configured in layer 2, layer 3, or mixed mode. Interfaces operating in Layer 2 mode classify traffic based on MAC address or assigned VLAN tag. Layer 3 interfaces classify traffic based on IP address. Interfaces in mixed mode use a combination of Layer 2 and Layer 3 modes. Figure 2 shows the mentioned types of firewall architectures.

The placement of NGFWs in a network architecture depends on the specific security requirements and the desired level of control over network traffic.

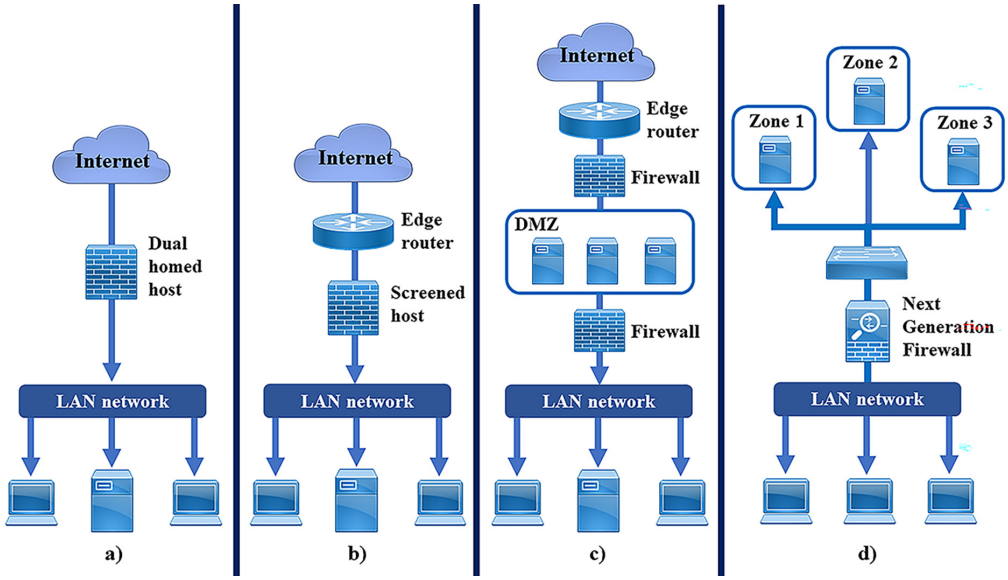

Figure 2. The various types of firewall architectures: A) dual-homed; b) Screened host; c) screened subnets; d) zone implementation

Source: Own research

One of the most common positions for an NGFW is at the network perimeter, acting as the first line of defense between the internal network and external networks (e.g., the internet). In this position, the NGFW monitors and filters incoming and outgoing traffic to prevent unauthorized access, block malicious content, and enforce security policies. NGFWs can be deployed between different segments of the internal network to control and monitor traffic between departments, business units, or other network segments. This helps in implementing and enforcing security policies for internal communications.

When organizations use VPNs for secure communication between remote offices or remote users, an NGFW can serve as the termination point for VPN connections. This allows the NGFW to inspect and secure VPN traffic, ensuring that encrypted communications are not used as a vector for threats. As organizations move services and applications to the cloud, NGFWs can be deployed at the edge of the cloud network or integrated with cloud security services. This ensures consistent security policies across on-premises and cloud environments.

NGFWs can be placed at the perimeter of the data center to protect critical servers and applications from external threats. They help in enforcing security policies and preventing unauthorized access to sensitive data. In distributed network environments with branch offices, NGFWs can be deployed to protect each branch's local network. This allows for consistent security policies and threat prevention across the entire organization.

Some organizations choose to deploy NGFWs inline within the network to inspect traffic between internal devices. This approach is used to add an extra layer of security and control over the lateral movement of threats within the network. NGFWs may be placed at internet egress points within the network to control and monitor outgoing traffic. This helps in preventing data exfiltration and enforcing security policies on outbound communications.

It is possible to implement failover for NGFW devices, organize them into clusters (Rajib, 2022), and thereby ensure a high level of availability. In this case, it is important to have two

identical firewall devices that are interconnected with a dedicated failover link. Simultaneously, a state link is configured for the exchange of stateful firewall information between the devices.

In Active-Standby failover mode, one firewall device is active and processes all traffic. The standby device in this mode does not process active traffic but synchronizes with the configuration and other information of the active device via the state link. When a failover occurs and the active firewall device goes down, the standby device is activated at that moment and takes over all traffic (Santos, 2020). The architecture of NGFW devices in Active-Standby failover mode is illustrated in Figure 3. In Active-Active failover mode, both devices monitor and filter traffic simultaneously.

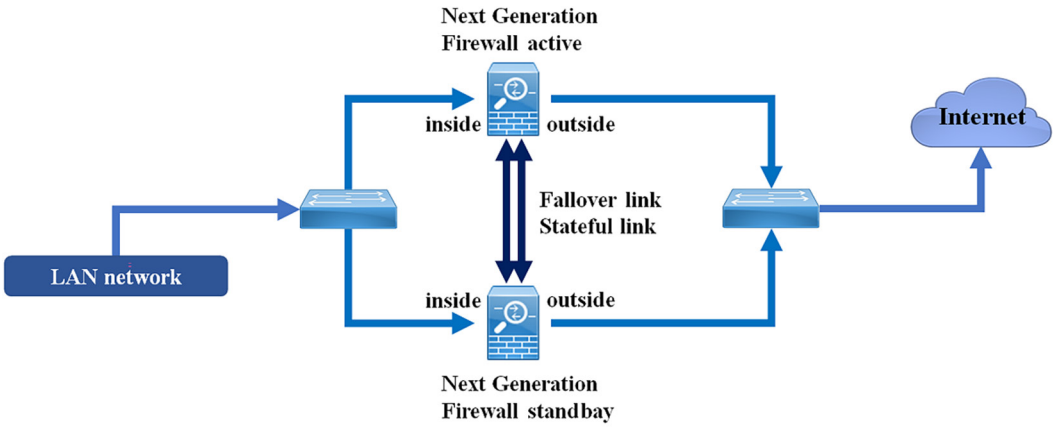

Figure 3. NGFW devices in Active-Standby failover mode

Source: Own research

The optimal placement of an NGFW depends on factors such as the organization's network architecture, security policies, and the specific use case. In many cases, a combination of these deployment scenarios is used to create a layered and comprehensive security strategy.

5. NEXT-GENERATION FIREWALLS IN IOT

IoT devices find applications across diverse industries, each employing unique architectures. Industrial and consumer IoT often adopt distinct structures, with manufacturers commonly utilizing the Purdue model to segment their Industrial Control Systems (ICS) networks. IoT network firewalls play a crucial role in reviewing and controlling traffic at network borders. This model divides the IoT architecture into several layers, each serving specific purposes. Level 4/5 is the Enterprise layer represents the corporate IT network, where Enterprise Resource Planning (ERP) systems oversee high-level manufacturing operations. Level 3.5 presents the Demilitarized Zone (DMZ) acts as a buffer separating IT and OT environments, incorporating security systems designed to safeguard OT environments from potential attacks via IT networks. Level 3 is Production Operations Systems manage workflows on the factory floor. Within the process network, operators use a Human Machine Interface (HMI) to access Supervisory Control and Data Acquisition (SCADA) software for monitoring and controlling physical processes and that would be Level 2. In the control network, intelligent devices such as Programmable Logic Controllers (PLC) and Remote Terminal Units (RTU) monitor and manipulate physical devices, defined in Level 1. The network field involves physical devices and sensors performing production operations and that would be Level 0.

Firewalls, which restrict incoming and outgoing network traffic based on predefined rules, are fundamental elements of network security. Firewalls are crucial to secure IoT devices, too. By utilizing an IoT firewall, administrators can narrow down their potential points of vulnerability, thereby minimizing the risk of an attack culminating in a security breach (Arefin et al., 2021). An IoT firewall is a security system that protects IoT devices and networks from cyber threats. Its primary purpose is to prevent unauthorized access to the Internet of Things behind the firewall and networks. The IoT firewall checks traffic from your devices and allows passage only to authorized traffic. Your devices are protected from network threats and illegal access by the firewall standing between them and the Internet. The IoT firewall analyzes network traffic and applies rules to decide whether to allow or stop it (Maheshwari & Dagale, 2018). For example, the firewall will determine if an attempt by a device to connect to the Internet is authorized. If so, the connection is valid; if not, the connection is blocked. IoT firewalls protect devices from exploitation and can be applied as IoT networks or IoT embedded firewalls. IoT network firewalls are deployed as part of network gateways and enable both macro and micro-segmentation of an organization's specific IoT implementation. IoT network firewalls can use VPNs to encrypt traffic between the network gateway and remote servers processing data collected by IoT devices.

On the other hand, IoT embedded firewalls are embedded in the operating system of IoT devices. They are installed by the manufacturer of IoT devices and can filter traffic to devices and potentially act as a VPN endpoint. These firewalls come in various types, each with unique features and capabilities. For example, some may encrypt communication to protect your data, while others may identify and prevent malicious traffic. IoT devices differ from traditional network firewalls. IoT security is crucial because of protecting personal data. IoT devices collect and store personal data that hackers can use to steal your identity, conduct illegal transactions, or even extort you. Securing your IoT devices prevents them from doing so. Furthermore, IoT devices are vulnerable to malware attacks, data leaks, and hacking. Installing reliable firewalls and antivirus software can prevent such attacks. To guarantee the efficiency of IoT networks and applications, users are encouraged to perform end-to-end testing. The network system must undergo several tests to ensure that all parts function together seamlessly, from end devices to cloud infrastructure such as Azure. Developers take necessary precautions to protect IoT applications from cross-site scripting (XSS). This script is a security flaw in which hackers access your network and other devices and data. Avoid such attacks by using the latest IoT security solutions. As more homes and businesses adopt IoT devices in their daily operations, they are increasingly used in critical resources and infrastructure. Breaching security in these systems can have catastrophic consequences, and it's best to stay ahead of attackers.

6. CONCLUSION

In today's world, there is no possibility of normal business operations without a developed information and communication system. A key aspect of protecting access to information systems is a well-configured and customized firewall. Traditional firewalls identified applications in a way that applied the rule IP address + port = application. Traditional security mechanisms performed their job well until the emergence of Web 2.0 applications. With the emergence and widespread use of Web 2.0 applications, user behavior changed, and concurrently, with the development and expansion of the Web, there is an increasing number of attack techniques and attempts. The operation of the next-generation firewall is based on three components: application identification, user identification, and content identification. By combining these three components, advanced security policies and controls can be created. There are many manufacturers and options for NGFW, and the choice depends on the user's needs.

The NGFW plays a pivotal role in enhancing the security posture of IoT environments by providing advanced threat protection, visibility, user identification, segmentation, and integration with broader security measures. It enables organizations to address the unique challenges posed by the diverse and dynamic nature of IoT ecosystems.

The implementation of NGFW is an evolving field, and future research may focus on several key areas to address emerging challenges and improve the effectiveness of NGFW technologies. It could be the development of specialized NGFW solutions for IoT environments, considering the unique challenges associated with securing a diverse range of IoT devices or investigation into the scalability and performance of NGFWs in large-scale IoT deployments.

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ICT as a Contribution to the Dissemination of Information to E-Consumers

Rodrigo Lopes[1]
Alcina Dourado[2]
Leonilde Reis[3]

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Data modeling

Abstract: *Currently, most organizations rely on Information Systems and Information and Communication Technologies to disseminate information in various contexts. Conversely, consumer rights are enshrined in the Constitution of the Portuguese Republic and Law no. 24/96, of July 31, emphasizing the right to consumer information. The underlying problem lies in the difficulty of accessing information on consumer rights and duties. The project aims to create a Web Application to simplify information retrieval, avoid time wastage across different platforms, enhance data access and sharing speed, and increase data availability and connectivity. It seeks to empower citizens as consumers and enable organizations to access and disseminate information more efficiently. The application, developed using the Design Science Research methodology, facilitates quick access to consumer rights information, allows user registration and authentication, and offers account management features. Overall, it adds value to consumers' lives by promoting awareness of responsible consumption.*

1. INTRODUCTION

The project called HUB E-CONSUMER aims to create a Web Application to simplify the search for information, avoiding wasting time using different applications and sources, increasing the speed of data access and sharing, and also increasing the scale of available data and connectivity. According to a study carried out in March 2019 on Consumer Protection Policy in Portugal, available on the website of the Directorate-General for Consumer Affairs (Consumidor, 2019), it was found that 30.2% of respondents say they do not know consumer rights and duties, 39.9% say they know, but little, 28.4% say they know, but reasonably, and only 1.2% say they have a lot of knowledge. The aim is therefore not only to empower citizens in their role as consumers but also to enable the organizations involved to access and disseminate information more easily, creating a tool that enhances this objective, with the potential for adaptability and enabling decisions to be made more proactively and less reactively. Based on the objectives, in short, the aim is to increase knowledge of consumers' rights and duties. The Design Science Research (DSR) methodology was used to develop this application.

2. THEORETICAL FRAMEWORK

This section presents the theoretical framework underlying the project, particularly information modeling, requirements analysis, programming, and software quality. Data modeling *is the process of diagramming data flows. When creating a new or alternative database structure, the designer starts with a diagram of how the data will flow into and out of the database. This flow diagram is used to define the characteristics of the data formats, structures and database handling*

[1] Polytechnic Institute of Setúbal, Campus do IPS - Estefanilha, 2910-761 Setúbal, Portugal
[2] Polytechnic Institute of Setúbal, Campus do IPS - Estefanilha, 2910-761 Setúbal, Portugal
[3] Polytechnic Institute of Setúbal, Campus do IPS - Estefanilha, 2910-761 Setúbal, Portugal

functions to effectively support the data flow requirements. After the database has been built and implemented, the data model remains the documentation and justification for the existence of the database and how the data flows have been designed (SAP, 2023). Types of Data Modeling - Regarding data modeling, there are essentially three types of data: Relational, Dimensional and Entity-Relationship Models. In the first case, *Although with an 'older' approach, the most common database model still used today is the relational one, which stores data in fixed format records and organizes them in tables with rows and columns (SAP, 2023).* In the second case, *less rigid and structured, the dimensional approach favors a data structure that is more related to the use or business context. This database structure is optimized for online queries and data storage tools. Critical data elements, such as the quantity of a transaction, for example, are called "facts" and are accompanied by reference information called "dimensions", be the product ID, the unit price or the date of the transaction. A fact table is a primary table in a dimensional model. Retrieval can be fast and efficient - with data for a specific type of activity stored together - but the lack of links between relationships can complicate analytical retrieval and use of the data. Since the data structure is linked to the business function that produces and uses the data, combining data produced by different systems (in a data warehouse, for example) can be problematic (SAP, 2023).* Finally, the Entity Relationship Model (ER Model) is *an E-R model that represents a business data structure in graphical form, containing boxes of various shapes to represent activities, functions or "entities" and lines to represent associations, dependencies, or "relationships". The E-R model is then used to create a relational database in which each row represents an entity and the fields in that row contain attributes. As in all relational databases, 'key' data elements are used to link the tables together. (SAP, 2023)* It is therefore considered that, given the specific nature of the project, the ER Model was adopted. Regarding data abstraction, there are three levels of data abstraction: *Conceptual data model, Logical data model and Physical data model. The Conceptual data model, characterized by being a "general" model, "represents the overall structure and content, but not the detail of the data plan. It is the typical starting point for data modelling, identifying the various data sets and the flow of data through the organization. This conceptual model is the high-level blueprint for developing the logical and physical models and is an important part of the data architecture documentation. The second level of detail is the Logical data model. It is more closely related to the general definition of "data model" in that it describes the flow of data and the contents of the database. The Logical model adds detail to the overall structure of the conceptual model, but does not include specifications for the database itself, since the model can be applied to various database technologies and products. (Note that there may not be a conceptual model if the project relates to a single application or other limited system) (SAP, 2023).*

Finally, *the physical model of the database describes the details of how the logical model will be realized. It should contain enough detail to allow technicians to create the actual structure of the database in hardware and software to support the applications that will use it. The physical data model is specific to a particular database software system. There can be several physical models derived from a single logical model if different database systems are used (SAP, 2023).* This process has evolved, with the emergence of Artificial Intelligence (AI). There are currently several applications that support this process, such as Tableau; Microsoft Power BI; SAP BusinessObjects; MySQL Workbench. These applications help with data modeling, which is a fundamental process in data analysis, database creation and other processes. In short, data modeling aims to structure data into a visual representation, such as diagrams or databases, which allows it to be analyzed from a better perspective. Another aspect to consider involves requirements analysis. This *is an important aspect of project management and is responsible for collecting the indispensable, necessary data that the user needs to solve a problem and achieve their objectives. As well*

as determining a user's expectations for a given product (Fernandes, 2015). To carry out a successful analysis, it is necessary to identify the following requirements in a project: functional and non-functional requirements. The functional requirement consists of *Statements that describe actions that the system should or should not do. These actions are usually associated with functionalities and behaviors and are specified as how the system reacts when faced with a certain input, how it behaves when faced with an error and what to do when faced with specific scenarios. These types of requirements can take on different levels of specificity and detail, depending on the situation being reported and the expected behavior of the system concerning that relationship. For example, a user should be able to search the agenda for all clinics; the system should generate each day, for each clinic, the list of patients for that day's appointments; each member of staff using the system should be identified only by their eight-digit number. Non-functional requirements correspond to restrictions on the services or functionalities offered by the system, such as security and time restrictions. In addition, non-functional requirements define system properties such as reliability and storage space, for example. Also known as quality requirements, they are generally more difficult to express measurably, making the analysis process more complex (Sommerville, 2011).* There are several non-functional requirements, shown in Figure 1.

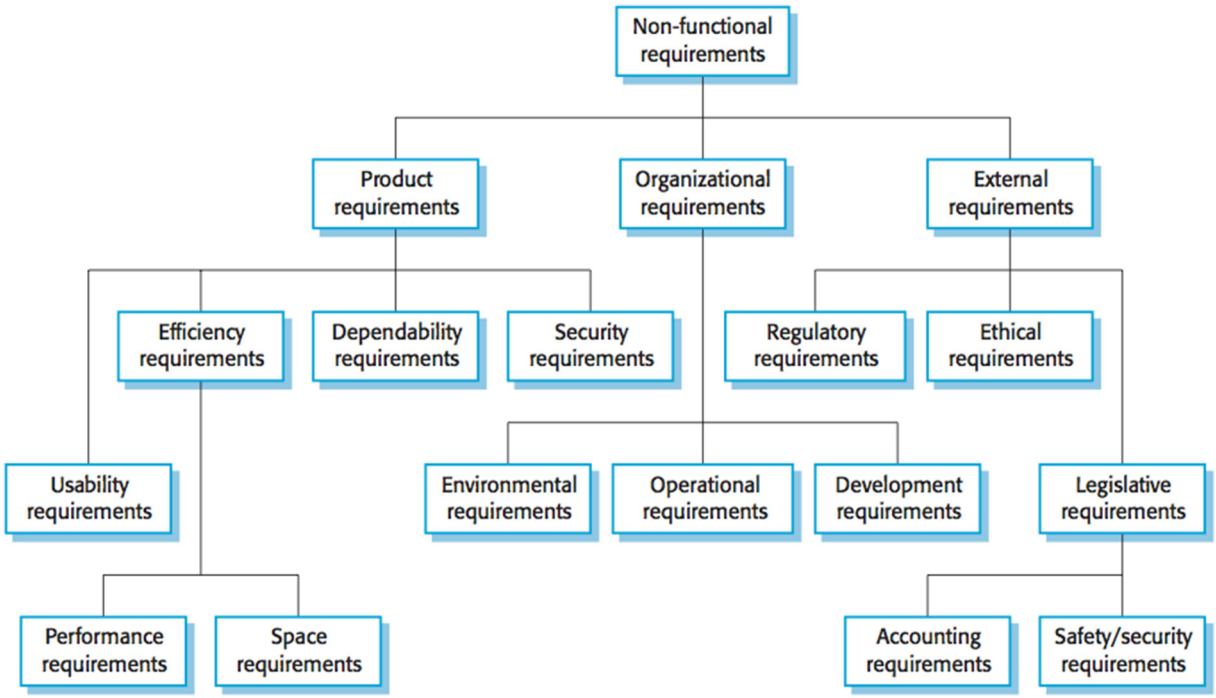

Figure 1. Types of Non-Functional Requirements

Source: Sommerville, 2011

According to Figure 1, non-functional requirements are subdivided into product, organizational and external requirements. In this sense, requirements analysis aims to identify the client's needs (requirements) for the realization of a project. Programming is the act of communicating instructions to a computer. To do this, it is necessary to adopt programming languages so that the computer can interpret the same instructions, thus building algorithms, such as the C# programming language. *C# is a modern, object-oriented programming language. C# allows programmers to build many types of secure and robust applications that run on .NET. C# (Microsoft, 2022).* An object can be defined as, for example, a car, in which it has variables such as license plate, color, model, make, among other identifiable variables in this object. In short, Object-Oriented Programming (OOP) *is a paradigm that interprets a problem as a collection of interacting objects. It is*

based on code reuse and the ability to represent the system much closer to what we would see in the real world (Coutinho, 2021). Software quality *is the conformity of explicitly stated functional and performance requirements to clearly documented development standards and the implicit characteristics that are expected of all professionally developed software (Pressman, 2019)*. In consulting, this phase is considered crucial for software to have the quality desired by the project's stakeholders. It is therefore important to carry out tests after the development phase in order to check that all the requirements mentioned above are met. The main levels of software testing are: Unit, Integration, System, Acceptance and Regression Testing and Unit Testing *aims to explore the smallest unit of the project, looking for faults caused by logic and implementation defects in each module separately. The target universe for this type of test is the methods of objects or even small pieces of code." The Integration Testing (Neto, 2016)* Aims to provoke faults associated with the interfaces between modules when they are integrated to build the software structure that was established in the design phase. *System Testing "Evaluates the software for faults by using it, as if it were a final use.* I*n this way, the tests are carried out in the same environments, with the same conditions and with the same input data that a user would use in their day-to-day manipulation of the software. It verifies that the product meets its requirements*: *Acceptance Testing implies that it is "generally carried out by a restricted group of end users of the system. They simulate routine system operations in order to check that the system behaves as requested.* Finally, *"Regression testing does not correspond to a level of testing, but is an important strategy for reducing "side effects". It consists of applying, with each new version of the software or each cycle, all the tests that have already been applied in previous versions or test cycles of the system. It can be applied at any test level (Neto, 2016).* It is therefore considered imperative to implement this phase, carrying out the previously identified tests, in software development, because without it, it becomes difficult to know the maturity of the development carried out, which could lead to poorly completed software, not meeting the client's expectations.

3. METHODOLOGY

The methodology used to develop the HUB E-CONSUMER project was Design Science Research (DSR), characterized by being *a research methodology that is suited to the field of Information Systems in the creation of an artifact (Peffers et al., 2017)*. The methodology consists of six stages: (i) Identification of the problem; (ii) Identification of the solution and its objectives; (iii) Development and design of the artifact; (iv) Demonstration; (v) Evaluation; (vi) Communication. The development of the application was based on the methodological assumption of using DSR. Regarding the problem identification stage, meetings were held with the project's stakeholders to identify the underlying problem, after which the project's objectives were identified with the stakeholders. After this stage, the design and development of the project began. Throughout the development, meetings were held with the stakeholders to demonstrate progress and provide feedback. Following these phases, scientific dissemination was carried out. This research methodology was adopted because it aims to study, research and investigate a particular problem. Based on this study, a solution is identified, which is then developed to mitigate the problem.

4. WEB APPLICATION DEVELOPMENT

Based on the problems identified, in coordination with the stakeholders, the need arose to create an aggregating web application, to simplify the search for information on consumer rights and duties, avoid wasting time using different applications and sources, increase the speed of data access and sharing, and increasing the scale of the data available and connectivity. The aim is also to

empower citizens in their role as consumers by creating a tool that integrates all the others, with the potential for adaptability and which allows them to make decisions more proactively and less reactively. In turn, the organizations involved are also empowered to access and disseminate information that meets consumer requirements, on the one hand, and adapt their communication to needs, on the other more easily. It is considered that this will be a tool that has the potential to contribute to the transformation of the age of consumerism, in other words, to help the transition from excessive materialism to responsible citizenship in the market for goods and services. *Consumerism is a movement that is characterized by citizen action within the context of the market through the creation of or adherence to movements or organizations that defend and promote the rights and duties of consumers with the aim of fighting (refusing from a negative perspective) or encouraging the act of purchasing (negotiating from a positive perspective), through the politicization of conscious and responsible consumption, based on values that privilege ethical, ecological and equitable purchasing, in search of quality of life and consumer self-determination (Silva, 2018).* The web application aims to centralize information on consumer rights (Law no. 24/96, of 31 July - Consumer Protection Law), as well as presenting it clearly and objectively to the following target audiences: (i) consumer associations, (ii) General Directorate for Consumers (DGC), (iii) general consumers, (iv) technicians from Consumer Information Centers, (v) academic researchers, (vi) teachers in the field, (vii) companies and (viii) non-profit organizations. The Web Application focuses on presenting information from the following sources: official gazette (Diário da República), Portuguese consumer associations (Associação Portuguesa para a Defesa do Consumidor (DECO), Associação dos Consumidores da Região Açores (ACRA), Associação de Consumidores de Portugal (ACOP), among others) - ANACOM (National Communications Authority), ECC-Net - European Consumer Center Portugal, Consumer Protection Service - Madeira (Regional Secretariat for Inclusion and Social Affairs of the Autonomous Region of Madeira) and Direção-Geral do Consumidor - Consumer Portal. The web application will have to achieve key objectives: guaranteeing quick access to information on consumer laws and rights, simplifying the presentation of the information in question, increasing the connectivity of the information, increasing the scale of the data available and, finally, reducing the time wasted in accessing the information. After identifying the problem, data modeling was carried out, starting by interviewing the stakeholders involved in the project, carrying out the following points in chronological order: (i) identification of the actors and their objectives as users, (ii) carrying out the requirements survey, (iii) identifying functional and non-functional requirements and the applications and components needed for development and (iv) based on the requirements, a data model was designed, using MySQL to build the Entity Relational Model (ER Model). The Web Application has eight Functional Requirements defined: Information Availability, Registration System, Information Filtering System, Help System, Authentication System, Actor Profile System, Management System and Logout System.

5. RESULTS AND DISCUSSION

Given the problem under study, it was possible to identify that consumers generally have gaps in their knowledge of consumer protection laws. All the tests passed the maturity assessment and were reported to the project's stakeholders via video conferences, which they approved. This project received several approvals during its development, undergoing various functional tests. All the stakeholders involved in this project had their say in the evaluation process and were present at meetings, thus approving this project and guaranteeing the objectives identified and established in the planning phase. After this phase, the results obtained in the project were scientifically disseminated. It is also considered that the development of this project should have a positive impact on the lives of consumers, helping to transform the era of consumerism into the

era of consumerism. It is believed that the application has a solid basis on which to build a more complete version, considering all the features developed. It should also be emphasized that, in view of the study's problem, the development of the application is considered to have systematized the search for information, thus optimizing the time spent searching in various sources (Lopes, 2023; Lopes et al., 2023).

6. CONCLUSION

Based on the results of the study presented, it is possible to identify that Portuguese consumers have little knowledge of consumer protection laws, which points to a current need that can be filled by the potential of technology. In view of this problem, the project aimed to develop a web application to aggregate and simplify the search for information on consumer rights and duties, speeding up the search for reliable and up-to-date data in different applications and sources of information. We believe that the development of this project will have a positive impact on the lives of consumers, transforming its users into responsible players in the market. It is believed that the application has a solid basis for a more complete version, considering all the features developed. It is also seen as adding value, as well as contributing to the field of literacy, by optimizing the use of different sources of information already available on the internet, thus increasing sharing and connectivity and enabling consumers to make more informed decisions.

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ONE Security Solution in a Cloud Environment

Marija Zajeganović[1]
Milan Pavlović[2]
Nenad Kojić[3]

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Virtualization

Abstract: *Over the past decade, cloud computing and virtualization have become one of the areas that increasingly capture the attention of the IT world. The significance and advantages of cloud platforms compared to traditional infrastructure systems are numerous. On the other hand, due to the openness of many services to the public network and the need for certain services to be accessible exclusively through secure and private networks, security in the cloud becomes a highly significant issue. In the first part of the paper, an overview of cloud service delivery models will be provided. The authors will then elaborate on some core cloud services and their security aspects in detail. Additionally, security mechanisms in a virtual private cloud will be explained.*

1. INTRODUCTION

Irrespective of the industry type or company size, whether it's a corporation or a startup, the capabilities of cloud technology have proven highly effective. An increasing number of companies are recognizing the significance and benefits of cloud platforms over traditional infrastructure systems. This has resulted in a significant rise in cloud migrations and an uptick in the utilization of cloud services. Due to the openness of many services to the public network, as well as the need for certain services to be available exclusively through a secured and private network, prioritizing security in the cloud has become crucial. The number of cyberattacks is increasing, and so are the resources invested in security. Numerous providers offer a diverse range of cloud services and infrastructures to users globally around the world. Azure Web Services is first cloud provider, started business in 2006. The three biggest cloud providers are Amazon Web Services (AWS), Azure, Google Cloud Platform.

This paper will present an overview of the cloud concept and cloud architecture, followed by an overview of cloud core services and their security aspects, and finally, as an example of a security solution in a cloud environment, security mechanisms in a virtual private cloud will be presented.

2. CLOUD COMPUTING CONCEPTS AND ARCHITECTURES

The principles underlying cloud computing include virtualization, scalability, flexibility and adaptability, pay-as-you-go model and high availability. Virtualization allows physical resources, such as servers and network infrastructure, to be shared and used in multiple ways. Virtualization enables better use of resources and greater flexibility in adapting resources to user

[1] The Academy of Technical and Art Applied Studies Belgrade, Department School of Information and Communication Technologies, Starine Novaka 24, Belgrade, 11000, Republic of Serbia
[2] The Academy of Technical and Art Applied Studies Belgrade, Department School of Information and Communication Technologies, Starine Novaka 24, Belgrade, 11000, Republic of Serbia
[3] The Academy of Technical and Art Applied Studies Belgrade, Department School of Information and Communication Technologies, Starine Novaka 24, Belgrade, 11000, Republic of Serbia

needs. Scalability provides the ability to quickly and easily scale resources. Users can easily increase or decrease capacity according to their current needs, thus achieving more efficient use of resources. Flexibility and adaptability allow users to connect to resources and services through the network from any location and various devices. Users can customize their resources, applications and settings according to their needs and preferences. One of the main advantages of cloud computing is the pay-as-you-go model where users only pay for the resources and services they actively use, eliminating the need for substantial investments in expensive infrastructure. This model enables better cost control. Cloud providers usually guarantee high availability of their services through redundancy and data distribution across multiple locations. This ensures that applications and data are available to users at all times, even in the event of hardware failure or problems at one location.

The definition of cloud computing (Mell & Grance, 2011) that received industry-wide acceptance was composed by the National Institute of Standards and Technology (NIST). "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models."

The five essential characteristics are on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service. The three service models are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) as shown in Figure 1. The four deployment models are private cloud, community cloud, public cloud and hybrid cloud.

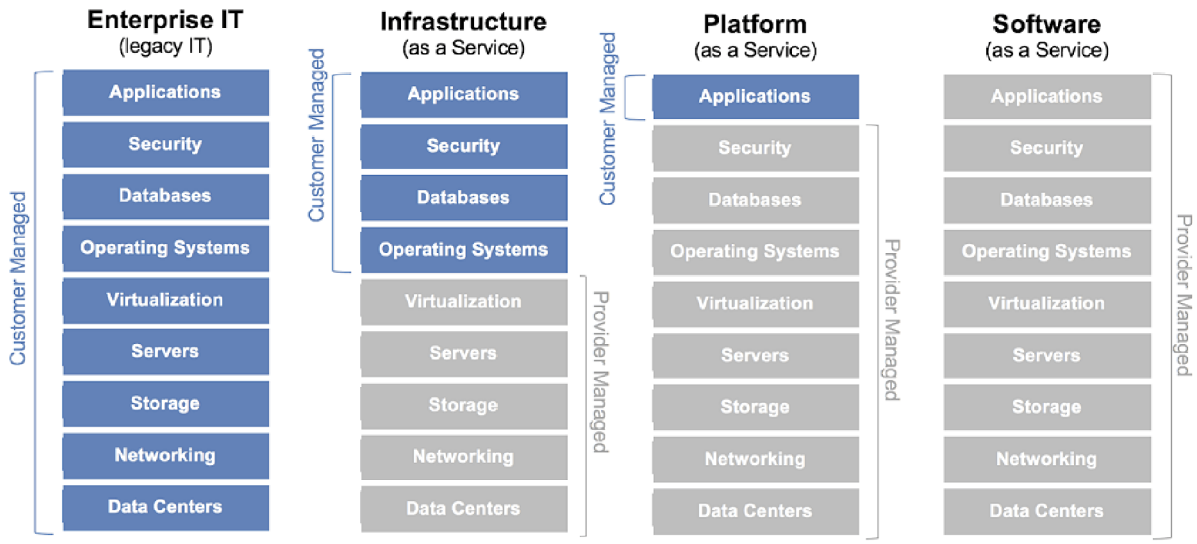

Figure 1. Cloud computing services defined by the NIST
Source: General Services Administration, n.d.

In Software as a Service (SaaS) model, the cloud provider assumes responsibility for granting access to applications and services, such as email, communication tools, and Office 365, all delivered over the internet. Users are relieved from managing any aspect of the cloud services, except for limited user-specific application settings. Their primary obligation is to provide their data.

For Platform as a Service (PaaS) model, the cloud provider is accountable for offering users access to development tools and services required for application delivery. Typically, these users are programmers who may exert control over the configuration settings of the cloud provider's application hosting environment.

In Infrastructure as a Service (IaaS) model, the cloud provider is tasked with providing IT managers access to network equipment, virtualized network services, and supporting network infrastructure. This cloud service allows IT managers to deploy and run software code, encompassing operating systems and applications.

None of the mentioned solutions is an ideal solution for every company, and most companies tend to change their cloud philosophy over five years.

Cloud service providers have extended this model to also provide IT support for each of the cloud computing services. For businesses, IT as a Service (ITaaS) can extend the capability of the network without requiring investment in new infrastructure, training new personnel, or licensing new software. These services are available on demand and delivered economically to any device anywhere in the world without compromising security or function and we also have a new model SECurity as a Service (SECaaS) (Theodoropoulos et al, 2023).

3. CLOUD CORE SERVICES AND THEIR SECURITY ASPECTS

Cloud core services serve as the foundational elements and resources that support the infrastructure of cloud platforms. They play a crucial role in the development and administration of various cloud-based applications and solutions. Security is a critical aspect of cloud core services, given the imperative to protect the cloud environment from potential threats and vulnerabilities. Key dimensions of cloud core services include physical security, data encryption, identification and authentication, access control, security monitoring, and measures for redundancy, as well as disaster recovery.

Identity and Access Management (IAM) stands as a vital element within cloud core services, serving as a foundational service enabling organizations to manage and regulate access to their cloud resources and services. IAM plays a foundational role in upholding the security and compliance of cloud-based environments. IAM identities, encompassing both human users and non-human entities like applications, services, or systems, are entities capable of making requests to access cloud resources. The significance of IAM services lies in their ability to finely control privileges and compel users to adhere to security policies. IAM policies define the permissions and access control rules for resources (Mell & Grance, 2011). These policies are attached to IAM identities and resources, specifying what actions are allowed or denied. Some of the features of the IAM service are centralized identity management, granular access control, multi-factor authentication, access delegation, auditing and activity monitoring.

IAM identities offer security mechanisms, including authentication and authorization, ensuring that only authorized users can access specific resources. Additionally, IAM identities support access delegation of access and facilitate compliance with data protection regulations and rules. These identities play a crucial role in precisely defining access rights, roles, and privileges, enabling organizations to effectively manage and control resources and data within the cloud infrastructure. User accounts, representing individuals within an organization or team, receive specific types of access and can be organized into user groups. User groups serve the purpose of grouping user accounts to grant privileges at the group level.

IAM policies play a key role in ensuring security and managing access in a cloud environment. They allow administrators to grant specific privileges to users or groups of users. This may include access to certain resources, services, or functionality. Granting privileges can be based on roles, business needs, or other factors. IAM policies can be designed to ensure compliance with data protection laws and regulations. For example, policies can ensure that only certain users have access to sensitive or regulated data. Also, policies may require the use of certain security mechanisms such as multi-factor authentication or data encryption. Policies are attached to identities and define the exact range of privileges that an identity can share within the system as shown in Figure 2.

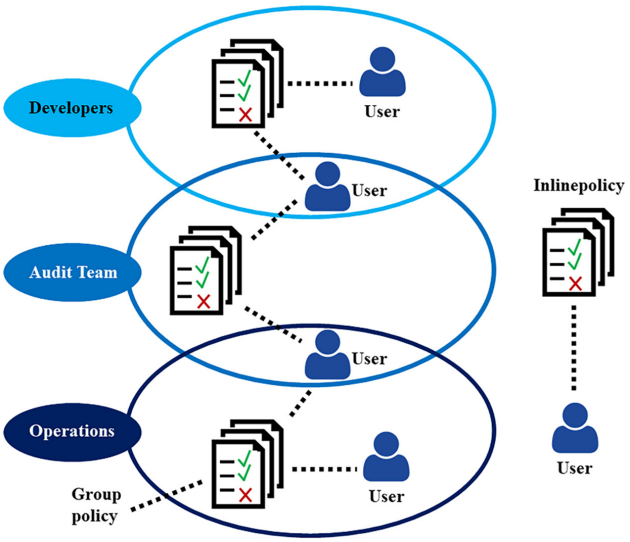

Figure 2. The way policies function within different user groups

Source: Own research

Multi-factor authentication (MFA) is a security mechanism that requires individuals to provide two or more separate factors to verify their identity during the authentication process. This additional layer of security makes it significantly more difficult for unauthorized users to gain access to an account or system (Kunduru, 2023). MFA devices can be physical and virtual. The essence of MFA is that even if user content is stolen, an attacker cannot access the service. In the event of an attempt to find a six-digit code using the "Brute-force" technique, logging into the service will soon be blocked and additional identity verification will be required. Multi-factor authentication is a perfect blend of what the user needs to know (credentials) and what the user has (device MFA).

Amazon Elastic Compute Cloud (Amazon EC2) is a web service offered by Amazon Web Services (AWS) that provides resizable compute capacity in the cloud. In simpler terms, it allows user to rent virtual servers on a pay-as-you-go basis. EC2 provides various mechanisms for security and access control, such as defining security groups that define rules for incoming and outgoing network traffic, integration with AWS IAM for managing identities and access rights, as well as the ability to use keys for data encryption.

Amazon Elastic Block Store (Amazon EBS) is a cloud-based block storage service provided by Amazon Web Services (AWS). EBS is designed to provide scalable and durable block-level storage volumes that can be attached to Amazon EC2 instances, making it a critical component for storing and managing data in the AWS cloud. One of the key functionalities of EBS is the ability to encrypt data at the disk level. Users can encrypt EBS volumes to protect data from unauthorized access.

4. SECURITY MECHANISMS IN A VIRTUAL PRIVATE CLOUD

The virtual private cloud architecture establishes a private cloud with underlying infrastructure that belongs to a public cloud provider but that is exclusively dedicated to one specific cloud consumer for whom the private cloud is delivered. This can be useful for an organization that wants to have a private cloud but does not have the necessary infrastructure to support it on-premise (Erl & Baecelo 2023). Virtual private cloud (VPC) represents a logical virtual private network in which cloud users implement their infrastructure. In many of its elements, VPC resembles the traditional network infrastructure of data centers, but with almost unlimited possibilities for scalability and expansion. A VPC is divided into multiple availability zones. It consists of many network components such as a router, internet gateway, and NAT gateway.

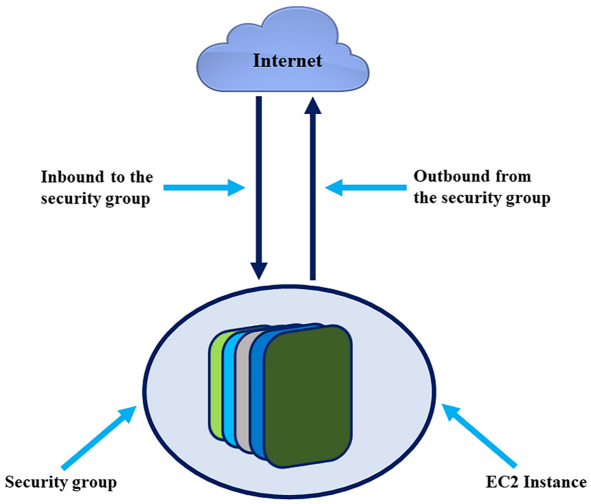

Figure 3. Inbound/Outbound security group rules

Source: Own research

Security groups represent the first level of protection. This is a type of firewall that controls inbound and outbound traffic at the EC2 instance level within the VPC as shown in Figure 3. Security groups contain only "allow rules", while at the end there is always an "implicit deny rule". When filtering traffic, it goes through all the rules in search of a permit rule.

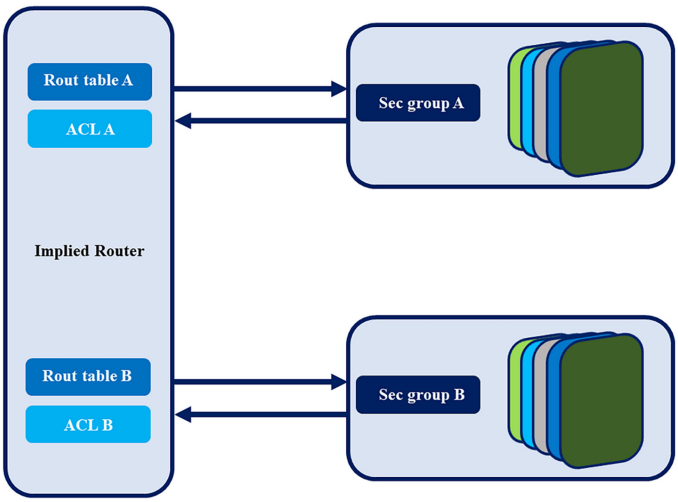

Figure 4. Security within a VPC

Source: Own research

Security groups are not the only type of protection. Access control lists (ACL) are responsible for protecting the third layer of the TCP/IP model. An ACL is a built-in feature within the default router, which is an integral element of every VPC as shown in Figure 4. ACLs use the stateless concept. In case inbound traffic is allowed, outbound traffic will not be allowed by default, but all outbound rules within the ACL will be taken into account. The same principle will be applied in the opposite direction of the network traffic. It goes through the rules until the moment of matching, and then apply the permit or deny rule. ACLs stand as a first line of defense for inbound traffic and a secondary line of defense for outbound traffic.

5. CONCLUSION

Cloud security is a shared responsibility between cloud providers and companies (users). Cloud providers are constantly improving and implementing advanced methods like encryption, firewalls, multiple levels of authentication and other security mechanisms to protect user data from unauthorized access. However, users also need to take on a large part of the responsibility, including implementing adequate security policies, regularly updating software, educating employees and implementing security protocols.

Based on all of the above, it can be safely concluded that sudden changes within the industry and all the improvements that come with them, bring more and more complex infrastructures that will require more and more complex security solutions.

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The Integration of Blockchain Technology in Food Supply Chain Management – A Systematic Literature Review

Alisa-Mihaela Ambrozie[1]

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Keywords:
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Food supply chain management;
Transparency;
Traceability;
Sustainability

Abstract: *In the current global context of food supply chain management, blockchain technology promotes transparency, assurance, traceability, authenticity, and security—imperative attributes in a domain where balancing transparency, sustainability, and efficacy is crucial. This article endeavors to elucidate the integration and advancement of blockchain technology's role within the food supply chain through a systematic review of the literature. Through the meticulous analysis of specialized, empirical, theoretical, and conceptual works, a coherent perspective on the trends, challenges, and opportunities inherent in implementing blockchain technology within the food supply chain emerges. While blockchain technology is ready to offer transparency, security, and compliance to the food supply chain, optimal implementation necessitates the consideration of organizational, technological, and environmental factors. The article not only serves as a foundation for future research but also as a catalyst for practical applications in the food supply chain sector, with the ultimate goal of increasing efficiency, sustainability and transparency.*

1. INTRODUCTION

Blockchain technology has revolutionized various sectors due to the principles of decentralization, transparency and immutability, the transformational potential of supply chain management has been fueled by growing concerns about food safety, authenticity and traceability. The integration of blockchain technology into supply chain management has been due to this technology's ability to ensure transparency, traceability and authenticity of transactions.

The food supply chain is a complex process that includes many stages from production to harvesting, processing, packaging, transportation, storage and consumption (Trienekens & Zuurbier, 2008). Each stage is critical in maintaining food quality and safety, these stages require a monitoring and verification system to ensure compliance with applicable health standards and regulations.

Transparency is a challenge in the food supply chain due to the global nature of the modern supply chain, thus geographical distances, different regulatory standards and the multitude of actors involved make it difficult to maintain transparency regarding the origin of food, handling processes and safety protocols, which can lead to significant problems such as food fraud, contamination or waste (Aung & Chang, 2014). The introduction of blockchain technology into the food supply chain is proposing a change in the way information is recorded, stored and shared. Through a decentralized ledger, blockchain provides a unified platform where data from different stages of the supply chain can be securely and transparently recorded. Every transaction, from a farmer recording harvest details to a retailer recording sales data, can be recorded in a

[1] The Economics and International Business Doctoral School, Bucharest University of Economic Studies, Street Piața Romană 6, zip code 010374, Bucharest, Romania

tamper-proof environment (Tian, 2016). Thus, customers can scan a code on the chosen product to find out the exact origin and route of the product. In addition, contaminated products can be quickly identified and withdrawn before further losses and consumers are affected (Mansfield-Devine, 2017).

By introducing smart contracts, the supply chain becomes faster, processes are automated, and when the terms of the contract are respected, the supplier can receive payment automatically, in a short time, and without an intermediary (Mihaylov et al., 2018).

In order for the implementation of blockchain technology to be effective, data recording protocols must respect data confidentiality, this is possible through standardization of protocols.

2. LITERATURE REVIEW

Blockchain technology became known for its decentralized nature, which records transactions in chronological order. These transactions, also called blocks, can create a chain of transactions that can be stored on different blocks in the same network. The design regarding decentralization proposed by Nakamoto is fundamental to the security of the blockchain, and the failure of one point cannot compromise the total integrity of the data because no entity has control over the entire chain (Nakamoto, 2008).

In food supply chain management, blockchain does more than just keep track of transactions. It gives a new way to share information and be open about it. Conventional supply chains can have a lack of clear information, which causes problems like inefficiency, distrust, and the inability to fix problems quickly. Blockchain solves these problems by creating a safe, unchangeable, and clear platform where all transactions, from making to selling, can be recorded (Casino et al., 2019).

One big benefit of blockchain is that it can't be changed and everyone can see what's happening. Once a transaction is written down, it can't be altered or taken away. This feature is really important in the food supply chain, where it's very important to know where the food comes from and who is responsible for it. For instance, blockchain can help people know where their food comes from and if it's good quality and made ethically. This can stop problems like fake food and wrong labels (Tian, 2016).

Blockchain technology is all about spreading out the work of processing, recording, and checking transactions across lots of computers, instead of just one central authority. This means that everyone in the network can see the same record of transactions, which makes the system more secure and transparent (Nakamoto, 2008).

In old-fashioned food supply chains, a small number of important groups, like main distributors or regulators, usually control the information. This can make it hard to see what's going on and cause problems with sharing and reporting data. Because security and reliability depend only on a few entities, in a central structure, the system can become vulnerable over time (Casino et al., 2019).

A transformative approach to data management in food supply chains can be achieved through the decentralization of blockchain technology (Ambrozie & Sorcaru, 2021). Copies of the

registers are stored by each participant or each note of the network, in this way the transactions are verified and can contribute to a consensus protocol that helps to validate blocks of transactions. Through this complex process, a single entity can't control or modify the registration data in a blockchain (Mihaylov et al., 2018).

Against unauthorized access or manipulation, a multifaceted security system of the food supply chain has been printed, giving at the same time accuracy and data protection, and, last but not least, food integrity. Traditional supply chain management systems often rely on centralized databases that, despite their best efforts, are susceptible to hacking, corruption, or loss due to their reliance on single control points. These vulnerabilities can have serious ramifications, including, economic loss, damage to brand reputation, and public health risks (Casino et al., 2019).

Blockchain technology effectively addresses several of these security concerns through its structure. One of the fundamental security features of blockchain is the use of cryptographic principles to create and link blocks, making the data structure tamper-resistant. This cryptographic linking of blocks makes it nearly impossible to change a single block without changing all subsequent blocks and achieving consensus from the majority of the network, which is virtually impossible (Nakamoto, 2008).

For food supply chains, this level of security is crucial. In this way, it is ensured that data, once entered, regardless of whether they are about the origin, ingredients, transport, or storage conditions of a food product, recorded in the blockchain cannot be fraudulently modified (Tian, 2016). Due to its decentralized nature blockchain ensures data security. The information is stored in a network of computers, instead of a single centralized database. Decentralization protects data that could be compromised due to a cyberattack, technical failure, or natural disaster. In the field of food supply, data integrity is very important because it can have major implications for public health and safety (Mihaylov et al., 2018).

The smart contracts that are possible thanks to blockchain technology, are executed automatically when the terms written in a code are fulfilled, without the need for the intervention of intermediaries, thus the costs are reduced, the waiting times are reduced, the procedures are efficient and the risk of fraud is minimized (Szabó, 1996). Smart contracts can be optimized by joining other technologies, such as IoT, which can record in real time data about the transport time, the transport conditions, or the temperature of the products during the entire transport period, helping the automatic management of quality control. If a product's temperature deviates from an agreed range, a smart contract could instantly trigger a quality inspection or even reject the shipment, ensuring that only products that meet specified standards reach consumers (Tian, 2016).

Traceability in food supply chains refers to the ability to trace any food through all stages of production, processing and distribution (including import and retail). Traceability, as part of broader supply chain transparency efforts, has always been a significant concern in the food industry. It is not only vital for ensuring food safety and quality, but also for managing recalls, verifying sustainable or ethical practices, and complying with applicable regulations (Aung & Chang, 2014).

Traditional traceability ways to track things use a lot of paper or digital systems that are all in one place. These can take a lot of time, make mistakes, and be changed or lost easily. These systems can make it hard to follow a product's journey from the farm to your table because the

information between different stages of the supply chain is not connected or available (Manning & Soon, 2016).

Blockchain technology can help with these problems. Blockchain helps to keep track of all the transactions and data in the food supply chain in a secure and easily accessible way. Each item has its special code, and every time something happens to that item, it gets written down in the blockchain. This makes a digital record of how each product travels from start to finish (Tian, 2016).

3. METHODOLOGY

A systematic review of the specialized literature is chosen because the challenges faced by the agri-food system are well known, and it currently needs a technology that offers a 'complete solution' to combat inefficient recalls and fraud (Shahid et al., 2020). A 'complete solution' for food supply management could be blockchain technology, therefore, through a systematic review of the specialized literature, we can elucidate the trends, challenges, and opportunities of its application.

For this article, Scopus, WoS, and Google Scholar were chosen as databases, designing a meticulous search strategy for as many relevant publications as possible. The search was conducted using keywords, employed in various combinations and queries, such as 'blockchain technology', 'food supply chain', 'blockchain', 'traceability', 'sustainability', 'food quality', 'food safety', and 'agri-food' to ensure broad coverage of writings on the theme of integrating blockchain innovation in various aspects of the food supply chain.

The publications were subjected to a screening process. The inclusion criteria were the following:

Relevance: The paper must focus on the application of blockchain technology in the food supply chain. Studies that mentioned blockchain only peripherally were excluded.

Date of publication: Given the rapid evolution of blockchain technology, only works published since 2020 have been considered to ensure the timeliness and relevance of the data.

Publication Type: Both empirical and theoretical studies were included to ensure a comprehensive understanding of the topic.

Language: only studies published in English were included.

The search yielded 218 papers, highlighting the growing interest and extensive research in integrating blockchain technology into the food supply chain.

The volume and complexity of the literature obtained through our initial search necessitated the use of analytical tools. Atlas.ti software was used for an in-depth analysis. For preliminary analysis, we used code words such as "traceability", "sustainability", "efficient", "supply chain", "food safety" and "smart contracts". The codes were chosen due to the objective of the research topic and due to the content of the text.

After initial coding, codes were categorized into looser themes and analyzed "Blockchain Technology in Food Supply", "Challenges", "Opportunities" and "Future Directions".

For relevance we resorted to selective coding, where we used refined codes and categories, the focus was on content that referred to the integration of blockchain technology in food supply chain management.

Atlas.ti facilitated cross-document analysis, where codes from different papers were compared. Thus, we could follow the consistency of the themes in the analyzed works and identify the works that had different perspectives.

The criteria that were the basis of the selection of specialized works were: empirical data about blockchain technology in the supply chain, works that presented methodologies and results about blockchain technology in the supply chain, or theoretical analyses about the topic of interest.

Following the steps taken, we arrived at a total selection of 57 works. These were subjected to comparative analysis to identify convergences, divergences and research gaps. This process was achieved by thematically grouping articles into common themes such as: "technological advances", "implementation challenges", "case studies" and "future perspectives". This thematic approach facilitated a targeted comparison in certain specific areas.

Cross-comparison: Within each thematic group, we conducted a detailed cross-comparison to identify similarities and differences in perspectives, findings and methodologies. Atlas.ti's network visualizations and concurrent coding tools were instrumental in visualizing relationships and disparities between studies.

The results of the comparative analysis. Our benchmarking provided some key insights:

Overall benefits: There has been a consensus among studies on blockchain's potential to revolutionize the food supply chain. Key benefits identified include improved traceability, improved food safety protocols, reduced fraud and increased consumer confidence.

Implementation Challenges: Despite its potential, researchers have consistently highlighted several challenges. These include technological issues (such as system interoperability and data privacy), organizational obstacles (such as resistance to change and collaboration challenges between stakeholders), and regulatory concerns (the need for standardized protocols and legal frameworks).

Diverse methodological approaches: We observed a rich diversity in research methodologies, ranging from case studies and systematic reviews to conceptual papers and empirical research. This diversity underscores the multifaceted nature of blockchain research and its interdisciplinary implications.

Sector-Specific Applications: Several papers have provided insight into blockchain applications in specific sectors of the food supply chain, such as dairy, agriculture and seafood.

Ethical and sustainability considerations: A growing trend in the literature is exploring the role of blockchain in promoting sustainability and ethical practices in the food supply chain. The papers discussed how transparent and immutable record-keeping could support fair trade practices and sustainable sourcing.

Future Directions: The analysis revealed an optimistic outlook for the future of blockchain in the food supply chain, with researchers advocating continued technological innovation, collaborative initiatives and supportive regulatory frameworks.

Research Gaps: Our review also uncovered several gaps in the literature, particularly in empirical research on long-term implementations, economic impact assessments, and studies of consumer responses to blockchain-tracked food products.

4. RESULTS

General presentation of the analyzed literature.

Our comprehensive review of the 57 selected papers revealed rich content around the application of blockchain technology in food supply chain management. These studies, diverse in methodology and scope, have collectively highlighted the transformative potential of blockchain while underscoring the complexities and challenges of its implementation.

Through the coding and classification capabilities of Atlas.ti, several key themes emerged from the literature, reflecting the primary concerns of the current research landscape and areas of interest:

Traceability and transparency: A prevalent theme in the literature has been the role of blockchain in improving traceability and transparency in food supply chains. Food fraud is eliminated through a transparent and trustworthy tracking method provided by the blockchain (Centobelli et al., 2022).

Food safety and quality: Several articles have talked about how blockchain affects the safety and quality of food. Blockchain technology helps the food industry share information quickly and securely, so safety issues can be resolved quickly and risks to people's health and food reputation are reduced (Choi & Lee, 2020).

Blockchain can help the food industry become more ethical and sustainable. Studies have shown that this technology can trace the origin of food and its route without this data being able to be altered. In this way, fair trade, ethical sourcing and compliance with environmental regulations are encouraged (Pirju, 2011).

In order to be able to use this technology successfully, a legally regulated framework is needed worldwide. These rules should protect people's information, and ensure safety and interoperability. The challenges of implementing blockchain in the food supply chain are related to the size of the data stored, data privacy and interoperability. Research shows that blockchain technology will make progress on these challenges but also that it can be improved by connecting with other technologies like IoT and AI (Wang et al., 2021).

Our analysis also revealed interesting methodological trends. While case studies and empirical research provided practical insights into the real-world applications and impact of blockchain, conceptual papers and systematic reviews contributed to a deeper theoretical understanding. There was a noted need for more longitudinal studies to assess the long-term implications of blockchain adoption in food supply chains (Davis et al., 2021).

While the papers reviewed provided extensive insights, they also highlighted gaps in current research. In particular, there is a dearth of studies exploring consumer perceptions of blockchain-tracked food products and the economic feasibility of blockchain adoption for small-scale producers. In addition, research on the integration of blockchain with other emerging technologies in the context of food supply chains remains limited but presents interesting future perspectives.

5. CONCLUSION

Through the systematic literature review, we were able to explore multiple aspects regarding the adoption of blockchain technologies in the food supply chain. The implementation of this technology presents the opportunity to increase transparency and improve traceability and sustainability of the food supply chain.

The systematic literature review shows that the food supply chain can benefit from the implementation of blockchain. Supplier accountability and increased consumer trust through full chain traceability and transparency are made possible by blockchain technologies capabilities to establish decentralized and immutable records, serving as a sustainable mechanism in the pursuit of food safety, ethical sourcing practices and quality assurance.

Implementing blockchain technology requires a holistic approach, the critical factors to be addressed are: scalability, regulations, data privacy and interoperability.

At a time when climate change and responsible consumption are hot topics, blockchain technology can become a catalyst for positive changes such as responsible sourcing, fair trade and environmental stewardship. Blockchain can also have positive implications for sustainability and ethical practices, increasing the potential of blockchain in addition to its operational efficiency within the food supply chain.

The analysis conducted indicates that further research is still needed to investigate the impact of the implementation of blockchain technologies under different aspects, such as the integration of blockchain technologies with other emerging technologies such as AI and IoT, and consumer perceptions of products tracked through blockchain technology. These research imperatives are a good opportunity for scientists and industry professionals to make progress in the field. Blockchain's potential isn't just theoretical, it's a catalyst for trust, accountability and efficiency.

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Aspects Regarding the Development of an Urban Smart Grid

Ovidiu Lucaciu-Gredjuc[1]
Monica Leba[2]

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Abstract: *Energy resources are essential for the functioning of modern society and their connection with smart grids. Developing an urban smart grid involves a multi-faceted process of upgrading and optimizing electrical infrastructure and represents a holistic approach to transforming urban energy ecosystems, aligning with global sustainability goals, while providing cities with resilient electrical infrastructure and efficient to face the challenges of the 21st century. This paper proposes to identify the theoretical and applied concepts related to the engineering of the control system that is the basis of a smart urban network, to present the relevant elements regarding concepts, structures, algorithms, and mathematical models. The paper contains an analysis of what exists in practical approaches, simulation platforms, connections to the Energy Internet, and examples of each. In the last part, it presents contributions and future research directions.*

1. INTRODUCTION

Energy resources are important for the functioning of modern society. They provide the energy needed to power various aspects of our daily lives, including transport, lighting, heating, and industrial production.

Fossil fuels and other energy sources are essential for propelling vehicles, ensuring mobility and connectivity for road, air, rail and sea transport, they are also used to heat homes in the cold season and to cool them in the warm season, providing comfort to residents.

Electricity is used to light homes, commercial buildings and streets, which is also used to power household appliances, electronic devices and other essential equipment for our daily activities.

Buildings have a significant impact on the environment: they consume about 40% of natural resources, generate almost 40% of carbon dioxide (CO2) emissions and contribute about 40% to the total waste produced, Najjar et al., (2019a).

Traditional energy sources such as fossil fuels have a negative impact on the environment through greenhouse gas emissions and other pollution. The development and adoption of sustainable and renewable energy sources are becoming increasingly important to ensure a sustainable future and reduce the negative impact on the environment.

Energy innovations such as solar, wind, hydropower and energy storage technologies are key to meeting the energy needs of modern society sustainably. Global electricity demand is expected to grow significantly, highlighting the imperative to improve energy efficiency in modern buildings Najjar (2019).

[1] Doctoral School, University of Petroșani, University street, no. 20, 332006, Petroșani, Romania
[2] Faculty of Mechanical and Electrical Engineering, University of Petroșani, University street, no. 20, 332006, Petroșani, Romania

2. RESEARCH METHODOLOGY

The process of developing a smart urban network is a complex undertaking involving multiple stages to modernize and optimize the city's electrical infrastructure.

The efficiency of renewable energy systems, such as solar photovoltaic panels and solar heating systems, requires meticulous planning and rigorous analysis to maximize performance Buonomano et al. (2018).

City officials and utility companies work together to set project goals and directions, by considering the need for energy efficiency, smart grid management and carbon reduction. Existing electrical infrastructure is analyzed to identify weaknesses, areas of congestion and possible areas for improvement. The analysis helps determine the specific needs of the smart grid.

The next step is deploying advanced sensors in the urban landscape, tasked with collecting real-time data on energy consumption, network performance, power quality and environmental conditions.

The sensors are connected to a communications network, allowing data to be transmitted to control centers. The data provides essential information for real-time decision-making and network optimization. The collected data is processed by advanced analysis platforms to obtain useful information.

Data analysis helps to identify consumption patterns, potential breakdowns and efficiency opportunities. Management systems are implemented to allow effective monitoring and control of the network.

These systems can automatically detect failures, redistribute tasks to avoid overload and efficiently manage resources according to requirements. It integrates advanced technologies such as automation and remote control to optimize operations. Thanks to these technologies, quick reactions to changes in energy demand and unexpected events are possible.

The use of solar energy in buildings can be passive or active, adapting to climatic conditions, built environment specifications, and building energy requirements, including heating, cooling and electricity supply Hojjatian et al. (2021).

3. RESEARCH RESULTS

Numerous specialized software programs allow the simulation and optimization of photovoltaic systems (PV), including Sunny Design Web (SMA) (SMA Solar Technology AG, 2023), PVsol (Valentin Software, 2023), HelioScope (Folsom Labs, 2023), TRNSYS (2023), PVsyst (2023), Canal Solar (2023).

Researchers have adopted these advanced software programs to achieve specific goals. They served in the detailed design of the PV systems, assisting in the installation stages and providing a detailed assessment of the energy production over a calendar year.

These tools also enabled a rigorous analysis of the viability of the systems on various types of pitched roofs, thus providing essential information for informed decisions. In addition, they facilitated an in-depth analysis of economics, including costs and benefits, to determine the financial feasibility of implementing these systems.

A study by Najjar et al. (2019b) presented a structured experimental design to optimize the power generation of photovoltaic systems. He used the PVsol software platform, thus approaching the simulation and facilitation of the design and implementation phase of these systems in building structures.

Similarly, Ozcan et al. (2019) used PVsol and TRNSYS applications to evaluate the annual production capacity of a photovoltaic system. Through their empirical research, these specialists have validated the effectiveness of the PVSOL software, achieving an impressive 94.33% performance in terms of accuracy and reliability.

In a significant study, Badawy et al. (2022) investigated the opportunities for implementing photovoltaic systems on pitched roofs in Egypt. To ensure an optimal design, they used PVsol Premium software to analyze all areas of the roof. Their research focused on evaluating the efficiency of monocrystalline and thin-film technologies in grid-connected photovoltaic systems, with a focus on historic buildings. PVsol was instrumental in the detailed performance analysis of the various technologies, evaluating the annual yield and performance indicators. Their major conclusion highlighted the limitations of polycrystalline technology in terms of durability and suitability in historic buildings with specific climatic conditions. Thus, the study underlines the imperative of adopting photovoltaic technologies adapted to such distinct contexts.

In an in-depth review, Cristea et al. (2020) investigated the economic implications of residential grid-connected solar PV systems. To make simulations and projections relevant to different regions in Romania, they adopted the PVsol Premium 2019 application. This research was not limited to simple evaluation; it involved a meticulous assessment of economic viability, considering many key variables and carrying out sensitivity analyses to outline realistic scenarios with fluctuating energy prices. In their process, they used robust financial indicators such as net present value, internal rate of return, profitability index and investment payback period to ensure a comprehensive assessment of the effectiveness of different approaches. Their conclusion highlighted not only the effectiveness of PVsol but also the adaptability and precision of this platform, confirming it as an unparalleled tool for reflecting and analyzing the results of their rigorous research.

4. FUTURE RESEARCH DIRECTIONS

Smart grids are designed to be adaptable to evolving technological changes. Future innovations in energy and communications can be seamlessly integrated, thus keeping the network up to current and future technology standards.

Efficiency in the use of energy and reduction of losses contribute to the sustainable growth and economic efficiency of the electrical infrastructure.

Finally, the development of smart grids contributes to the transformation of cities into smart hubs, where technology, sustainability and quality of life are harmoniously integrated. It is

redefining how cities function and respond to the needs of communities, adapting to the demands of our century.

By taking a holistic and integrated approach, researchers and practitioners continue to address urban smart grids that not only bring immediate benefits in terms of energy efficiency but also contribute to building a more sustainable and resilient future.

This is an essential part of transforming urban infrastructure to meet the increasing challenges of the 21st century and contribute to the achievement of global sustainability goals.

5. CONCLUSION

Smart grid technologies are constantly evolving, measuring their efficiency and reliability. These properties of the technologies are essential in the field of energy efficiency and smart grid management. The central objective of this analysis was to present a detailed assessment of the performance of the most effective technologies in the field.

Our conclusions are particularly relevant for specialists and experts who want to identify and adopt the optimal solution in various scenarios, integrating new technologies to monitor and control the network in real-time.

The study highlights that systems based on advanced artificial intelligence algorithms are superior in the efficient management of smart grid networks.

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Face Recognition: A Literature Review

Gabriela Laura Salagean[1]
Monica Leba[2]

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Face analysis;
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Abstract: *Face recognition is a crucial and rapidly evolving field within computer vision and artificial intelligence. The human face is one important element for recognizing a person in a group. The mechanism used by the human brain for face recognition is not yet fully understood, making it a complex problem. Over the past decade, there have been significant advancements in both the accuracy and applicability of face recognition systems. Deep learning techniques, particularly convolutional neural networks (CNNs), have played a pivotal role in achieving state-of-the-art performance in face recognition tasks. This paper proposes a review of research on face recognition techniques, algorithms and existing applications, with their advantages and disadvantages. It also includes a comparison of the results obtained with various algorithms and the related limitations. In the last part, it presents future directions of development in the field of face recognition.*

1. INTRODUCTION

Face recognition is a topic that has been and will be studied by many researchers from various field points of view. The human face is one of the most important elements for recognizing a person in a group. It exhibits particular, unalterable physical characteristics that can be captured in a photograph.

People recognize faces with the help of two components: the sensors which are inside the eyes and the processor, which is the brain. The mechanism used by the human brain for face recognition is not yet fully understood, making it a complex problem.

Face recognition is a crucial and rapidly evolving field within computer vision and artificial intelligence. Various algorithms have been implemented and face recognition applications have been developed. Over the past decade, there have been significant advancements in both the accuracy and applicability of face recognition systems. Deep learning techniques, particularly convolutional neural networks (CNNs), have played a pivotal role in achieving state-of-the-art performance in face recognition tasks.

No matter the method or algorithm chosen, all researchers use the three main stages of facial recognition: face detection, feature extraction and face recognition.

The evolution of facial recognition techniques can be grouped into five significant phases described in Adjabi et al. (2020) research paper:

Phase One: 1964 - American researchers Bledsoe et al. studied facial recognition based on human markers obtained through manual measurements.

[1] Doctoral School, University of Petrosani, street Universității, no. 20, 332006, Petroșani, Romania
[2] Faculty of Mechanical and Electrical Engineering, University of Petrosani, street Universității, no. 20, 332006, Petroșani, Romania

Phase Two: 1988 - Artificial intelligence was introduced, specifically the use of linear algebra in facial recognition algorithms. This leap facilitated a more systematic approach to the analysis of facial features, laying the foundation for more accurate methods.

Phase Three: 1991 - Alex Pentland and Matthew Turk from the Massachusetts Institute of Technology (MIT) presented the facial recognition algorithm called Eigenfaces, which uses the statistical method of principal component analysis (PCA) to represent facial features, allowing significant progress in accuracy and reliability.

Phase Four: 1998 - Defense Advanced Research Projects Agency (DARPA) implemented the FERET program. FERET encouraged innovation and provided a sizeable database of 2,400 images for 850 individuals.

Phase Five: 2011 - Deep learning was integrated into facial recognition.

2. RESEARCH METHODOLOGY

Face recognition: A literature review is an exhaustive investigation aimed at synthesizing the knowledge related to face recognition. This approach begins by identifying the current state of the art or knowledge in the face recognition field, explores existing gaps, and concludes by making strong arguments to provide directions for future research. Kitchenham and Charters (2007) in their Guide to conducting systematic literature reviews in software engineering proposed a plan for carrying out such research, which includes: Planning, Conducting, and Presentation of the results.

In the planning phase, we defined the research question: What is the best method or algorithm for facial identification?

To be able to answer this question, we studied articles that presented studies on the accuracy of facial recognition algorithms. We considered articles published in one of the scientific article databases Web of Science and Scopus from the last 5 years.

In the conduction phase, in order not to limit the search and to obtain the most relevant articles, we used the following keywords: algorithms for facial recognition, deep learning algorithm for facial recognition. We obtained 10 articles which were of interest to our research.

3. RESEARCH RESULTS

According to Jing et al. (2023) and our synthesis of recent literature, conventional facial recognition algorithms can be grouped into: local, global and hybrid algorithms. This classification was done according to the approach to feature extraction. Local algorithms - mainly focus on specific facial features such as nose and eyes. Global algorithms - focus on the whole face to generate feature vectors for classification. Hybrid algorithms - combine both local and global facial features.

Analyzing the published articles, we noticed that the most commonly used methods are Eigenfaces and Fisherface.

The Eigenfaces algorithm was one of the pioneering methods in the facial recognition field. This method was implemented by Turk & Pentland in 1991 and is based on creating an “eigenface”

based on a provided facial image and calculating the Euclidean distances between the face and the set of created eigenfaces. The self-face with the smallest Euclidean distance signifies the greatest similarity to the individual. A strong correlation is expected between the training data and recognition data. Çarıkçı and Özen (2012) implemented this method and the success rate for this method is 94.74% in specific conditions.

Fisherface or Fisher's Linear Discriminant (FLD) is based on face space dimension reduction using the Principal Component Analysis (PCA) method to obtain the feature image. Anggo and La Arapu (2018) implemented this method and the success rate of this method in facial recognition is 93%.

Sveleba et al. (2019) developed the system based on the Viola-Jones algorithm, used to detect people in a sequence of video images and local binary templates achieved 93% accuracy.

Shan and Gritti (2008) present in their paper the implementation of the LBP-Discriminative Histogram bins (LBPH) algorithm for the task of facial expression recognition and by adopting SVM with the selected multiscale LBPH bins, achieving an accuracy of 93%

After studying the articles on the accuracy of facial recognition of the methods presented above, we identify and agree with Jin and Sheeja (2019) and Himanshu and Prabhakar (2023) that these methods have limitations related to head orientation, lighting conditions, image quality, and occlusion.

To eliminate these limitations, researchers have proposed face recognition methods based on neural networks.

Deep Learning-based techniques represented a revolution in the field of facial recognition and have enabled the establishment of exceedingly precise and resilient facial recognition systems, effectively tackling a multitude of challenges, encompassing variations in lighting, facial orientations, and expressions.

Adjabi et al. (2020) classified the Deep learning methods into three primary categories based on the utilization of the technique and architecture:

a) Unsupervised or generative: auto encoder (AE), Boltzman machine (BM), recurrent neural network (RNN), and sum-product network (SPN);
b) Supervised or discriminative: convolutional neural network (CNN);
c) Hybrid: deep neural network (DNN).

Analyzing the selected articles, especially those using artificial neural networks (ANN), two analysis directions are outlined. The first direction focuses on the segregation of technologies applied at each stage of the facial recognition process, and the second focuses on heterogeneous solutions (the authors of the articles conducted tests to determine the stages in which the algorithm fits best, analyzed and sought to achieve higher levels of accuracy).

Karthick et al. (2021) implemented HAAR Cascade algorithm for face recognition and Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) as statistical data classifiers to develop facial recognition methods and achieved an accuracy level of 98% in both methods.

Jin et al. (2019) proposed a dual recognition approach (adding pedestrian motion recognition to the whole face recognition process) to improve the performance and accuracy of the system, the solution accuracy reached 77.4% compared to 67.7 % in solutions using only one approach.

The study made by Maharani et al. (2020) used HAAR Cascade and MobileNet for face detection, integrating the cosine distance method. In the facial recognition stage, they used Visual Geometry Group 16 layers (VGG16) learning transfer methods The accuracy rates varied across scenarios, with VGG16 achieving up to 100% accuracy in specific conditions. When they used Triplet loss FaceNet algorithms in the facial recognition stage, they achieved 82.20% accuracy.

DeepFace was proposed by Taigman et al. (2014) and was one of the first methods to achieve 97.35% accuracy. DeepFace uses 3 deep neural networks with 9 layers trained for facial recognition.

FaceNet was suggested by Schroff et al. (2015) and used a GoogleNet architecture network with a triplet loss function at the final layer. The method has an accuracy of 99.63 %.

Deng et al. (2017) implemented the marginal loss function using a network with ResNet-27 architecture obtaining an accuracy of 99.48%.

Method CosFace introduced a new loss function called large-margin cosine loss (LMCL) to conduct a ResNet-64 network to learn more discriminative features for face recognition and was proposed by Wang et al. (2018) This method has an accuracy of 99.73%.

ArcFace is a method developed for face verification and recognition tasks. In the variant implemented by Deng et al. (2019) it is based on a network with ResNet-100 architecture. It is specially designed to generate discriminative features for face recognition. It is widely used in computer vision for tasks involving facial recognition because it has an accuracy of 99.62%.

Ling et al. (2020) introduced an attention-based neural network (ACNN) to learn the global feature relationships of aligned facial images. This network aims to embed discriminative facial features, which intends to reduce the information redundancy between channels and focus on the most informative elements of facial feature maps.

Regarding the programming languages for implementing the algorithms, they were Matlab and Python.

4. FUTURE RESEARCH DIRECTIONS

Despite these advancements, several challenges remain in the field of face recognition. There is an ongoing need for more diverse and representative datasets to reduce bias in face recognition algorithms, single-sample face recognition (only one face representation for each individual in the training set) is one of the most challenging problems. Another challenge is related to facial aging because the aging process affects the shape and texture of the face. Another significant issue is the need to balance accuracy with privacy and security concerns. Striking the right balance between the convenience of face recognition technology and safeguarding individual privacy remains a complex challenge.

Researchers and practitioners must continue to address these challenges while striving for further improvements in accuracy and efficiency to enable the responsible and ethical deployment of face recognition systems in various applications, from security and authentication to human-computer interaction and healthcare.

5. CONCLUSION

Facial recognition algorithms are in continuous development, constantly improving their accuracy and reliability. These characteristics of algorithms are very important in security and privacy applications. The main purpose of this research was to provide a brief performance analysis of the most widely used facial recognition algorithms. The results of our study are especially useful for researchers and professionals who need to choose and implement the right algorithm in different contexts. Results demonstrate that models based on convolutional neural networks are superior in facial recognition tasks.

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Decision Support System with AI-based Gait Estimation as Aid for Neurodegenerative Disease Patients

Arun-Fabian Panaite[1]
Monica Leba[2]

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Abstract: *AI-based uncertainty handling can be applied to multimodal data fusion for IMU (Inertial Measurement Units) sensor-based gait motion capture in tracking gait differences in patients with Alzheimer's disease or other medical conditions. The challenge is represented by monitoring and analyzing gait patterns in patients with Alzheimer's disease to detect changes over time and assess disease, progression, or treatment effectiveness. Machine learning models are used to enhance the accuracy of gait analysis systems, making them valuable tools in healthcare for diagnosis and rehabilitation. Thus, IMUs have evolved with multi-sensor systems, sensor fusion, and machine learning for precise gait analysis, finding applications in clinical and consumer settings. AI-based gait motion capture has advanced through deep learning and video-based methods, enabling non-invasive, markerless analysis for individual identification, and enhancing healthcare diagnostics and rehabilitation. Recurrent neural networks (RNNs) or long short-term memory networks (LSTMs), are developed and trained using historical gait data from patients with Alzheimer's disease that also include the uncertainty estimates as input features to the models. AI-based uncertainty handling integrated into gait motion capture and analysis allows continuous monitoring of gait differences in patients with Alzheimer's disease and other medical conditions.*

1. INTRODUCTION

The problem addressed in the research is the need for high-precision motion capture and gait analysis in various domains such as medicine, sports, entertainment, military, and aerospace. The existing methods using IMU sensors for motion capture suffer from measurement errors, leading to inaccurate orientation estimations and imprecise positions, especially during rapid movements. This hinders the applicability of IMU sensors in real-time trajectory assessment, bio-mechanical modeling, and gait analysis, which are crucial for rehabilitation, training, and other applications.

The approach taken in the research involves the development of dedicated criteria and a set of instructions for anomaly detection and error reduction in motion capture using IMU sensors. The goal is to enhance the accuracy and application of IMU sensors in diverse domains by leveraging a precise motion capture system.

The proposed solution involves a meticulous methodology that encompasses both hardware and software components essential for accurate gait data recording and processing. The research leverages wearable 6-axis accelerometer sensors, an Arduino Uno R3 board, and a Serial Port Expander for data collection and processing. The system design includes careful placement and

[1] Faculty of Mechanical and Electrical Engineering, University of Petrosani, Street Universității, no. 20, 332006, Petroșani, Romania
[2] Faculty of Mechanical and Electrical Engineering, University of Petrosani, street Universității, no. 20, 332006, Petroșani, Romania

arrangement of sensors on the lower body, optimal settings for data collection, and software components for signal processing and visualization. The MATLAB Simulink model is utilized for simulation and control of the motion capture system.

During the practical implementation phase, the gait capture system is physically assembled, rigorously tested, and calibrated to ensure accuracy and reliability. Human participants are involved in pilot studies and data collection sessions to capture diverse walking movements under various circumstances and scenarios. The collected walking motion data undergoes pre-processing and analysis using signal processing techniques to derive gait characteristics.

The results of the study involve a meticulous evaluation of gait characteristics by comparing them to established reference values and standards. Various measurements such as joint angles, cadence, stride length, and stride duration are employed to comprehensively assess gait patterns. Correlation analysis and comparison tests are conducted to examine the relationships between different gait measurements and ascertain the variations in gait parameters across different scenarios or participant groups. The customizable data filtering criteria developed in the research is a highly important aspect of the solution. It allows for the customization of multiple sub-criteria, such as the number of read values to calculate the mean value from, time intervals for data reading, and the number of comparisons, enabling destination-specific levels of precision for motion capture analysis.

In conclusion, the research addresses the problem of high-precision motion capture and gait analysis by developing dedicated criteria and a set of instructions for anomaly detection and error reduction. The approach involves a meticulous methodology encompassing both hardware and software components essential for accurate gait data recording and processing. The goal is to enhance the accuracy and application of IMU sensors in diverse domains, and the proposed solution achieves this by providing customizable data filtering criteria for high-precision motion capture analysis.

The research findings contribute to the advancement of gait analysis methodologies and hold implications for various fields such as health monitoring, age-related therapies, sports performance, rehabilitation, and assistive technology. The customizable data filtering criteria open doors to diverse precision levels in motion capture analysis, offering valuable insights for various applications and driving progress in gait capture research.

2. LITERATURE REVIEW

Wearable inertial measurement units (IMUs) and motion capture systems have been extensively researched to analyze human walking patterns (Fusca et al., 2018). The goal is to assess motor functionality and evaluate gait. However, the lack of reliable validation for these systems necessitates the development of standardized approaches. IMUs utilize accelerometers, gyroscopes, and magnetometers to track the trajectory of body segments, while sensor fusion algorithms are employed to improve tracking accuracy. However, the adoption of motion capture systems is limited by cost and the issue of occlusion (Tsilomitrou et al., 2021).

In terms of validation, a neural network architecture has been proposed to predict trajectories and calibrate sensors, but its validation has been limited to optical systems (Kim et al., 2021). It is crucial to explore and validate these methods in diverse real-world scenarios. While research has

primarily focused on validating IMUs for gait measurement, there are certain limitations such as methodological constraints and a lack of assessment regarding repeatability (Lewin et al., 2022). Although IMUs placed on the shank can detect gait events, challenges arise when it comes to detecting turning movements, as false events and missed detections can occur (Romijnders et al., 2021). Reliable detection of gait parameters has been observed in straight and slalom walking, but caution should be exercised when dealing with rotations and disruptions. Other factors, such as environmental conditions and individual differences, also need to be taken into consideration.

One study presents a calibration protocol tailored specifically for children, utilizing magneto and inertial sensors for motion tracking (Ricci et al., 2014). Another research introduces an artificial neural network-based quality control algorithm to evaluate joint orientation estimates from IMUs, which holds potential for remote patient monitoring (Lebel et al., 2016). IMU precision and accuracy in measuring running frequencies and magnitudes have been investigated, but the study was limited by a small sample size and a focus solely on running (Provot et al., 2017). Accurate indoor pedestrian tracking using low-cost sensing systems has also been explored, emphasizing the need for aesthetic improvements and enhanced knowledge input (Zizzo & Ren, 2017). Additionally, a proposed complementary filter that integrates optical and inertial technologies shows promise in detecting both small and large-scale motions but struggles with micro-motions of small amplitude and high frequency (Phan et al., 2020).

IMUs have demonstrated agreement with motion capture systems when measuring hip-joint angles, but they exhibit increased errors when assessing knee and ankle joints (Park & Yoon, 2021). In the context of a teleoperated robot system, IMUs and armbands effectively correct upper arm and forearm roll angles (Zhu et al., 2022). IMUs have proven valuable in estimating joint kinematics during movements, but challenges persist, such as sensor alignment errors and reliance on motion capture data (Potter et al., 2022). Deep neural networks based on IMU data can accurately predict locomotion intentions in amputees, underscoring the importance of subject-specific training data (Mazón et al., 2022). A human pose estimation method that combines IMUs with spatial attention and kinematic regression networks achieves superior accuracy (Liao et al., 2023). While IMU-based advancements provide valuable insights, there are still challenges that need to be addressed through further investigation to refine these techniques and expand their applications.

In a research article, the authors (Panaite et al., 2021a) unveil a few benefits. They ingeniously employ budget-friendly, wearable devices, ensuring easy accessibility for all. Multiple sensors heighten the data wealth, offering a potential source for machine learning. Moreover, the motion capture system's flexibility opens doors for future expansion. By endorsing free software, the researchers present a viable solution for rehabilitation, recreation, and technical pursuits. Nevertheless, they highlight some intriguing research gaps, like the need to scrutinize accuracy, explore diverse applications, and develop advanced algorithms.

As another possibility (Olar et al., 2020), augmented reality reigns, enhancing a robotic arm's control and precision. Empowering patients to perform tasks with newfound dexterity. Remote supervision enables healthcare professionals to offer assistance from afar, promoting a better quality of life. The findings (Panaite et al., 2021b) provide various sensor technologies for motion analysis. Marker-less motion tracking and mathematical models propel accuracy. Camera-based systems extend their use underwater and in medical imaging for real-time monitoring and motion correction.

Advancing in prosthetics (Rosca et al., 2020), the research models and simulates a 3D prosthesis. A lifeline for amputees, the design's adaptability caters to diverse patients. Offering a wide array of movements akin to real limbs, this solution addresses existing limitations while being cost-effective and comfortable. In another pursuit (Olar et al., 2021), the research sets its sights on replicating natural biomechanics. The result: a low-cost, reliable, and forceful motion system. The synthesis of joint movements reaches new horizons.

Wearable IMUs and motion capture systems hold great potential for gait analysis and motor functionality assessment. Challenges such as validation, occlusion, and accuracy persist, but innovative approaches, like neural networks and sensor fusion algorithms, offer promise. This research is needed to address limitations and refine these technologies for diverse applications.

The previous works mentioned in the provided text encompass a wide range of research and development efforts in the field of motion capture systems, particularly focusing on the use of IMU sensors and wearable technology for gait analysis and motion tracking. These works have contributed significantly to the advancement of various applications in domains such as medicine, sports, entertainment, military, and aerospace. In this detailed analysis, we will discuss the pros and cons of the previous works, highlighting their contributions, limitations, and potential for future advancements.

Pros of Previous Works:

1. Diverse Applications: The previous works have demonstrated the versatility of IMU sensors and motion capture systems in diverse applications such as rehabilitation in medicine, optimizing training exercises in sports, motion capture for video animation in entertainment, enhanced training and ergonomics in the military, and potential use in aerospace for training astronauts. This highlights the broad impact and potential of these technologies across different industries.
2. Real-time Trajectory Assessment: The utilization of IMU sensors for motion capture enables real-time trajectory assessment and bio-mechanical modeling, benefiting rehabilitation and training. This real-time assessment provides immediate feedback and monitoring, which is crucial for applications such as rehabilitation and sports training.
3. Sensor Fusion Algorithms: The use of sensor fusion algorithms to improve tracking accuracy is a significant advancement. By integrating data from accelerometers, gyroscopes, and magnetometers, these algorithms enhance the precision of motion tracking, leading to more accurate gait analysis and motion capture.
4. Neural Network-based Quality Control: The introduction of an artificial neural network-based quality control algorithm for evaluating joint orientation estimates from IMUs holds potential for remote patient monitoring. This technology has the potential to empower patients to perform tasks with newfound dexterity and enable healthcare professionals to offer assistance from afar, promoting a better quality of life.
5. Wearable IMUs and Motion Capture Systems: The development of wearable IMUs and motion capture systems holds great potential for gait analysis and motor functionality assessment. These technologies offer promise for addressing challenges such as validation, occlusion, and accuracy, paving the way for advancements in motion capture and gait analysis methodologies.

Cons of Previous Works:

1. Measurement Errors: One of the major challenges highlighted in the previous works is the presence of measurement errors, leading to significantly inaccurate orientation estimations, especially when the sensors are moved rapidly. This limitation can affect the precision and

reliability of the captured motion data, impacting the accuracy of gait analysis and motion tracking.

2. Cost and Occlusion: The adoption of motion capture systems is limited by cost and the issue of occlusion. The cost associated with acquiring and implementing motion capture systems may pose a barrier to widespread adoption, especially in resource-constrained settings. Additionally, occlusion can hinder the accurate tracking of body segments, affecting the overall quality of motion capture data.
3. Methodological Constraints: Previous research has highlighted methodological constraints and a lack of assessment regarding repeatability when validating IMUs for gait measurement. These constraints can limit the reliability and reproducibility of gait analysis results, impacting the overall utility of IMU-based motion capture systems.
4. Environmental and Individual Variability: Challenges arise when dealing with environmental conditions and individual differences in gait patterns. Factors such as environmental conditions and individual differences need to be taken into consideration to ensure the robustness and generalizability of gait analysis results across diverse scenarios and populations.
5. Data Anomalies and Filtering: The presence of data anomalies and the need for effective data filtering criteria have been highlighted as important considerations. Anomalies in the captured data can complicate the gait measurement process, necessitating the development of robust data filtering criteria to ensure the accuracy and reliability of motion capture analysis.

Future Directions and Potential Advancements:

Despite the limitations and challenges identified in the previous works, there are several potential advancements and future directions that can address these limitations and further enhance the capabilities of IMU-based motion capture systems:

1. Error Reduction and Precision Enhancement: Future research can focus on developing advanced error reduction techniques and precision enhancement algorithms to mitigate the impact of measurement errors and improve the overall accuracy of motion capture data.
2. Cost-effective Solutions: Efforts to develop cost-effective motion capture systems and wearable IMUs can help address the cost barrier associated with the adoption of these technologies, making them more accessible for a wider range of applications and settings.
3. Validation and Standardization: Continued research into validation methods and standardization approaches for IMU-based motion capture systems can contribute to improving the reliability and reproducibility of gait analysis results, addressing methodological constraints and enhancing the overall utility of these systems.
4. Environmental Adaptability: Advancements in motion capture technologies that can adapt to diverse environmental conditions and accommodate individual variability in gait patterns will be crucial for ensuring the robustness and applicability of these systems across different scenarios and populations.
5. Customizable Data Filtering Criteria: The development of customizable data filtering criteria, as mentioned in the previous works, can open doors to diverse precision levels in motion capture analysis. Future research can focus on refining and optimizing these criteria to cater to specific application requirements and resource management needs.

In conclusion, previous works have made significant contributions to the field of motion capture systems and IMU-based gait analysis. While they have demonstrated the potential of these technologies in various domains, some challenges and limitations need to be addressed. Future research and advancements in error reduction, cost-effectiveness, validation, environmental

adaptability, and customizable data filtering criteria hold promise for further enhancing the capabilities and applicability of IMU-based motion capture systems. These advancements have the potential to drive progress in gait analysis methodologies and contribute to the development of innovative solutions for healthcare, sports, rehabilitation, and assistive technology applications.

3. BENCHMARK DATASET

The benchmark dataset in this research utilizes data collected from wearable inertial measurement units (IMUs) and motion capture systems. These systems employ accelerometers, gyroscopes, and magnetometers to track the trajectory of body segments, enabling the assessment of motor functionality and gait analysis. The dataset encompasses gait characteristics such as joint angles, cadence, stride length, and stride duration, derived from the recorded acceleration data. The dataset is meticulously evaluated by comparing the gait characteristics to established reference values and standards, and correlation analysis is conducted to examine the relationships between different gait measurements. This benchmark dataset serves as a fundamental basis for the advancement of motion capture and gait analysis methodologies.

The paper presents a comprehensive study on the development and implementation of a lower body motion capture system using IMU sensors. The study aims to enhance the precision of synthesized motion from captured data and explores the potential applications of this technology in various domains such as medicine, sports, entertainment, military, and aerospace.

The methodology employed in the study is meticulous and encompasses several key phases. The research begins with a thorough review of existing literature to understand the state of the art in motion capture systems and to identify the gaps and opportunities for improvement. The design phase involves the creation of a complete system design, including both hardware and software components essential for accurate gait data recording and processing. This includes the placement and arrangement of 6-axis accelerometer sensors on the body, integration with the Arduino Uno R3 board, and the development of optimal settings and parameters for data collection and processing.

The software components are developed in parallel with the hardware design, with a focus on choosing suitable frameworks and programming languages to effectively fulfill the required functions. The Arduino Integrated Development Environment (IDE) plays a central role in programming the Arduino Uno R3 board, and the software architecture takes into account signal processing methods necessary for extracting relevant gait parameters from the accelerometer data.

The practical implementation phase involves the physical assembly of the motion capture system, rigorous testing, and calibration processes to ensure the accuracy and reliability of the system. Pilot studies and data collection sessions are conducted with human participants, capturing diverse walking movements under various circumstances and scenarios. The collected walking motion data undergoes pre-processing and analysis using signal processing techniques, including filtering the data to remove noise and artifacts, standardizing, and calibrating the data for consistency across all participants.

The results of the study are meticulously evaluated by comparing gait characteristics to established reference values and standards. Multiple measurements, such as joint angles, cadence, stride length, and stride duration, are employed to comprehensively assess gait patterns. Correlation analysis is conducted to examine the relationships between different gait measurements,

and comparison tests are employed to ascertain the variations in gait parameters across different scenarios or participant groups.

The study's findings provide valuable insights into the system's accuracy and reliability, serving as a fundamental basis for the advancement of motion capture and gait analysis methodologies. The authors also discuss the implications of the findings for various fields, including health monitoring, age-related therapies, gender differences in gait patterns, and walking mechanics. The customizable data filtering criteria developed in the study opens doors to diverse precision levels in motion capture analysis, contributing to advancements in the field of gait capture.

4. RESEARCH METHODOLOGY

The research methodology employed in the study involved a comprehensive approach to developing a gait capture system. The process began with an extensive review of existing research, followed by the design, implementation, testing, and analysis of the system's performance. The methodology encompassed both hardware and software components essential for accurate gait data recording and processing. Careful consideration was given to the placement and arrangement of 6-axis accelerometer sensors on the body, taking into account the biomechanical nuances of walking. The integration of these sensors and data collection was simplified using the Arduino Uno R3 board and a Serial Port Expander.

The software components were developed in parallel with hardware design, with a focus on choosing suitable frameworks and programming languages that could effectively fulfill the required functions. The Arduino Integrated Development Environment (IDE) played a central role in programming the Arduino Uno R3 board, offering a user-friendly interface for firmware creation, development, and uploading. The software architecture took into account signal processing methods necessary for extracting relevant gait parameters from the accelerometer data. This involved employing filtering techniques to eliminate noise and artifacts, segmentation algorithms for identifying specific steps, and feature extraction approaches to measure gait characteristics. A graphical user interface (GUI) or visualization component was developed to present and analyze gait data in a user-friendly manner, enabling real-time monitoring of gait parameters, visualization of gait patterns, and comparison across multiple trials or participants.

The practical implementation phase involved the physical assembly of the gait capture system, rigorous testing, and calibration processes to ensure the accuracy and reliability of the system. Pilot studies and data collection sessions were conducted with human participants, capturing diverse walking movements under various circumstances and scenarios. The collected walking motion data underwent pre-processing and analysis using signal processing techniques, and the findings were compared with established gait analysis methods and existing literature to validate the accuracy and efficacy of the gait capture technology.

The methodology was thoroughly documented, providing comprehensive information about the system's capabilities and limitations. This documentation served as a record of the system implementation process, and the results yielded valuable insights into the system's accuracy and reliability, serving as a fundamental basis for the advancement of motion capture and gait analysis methodologies.

The paper focuses on developing a lower body motion capture system using IMU sensors for applications in various domains such as medicine, sports, entertainment, military, and aerospace. The

methodology involves a comprehensive review of existing research, system design encompassing hardware and software components, and meticulous testing and analysis of the system's performance. The results include detailed evaluations of gait characteristics, comparison with established norms, and the successful implementation of data filtering criteria to enhance motion capture accuracy. The customizable data filtering criteria hold promise for diverse precision levels in motion capture analysis, contributing to advancements in gait analysis methodologies and various fields.

The data circuit in the system involves the flow of sensor data from the inertial measurement unit (IMU) sensors, specifically the 6-axis accelerometer sensors (SEN0386), to the Arduino Uno R3 board for processing and then to a PC for further analysis and visualization (Figure 1).

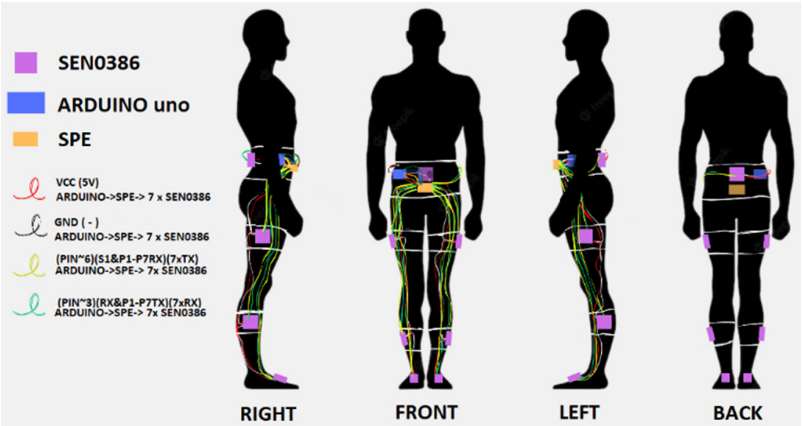

Figure 1. Circuit Design
Source: Own research

The sensor data is acquired from the IMU sensors through a microcontroller's virtual serial monitor and is then transmitted to the Arduino Uno R3 board. The Arduino Uno R3 board serves as the intermediary for processing and handling the sensor data. It is programmed to collect, filter, and process the sensor data using the Arduino Integrated Development Environment (IDE) and the Arduino programming language based on C/C++.

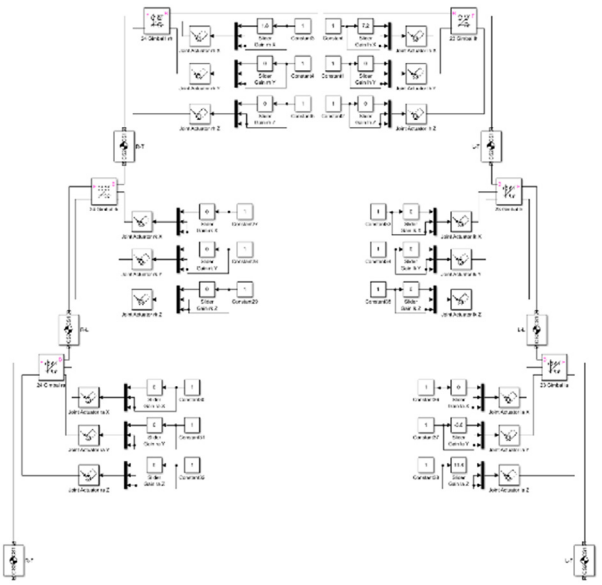

Figure 2. MATLAB Simulink model
Source: Own research

Figure 3. Motion capture devices mounted
Source: Own research

Once the sensor data is processed and filtered by the Arduino Uno R3 board, it is then transmitted to a PC for further processing, calculations, and synthesis. The PC is used for analyzing the gait data, applying signal processing techniques, and visualizing the gait patterns. The data circuit is completed by the transmission of the processed sensor data from the Arduino Uno R3 board to the PC, where it is utilized for motion capture analysis and gait assessment, implemented in MatLab as seen in Figure 2.

In summary, the data circuit involves the flow of sensor data from the IMU sensors to the Arduino Uno R3 board for processing and then to a PC for further analysis and visualization of gait patterns and motion capture data. Figure 3 presents the IMU sensors' placement.

5. EXPERIMENTAL RESULTS

The experiments conducted in this research focused on developing and testing a gait capture system using wearable inertial measurement units (IMUs) and motion capture technology. The system was designed to accurately record and analyze walking motion data, with a specific emphasis on gait characteristics such as joint angles, cadence, stride length, and stride duration. The methodology involved a comprehensive review of existing research, followed by the design, implementation, testing, and analysis of the system's performance.

This study rigorously evaluated gait characteristics, comparing them to established standards. Various measurements, like joint angles, cadence, and stride length, were analyzed. Correlation and comparison tests were conducted for insights into gait variations. Challenges were addressed, and the system's capabilities and limitations were explained, contributing to motion capture advancements. The algorithm effectively filtered data anomalies by considering the angular speeds of the ellipsoidal joint for each leg.

Read $\alpha 1$ at t0
Read $\alpha 2$ at $t0 + \Delta t$
If $\alpha 2 - \alpha 1 > 0.6° \cdot (\Delta t)/10$ then
Read $\alpha 3$ at $t0 + 2 \Delta t$
$\alpha 2 = (\alpha 1+\alpha 3)/2$

Where: $\alpha 1$, $\alpha 2$ and $\alpha 3$ are angles; t0 is the initial moment of gait; and Δt is the period of walking.

During the practical implementation phase, the gait capture system was assembled and tested, and data collection sessions were conducted with human participants. The collected walking motion data underwent pre-processing and analysis using signal-processing techniques to derive gait characteristics (Figure 4). The results were meticulously evaluated by comparing them to established reference values and standards, and correlation analysis was conducted to examine the relationships between different gait measurements.

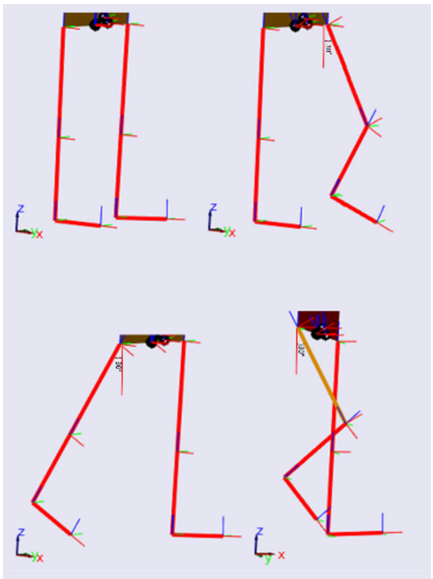

Figure 4. Visual Simulation
Source: Own research

The findings provided valuable insights into the system's accuracy and reliability, serving as a fundamental basis for the advancement of motion capture and gait analysis methodologies. The data filtering criteria, which were applied to the motion data, successfully filtered out anomalies and contributed to the system's overall success in accurately measuring and recording gait data. The customizable nature of the data filtering criteria allows for diverse precision levels in motion capture analysis, opening doors to various applications in health monitoring, age-related therapies, walking mechanics, and more.

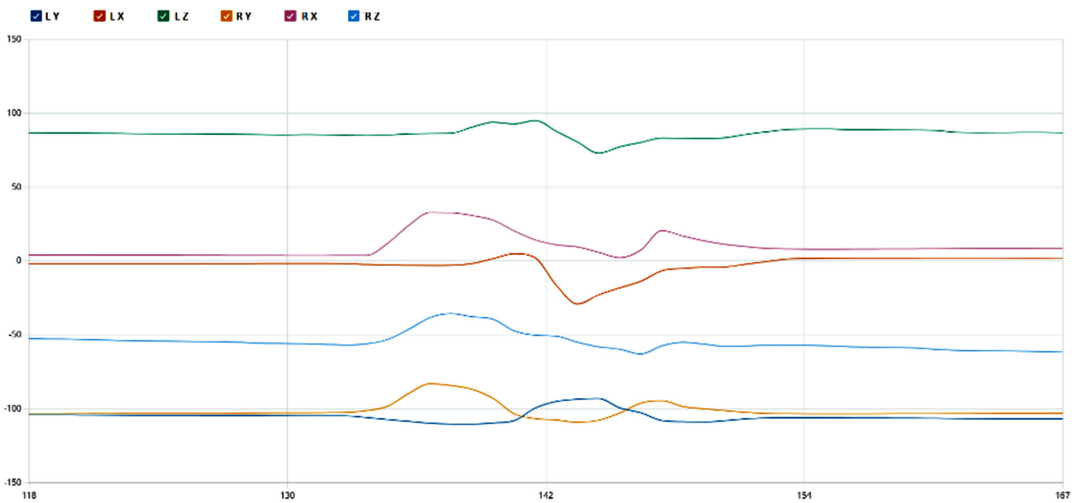

Figure 5. Data diagram
Source: Own research

In summary, the experiments and results of this research demonstrated the successful development and testing of a gait capture system, providing valuable insights into gait analysis methodologies and their implications for various fields (Figure 5).

The study utilized 6-axis accelerometer (SEN0386) sensors placed on the body, and the integration of these sensors and data collection was simplified using the Arduino Uno R3 board and a Serial Port Expander. The system design also encompassed the creation of wiring diagrams, ensuring secure and reliable connections while minimizing signal interference and noise. The software components were developed in parallel with hardware design, with careful consideration given to choosing suitable frameworks and programming languages that could effectively fulfill the required functions.

During the practical implementation phase, the system demonstrated its ability to accurately record and display walking motion data. The results encompassed detailed descriptions of the acquired gait data, statistical analyses, and comparisons with established norms. Gait parameters were compared to reference values, and their correlations with participant characteristics were thoroughly explored. Furthermore, the clinical relevance of the findings was discussed by juxtaposing the results with relevant thresholds, that are customizable by all sets of parameters.

6. CONCLUSION

In conclusion, the research has made significant strides in advancing gait analysis methodologies, with implications for health monitoring, age-related therapies, and walking mechanics. The customizable data filtering criteria offer diverse precision levels in motion capture analysis, addressing hardware resource management. The findings hold promise for therapeutic, sports, rehabilitation, and assistive technology applications, driving progress in gait capture research. Future research could focus on refining the data filtering criteria, exploring its applications in diverse domains, and collaborating on ethical considerations to further foster advancements in the field of gait capture.

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Deep Machine Learning for Time Series Inbound Tourism Forecasting

Ivanka Vasenska[1]

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Time series;
Deep machine learning;
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Bulgaria inbound tourism forecast

Abstract: *Accurate inbound tourism flow forecasting has been a challenge for all stakeholders related to the sector. The multidisciplinary character of the tourism product which has been directly and indirectly influenced by all types of risks, cataclysms and crises further exposed its intangible nature to shocks and flows disruption. Thus, forecasting inbound tourism flows with advanced data science and AI (artificial intelligence) methods has been gaining momentum, which the COVID-19 pandemic boosted. Therefore, this paper aims to examine the relevant AI forecasting methods by applying a deep machine learning technique comparing different Python time series forecasting libraries via a Jupyter Notebook computer environment. Bulgaria's inbound tourism data has been used to develop an advanced deep neural network with the DARTS Python library and compare its accuracy with other Python library models.*

1. INTRODUCTION

Deep machine learning (DML) is a branch of AI and a sub-branch of machine learning (ML) using artificial neural network (ANN) architectures that are significantly advanced and can be applied through computer iterations to speech recognition, natural language processing and other domains (Géron, 2019; Goodfellow et al., 2016). Artificial neural networks use network architectures (similar to the biological neural networks (NNs) that the human brain uses) with a large number of interconnected processing layers. The birth of idea and description of an artificial neural network was first published in the 1940s, presenting a simplified model of how the human neuron works. McCulloch and Pitts (1943), describe in a paper the mathematical structure of a simplified neural model viewed as a Threshold Logic Element (THL) which ever since has been considered as the first mathematical model of a neural network. Building on the ideas of Turing (1936) the paper by McCulloch and Pitts provides a way to describe brain functions in abstract terms and demonstrates that simple elements connected in a neural network can have enormous computational power.

NNs are models that resemble human brain activity and, in particular, the connections between neurons (nodes) in the human brain. A node or "neuron" is a computational unit that has one or more weighted values and acts as a miniature mathematical function. Depending on the task at hand, the nodes are organized in a layer to make up a network - AAN, with a possible size from one layer to 100 layers of nodes. The first layer is the input layer, and the output layer is the resulting function transformation, once propagated through the middle "hidden" layers, which is where the term "deep" in DML comes from - the depth of the network's hidden layers.

DML algorithms are applied in tourism and hospitality sectors to recognize faces in an image or footage, in check-in/ check-out procedures, at airports through automatic face recognition,

[1] South-West University "Neofit Rilski", 60 Ivan Mihaylov str., Bulgaria

and even to detect emotions in people passing a certain point (eg. the happiness of those leaving the facilities).

The most common methodology for building an NN architecture structure is by applying the Python computer language and its libraries on potentially thousands of multi-GPU servers through computational graphics and a Python library. The main Python library ecosystem applied for time series forecasting is SciPy and it consists of the depicted-on Figure 1. libraries.

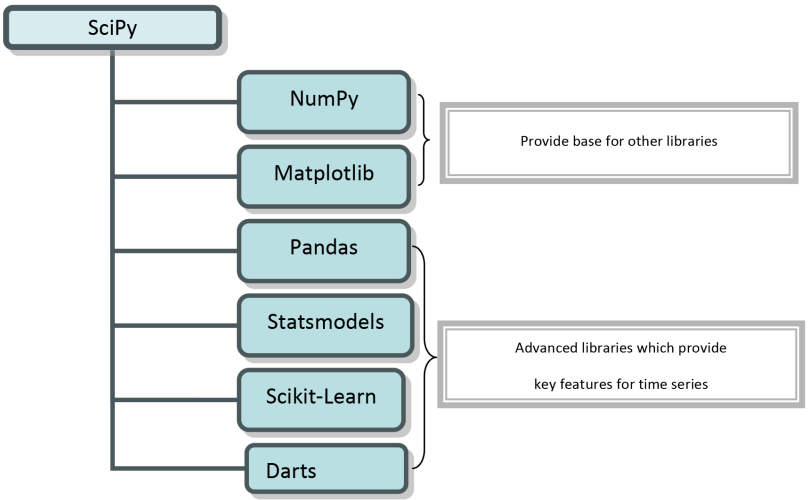

Figure 1. SciPy ecosystem libraries for time series forecast
Source: Own processing based on Lazzeri, 2021

- SciPy is developed in the open on GitHub, through the consensus of the SciPy and wider scientific Python community and is an open-source software for scientific computing package, developed openly and hosted on public GitHub repositories under the Scipy GitHub organization.
- NumPy - multidimensional data and mathematical functions working with the data;
- Matplotlib is a Python plotting library that produces publication-quality figures in a variety of hardcopy formats and interactive environments across platforms.
- Pandas - data manipulation and analysis;
- Statsmodels is a Python module that provides classes and functions for the estimation of many different statistical models as well as for conducting statistical tests and statistical data exploration. The results are tested against existing statistical packages to ensure that they are correct (Lazzeri, 2021).
- Scikit-Learn - data modeling;
- Darts is a Python library for user-friendly forecasting and anomaly detection on time series.

Among the above-mentioned ecosystem, there are many more essential Python libraries, such as:

- TensorFlow - distributed numerical computation using data flow graphs;
- Keras - python wrapper library, can be built independently on top of TensorFlow;
- Natural Language Toolkit (NLTK) with its lexical resources FrameNet, WordNet, Word2Vec;
- Spark MLlib - computing scaling;
- Thano - scientific computing on a large scale;
- MXNet - fast model training.

For the purpose of the current paper, the DARTS open-source data forecasting library has been used to predict the inbound tourist flows to Bulgaria for 2023 based on time series data from 2005 to 2022 with DML architectures by Python, in a computer-generated environment – Jupyter Notebook.

2. LITERATURE REVIEW

Artificial Intelligence - AI, machine learning - ML, data mining, big databases and smart data are just some of the many buzzing trends that have taken a dominant position in science, business and media in recent years (Egger, 2022). Although these increasingly popular phrases may seem catchy, they still have an attractive force, mainly because they have undoubtedly infiltrated our daily lives, whether in the personal or professional sphere. The rapidly advancing digitalization of our society has laid the foundations for this (Neuburger et al., 2018) increasing computing power, greater storage capacity, faster internet connections, the rapid development of powerful algorithms, and the availability of vast amounts of data for the purposes of analysis are only some of the driving forces that have and continue to allow us to apply new analytical methods and generate useful knowledge for science, business and ultimately society as a whole (Egger, 2022; Skiena, 2017). Furthermore, the application of emerging technologies in the post-COVID-19 era must adapt to changes in consumer behavior (perceptions of risk, last-minute bookings, desires for advance bookings in new contexts in museum exhibitions, need for highly personalized tourist packets) and likely changes in interaction mode (from physical touch to voice or from input to automated discovery) (Gretzel et al., 2020).

Today, we all witness how sensor devices monitor everything that can be monitored: video streams, social media interactions, and generally the position of anything that moves. Cloud computing allows us to use the power of a huge number of machines to systematize, process and analyze this data. It's hard to imagine, but hundreds of computers kick in every time we search Google or any metasearch engine on the Internet, scrutinizing all of our previous activity just to decide which is the best ad to generate based on our search history. The result of all this is the birth of data science, a new field dedicated to maximizing the value of vast databases of information. As a discipline, data science sits somewhere at the intersection of statistics, computer science, and machine learning, but it is building its own strength and character (Skiena, 2017). Furthermore, data science is focused on quantitative data collection and interpretation by the use not only of statistics but also by the application of scientific methods, processes for data systemization, visualization and analysis to extract meaningful insights for business.

According to Encyclopedia Britannica AI, is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings (Copeland, 2023). AI is a broader concept of machines' capability to perform tasks that normally require human intelligence, such as understanding natural language, recognizing objects and sounds, and solving empirical problems. And by machines, we don't just mean the physical robots, but also the software running on, for example, your computers, phones and connected home devices. In addition, AI research areas include rule-based reasoning, ML and DML where, additional layers, complex neural architectures subject to ML techniques are added, processing of natural language - Natural Language Processing (NLP), computer vision, speech analytics and robotics (Egger, 2022). AI can be seen as a key driver of innovative solutions for businesses of all sizes and industries (Mich, 2020), including tourism.

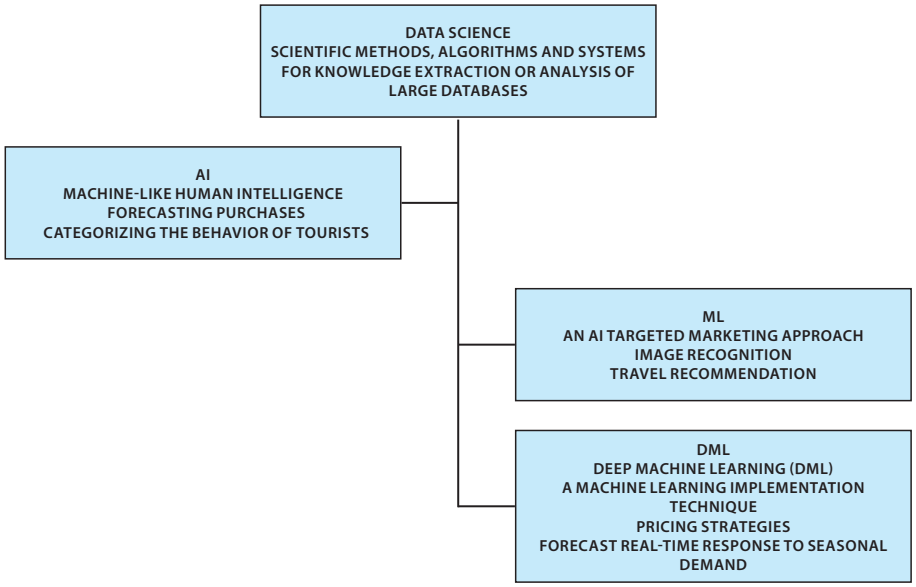

Figure 2. Data science and AI impact on tourism
Source: Own processing

Data science lies at the intersection of computer science, statistics, and their applied domains. From computer science comes machine learning and high-performance computing technologies to handle large-scale computation. From statistics comes a long tradition of exploratory data analysis, significance testing, and visualization. From the fields of application in business and science come challenges and evaluation standards to assess when they have been adequately overcome (Skiena, 2017). These principles and techniques are widely applied across functional areas in business as well as tourism. Probably the most extensive business applications are in marketing, for target marketing tasks, online advertising and cross-selling referrals. Data science is also applied in overall customer relationship management to analyze customer behavior to manage human capital and maximize expected customer value (Provost & Fawcett, 2013).

According to some researchers, data science, as an important aspect of AI, includes a comprehensive set of methods, algorithms and systems that are applied in various sectors of an interdisciplinary field (Egger, 2022), such as tourism. By observing Figure 2, the infernal deduction can lead us to the conclusion that data science combines computer science, mathematics and statistics, as well as tourism domain-specific knowledge, in order to obtain valuable information from large sets of structured, semi-structured and unstructured data (Egger, 2022). This therefore helps to explain and understand tourism phenomena and processes in the present and, with its predictive power, to some extent, future forecasts as well. Thus, computer languages such as Python are pivotal, especially for the current paper's aim achievement when the object is a data analysis with a forecasting task.

Python is an object-oriented programming-interpreted language. Python uses code modules that are interchangeable instead of a single long list of instructions that was standard for functional programming languages. Python libraries are called "modules". These modules provide commonly used functionality in the form of different objects or functions. For example, there is a module that has functions you can use in your code to test if files exist on your hard drive; there are modules that have functions for implementing web server, or web-browser functionality; there are modules to work with images; there are modules to create charts and graphs; there are modules to parse XML or HTML files; etc. To achieve the present research aims the Darts Python module/ library was applied.

Scientist working with time series already knows that time series are special creatures. If you possess regular tabular data, you can often just apply Scikit-learn to do most ML operations from preprocessing to prediction and model selection. Nevertheless, with time series, they should be different. Furthermore, the time series task can require one library for pre-processing (e.g. Pandas to interpolate missing values and re-sample), a different one to detect seasonality (e.g. Statsmodels), a third one to fit a forecasting model (e.g. Facebook Prophet), and what is more a backtesting and model selection routines must be performed as well. Such a process can be quite tedious, as most libraries need different APIs and data types. Also, in cases involving more complex models based on NN, or issues involving external data and additional dimensions the task can be more time-consuming. If that is the case a self-made model or so-called "use-case" should be implemented r, for instance using libraries such as Tensorflow or PyTorch. On the other hand, the Darts Python library can be seen as an attempt to smooth the end-to-end time series machine learning experience in Python.

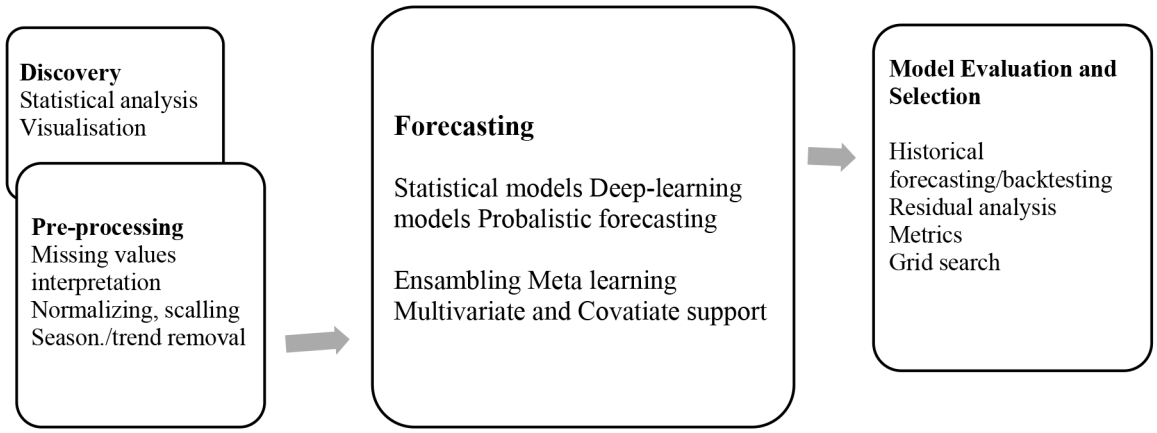

Figure 3. DARTS learning experience

Source: Own processing based on Herzen et al. (2022)

The library allows forecasting model applications in the same way similar to scikit-learn, using fit() and predict() functions (Herzen et al., 2022). The library developers also consider that by applying it the following processes are pretty straightforward - to backtest models, combine the predictions of several models, and take external data into account. What is more, the library supports both univariate and multivariate time series and models (Herzen et al., 2022). All ML or DML-based models can be trained on potentially large datasets containing multiple time series, by applying the library and what is more, some of the models give good support for probabilistic forecasting. Darts also offers extensive anomaly detection capabilities. For example, it is trivial to apply Python Outlier Detection models on time series to obtain anomaly scores, or to wrap any of Darts forecasting or filtering models to obtain fully fledged anomaly detection models (Herzen et al., 2022). Therefore, applying the Darts library is considered less time-consuming, more accurate data processing, better model pre- and fully-processing and last but not least simultaneous backtests performed together.

3. RESULTS AND DISCUSSION

Challenging time series forecasting problems have been an issue for scientists and practitioners for several decades. Thus, we have implied some novel automated methodologies that combine classical methods for time series forecasting in tourism with up-to-date models performed in a Python web-based platform - Jupiter Notebook (https://jupyter.org/) using a taxonomy and

framework of questions. We have applied naive, classical, machine learning and deep learning forecasting methods in order to estimate which of them is the most suitable and has better parameters for the task of forecasting in tourism, namely the overnight stays in the Bulgarian accommodation facilities by month for the period 2005 - 2023. For accurate task performance, we have chosen a specific user-friendly library of Python – Darts, which has been developed particularly for forecasting and anomaly detection on time series (Herzen et al., 2022).

The input data is the number of overnight stays registered in Bulgaria for the period 2005 to 2022 and our output data is the prediction made by the models which have been compared with the real-time data - overall of 216 observations. The data was obtained via the websites of The National Statistical Institute of the Republic of Bulgaria (2023) and Eurostat - the statistical office of the European Union (Eurostat, 2023).

From the python environment, a TensorFlow environment was activated and then Jupyter Notebook environment was created. All the bellow mentioned modules were generated with the functions from () and import ():

```
import math
import numpy as np
import pandas as pd
from pandas import read_csv

import matplotlib.pyplot as plt

import scipy.stats
import scipy.optimize
import scipy.spatial
from statsmodels.tsa.seasonal import seasonal_decompose
import tensorflow as tf
tf.autograph.experimental.do_not_convert
from darts import TimeSeries
from keras.preprocessing.sequence import TimeseriesGenerator
from sklearn.model_selection import train_test_split
from tensorflow.keras.layers import Input, Dense, LSTM
from tensorflow.keras.models import Sequential
from sklearn.metrics import mean_squared_error
from math import sqrt
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.callbacks import TensorBoard, ModelCheckpoint
```

Then the data was imported into the Jupyter Notebook environment:

```
df = pd.read_csv('Bulgaria.csv', sep = ";", parse_dates = True)
```

and then the data itself was observed via the pandas library:

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 216 entries, 0 to 215
```

```
Data columns (total 2 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   Month     216 non-null    object
 1   arrivals  216 non-null    int64
dtypes: int64(1), object(1)
memory usage: 3.5+ KB
```

Following this, for the forecasting task, the time series were split (Figure 4) as the last 36 months of data were used for the prediction:

```
series1, series2 = series[:-36], series[-36:]
series1.plot()
series2.plot()
```

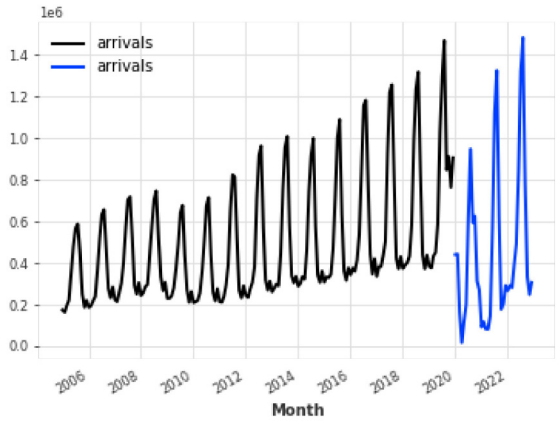

Figure 4. Time series overnights stay per month train test split

Source: Own processing

Following the data observation, the models for the forecast were created and performed, to evaluate the best-performing model, namely

- ExponentialSmoothing - Holt-Winters Exponential Smoothing, is used for time series forecasting when the data has linear trends and seasonal patterns.
- TBATS - Trigonometric seasonality, Box-Cox transformation, ARMA errors, Trend and Seasonal components.
- AutoARIMA - Automatically discover the optimal order for an ARIMA model.
- Theta - is a simple forecasting method that involves fitting two θ -lines, forecasting the lines using a Simple Exponential Smoother, and then combining the forecasts from the two lines to produce the final forecast.

For model estimation, the Mean Absolute Percentage Error (MAPE) was used as it is quite convenient and scale-independent for empirical experiment purposes since measures the average magnitude of error produced by a model, or how far off predictions are on average. In Darts it is a simple function call:

```
from darts.metrics import mape
```

The results were generated as follows:

```
model ExponentialSmoothing() obtains MAPE: 49.96%
model TBATS() obtains MAPE: 56.45%
model AutoARIMA() obtains MAPE: 77.88%
model Theta() obtains MAPE: 51.13%
```

Since the best performing model so far is the Exponential Smoothing with MAPE value of 49,96% which means that the average absolute percentage difference between the predictions and the actuals is nearly 50% a better result may be achieved with the probabilistic forecast with Monte Carlo samples describing the distribution of the time series values with simple Exponential Smoothing model. Here the MAPE was estimated at 49.34%.

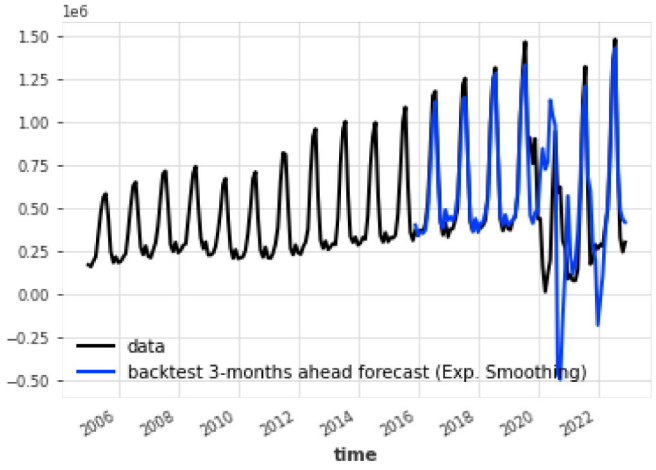

Figure 5. Monte Carlo simple Exponential Smoothing model

Source: Own processing

The unsatisfactory results from the above-described models had initiated further empirical tests this time with more sophisticated models based on ML and DML. The first one tested was the Long Short-Term Memory Neural Network (LSTM). LSTSM is a variety of recurrent neural networks (RNNs) that are capable of learning long-term dependencies, especially in sequence prediction problems. LSTM has feedback connections, i.e., it is capable of processing the entire sequence of data.

```
RNNModel(model=LSTM, hidden_dim=20, n_rnn_layers=1, dropout=0, training_length=20, batch_size=16, n_epochs=100, optimizer_kwargs={'lr': 0.001}, model_name=Nights_RNN, log_tensorboard=True, random_state=42, input_chunk_length=14, force_reset=True, save_checkpoints=True)
```

Here the error metrics are different, namely the loss error as with ML and DML the main objective is to minimize the loss to evaluate the model performance. The estimation came as: train_loss=0.00142, val_loss=0.0335, and thus our model based on the LSTM had generalized the results good which means it can be applied to another forecasting task of the type described above. For model evaluation, the training horizon was expanded and a large portion of the data set – from 2016, was used as again the MAPE was the error metric. The model was tested to predict from 12 to 96 months in advance from that point and the best results were described in Table 1 below:

Table 1. The model

Prediction horizon	MAPE in %
12 months	8.63
24 months	7.35
36 months	6.77
48 months	15.56
60 months	26.81
72 months	34.74
84 months	35.49
96 months	35.49

Source: Own calculations

An up-worth progression of the MAPE can be observed especially when the COVID-19 pandemic started which can explain the model's bigger evaluation error. On the other hand, due to the small volume of the time series, respectively the small validation set the overfitting of the data was inevitable.

4. FUTURE RESEARCH DIRECTIONS

Since the results from the DML model performance are satisfying to a large extent a further more sophisticated state-of-the-art test can be performed bearing in mind the need for a larger data set for a better model performance and more accurate evaluation. Such can be the application of another library, e.g. Facebook Prophet, or another model, such as the NBEATS Model.

5. CONCLUSION

The article demonstrated the usage of ML and DML Python models for forecasting tourism data tasks. As demonstrated by the results an assumption that DML models outperform the basic and probabilistic forecast can be made which means that all the benefits from forecasting with the Darts Python library can be applied to other datasets with the same success. Furthermore, forecasting with AI development should be observed and more experiments with innovative models and libraries must be performed for scientific clarification and precise estimation. The ML and DML for tourism forecast purposes are on the verge of transformation and AI for science development together with the COVID-19 pandemic are one of the main catalyzers of this process. Another push in this direction can be considered all industry stakeholders involvement in AI, ML and DML in additional tourism operations, development and practical application.

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Pandemic Contraction and Recovery of the Russian Tourism Industry in 2019-2021 against the Backdrop of Other G20 Countries

Lyudmila Bogachkova[1]
Olga Oleynik[2]
Arina Shevelyushkina[3]

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Contraction of the industry;
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Russia;
G20 Countries

Abstract: *The paper highlights the significance of tourism sector support measures in modern Russian economic policy. Special attention is given to an aggregate indicator of tourism's contribution to the economy. This indicator has been calculated taking into account the share of tourism in the country's GDP; the share of tourism in the total number of jobs; the share of tourism in total export revenues. The research is based on the data of the World Travel and Tourism Council. The effects of the pandemic and the subsequent recovery of the industry have been described using the 2019 indices of the composite indicator. It has been revealed that Russia ranks second to last among the G20 countries in terms of the aggregate contribution of tourism to the economy. At the same time, Russian tourism was characterized by a relatively small contraction in 2020 and a low recovery rate in 2021, which indicates the need to make regulation measures more effective.*

1. INTRODUCTION

In the economic policy of modern Russia, much attention is paid to the tourism sector, as well as to the measures of its support and funding. The Federal Target Program on the Development of Domestic and Inbound Tourism in the Russian Federation (2019-2025) was approved in 2018 (Federal Target Program, 2018). The Tourism Development Strategy of the Russian Federation up to 2035 (2019), and the National Project on Tourism and Hospitality Industry (National project, 2021) have been developed and implemented. In 2023 the volume of government subsidies aimed at the development of tourism infrastructure, equipment, and camping will make 13,8 billion rubles. 63 regions claim to receive this support. According to the newsletter 'Who will Receive Support in the Tourism Sector' (2023), in 2022 the subsidies amounted to 5 billion rubles and were distributed among 30 regions.

The intensive development of the tourism industry in the global economy has been observed over the past 30 years. The added value in this industry is growing faster than the economy as a whole, and according to forecasts, it will double every 10–15 years. Exports from the tourism sector rank third in global exports after chemicals and fuels, outrunning automotive products. It is expected that by 2032, i.e. over the period of 10 years, the industry will grow by 75%, while

[1] Department of Applied Informatics and Mathematical Methods in Economics, Volgograd State University, Prosp. Universitetsky, 100, 400062, Volgograd, Russia
[2] Department of Accounting, Analysis and Audit, Volgograd Institute of Management, Branch of the Russian Presidential Academy of National Economy and Public Administration, Gagarina St, 8, 400131 Volgograd, Russia
[3] Department of Applied Informatics and Mathematical Methods in Economics, Volgograd State University, Prosp. Universitetsky, 100, 400062, Volgograd, Russia

the entire global economy will grow by only 30% during the same time (Tourism Development Strategy of the Russian Federation up to 2035, 2019; Travel and Tourism, 2022).

Such a significant role of tourism is associated with the following features of this industry:

1. It provides the opportunity to generate recreational resource rent, which is currently very important for Russia, given the difficulty of maintaining rental income in the raw material sector of the economy.
2. It is characterized by low capital intensity of business and the possibility of rapid creation of new jobs.
3. It is a driver of economic development with powerful multiplier effects (in transport, trade and services; incentives for the development of road and hotel facilities).
4. It is a favourable area for small and medium-sized businesses, which is effective along with tourism transnational corporations (Travel and Tourism, 2022).
5. It is the only industry with economic incentives aimed at environment protection and biodiversity preservation.

Indeed, the influence of the tourism industry on recreational resources and society is ambiguous and multifaceted. For example, on the one hand, the incomes of travel companies depend on the environmental conditions; on the other hand, tourists can pollute this environment. However, searching for ways to deal with possible negative effects of tourism is beyond the scope of this article and deserves special consideration.

The COVID-19 pandemic had a shock effect on the tourism industry. Its influence is studied in many works from various viewpoints, for example, modeling the propensity of households to save travel expenses due to a reduction in their income (Orîndaru et al., 2021); assessment of the consequences of the pandemic on the development of tourism in individual regions and countries (Moreno-Luna et al., 2021; Almeida & Silva, 2020; Marome & Shaw, 2021); modeling of the impact of a tourism income decrease on the US economy using the input-output balance method (Rodousakis & Soklis, 2022); justification of priorities and identification of threats to the development of regional tourism in Russia (Leonidova, 2022). At the same time, the estimation and comparative analysis of the contraction of the aggregate contribution of the tourism industry to the economy is of much interest and deserves scientific consideration.

2. KEY INDICATORS OF THE TOURISM CONTRIBUTION TO THE ECONOMY

The indicators of tourism contribution to the economy may include the share of this industry in GDP, the total number of jobs, and total export revenues (since the expenses of foreign tourists in a host country represent the export revenues of this country). Data on these indicators for 2019–2021 both on a global scale and concerning the Russian economy are illustrated in Table 1.

Before the pandemic (in 2019), world tourism accounted for 10.3% of global GDP (including direct, indirect and induced impacts) and 10.3% of all jobs. The share of tourism in total export revenues was 6.8%. In 2020, the contribution of tourism to the economy decreased by 50.4%, while the global economy itself shrank by 3.3%. The recovery of the global tourism sector began in 2021. The share of this industry in GDP increased from 5.3% in 2020 to 6.1% in 2021. According to the World Travel and Tourism Council (2023), the sector saw a recovery of 18.2 million jobs (see Table 1).

Table 1. Indicators of the tourism industry contribution to the global and Russian economies

Indicators/years	2019	2020	2021
Share in GDP (including direct, indirect, and induced effects, %)			
World	10,3	5,3	6,1
Russia	5,0	2,9	3,7
Share in total number of jobs (%)			
World	10,3	8,3	9,0
Russia	5,6	5,3	5,3
Share in total exports (%)			
World	6,8	–	–
Russia	3,3	1,2	1,1

Source: Own calculations based on the data of World Travel and Tourism Council, 2023

In Russia, the contribution of tourism to the economy is much less than on a global scale, despite the richest natural resources and cultural heritage. Moreover, this contribution decreased sharply under the influence of the pandemic. The industry's recovery began in 2021 (the share in GDP increased from 2.9% in 2019 to 3.7%), but not across the three indicators under consideration. Thus, the share of tourism in the total number of jobs in 2021 turned out to be the same as in 2020 (5.3%), and its share in total exports continued its downward trend: from 3.3% in 2019 to 1.2 % in 2020 and 1.1% in 2021 (Table 1). The insufficiency of the tourism industry development in the Russian Federation is also evidenced by the fact that "the expenses of Russian tourists abroad before the pandemic amounted to approximately 2% of all international tourism expenses, while Russia accounted for only 1% of global income from foreign tourists" (Zaitsev & Ismagilova, 2020).

According to the Travel & Tourism Competitiveness Report of 2019, which ranks countries once every 2 years within the framework of the World Economic Forum, Russia ranked 39 (The Travel & Tourism, 2019). This result is higher as compared to previous years but it is still insufficient taking into account recreational opportunities and other tourist attractions of Russia. Russia was not included in the updated 2021 ranking (The Travel & Tourism, 2021).

The strategy for the development of Russian tourism up to 2035 determines the main target parameters: by 2035, tourism should provide at least 6% of the country's GDP (excluding indirect and induced impacts), and the number of trips around Russia per one Russian citizen should increase by more than 2 times. The set goals make urgent a comparative analysis of the dynamics of the abovementioned indicators in order to assess the effectiveness of tourism support measures in current conditions.

3. AGGREGATE INDICATOR OF THE TOURISM CONTRIBUTION TO THE ECONOMY

Even though big data are now increasingly used in global monitoring and tourism statistics, meaningful qualitative conclusions can be obtained in a simple way proposed here. A rapid post-pandemic recovery of the industry is impossible without effective government support. To assess the effectiveness of measures implemented in different countries and identify best practices, it is advisable to perform a cross-country comparative analysis of an aggregate indicator of the tourism contribution to the economy. This indicator can be calculated as the distance of a point in 3-dimensional space from the origin:

$$R = \sqrt{r_1^2 + r_2^2 + r_3^2} \quad (1)$$

where the point coordinates are as follows: r_1 – share of the tourism industry in the country's GDP; r_2 – share of the tourism industry in the total number of jobs in the economy; r_3 – share of the tourism industry in total export revenues.

The pandemic contraction and the subsequent recovery of the industry can be described using the basic indices of the indicator *R* with its value in 2019 serving as a base:

$$T_{2020/2019} = \frac{R_{2020}}{R_{2019}} \cdot 100\%. \quad (2)$$

$$T_{2021/2019} = \frac{R_{2021}}{R_{2019}} \cdot 100\% \quad (3)$$

The closer the $T_{2020/2019}$ value to 100%, the more resilient the industry to the pandemic shock in 2020. The less $T_{2021/2019}$ differs from 100%, the closer the industry's contribution to the economy in 2021 to its pre-pandemic value.

The data of the World Travel and Tourism Council (WCTT) for the G20 countries have been used for calculations.

4. RESULTS

Figure 1 shows the values of the composite indicator R (in %) for G20 countries for 2019, 2020, and 2021. Figure 2 shows the corresponding values of the contraction/recovery indices of tourism's contribution to the economy. The G20 officially includes not only the 19 listed countries but also the European Union, which is excluded from consideration due to a lack of data.

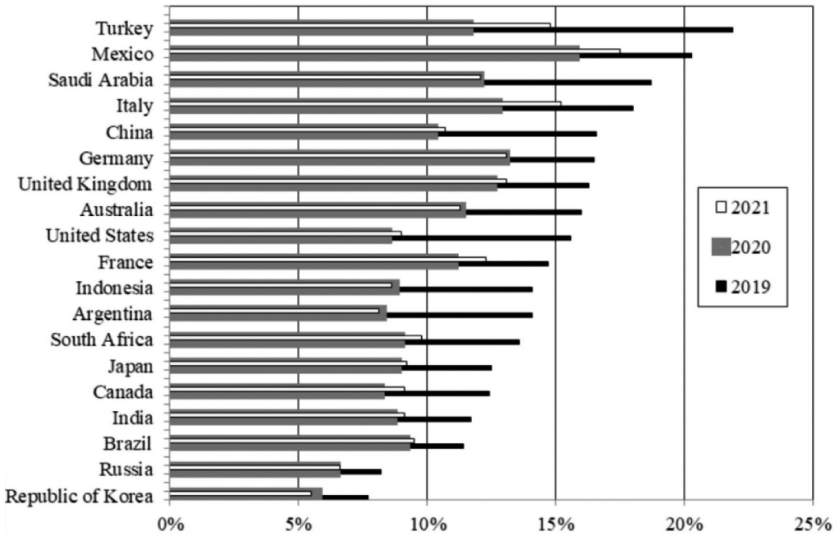

Figure 1. The aggregate indicator (*R*) of the contribution of tourism to the economy
Source: Own calculations based on the data of World Travel and Tourism Council (2023)

As shown in Figure 1, in pre-pandemic 2019, Turkey (21.9%) had the maximum value of the composite indicator of the tourism contribution to the economy (*R*), and South Korea (7.7%) – the minimum one. The values close to the average (from 14% to 16%) were observed in Australia, the USA, France, Indonesia and Argentina. Russia ranked second to last among the countries under consideration (8.2%). Amid the pandemic (in 2020), *R* values dropped significantly in all

the countries considered. Mexico ranked first in terms of *R*-value (15.7% compared to 20.3% in 2019); South Korea remained last (5.7%); the average *R*-value dropped to 10%, and the value close to the average was observed in China (10.2% compared to 16.6% in the previous year). Russia underwent a relatively slight contraction of the tourism industry (up to 6.4%). In 2021, the industry began to recover in most of the countries under consideration, but the rate of increase in its weight was very low, except for Turkey, Mexico, Italy, and France.

Figure 2 shows the basic indices of the aggregate indicator of the tourism contribution to the economy in the pandemic 2020 and post-pandemic 2021 (as compared to the level of 2019).

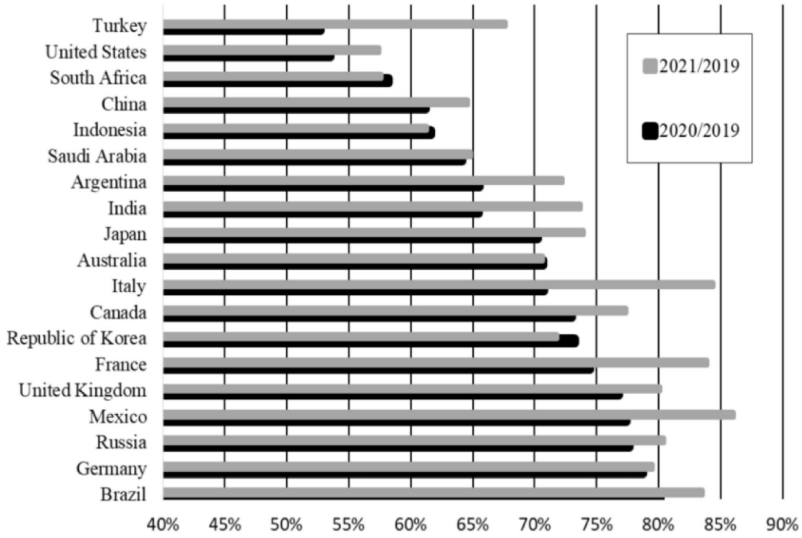

Figure 2. The indices of contraction ($T_{2020/2019}$) and recovery ($T_{2021/2019}$) of the aggregate contribution of tourism to the economy

Source: Own calculations based on the data of World Travel and Tourism Council (2023)

As shown in Figure 2, in 2021, the values of tourism contribution to the economy closest to pre-pandemic levels were observed in Mexico ($T_{2021/2019}$ = 86.0%) and Italy ($T_{2021/2019}$ = 84.4%). The least close values were observed in the USA ($T_{2021/2019}$ = 57.4%) and South Africa ($T_{2021/2019}$ = 57.6%). The average values of the tourism contribution index were found in Argentina ($T_{2021/2019}$ = 72.2%), South Korea ($T_{2021/2019}$ = 71.8%) and Australia ($T_{2021/2019}$ = 70.6%). Russia demonstrated a relatively low rate of industry recovery (80.4%), ranking fifth among G20 countries in terms of the sustainability of the industry's contribution to the economy.

5. CONCLUSION

Thus, Russia ranks penultimate among the G20 countries in terms of the aggregate indicator of the contribution of tourism to the economy. The indicator has been calculated based on the industry's share in GDP, share in the total number of jobs, and share in total export revenues (Figure 1). The values of this indicator in 2019, 2020 and 2021 for the Russian Federation were 8.2%, 6.4%, and 6.6%, respectively, while its average values for the totality of the countries under consideration in the same periods were 14.0%, 10.7%, 11.5%. Only in South Korea tourism has less weight in the country's economy. At the same time, a noticeable inertia of tourism in relation to the pandemic shock was observed in Russia, namely: a relatively small degree of industry contraction in 2020 ($T_{2020/2019}$=77,6% compared to the average level of 65.5%), and a slow industry recovery in 2021 ($T_{2021/2019}$= 70.6% compared to an average of 72.2%).

The relatively weak response of Russian tourism to the pandemic can be explained, first of all, by the relatively small value of its initial contribution to the economy and, secondly, by the effectiveness of state support measures for the industry. In particular, employment support measures prevented a sharp decline in tourism jobs in 2020 (Table 1). In Russia, loans were issued at low rates (2-3%) to support employment within the framework of the preferential loan programs FOT 2.0. and FOT 3.0. Under the first of these programs, approximately 226,000 loan agreements were concluded for a total amount of about 443 billion rubles, which helped save 5.4 million jobs. Besides, Varshavskaya (2021) and Shokhina (2021) point out that "the dismissal procedure is extremely complicated in Russia and its costs are high". At the same time, the relatively low rate of recovery of Russian tourism in 2021 indicates the need to improve the effectiveness of measures to support the industry and study the best world practices in such countries as Mexico, Italy, Turkey and others. A deep analysis of the factors that predetermined the response of the tourism industry in different countries to such an external challenge as a pandemic is of great interest and may become the subject of new research.

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Selected Financial Factors of Tourism in the Slovak Republic

Dana Országhová[1]

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Abstract: *Tourism is one of the economic sectors extremely affected by the COVID-19 pandemic on a global scale. In addition to the rapid reduction of financial income from tourism, the negative impact caused the lack of employees who evaluated this sector as risky and sought employment in another sector. The main goal of this paper is to evaluate selected financial factors of tourism with a focus on post-pandemic changes in the conditions of the Slovak Republic. During the pandemic, there was a significant drop in the number of visitors to accommodation facilities, specifically between 2019 and 2020 there was a drop of 50%. Revenues from tourism in 2020 decreased by an average of 60% compared to 2019. Comparing results in the period before and after the pandemic brought positive information about the restart of domestic tourism in Slovakia and also about increasing revenues of active and passive tourism.*

1. INTRODUCTION

Tourism includes and combines various products and activities from transport services, various types of accommodation and catering through recreational offers to client insurance and rescue services. The following basic conditions are necessary for the implementation and development of tourism:

- Natural locations, cultural and historical objects,
- Good level of services for tourists (restaurants, attractions, information offices, etc.),
- Sufficient accommodation facilities (hotels, guesthouses, campsites, cottages),
- Quality transport network for visitors.

In tourism, globalization is manifested by territorial expansion on a global scale, and tourism demand factors are significant for all tourism actors (Matijová et al., 2023). The existing potential of the region is a summary of prerequisites and conditions for tourism (Švedová, 2013). New technology is another factor for tourism development, especially for tourism in smart cities. As Anthopoulos (2017) declares, smart services refer to the utilization of technology and ICT in various areas like health, safety, education, or tourism. Changes in the tourism market in the new millennium were reflected in the competition between tourist destinations. Šenková (2018) states that Slovak regions need modern destination management and marketing, therefore tourism organizations strive to improve the position of tourism in the region.

Tourism in Slovakia is one of the important economic sectors. Data on tourism in the Slovak Republic confirmed that tourism had a growing trend in the decade before the outbreak of the COVID-19 pandemic. According to Tajtáková (2021), between 2009 and 2019, the number of visitors to Slovakia almost doubled, while in terms of total attendance, 2019 was a record year. The positive impact of tourism can be seen in the development of regions, in the balancing of regional disparities, and the improvement of the standard of living of inhabitants; tourism has a significant impact on the existence and creation of jobs in this industry,

[1] Slovak University of Agriculture in Nitra, Faculty of Economics and Management, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic

so it is also a significant source of income (Farkašová et al., 2021). These factors were manifested negatively during the COVID-19 pandemic, when the number of foreign visitors to the Slovak Republic dropped significantly, which had a liquidating effect on accommodation facilities, hotels, and restaurants. Closed borders and restrictions on movement between states, bans on gatherings of large numbers of people, closure of food establishments and other restrictions immediately affected the tourism and hospitality industries (Đokić & Janjić, 2022). The pandemic crisis showed the significance of tourism for economies and societies (Beresecká et al., 2022).

From the point of view of the size and shape of the territory, the cross-border cooperation between the Slovak Republic and Poland offers many opportunities for local development in the socio-economic area (Tej et al., 2021). In Slovakia, cross-border shopping tourism is a new form of tourism used by inhabitants living in border regions. They visit nearby foreign countries to buy different commodities at favorable prices (Klamár & Kozoň, 2022). It is essential to ensure economic effects for regions in the form of consumption by incoming tourists (Vargová, 2018). In the development and support of tourism, family farms with typical products in the given region also have an important place, which can also attract tourists and visitors through food festivals and tourism events (Horská et al, 2020). The networking of tourism entities is another stimulus for effective destination management (Šambronska et al., 2021).

The strategy for the sustainable development of the Slovak Republic includes these main objectives in the field of tourism:

- Ensuring effective and sustainable management of natural resources,
- Ensuring effective and sustainable management of cultural resources,
- Increasing the competitiveness of the Slovak Republic in tourism: making cultural heritage sites more attractive and their connection to the development of additional services in the framework of sustainable cultural tourism (Vision and strategy for the development of Slovakia until 2030, 2021).

2. MATERIAL AND METHODS

This contribution aims to evaluate selected tourism factors in the Slovak Republic with a focus on domestic tourism and tourism revenues. Tourism in the Slovak Republic had a growing trend in the decade before the outbreak of the COVID-19 pandemic; therefore, a comparison of data in the period before and after the pandemic will provide important information about the restart of tourism in the Slovak Republic. In the Act on the Promotion of Tourism (2010), there are fundamental conditions for tourism in the Slovak Republic. "This act regulates the support of tourism, the rights and obligations of natural persons and legal entities operating in the tourism industry, the creation of conceptual documents and the financing of tourism development". The program statement of the Government of the Slovak Republic for years 2020-2024 contained the main goals for the restoration of tourism because tourism is connected with jobs and source of income for inhabitants of the Slovak Republic.

As concerns concepts in this paper, active tourism includes foreign visitors (not residents of **the** Slovak Republic**)** while traveling in the Slovak Republic. Passive tourism represents Slovak citizens using services of tourism while traveling abroad. Domestic tourism represents the travelling of residents within their domestic country (Slovak Republic), outside of their usual environment (Tourism, 2023). The research data were obtained from the available databases of the

Statistical Office of the Slovak Republic (Domestic tourism in the Slovak Republic, 2023; Tourism revenue in the Slovak Republic, 2023). The comparison of selected statistical indicators showed the development and current state of tourism in the period 2000-2022 in the article. The data were evaluated using regression trends and the correlation coefficient.

3. RESULTS

3.1. Domestic Tourism in Slovakia

In Slovakia, traditional domestic tourism has good conditions in the form of tourist and spa destinations, as well as a wide range of historical monuments. Figure 1 shows the number of people - participants in domestic tourism in Slovakia. From 2008 to 2019, the development had an increasing trend. It is a decrease in 2020 and 2021 due to pandemic restrictions and a re-increase in the number of people in domestic tourism in 2022. A comparison of the percentage development concerning 2019 is as follows: 2019/2020 decreased by 32%; 2019/2021 decreased by 30%; 2019/2022 increased by 6.8%.

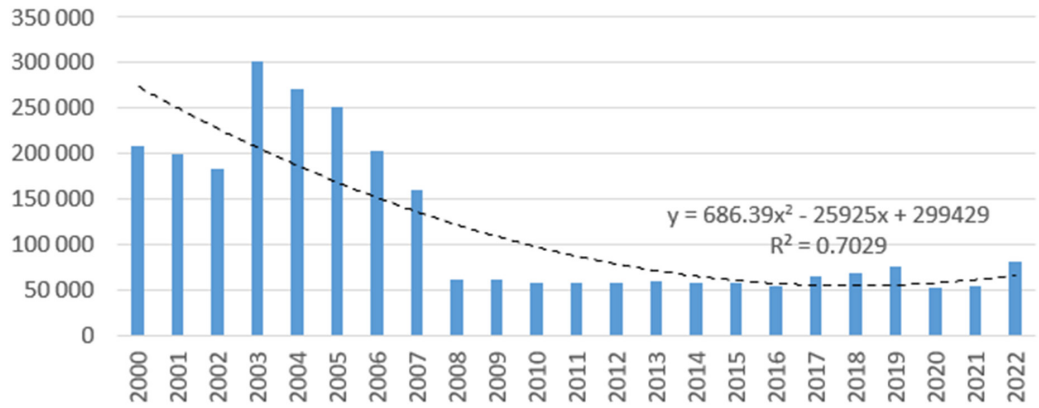

Figure 1. Domestic tourism in Slovakia – number of persons

Source: Domestic tourism in the Slovak Republic (2023), own processing

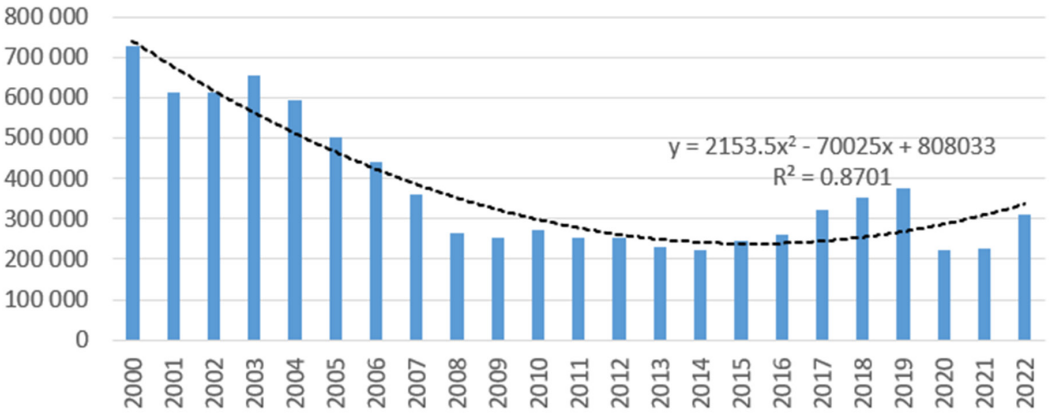

Figure 2. Domestic tourism in Slovakia – days of stay

Source: Domestic tourism in the Slovak Republic (2023), own processing

The development in the number of days in domestic tourism showed a similar development (Figure 2). The average length of stay (days) for Slovak domestic tourism is in Figure 3; average values are in the interval (min=2, max=5.1).

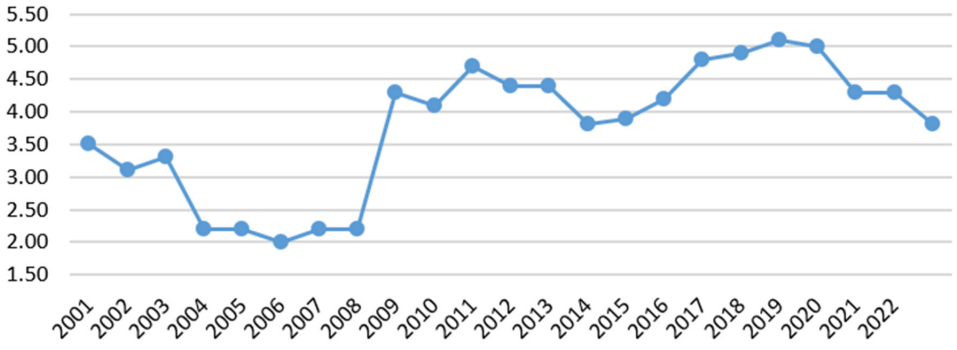

Figure 3. Domestic tourism in Slovakia – average length of stay in days
Source: Domestic tourism in the Slovak Republic (2023), own processing

3.2. Revenues of Active and Passive Tourism in Slovakia

The financial benefit of tourism can be evaluated through sales, in the studied case obtained for individual years. In 2020, tourism was at least partially maintained only by those countries and regions that managed to maintain the interest of domestic visitors. Support tools for financing tourism in the Slovak Republic also include a recreation allowance (recreation voucher). Since its introduction, the practice has confirmed an increase in the number of domestic overnight stays, and the supporting effect was also confirmed when the tourism industry restarted after the end of the pandemic (Tourism in years 2020-2022, 2023).

Other forms of Slovak tourism support are new tools, such as forms of aid from the Recovery and Resilience Plan in cooperation with the Ministry of Investments, Regional Development and Informatization of the Slovak Republic or the Ministry of the Environment of the Slovak Republic, but also partnership agreements at the interdepartmental level.

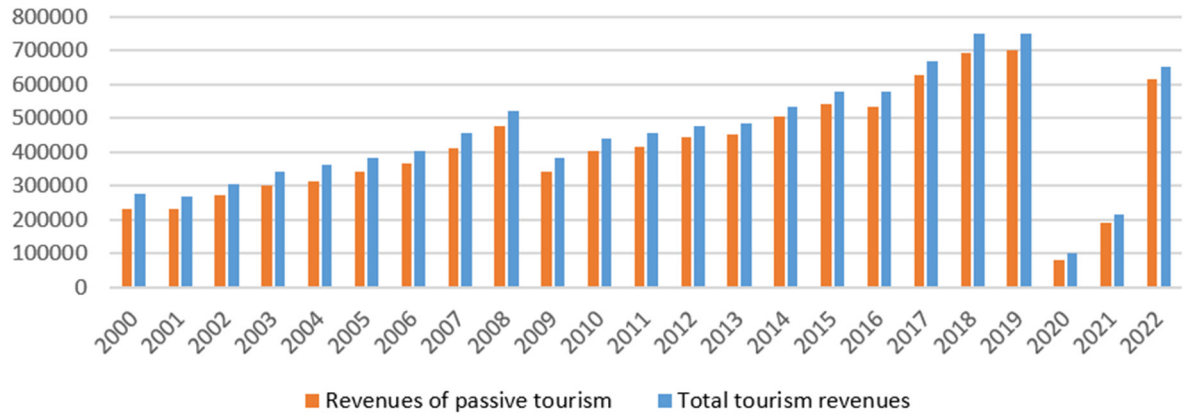

Figure 4. Comparison of revenues of tourism in Slovakia
Source: Tourism revenue in the Slovak Republic (2023), own processing

Figure 4 demonstrates that in Slovakia revenues of passive tourism and total tourism revenues followed the same trend. A sharp decline in tourism revenue in 2020 and 2021 is followed by an increase in 2022.

Figure 5 shows that revenues of active tourism (foreign visitors) are lower than revenues of passive tourism (domestic visitors) in the examined period. The trend after the pandemic is growing again, but passive tourism shows a better re-start of revenues.

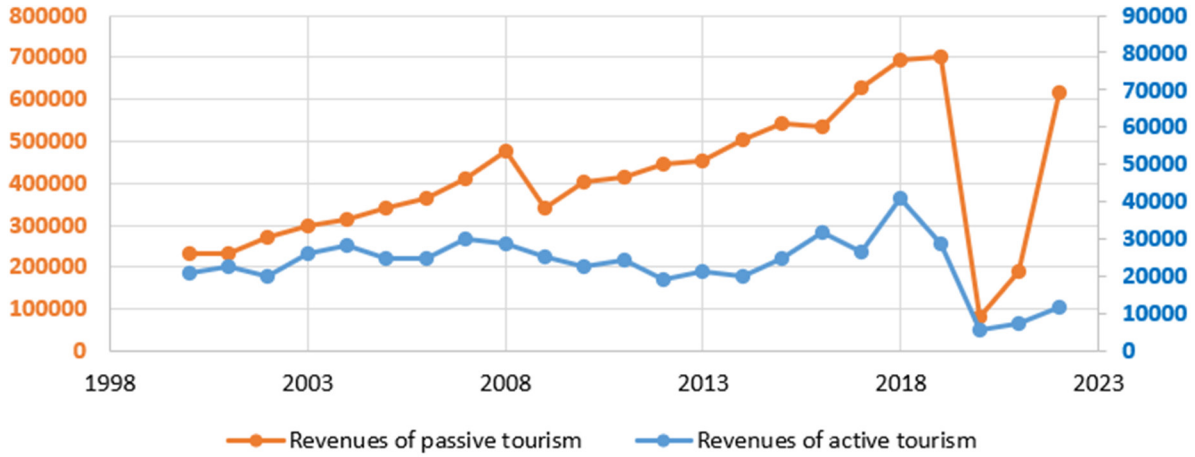

Figure 5. Revenues of active and passive tourism in Slovakia (2000-2022)
Source: Tourism revenue in the Slovak Republic (2023), own processing

Table 1 shows the correlation between revenues from active and passive tourism and revenues in general. Revenues from passive tourism copy revenues from overall tourism, therefore the correlation is 0.99 (very strong positive correlation). The correlation between the revenue of active and passive tourism is 0.56 (moderate positive relationship). Total tourism revenue and active tourism have a correlation of 0.59 (moderate positive relationship).

Table 1. Correlation between revenues of tourism in Slovakia

Revenue	Active tourism	Passive tourism	Total tourism revenues
Active tourism	1		
Passive tourism	0.56	1	
Total tourism revenues	0.59	0.99	1

Source: Own calculations

4. FUTURE RESEARCH DIRECTIONS

Relaxation activities of people in the 21st century are connected with traveling to the mountains, to the sea, for sports, where participants in the tourism industry are looking for relaxation and new experiences. Some residents spend their free time at water attractions, by the sea, or in nature and mountains, where they seek rest and relaxation from the stress of cities. Part of the population prefers cultural experiences and getting to know historical monuments in their free time. Based on the results, the authors of the study (Csapó et al., 2022) state that consumer segmentation based on clusters is important for creative tourism in the coming period; it is necessary to know the country's tourism offer and possible consumer attitudes and habits. Sigala (2018) claims that for the regeneration and restart of the tourism industry after the pandemic, it is also necessary to address sources for tourism, organizations, and government measures.

5. CONCLUSION

Tourism is characterized as a crosscutting sector of the economy. In the 21st century, international tourism has become one of the most important economic activities. A thriving business sector in tourism, with growing demand, creates new jobs and has the potential to attract skilled workers at various levels of qualification.

The aim of this contribution was the analysis of selected statistical indicators associated with the evaluation of the development and performance of tourism in the Slovak Republic. Statistical data showed the development of tourism in Slovakia in the years 2000-2022 and its state after the pandemic period in 2020. After the retreat of the first wave of the pandemic in the summer season of 2020, the dominance of domestic visitors was confirmed in Slovakia due to ongoing restrictions on travel abroad. The results of the analysis show that within the framework of domestic tourism, the process gradually recovered after the pandemic, and in 2022 it reached a level comparable to 2019.

The Slovak Republic is rich in natural beauty and historical monuments that could be an important alternative for the development of tourism in Slovak regions. More and more visitors are looking for experiences on vacation that would compensate them for endless months of sitting over work.

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Tourism Recovery after COVID-19 Pandemic in Typical Rural Areas in Bulgaria

Violetka Zheleva[1]
Emil Mutafov[2]

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Keywords:
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Abstract: *Rural areas in Bulgaria are strategically important for the national well-being in every country and Bulgaria is not an exception. After the COVID-19 pandemic, the tourism sector was on hold with a devastating impact on the Accommodation establishments' number and Nights spent. The main goal of this research is to review current data on the tourism sector in typical rural areas in Bulgaria and suggest possible measures to increase vital indicators. The study is based on three approaches to classify urban and rural areas according to NUTS 3 regions. A multi-component methodology has been applied to ensure the correct treatment of the information on a regional basis. The results presented show that there has been a decline in overnight stays and accommodation in Bulgaria. There is a recovery trend after the COVID-19 pandemic and a slight increase in both indicators. Revenue from overnight stays increases after 2020. There is a promising trend related to the development of the tourism sector.*

1. INTRODUCTION

Tourism is vital on the national level for generating well-being status. The whole world was affected by the COVID-19 pandemic and Bulgaria is not an exception. However, the strategic location and different types of tourism could play a key role in the sector recovery process.

Bulgaria, as part of the EU, accepted the NUTS in 2000 and it is divided into 28 regions from type NUTS 3. For the purpose of this study, there are three types of approaches to classify urban and rural areas according to NUTS 3 regions.

The typology „urban-rural territories" is presented by Eurostat in the Guide to Typologies of Regions (European Commission, 2020).

The first step is to identify the population in Rural areas: „Rural areas" are all areas outside urban clusters. „Urban clusters" are groups of contiguous grid cells of 1 km² with a density of at least 300 inhabitants per km² and a minimum population of 5,000.

Secondly, NUTS 3 regions are classified based on the proportion of their population in rural areas:

- *"Predominantly rural"* if the share of the population living in rural areas is higher than 50%
- *"Intermediate areas"* if the share of the population living in rural areas is between 20% and 50%
- *"Predominantly urban"* if the proportion of the population living in rural areas is less than 20.

In the third step, the size of urban centers in the region is taken into account.

[1] Trakia University, Faculty of Economics, Stara Zagora, Bulgaria
[2] Trakia University, Faculty of Economics, Stara Zagora, Bulgaria

A predominantly rural region that contains an urban center of more than 200,000 inhabitants, constituting at least 25% of the region's population, becomes intermediate.

An intermediate region that contains an urban center of more than 500,000 inhabitants, constituting at least 25% of the regional population, becomes predominantly urban.

The OECD produced a new typology complementing the previous typologies by introducing the concept of *functional urban areas* to better reflect the link between rural and urban areas (Féret et al., 2020).

The image of the urban-rural regions in the EU is shown in Figure 1.

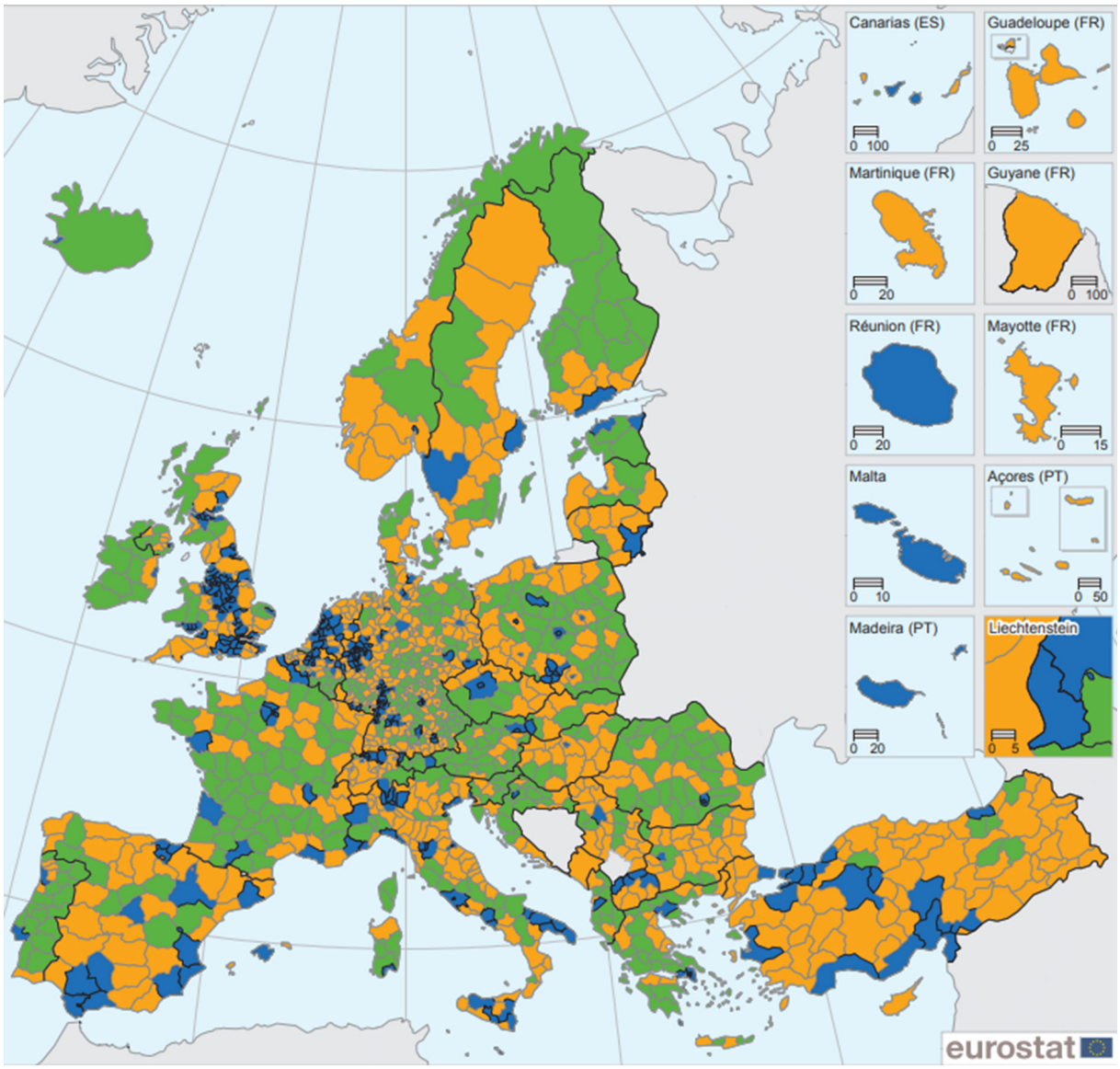

Figure 1. Urban-rural typology regions in the EU in 2022

Source: Eurostat, 2023

It is important to define that all regions in Bulgaria according to NUTS 3 level are 28 and they match with the districts of the national regions division.

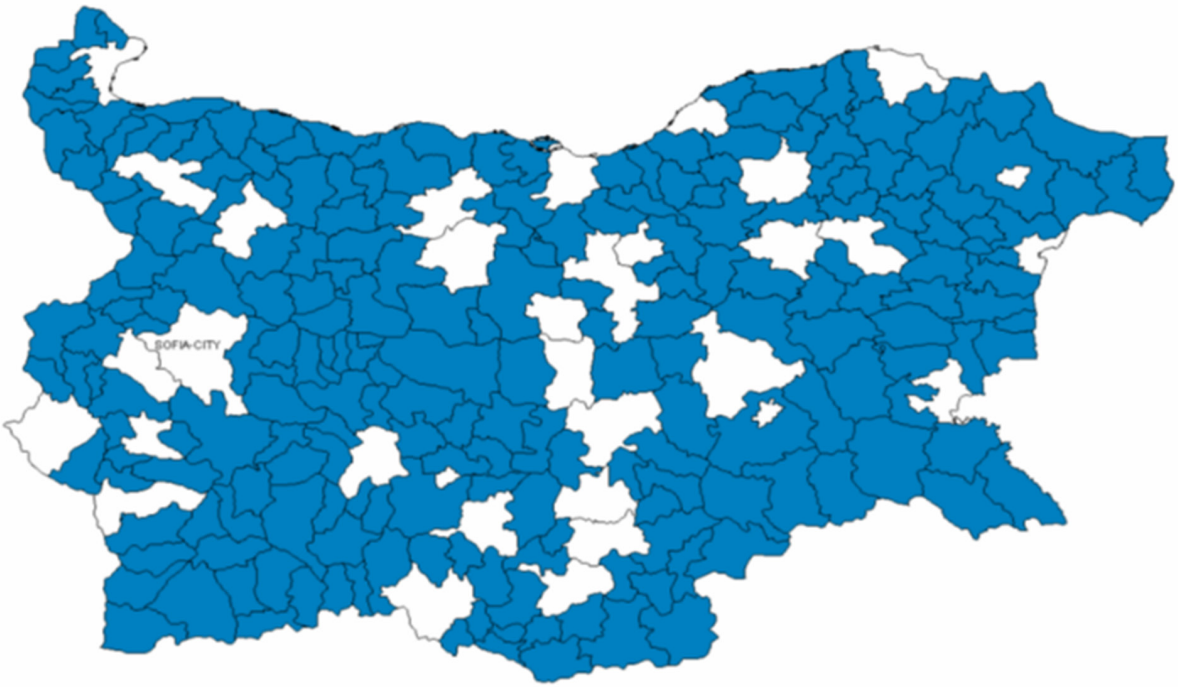

Figure 2. Rural-urban territories, LAU 1, Bulgaria
Source: Spatial Concept of Development in Bulgaria 2013-2025, 2013

More than 80% of the territory of the country is rural and you can see the exact distribution in Figure 2 (NSRD, 2019).

According to the Concept of Tourism Regionalization (Concept of Tourism Regionalization, 2015), one of the common forms of alternative tourism practiced in Bulgaria is rural tourism. In recent years, there has been a growing interest in rural areas by Bulgarian and foreign tourists, who recognize them as an interesting destination for their holidays. In its essence, this type of tourism is a set of activities that satisfy their interests, as well as experiences focused on rural life and culture, traditions and customs, and traditional industries. The search for tranquillity, solitude, and a growing interest in outdoor activities are an important part of the driving motives for traveling to destinations characteristic of this type of tourism. Thus, nostalgia for the rural way of life, the appeal of basic aspects of life, and the need to reconnect with nature in rural areas are proving most attractive, especially to those who lead an urban lifestyle.

Various terms and concepts referring to this type of tourism are used in scientific literature, the most common being „rural tourism“ and „agrotourism“. Concepts of ‘rural’ vary from country to country and from time to time. The term ‘rural tourism’ is a widely used concept and, although it is highly debated, there is still no single universally accepted definition. Rural tourism is very often defined as ‘local’, ‘alternative’, ‘agro’, ‘green’, and anything but mainstream.

Conceptually, rural tourism can be seen as tourism in the countryside. A form that encompasses the rural environment as the core of the product offered. The Organisation for Economic Co-operation and Development defines rural tourism as any “tourism taking place in the countryside”. In this context, rural areas are the „central and unique selling point in the rural tourism package“. Lane (2014) suggests that, ideally, rural tourism should, in addition to being located in rural areas, be functionally small in scale, traditional in nature, organic and slow-growing, and also controlled by local people (Lane, 2014).

According to EU data, a quarter of the population in the union makes a mechanical movement to the countryside. The results of a nationally representative survey conducted in 2021 on the attitudes of the population in the country towards tourism show a high percentage (74%) of respondents who consider „the development of rural and ecological tourism as a priority" and say that „over the past more than 25 years rural and ecotourism have significantly increased their attractiveness and are present among the public expectations for the future development of the tourism industry in Bulgaria" (National Assembly of the Republic of Bulgaria National Centre for Parliamentary Research (NCPR), 2021).

In a study, Yarkova and Stoykova consider a set of indicators of sustainability in rural tourism: „tourism planning, number of visitors (tourists) in a destination, natural and cultural attractions, participation of the local population, number of jobs created by rural tourism, the contribution of rural tourism to the local economy, environmental factors, training and qualification of the workforce, satisfaction with the development of rural tourism, security of tourists" (Thus the following indicators of sustainability in rural tourism are: tourist planning, number of visitors (tourists) in a given destination, natural and cultural attractions, involvement of local population, number of jobs opened by rural tourism, the contribution of rural tourism to the local economy, environmental factors, training and qualification of labor force, satisfaction from the development of rural tourism, security for tourists.) (Yarkova & Stoykova, 2008). Based on this, it could be concluded that for Bulgaria, tourism developed in rural areas is extremely important in many aspects, including improving regional sustainability.

The social and economic status of each region, its development programs, as well as national strategies and plans must be taken into account when planning the goals and objectives for sustainable development (Marinov, 2021).

2. METHODS

Since the main goal of the paper is to analyze the tourism sector before and after the COVID-19 pandemic in typical rural areas in Bulgaria, there is a need to define the exact territories for this analysis.

According to the NUTS 3 classification and the urbanization typology of Eurostat, there are 7 regions covering the requirements to be called „Typical rural areas". These are Vidin, Razgrad, Silistra, Targovishte, Sofia district, Kurdzhali, and Smolyan.

The period of the research is 4 years and data is provided by the National Statistical Institute, Bulgaria for both indicators: Accommodation establishments and Nights spent, both for all targeted 7 regions and also on a national level.

The regional cut in the research methodology is based on the data from the tourism sector in Bulgaria. In order to guarantee proper information processing, the following methods are used: analysis and synthesis; inductive, deductive, and translational methods; grouping, systematization, classification, structural analysis; econometric methods; cluster analysis.

3. RESULTS AND DISCUSSION

In Table 1, we can preview the available accommodation establishments and the nights spent for the period of 4 years (2018-2021) for the typical rural areas. Strangely in half of the typical rural

areas we are monitoring a trend of decrease in the realized nights for the second half of the period, which is exactly covering the COVID-19 pandemic beginning. These are the areas of Vidin, Targovishte, Sofia district, and Somlyan. The other three areas mark an increase in the accommodations and nights spent in the second half of the period compared to the first 2 years.

Table 1. Accommodation establishments and Nights spent, in typical rural areas, 2018-2021

			2018	2019	2020	2021
Vidin	Accommodation establishments	Number	30	30	26	24
	Nights spent - total	Number	55168	67568	87614	50050
Razgrad	Accommodation establishments	Number	16	18	19	19
	Nights spent - total	Number	48029	60416	63807	50962
Silistra	Accommodation establishments	Number	16	28	25	25
	Nights spent - total	Number	31418	44536	26115	31436
Targovishte	Accommodation establishments	Number	19	17	14	13
	Nights spent - total	Number	41101	45740	39724	28371
Sofia district	Accommodation establishments	Number	118	116	117	111
	Nights spent - total	Number	806898	798416	515648	544325
Kardzhali	Accommodation establishments	Number	38	39	52	68
	Nights spent - total	Number	76478	71183	72726	134749
Smolyan	Accommodation establishments	Number	330	339	324	311
	Nights spent - total	Number	724056	802026	627142	608175

Source: NSI, 2023

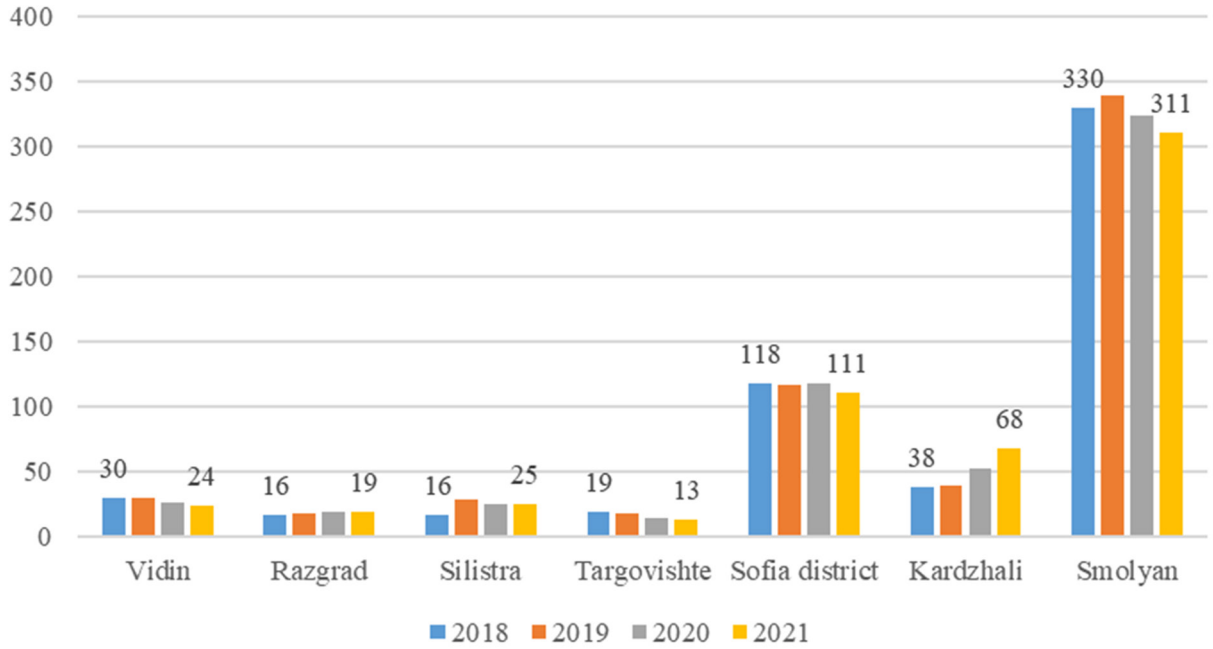

Figure 3. Accommodation establishments, number, 7 typical rural areas

Source: NSI, 2023

From the data in Figure 3, it can be seen that accommodation establishments in the typically rural areas decreased at the end of the considered period compared to its beginning. A steady downward trend is observed for this indicator in 2020 and 2021. In Silistra and Razgrad, according to the data, a slight increase in accommodation establishments is visible, but nevertheless, the values are close to the maximum reported during the considered period. Only one region is out of that trend and it is Kardzhali, where we can monitor an increase of about 80% in the number of accommodation places, and even in the worst year of COVID-19, growth is observed.

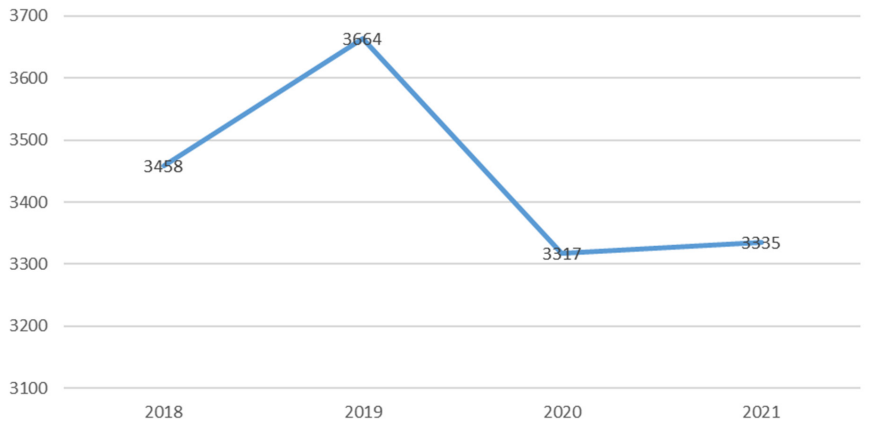

Figure 4. Accommodation establishments for Bulgaria, total, number

Source: NSI, 2023

At the national level, the trend of an overall reduction in accommodation establishments is confirmed the same as in the typically rural areas. Those who failed to recover from the crisis in 2020 and then decided not to risk and continue their business in this area are about 10%. However, after the biggest drop in 2020, there is a recovery trend in accommodation of around 1% and growing.

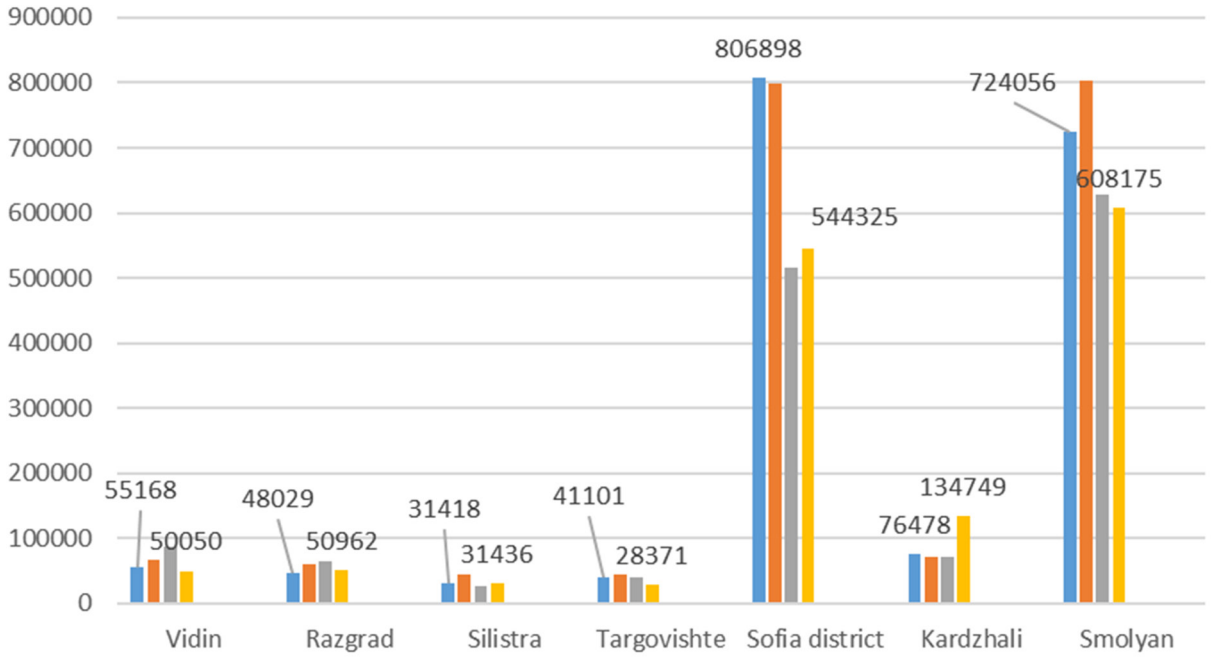

Figure 5. Overnight stays, number

Source: NSI, 2023

The data show a decrease in overnight stays in typically rural areas at the end of the considered period compared to its beginning. Two types of trends are observed, namely in the regions of Vidin, Razgrad, Targovishte, and Smolyan, the lowest values were measured in the last year (2021), while in Silistra, Sofia region, and Kardzhali, we have a partial increase and recovery of realized overnight stays in 2021 compared to the previous year.

At the national level, there was an increase in overnight stays at the end of the period compared to the previous year, but even so, the pre-pandemic levels cannot be reached.

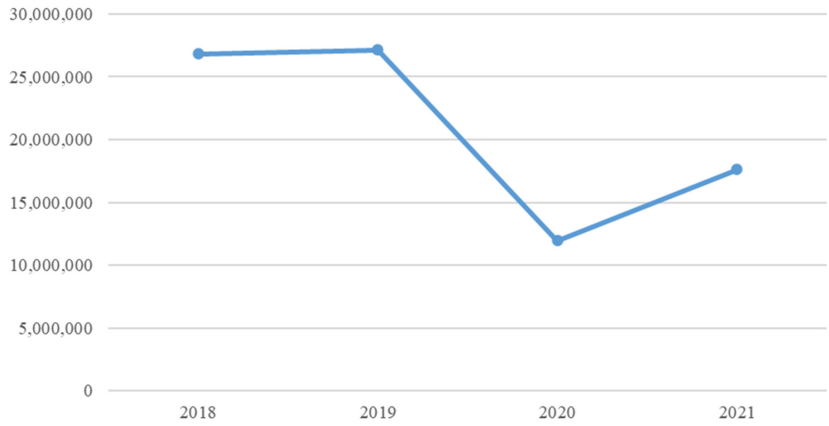

Figure 6. Overnight stays total for Bulgaria, number

Source: NSI, 2023

It is possible to take many measures to restore the trend in tourism, such as:

- Attractiveness with various activities and visits to attractions during the tourists' stay
- Increasing hygiene habits and establishing safety protocols after the COVID-19 pandemic
- Modernization of the bed base and improvement of the conditions for tourism in typically rural areas
- Investments in new accommodation, according to the demand in the sector.

4. CONCLUSION

The following conclusions can be drawn from this analysis:

- Without making an exception, in Bulgaria, there is a decrease in overnight stays and a decrease in accommodation establishments
- There is a trend of recovery after the COVID-19 pandemic and a slight increase in both indicators. The income from overnight stays increases after 2020.

The movement of the population to the countryside is a factor in the development of tourism, improving and balancing the economic and social development of rural areas, or put another way, promoting rural sustainability.

Rural and agrarian tourism in Bulgaria is a relatively fast-growing and well-established alternative form of tourism. In recent years, there has been a positive trend of increasing interest in this type of tourism, an increase in the number of tourists visiting rural regions and using its services, and a diversification of the elements of the tourism product offered.

The development and consolidation of tourism in the country has led to many positive effects on the way of life in rural regions/villages and is of particular importance for improving the economic situation of underdeveloped and lagging regions and for preserving Bulgarian traditions and lifestyles.

Acknowledgment

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Rural Tourism as a Tool for Sustainable Development of the Srem District in Serbia

Nada Kosanović[1]
Mirjana Bartula[2]

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Keywords:
Rural tourism;
Srem district;
Sustainable development;
Brand

Abstract: *The beginning of the twenty-first century is characterized by numerous changes in all areas of life. These changes give us the right to anticipate some global trends in the field of economy and business of the population in rural areas. Contemporary trends in the field of business in rural areas actualize tourism as the most important component of integral rural development and indicate that significant changes are expected in that area. The twenty-first century will be a period in which the needs and expectations of domestic and foreign demand will become increasingly refined, therefore it will be necessary for rural tourism to represent a combination of different aspects and a value perception of the presentation of rural life. Family farms will be differentiated by the success of product and area branding, while intangible marketing assets such as brands, market knowledge, relationship with customers, and distribution coverage, will become a significant value of the region. The main goal of the research is to assess the potential and opportunities for the development of a new program of rural tourism in the Srem District in Serbia based on sublimated and analyzed indicators for seven municipalities, which will contribute to the affirmation and development of rural tourism in the region.*

1. INTRODUCTION

The Srem region is characterized by fertile soil, which has had a significant impact on the development of agriculture. This, however, has also played a crucial role in the growth of rural tourism within these areas, providing an additional avenue for income for families residing in the countryside. Many engage in this form of tourism as a supplementary activity alongside agriculture, with a particular focus on the development of organic farming.

The advantages of rural destinations in the Srem area include a favorable geographical location, excellent transportation links, as well as multiculturalism, multiethnicity, and multiconfessionalism. Additionally, the preservation of original features in Pannonian-style rural settlements, encompassing morphology, internal and external physiognomy, and appearance, contributes to the charm of these locations. The richness of national heritage and folklore, including customs, costumes, food, dialects, and handicrafts, further enhances the appeal of the region. The local population, cultural institutions, and influential individuals actively contribute to the development of sustainable forms of tourism. Moreover, the area boasts a wealth of cultural heritage, cultural values, and assets, many of which are under protection.

Tourist destinations in the Srem district offer diverse and attractive traditional environments, often surrounded by natural beauty and historic houses. Ethnic workshops, museums, exhibition spaces, windmills, farms, and various cultural attractions provide a unique vacation experience. To preserve national consciousness, a variety of events are organized, enriching the

[1] Faculty of Applied Ecology Futura, Metropolitan University, Požeška 83a, 11000 Belgrade, Serbia
[2] Faculty of Applied Ecology Futura, Metropolitan University, Požeška 83a, 11000 Belgrade, Serbia

overall tourism experience. Rural tourism in the region encompasses visits to national and nature parks, monasteries, cultural heritage sites in rural areas, various excursions, and the enjoyment of rural landscapes, including stays on farms. Through rural tourism, visitors can actively participate in rural activities, experience local traditions, and adopt the lifestyle of the indigenous population through personal contact (Drča, 2013).

The potential benefits that the Srem district can derive from the development of rural tourism and related forms are numerous. These include the creation of conditions for new job opportunities, employment for women and young people, marketing agricultural and food products, revitalization of villages and rural areas, and fostering awareness among the local population regarding the preservation of rural values.

2. METHODS OF RESEARCH AND DATA SOURCES

Collective awareness and responsibility, more than ever, are deeply rooted in the present, facing life challenges. Socio-economic and political changes, of which we are witnesses, influence our existence and consequently should change our patterns of behavior, thinking, and action. They direct us both to questions and to the search for answers in creating mechanisms and models for survival and survival.

As one of the world's largest industries and one of the fastest-growing sectors in the global economy, tourism has a multifaceted impact on people's lives, the social community, and the environment. The concept of planned and sustainable tourism development can be applied to all types of destinations, including the development of mass tourism, as well as the development of various tourism niches. Finding the right balance between development dimensions, which will guarantee the long-term sustainability of the area, is today a skill and art of product and area branding creators.

Local self-governments, regions, and states derive significant benefits from proper tourism planning. Due to the growth of tourism and its numerous and diverse impacts on both the national and local economy and society as a whole, local self-government needs to adopt a plan or tourism development program in order to effectively manage these effects.

A professional and independent analysis of the state and resources of the local community in the Srem Administrative District was conducted through observation and analysis. Through descriptive analysis, we obtained data on rural tourism and the problems arising from the national and institutional framework of the subject research.

Using the empirical method as an important analytical method, the processing of empirical data was conducted, applying statistics and mathematics. The statistical method was used to collect, present, analyze, and interpret numerical data. The analysis is based on data from relevant state institutions - the Republic Statistical Office, documentation of the City Administration of Sremska Mitrovica and the Municipal Administration of the municipality of Šid, data from the Regional Srem Chamber of Commerce, the documentation base of the Ministry of Agriculture, strategic documents of higher order, internet presentations of tourist agencies in the Srem region, as well as on surveyed problems and needs of the local population – stakeholders, which were obtained through a questionnaire. The proposals obtained were valorized by the authors in this paper.

Defining and identifying the basic factors of heterogeneity of rural space in the function of comprehensive consideration of the complex rural reality of the Srem District are the basic starting points of this paper. The main research goal relates to the identification of potential development nuclei in the function of creating a Marketing plan for sustainable rural tourism development in the Srem District.

3. STUDY AREA

The future economic vitality of municipalities in Srem is determined less by available resources and geographical location, and more by strong leadership and effective strategy. This is essential for creatively connecting and efficiently combining various development factors, creating a foundation for successful tourism development that contributes to social, economic, and ecological progress.

The strengths of these municipalities lie in their natural and immovable cultural assets, serving as potential drivers for tourism development. Additionally, there is a substantial construction fund comprising residential and commercial spaces, along with a well-established utility network. Public services and the IT sector have also been well-developed. The tables presented below contain data and indicators crucial for assessing the potential intensity of tourism development in the Srem district. Simultaneously, these indicators can serve as a foundation for initiating new, specific activities aimed at affirming and branding these municipalities as rural zones with distinctive characteristics.

Table 1. Overview of Basic Data and Numeric Indicators for the Development of Rural Tourism in the Srem Administrative District

Area	**Srem Administrative District**
It includes the following cities and municipalities:	Sremska Mitrovica Town, location Sremska Mitrovica Municipality of Šid, location Šid Municipality Inđija, location Inđija Municipality Irig, location Irig Municipality Ruma, location Ruma Municipality Stara Pazova, location Stara Pazova a Municipality Pećinci, location Pećinci
The number of agricultural households engaged in another profitable activity (non-agricultural) and the number of rural tourist household	739/ 300/51
Average age	43,6 years
Number of inhabited places	109 (7 urban and 102 rural)
Surface area Cultivable areas Average holding size	762km2 229,195 hectares/arable land and gardens, 213,715 orchards, 5,153, vineyards 1,172 and meadows and pastures 7,409 hectares/ 7.82 ha 34% of farms have a cultivable area of up to one hectare.
Climate conditions	Steppe continental climate, with a medium annual temperature of 10,8˚C
The number of agricultural households (2022)	21.818
Population (2022)	284,436 inhabitants, which is 27,842 or 9.1% less compared to the last census, when 312,278 inhabitants lived here
Rural settlement with the biggest and the smallest by the number of inhabitants (2022)	Laćarak - 10638 Erem - 100
Density of population (in h./km2)	89,58 inh./km2
Average age /2021./ Number of young people aged 15-29	43,7 years 46.932
Absolute decline population 2002/2011	9.1%
Number of employees/ number of the unemployed (2022)	95243 9800

Tourist overnight stays in 2020 Domestic Foreign Tourist overnight stays in 2021 Domestic Foreign	164.508 139.739 24.769 257.611 204.312 53.299
Main economic branches	Agriculture is the main economic branch in Srem, and it participates with 36.3 percent in the social product of the region. In second place in terms of participation in the social product of the region is the processing industry, which is represented by 20.3 percent.
Incentives for regional development in thousands of RSD for the Srem district in 2020 in 2021	 4.328.373.000,00 4.537.980.000,00
Natural values	Fruška Gora National Park, Fruško Gora Monasteries, Sava River, 12 natural assets and the Zasavica Special Nature Reserve
Typical products of the areas	Srem kulen, Fruškogorsk linden honey, Srem cheese, traditional cuisine
Leading tourist centers	Sremska Mitrovica (Imperial Palace, Srem Museum), Stara Pazova, Ruma (Borkovačko lake, Bara Zasavica, Bara Trskovača), Fruškogorsk monasteries, Šid (Memorial House of Sava Šumanović)
Length of roads/km/	1.150 km

Source: Made on the basis of the author's theoretical-empirical material/Vital statistics, Republican Bureau of Statistics

In the following table is a presentation of indicators of the arrival and overnight stays of foreign and domestic tourists of the Srem district, through a schedule/period of two years, and the types of tourist places are municipalities and cities of the Srem district. (Table 2).

Table 2. Overview of basic data and figures of the area covered by the Strategy

Criterion/Municipality	Sremska Mitrovica	Indija	Irig	Pećinci	Ruma	Stara Pazova	Šid
Surface (km2) (2021)	762км2	385км2	230км2	489км2	582км2	351км2	1687км2
Number of settlements (2021)	26	11	12	16	17	9	19
Population ─ mid-year estimate (2021)	73345	45642	9942	19175	48966	65792	30153
Density of population (population / km2) (2021)	97	119	43	39	88		44
Road length /km/	262	188	107	118	215	125	173
Incentives for regional development in thousands of RSD for the Srem district in 2020 in 2021	 607.677 427.561	 417.397 668.394	 632.228 380.464	 424.306 533.334	 656.936 383.403	 1.203.182 1.702.766	 373.687 411.804
Proportion of territory under forest (%)	13%	2%	19%	17%	16%	0%	32%
Tourist arrivals, 2020-2021	2.340 4.311	1.068 1.512	33.372 56.569	978 1516	12.214 16.453	9.018 17.750	2.923 2719
Tourist overnight stay in 2020 In total: Domestic Foreign	 5.911 4.679 1.232	 5.664 4.759 905	 102.751 96.438 6.313	 978 694 284	 12.214 7.665 4.549	 9.018 6.788 2.230	 2.923 1.783 1.140
Tourist overnight stay in 2021 In total: Domestic Foreign	 7.917 5.607 2.310	 6.826 6.129 697	 157.436 137.816 19.612	 1.516 1.288 228	 16.453 9.841 6.612	 17.750 11.948 5.802	 3.935 1.973 1.962

Source: Made on the basis of the author's theoretical-empirical material/Vital statistics, Republican Bureau of Statistics

Based on the data from the preceding tables and the Srem District Agricultural Census of 2022, a total of 21,818 agricultural farms were officially registered. This figure represents 15.46% of the total number of households in the Province which is a 13% decrease compared to the 2012 census. Legal entities and entrepreneurs own a substantial share, accounting for 23% of the total number of agricultural holdings in Srem. The average size of an agricultural holding in the region is 10.9 hectares. Notably, 70% of farms utilize agricultural land below 5 hectares, while 10% have land exceeding 20 hectares.

Regarding the type of farms in Srem, the most prevalent are those specialized in arable farming (40.8%), followed by mixed agricultural farms combining crop and livestock production (23.7%), and specialized farms for pig and poultry breeding (19%). Other categories include specialized farms for breeding cattle, sheep, and goats (3.3%), those for permanent plantings, vines, and fruit (2.8%), and specialized farms for vegetable and flower cultivation and other horticulture (1.6%). Additionally, there are mixed farms with livestock production (4.8%), mixed farms with vegetable production (3.3%), and a small percentage of unclassified farms (0.3%). Srem possesses favorable conditions for integral and organic production. However, the number of agricultural producers with certified organic products, and those in the conversion process, remains remarkably low compared to the potential. The areas dedicated to organic production have been increasing yearly, reaching 23,527 hectares in 2022 which is a 12.2% rise from 2020. Thus, additional support is crucial, both in the certification process and in the organic production itself, given its unique nature.

The challenges facing rural development in Srem are evident in several aspects. Firstly, agriculture remains the predominant economic activity in the majority of municipalities. Secondly, the infrastructure is inadequately developed, and existing facilities are not adequately maintained or are dysfunctional in terms of both current and future needs. Additionally, there is a notable lack of institutional development, along with pronounced disparities in the level of development among individual municipalities.

As indicated in the preceding tables, Srem possesses considerable resource potential for the advancement of rural tourism. This potential is rooted in diverse features of the terrain, such as Fruška Gora, the Danube and Sava rivers, as well as sources of thermal and mineral water. Furthermore, the region benefits from a relatively favorable climate, abundant flora and fauna, multiculturalism, multiconfessionalism, traditional folk architecture, gastronomy, and more. Despite these favorable conditions, the existing capacities for rural tourism are not fully realized. There is also underutilization of rural tourism facilities, coupled with the inadequate development of additional supporting services in rural tourism, hindering the generation of supplementary income.

Due to the heterogeneity of the natural resources in rural areas of Srem, three primary types of rural areas can be identified. Based on their characteristics, the potential for sustainable rural tourism development can be determined, specifically focusing on natural resources within these areas:

1. **Highly Productive Agriculture and Integrated Economy Area:** This region encompasses the rural areas of the Municipalities of Sremska Mitrovica and Ruma, where agriculture stands as the dominant economic sector. However, due to the excessive use of chemicals and other agrotechnical measures, the natural resources in this area have been partially compromised, diminishing the potential for sustainable tourism development. In this context, tourism development relies more on anthropogenic factors than on natural

resources. As a result, the area is well-suited for advanced forms of rural tourism, including demonstration, gastronomic, farming, wine, religious, excursion, and partially eco-rural tourism, particularly in protected areas.

2. **Mountain Economy-Oriented Area with Emphasis on Natural Resources:** This region characterizes the Municipalities of Šid and Irig and is primarily focused on the mountain economy, showcasing marked demographic backwardness and economic underdevelopment. Despite these challenges, the area boasts a wealth of preserved natural resources. The agricultural sector, including cereals, buckwheat products, organic baby food, marmalades, jams, compotes, fruit syrups, and juices, holds significant potential. Industrial vegetable processing is also a noteworthy aspect. Viticulture and fruit growing play a crucial role, with the Fruškogorje apple and apple brandy plantation in Irig being particularly important. In the upcoming period, there is considerable opportunity to leverage the resource potential for the development of various forms of rural tourism, including agricultural, ethnic, gastronomic, wine, educational, eco-rural, event, sports, and religious tourism.
3. This region is characterized by an economy with a high degree of workforce employment, not requiring extensive spatial occupation, large-scale transportation, environmental pollution, and widespread expansion, and spans across the rural areas of the municipalities of Inđija, Stara Pazova, and Pećinci. Within this area, there are favorable conditions for the development of various forms of tourism, including gastronomic, farming, ethnic houses and farms, sports, events, and shopping tourism. Additionally, in the field of crafts, there exists growth potential, particularly in coppersmiths and other craft workshops (specializing in cake, kuglof, local area souvenirs, weaving, and embroidery), household services, and traditional crafts characterized by small-scale economic activities.

4. ANALYSIS OF THE QUESTIONNAIRE

In the context of this study, a survey was conducted to assess the needs of owners of rural tourist accommodations, and their suggestions for the development of rural tourism in the Srem region were gathered. The research was conducted using a questionnaire during the period of April-May 2023. Contact was established with municipal tourism organizations, which provided data on registered individuals involved in tourism-related activities. The respondents were then contacted by phone, and the purpose and structure of the questionnaire were explained to them. Verbal consent was obtained from those who expressed a willingness to participate.

A total of 12 owners of rural accommodations took part in the research, distributed by the municipality as follows: 5 respondents from Sremska Mitrovica, 5 respondents from Irig, and 2 respondents from Stara Pazova.

The findings revealed that all respondents with overnight accommodations promote their offerings on platforms dedicated to lodging services, such as booking.com and airbnb.com. Additionally, half of the participants are active on social networks like Facebook and Instagram.

Furthermore, 75% of the respondents were registered as farmers, with the remaining participants engaged in various other activities, primarily in the catering sector.

Accommodation services are provided by 91% of the respondents, but only 41.7% offer the option of preparing meals for guests. Additionally, seven households cultivate fruit and allow guests to pick and consume it, two households focus on vegetables, and one of the aforementioned

households, besides fruit, provides guests with the opportunity to purchase brandy, jam, and homemade cured meat products. Some participants mentioned that, apart from renting accommodation, they can offer guests to purchase of domestic products, to rent bicycle with planned routes for bike paths, or to rent a boat, canoe, or board.

Of particular interest for our research is the fact that 62.5% of the respondents report having over 30% foreign overnight guests (details below), suggesting a potential opportunity to further develop tourism in Srem to make it more appealing to international visitors. Half of the respondents express satisfaction with the income derived from this activity, while the remaining 50% are dissatisfied. Despite 54.5% indicating that they view it as a secondary rather than primary occupation, 66.7% express intentions to contemplate expanding or renovating their facilities and services.

Following the formal inquiries, participants were invited to share recommendations and suggestions based on their experiences, aiming to identify areas for improvement to foster the development of tourism in a more positive direction.

The consolidated suggestions include the need for increased advertising and marketing support.

While the collaboration with the Municipality's tourist organization is currently robust, it is recommended that they consolidate offerings from various locations and present them to the rural tourist households. This approach aims to facilitate extended guest stays by providing diverse experiences such as horse-stable tours, museum visits, monastery tours, and quad rentals. The idea is that guests would be inclined to choose our location for a vacation, leading to reduced accommodation costs (specifically in Stari Banovci).

Infrastructure improvements are deemed necessary, exemplified by instances like Ležimir facing water shortages. Enhancements to pedestrian and hiking trails are also needed, as observed in Vrdnik.

Monasteries often house women's dormitories, but the rural tourist households have significantly reduced their operations. The surveyed households suggest that creating a clearer itinerary for monastery visits could encourage people to opt for private lodgings. Educating the community about tourism regulations is crucial. Respondents emphasize the importance of external assessments to better comprehend areas requiring improvement and change.State assistance is sought through subsidies and promotional efforts, utilizing funds from higher levels of government to foster tourism development. Lastly, there's a call for networking among entities in the tourism industry at the municipal level. This collaboration is envisioned to benefit not only tourism but also the local economy and the self-governance structure.

5. BRANDING OF THE REGION OF SREM DISTRICT

Even today, when Slovaks from Vojvodina are mentioned, the immediate association is often with the naive painter Zuzana Halupova and her depictions of orderly villages adorned with blue-painted houses (Kosanović & Vještica, 2021). While this work does not focus on an artistic interpretation of the famed painter's blue villages, it draws on this association as a guide for establishing a brand perception of Srem's tourism potential. This branding is seen as instrumental in fostering the sustainable development of rural and suburban settlements, including

agricultural farms, aligning with current trends and environmental considerations. The pursuit of these objectives aligns closely with the research goals and involves seeking out strategies from various authors to implement effective and feasible actions in the rural areas of Srem.

In crafting the tourist offerings of Srem, emphasis should be placed on forms of tourism that can be swiftly developed without substantial initial investments, ensuring competitiveness in the tourist market. Consequently, the growing and sought-after domain of rural tourism becomes a focal point in this endeavor.

5.1. Development concept proposal

The following key objectives are deemed essential:

- Establishment of a distinctive tourist identity for Srem.
- Creation of a unique Srem production profile.
- Economic empowerment of the region.
- Ensuring widespread community benefits.
- Generation of income through innovative ideas.
- Development of the tourism brand value for Srem, aiming at successful regional positioning and enhanced competitiveness.

To achieve the sectoral goal, the implementation of the following tasks is imperative:

1. **Preparation of Project Documentation:**
   - Essential for the elaboration and execution of positioning activities.
   - Involves product and area differentiation concerning competition.
   - Facilitates the pursuit of funding from local self-government, national, and international projects.
2. **Integral Marketing Plan:**
   - Recognizing that brands thrive on fostering emotional connections with consumers.
   - Aims to promote a sense of love and intimacy with the target audience.

6. CONCLUSION

Considering the diverse array of natural, cultural-historical, and gastronomic resources within the municipalities of the Srem district, there exists a significant opportunity for tourism to evolve into a pivotal economic sector. The realization of this potential hinges on effective marketing of an integrated rural tourism product in the foreign market, contingent upon ensuring high-quality standards in the rural tourist offerings. Such efforts would not only attract international guests but also lead to the realization of "invisible exports," contributing favorably to the country's balance of payments.

The development of rural tourism carries both social and political significance, as it fosters cultural understanding, offering insights into different ways of life and promoting better cross-cultural comprehension (Njegovan et al., 2015). Consequently, it becomes imperative to align rural development programs with the training of residents in rural areas to embrace new technologies, thereby diminishing isolation in crucial regions and accentuating local conditions and opportunities.

Local Government Units (LGUs) play a pivotal role in rejuvenating rural areas by championing the promotion of tourism products in the Srem district. This effort is intricately linked with the

overarching policy of economic development, emphasizing the importance of cultivating competitive advantages rather than merely comparative ones (Kosanović et al., 2019).

A robust presence of tourist brand products and areas in the market, coupled with strategic development-oriented tourism concepts, is integral to enhancing the competitiveness of agrarian goods and areas. This entails elevating product quality, creating and promoting reputable brands, and thereby ensuring a sustainable trajectory for all facets of overall sustainable development.

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Archaeological Sites and Local Renaissance: Enlightening Italy's Inner Rural Areas – The Case Study of the 21 Villages in the Madonie Park, Sicily

Luisa Lombardo[1]

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Abstract: *In Italian inner rural areas, archaeology emerges as the thread that connects past and present, revealing the cultural and historical roots of often overlooked small villages. These settlements, like the Madonie District and its 21 villages, nestled in picturesque landscapes, hold archaeological treasures that, if properly rehabilitated and valorized, can trigger a social, economic, and cultural revival. Archaeology can play a pivotal role in reigniting the vitality of these communities with the contribution of technological innovation. Using augmented and virtual reality and emerging technologies, it is possible to immerse oneself in antiquity and have immersive experiences that allow the perception of inner rural areas history in new ways that revitalize existing sites but also enable the experience of what no longer exists, digitally reconstructing structures and realities lost over the centuries. This can attract visitors eager to uncover the authentic charm and intrinsic history of these places and can transform them into smart villages.*

1. INTRODUCTION

In the northwestern part of Sicily, at the heart of the Mediterranean Basin, lies a protected natural gem known as the Madonie (Farinella, 2022) GeoPark UNESCO (Figure 1). Spanning 39,679 hectares and encompassing 21 municipalities in the province of Palermo, this geological wonder offers a captivating journey through landscapes (Anselmo, 2020) ranging from the Mediterranean coast to snow-capped mountain peaks. Majestic and diverse natural attractions include Mount Carbonara, the second-highest peak in Sicily at 1,979 meters above sea level, and the Pollina River Valley, a fluvial valley adorned with lush vegetation and wildlife, completing the panorama of this exceptional natural paradise (Trapani & Vesco, 2013). The Madonie Park is not merely a testament to grand landscapes; it is also a biodiversity sanctuary, home to century-old trees like the Abies Nebrodensis, Mediterranean plants, and a variety of wildlife (Schicchi & Inglese, 2022). Beyond being a prominent tourist attraction, this extraordinary place offers a range of activities and attractions. Nature enthusiasts can partake in hiking, trekking, and mountain biking, while those with a penchant for culture can immerse themselves in the historical centers of the park's villages. Tastings of local typical products add the finishing touch to the experience. Yet, the Madonie Park is more than a natural treasure; it is a guardian of human history (Gennuso, 2022). Neolithic, Bronze Age, Iron Age, Roman dominion, and influences from Byzantine and Arab cultures have shaped Madonie's history, evident in the remains of ancient villages, castles, and churches. Recent archaeological discoveries in the Madonie Park have further enriched our understanding of this millennia-old history, unveiling secrets dating back to remote epochs, such as Neolithic villages, Greek sanctuaries, and Roman settlements.

Archaeological findings (Figure 2) have demonstrated that Madonie has been inhabited since prehistoric times, hosting a variety of diverse cultures over the centuries. The earliest traces of human

[1] Department of Architecture, University of Palermo, Viale delle Scienze Bld. 8-14, 90128, Palermo, Italy

activity date back to the Lower Paleolithic, when the area was inhabited by groups of hunter-gatherers. During the Neolithic period, the population settled more permanently and began practicing agriculture and animal husbandry. In this period, the first villages of the Madonie were built, the remains of which are still visible. It has also hosted a variety of diverse cultures over the centuries; in the Bronze Age, it was inhabited by populations of Sican culture, who built numerous settlements. In the Iron Age, the district was conquered by the Siculi, who founded the city of Himera (Farinella, 2021). In the Roman era, it was an important center of agricultural production, and, in the medieval period, it was inhabited by populations of Byzantine and Arab culture. Archaeological findings, today, provide information about the economic activities practiced in the Madonie over the centuries. For example, discoveries of agricultural settlement remain attest to the importance of agriculture and animal husbandry. Discoveries of artisanal artifacts testify to the importance of craftsmanship. But also, findings provide information about the customs and beliefs of the populations that have inhabited this place over the centuries, for example, discoveries of ritual objects attest to the importance of religious practices.

Figure 1. Madonie Geopark
Source: Carmelo Di Salvo, 2022

Figure 2. Grotta della Gurfa
Source: Visit Madonie, 2023

Still today, the archaeology of the Madonie is a continually evolving field of research. Discoveries are made every year, contributing to improving our knowledge of this territory rich in history and culture. On the contrary, despite the numerous architectural, naturalistic, and archaeological peculiarities of the "Parco delle Madonie" region, it is regrettable to note the presence

of serious issues within the surrounding villages. Presently, these communities face the challenge of a significant demographic gap, especially among the elderly, a lack of adequate and sufficient services, a locally prosperous economy that struggles to expand beyond the territorial borders, and a deficiency of a significant number of young people (Farinella & Anselmo, 2023). These factors put the region at risk, like many other internal areas of the Italian territory, of disappearing and becoming a neglected portion of our country. However, it is essential to consider the opportunity to promote initiatives aimed at the recovery and enhancement of these areas, which represent the most identifying roots of our country. Promoting a different and more innovative approach to protection and conservation could provide future generations with a heritage rich in history, architecture, arts, and millennia-old traditions. If well-appreciated, these features could bring the Madonie district to a condition of absolute prestige on the island and in Italy. In particular, the use of numerous archaeological areas in the region could enable a more informed enjoyment of the places and promote different paths of urban revitalization. The integration of technology in archaeology or technological design to enhance the usability of archaeological areas often left abandoned, for example, could play a key role in making these territorial peculiarities accessible and attractive, thereby increasing tourist enjoyment, and stimulating the sustainable economic development of the region.

2. UNLOCKING ITALY'S ARCHAEOLOGICAL TOURISM POTENTIAL

During the second edition of the Mediterranean Archaeological Tourism Exchange (BMTA, 2023) held in Paestum, the research conducted by Intesa Sanpaolo's study center highlighted that UNESCO recognition can be an economic development catalyst only if supported by a strategic plan and strategy. Italy stands out globally for the number and diversity of its 45 archaeological sites recognized by UNESCO (Settis, 2018), with the Southern regions boasting 12 of them, representing 27% of the national total. In the historical-archaeological context, the southern region exhibits significant tourist appeal, aligning with the rest of the country. Despite representing 27% of UNESCO-recognized historical-archaeological areas, the Southern Peninsula attracts 30% of visitors and contributes to 27% of the total revenue. Italy is the country with the highest number of UNESCO World Heritage sites globally (Figure 3), and many of these sites are linked to the archaeological world, spanning from prehistory and Magna Graecia to the Roman Empire and the Paleochristian tradition (Settis & Di Teodoro, 2022). In this context, rural areas play a vital role in preserving Italy's rich historical heritage. Due to their geographical isolation from urban hubs, small towns, especially those in the hinterland, have diligently safeguarded and showcased the historical treasures passed down to them. Italy boasts numerous instances of smaller communities successfully preserving their historical significance and, of course, some of them are also UNESCO sites. Italy hosts numerous villages - true hidden gems waiting to be revitalized and restored, rich in history and nature. Leveraging emerging technologies, especially for the preservation of archaeological heritage, could ensure the transmission of these forgotten treasures across generations.

Harnessing emerging technologies could ensure the sustainable development of these sites, enriching the tourism offerings and promoting a green economy. For example, revitalization projects include Craco Vecchia (Figure 4), a village dating back to 1154 whose enjoyment is now possible thanks to the ability to enter within a predetermined path enclosed by metal cages, a technology employed to protect visitors, accompanied by appropriate tour guides, from potential structural collapses (Laterza, 2022). This allows them to experience the charm of a decayed yet unforgettable place. Pentedattilo on Mount Calvario in Calabria, both aspiring to transform into tourist destinations with technological applications and tools ICT.

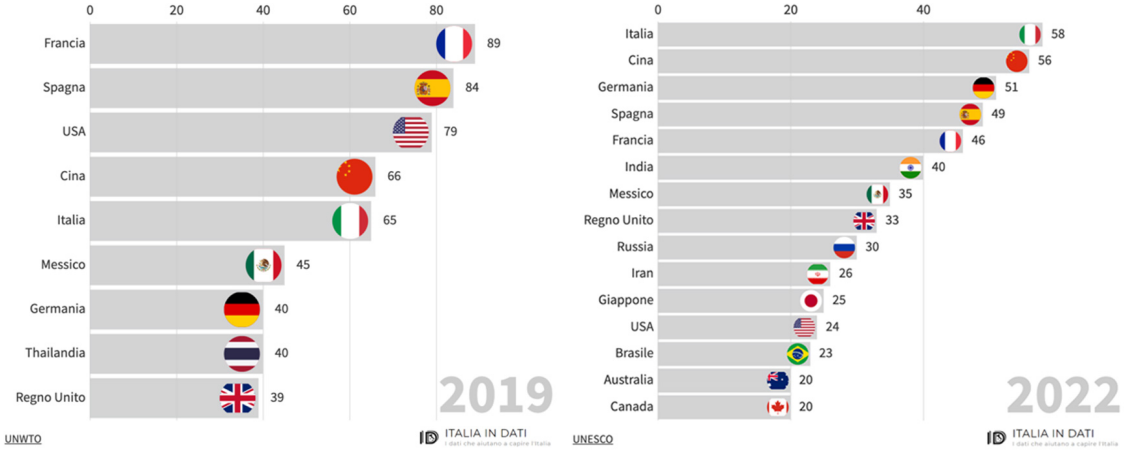

Figure 3. Scheme of the most visited cities and concentration of UNESCO sites
Source: Italia in dati, 2022

Figure 4. Craco Vecchia, Basilicata, Italy
Source: Luisa Lombardo, 2022

In Sant'Angelo, Basilicata, tombs dating back to the 8th century B.C. have been discovered, highlighting the potential for sustainable tourism through geo-archaeology with murals, street art, and land art to involve tourism. Mozia, in Sicily, is an exemplary and intact city from the 8th century B.C., emphasizing its unique potential to preserve the charm of Sicilian Carthage, important to be valued and rediscovered (Farinella, 2021). Through the construction of the power line connecting the island to the mainland for the transmission of electrical energy, a definitive end is brought to the series of limitations to which the island has been subjected. This initiative promises increased tourism and cultural accessibility on the island, translating to enhanced comfort for visitors to the archaeological museum managed by the Giuseppe Whitaker Foundation by extending visiting hours, illuminating external pathways, and excavating areas. The research and geo-archaeological study represent an extraordinary opportunity for documentation and surprising knowledge in these places, as well as in lesser-known territories like the recovered village of Pentidattilo in Calabria (Gaetano, 2022). Promoting archaeological itineraries to explore our past and using emerging technologies can enhance the documentation and study of these places, capturing the interest of scholars, tourists, and researchers is crucial for the revival of these territories. There is much to rediscover in Italy, remarkable geo-environmental and archaeological sites that can facilitate substantial development of cognitive activities, exploring emerged territories and submerged coastal

areas. Leveraging emerging technologies for heritage preservation is imperative not to be overlooked, as geo-archaeology emerges as an inexhaustible field of study and knowledge, offering a new and original approach to integrated and multidisciplinary understanding of the past and approaching the oldest. Unfortunately, these sites are not being fully utilized and are allowed to deteriorate, but they represent unique intersections of history, environment, and archaeology, offering a singular perspective under the geo-archaeological lens.

In Italy, in recent years, several initiatives have focused on archaeology, particularly in smaller communities, such as the "Night of Archaeological Villages" - sustainable heritage for lively communities, and the "Orange Flag Villages" (Borghi Bandiera Arancione, 2023). These events facilitated exploration, guiding participants through an itinerary along the village streets, unveiling the rich historical tapestry beneath the surface. Beyond archaeological exploration, these initiatives were collaborative efforts actively engaging citizens and local associations that provided an immersive experience, leveraging the principles of archaeology as a medium for storytelling. These are some examples of smart strategies applied to Italian heritage and archaeology, particularly in the inner areas, aimed at enhancing the more remote regions of our territory. Beginning with culturally focused strategies, accessibility features, routes and itineraries, it becomes possible to revitalize the territories of Italy's inner areas. Moreover, considering the prospect of sustainable technological design opens avenues for experiencing archaeological sites not only through traditional tourist tours but also by advancing into the digital realm (Condorelli & Bonetto, 2022). This approach facilitates the appreciation and innovative storytelling of these sites, providing a broader perspective for the new generation. It allows them to view archaeological heritage through a different lens, offering them a unique opportunity to engage with and appreciate our cultural legacy in a novel and meaningful way. At the same time, this can be a methodology to apply to invigorate these areas from a tourist perspective and reactivate the local economy. The combination of cultural strategies and sustainable technological solutions not only enhances the tourist experience but also contributes to the economic growth of local communities. The innovative enjoyment of archaeological heritage, supported by technology, can become a driving force for attracting visitors, generating employment opportunities, and promoting the sustainable development of Italian inner areas (Beale et al., 2022).

3. SMART – IN MADONIE: ROCK ARCHITECTURE, TEMPLES, AND CASTLES IN THE MADONIE

In the evocative context of Madonie Park, comprising 21 municipalities, a rich archaeological heritage emerges, which, unfortunately, is currently poorly preserved, sometimes abandoned or neglected over time. Despite the presence of sites of considerable value in each municipality, the current lack of an appropriate technological approach hinders the widespread enjoyment of these historical testimonies. Each municipality boasts significant archaeological sites that, however, lack a technological project enabling easy and informed public access. The absence of technology-oriented infrastructure for an intelligent visit experience is evident, as well as the lack of plans for the restoration, enhancement, and use of these sites. Currently, these testimonies are left to degradation and neglect, without the possibility of returning to the center of public interest. The lack of funding and the absence of a programmatic plan for events aimed at their use inevitably leads to a lack of interest, contributing to the closure of these sites, and making them inaccessible to the public. This situation has also prevented tourists, who rarely manage to discover the wonders of the hinterland because they are less known or less accessible, from enjoying a complete experience aimed at understanding the immense architectural, monumental, and archaeological heritage

present. Peak hours, especially during the weekend, prove critical, with bars and museums often closed. The use of these places and their related services is not guaranteed, undermining the opportunity for a fulfilling and cultural discovery for both visitors and residents.

To cite just a few of the archaeological sites in the vast Madonie District, the most famous and recent is the Virtual Archaeological Museum (M.A.V.) (Figure 5) to relive 5000 years of archaeological history of the Madonie and make archaeological sites virtually accessible today due to geomorphological conditions. The museum, once open to the public, also allowed children to learn archaeology through play. However, today, its use is not allowed. The archaeological site Balza Areddula, between Balza Areddula and Balza Solletta the Strittu, a gorge where the Salso River narrows, creating a beautiful landscape with small natural pools and sulfur springs. Also, the Roman Villa of S. Marina in Petralia Soprana, Monte Aburchia, one of the most important archaeological areas in the Madonie, the Civic Museum of Castellana Sicula, located within the archaeological area of Contrada Muratore, Grotte della Gurfa (Figure 2), rock architectures on multiple levels, probably of protohistoric age and today always closed unless requested by the local administration. Not to be overlooked is the presence of Himera, a Greek city founded in 648 B.C. by the citizens of Zancle and now an archaeological park, but not easily accessible. Caccamo, with its medieval castle, Isnello and its Urban Geological Path, the Civic Museum "Antonio Collisani" in Petralia Sottana, and other civic museums in the Madonie, some recently discovered Menhirs and Cromlechs in the Madonie Park, currently under study. Lastly, Contrada Muratore, in Castellana Sicula, is the three-arched Romanesque bridge in Blufi, erected over the Southern Imera River in the medieval period, between the territories of Blufi and Petralia Sottana.

Figure 5. Virtual Archaeological Musem, Bompietro, Sicily, Italy
Source: M.A.V., 2018

The "Archeoaccessibility" project was initiated as part of the "In the Heart of the Madonie. Villages Accessible to All" initiative, supported by the Foundation with the South for an experiential journey inside the Archaeological Museum of Gangi. However, what has been accomplished so far is insufficient: 21 municipalities are not self-sufficient from a tourist perspective, unable to propose itineraries suitable for their heritage. Sites that could be revitalized differently through technological implementation can indeed promote the development of rural areas by sharing information and moments of what once existed. Concerning the possibilities offered by new technologies in archaeology, consider, for instance, the concrete ability, thanks to cutting-edge tools, to pinpoint the exact location, material quality, and size of a specific archaeological artifact deep within the ground without even excavating the soil. This innovation makes previously unthinkable discoveries possible and, at the same time, allows the preservation of each site by avoiding overly invasive investigations.

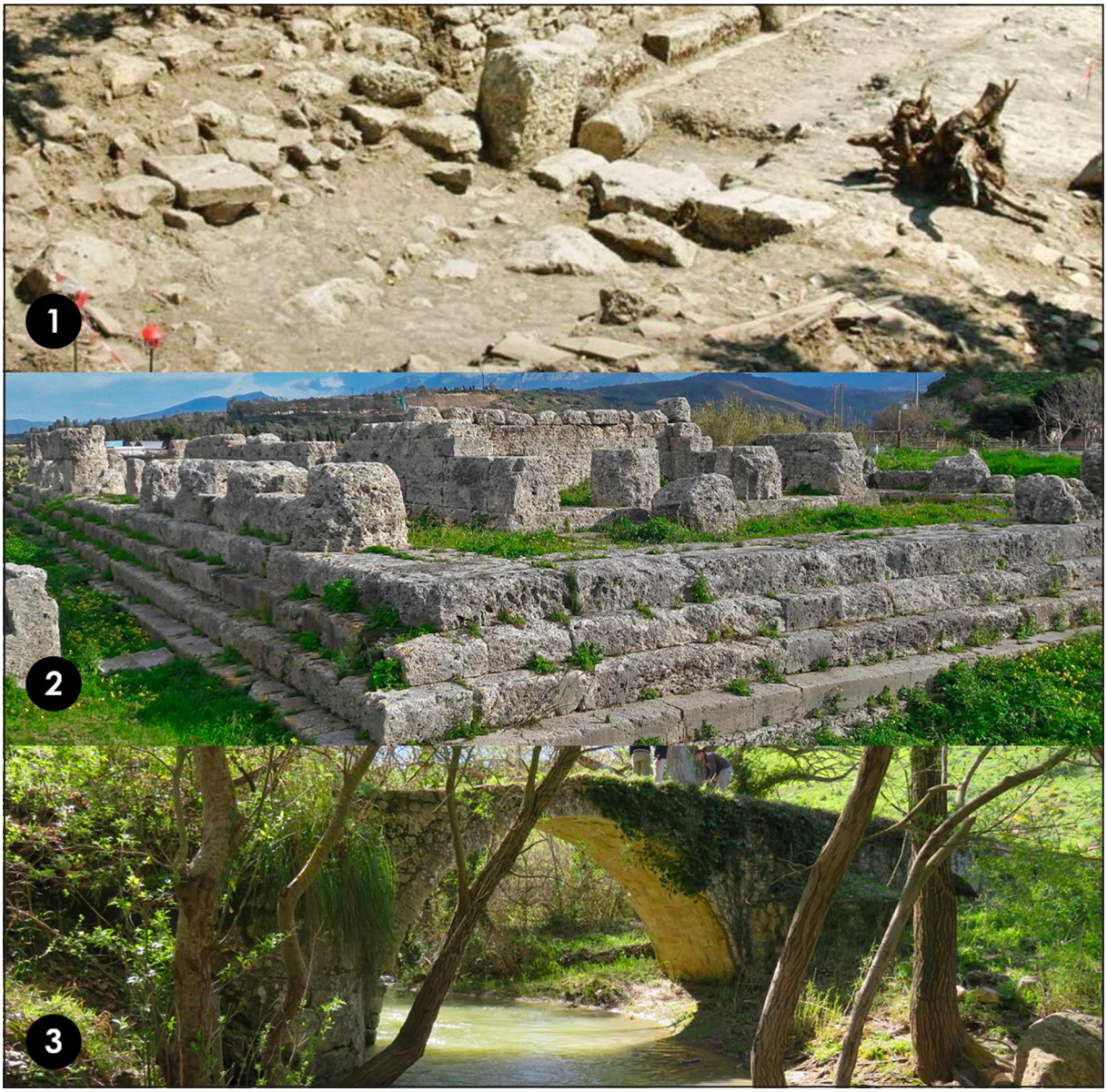

Figure 6. Villa Romana in Petralia Sottana, Himera, Roman arches in Blufi, Madonie, Sicily, Italy

Source: Luisa Lombardo, 2023

Radar, 3D technologies, drones, lidar cameras, infrared remote sensing technologies, computerized tomography, and magnetometers are just some of the tools used in modern archaeology today, for example in Pompeii. They not only generate realistic images for public display but also enable meticulous reconstructions of past eras and contexts that have led to what is now our present. The goal is to create a comprehensive and immersive approach that engages both the local community and tourists in a deeper exploration of the inner rural areas, significant monuments, traditions, and collective memory. Proposed activities include an interactive map of monumental heritage both online and on-site, serving as a comprehensive guide showcasing the rich monumental heritage of the area, and integrating geographical and historical information about each site. A dedicated rural area app could offer features such as guided tours, historical insights, and interactive elements like quizzes or challenges to engage users in the cultural narrative. Additionally, features for route customization, duration adjustment, and theme selection could cater to the preferences of individual visitors (Hein, 2022). An exhibition and

video documentation for an immersive exhibition that combines artifacts with multimedia elements to showcase the monuments, history, and culture of the region. Produce a visually compelling video documenting significant cultural aspects, providing a captivating narrative accessible both physically and virtually. Community dialogues could facilitate moments of debate and conversation within the community through digital platforms or live events, encouraging active participation, exchange of insights, and collaborative storytelling to enrich the cultural heritage experience. Multimedia installations, including interactive displays, audiovisual presentations, and augmented reality elements, create an engaging and educational environment for visitors. A guided visitor app could be developed as an advanced mobile application for guiding visitors to key points of interest in rural areas, contributing to a networked system of cultural offerings, and ensuring a comprehensive exploration of the heritage sites. Integrated features such as automatic recognition of archaeological structures, detailed descriptions, automatic readings, and augmented reality enhancements provide a rich and personalized experience. Last but not least, accessibility features: To ensure inclusivity, the smartphone app could incorporate features catering to visitors with visual disabilities. It will automatically recognize archaeological structures through the phone's camera, providing detailed descriptions. The app could also offer automatic readings and use augmented reality to highlight specific parts of the structure described. Visitors can customize their experience, ensuring a unique and personalized journey into the past. By combining these innovative initiatives, it is possible to transform the cultural heritage experience in the rural inner area of the Madonie in Sicily into an engaging, accessible, and highly personalized adventure for both the local community and tourists. This holistic proposal aligns seamlessly with the broader objective of preserving and promoting the historical and cultural richness of the region through the integration and enrichment of state-of-the-art technologies. In addition to providing an immersive and personalized cultural heritage experience, the proposed technological solutions play a crucial role in empowering visitors to explore the rural inner areas of Sicily independently. This autonomy becomes particularly significant where there is a shortage of personnel, addressing the challenges and enhancing the accessibility of historical sites in remote regions.

The integration of an interactive map of monumental heritage and a dedicated rural area app allows users to embark on self-guided tours. Visitors can delve into the rich history and cultural significance of each site at their own pace, aided by detailed information, interactive features, and customizable routes. This self-guided approach is particularly advantageous in areas where limited staffing may pose challenges to providing on-site assistance. The guided visitor app further contributes to independent exploration by offering automatic recognition of archaeological structures through smartphone cameras. This feature proves invaluable in instances where personnel may be scarce, enabling visitors to access comprehensive and detailed descriptions of historical sites without the need for on-site guidance. Moreover, the incorporation of augmented reality in the app enhances the overall experience, allowing users to visually engage with highlighted parts of structures as they are being described. This not only adds an interactive dimension but also compensates for the absence of on-site personnel, ensuring that visitors receive a thorough and informative encounter with the cultural heritage. Multimedia installations strategically positioned throughout the rural area serve as educational touchpoints, offering insights and information even in the absence of dedicated personnel. These installations become integral in compensating for the challenges faced by remote regions, ensuring that the cultural richness of these areas is accessible and appreciated. These solutions enable visitors to autonomously unravel the historical tapestry of the region, ensuring that the cultural treasures of rural areas are not only preserved but also celebrated in a technologically enhanced and inclusive manner.

4. CONCLUSION - ARCHEOLOGICAL SMART VILLAGES

In a landscape marked by ongoing transformation and globalization, the smaller, lesser-known Italian towns are poised to unearth fresh opportunities for growth and advancement by revitalizing their archaeological heritage (Colajanni et al., 2021). Archaeology, seen not merely as a study of the past but as a dynamic asset for the present, assumes a pivotal role in promoting these locales, captivating aficionados of history and archaeology. The application of cutting-edge technologies greatly magnifies the tourism prospects of these sites. Through digital tools and virtual reality, visitors can dynamically engage with bygone eras, exploring what once existed, what remains, and the possibilities of epochs past. This innovative mode of exploration not only yields a deeper understanding of the location's history but also creates an immersive experience appealing to a wider and more diverse audience. Presently, numerous sites in the Madonie region, steeped in history and archaeology, languish in obscurity. Their lack of visibility, hindered by insufficient accessibility and promotion, hampers their full contribution to the economic and cultural growth of local communities. However, adopting a modern approach to promote and present these sites could pique interest, raise awareness, and foster greater public engagement. The astute utilization of these archaeological resources not only safeguards the past but also nurtures sustainable territorial development. Crafting tailored tourist itineraries, hosting cultural events, and integrating technological solutions for dissemination can metamorphose these sites into significant tourist magnets. This not only draws ardent visitors but also fuels local employment opportunities and bolsters economic growth through tourism. In addition, the presence of diverse archaeological sites across the Madonie enclave offers a chance to create bespoke paths, contributing to the development of a robust network of smart archaeological sites. This strategy allows visitors to delve deep into the ancient history that has shaped the fabric of Madonie (Lombardo, 2022). Promoting tailored cultural circuits not only enriches visitors' experiences but also has the potential to spur increased local employment. Designing thematic itineraries supported by cutting-edge technological solutions aids in spreading awareness about previously less-known archaeological sites. This innovative approach not only appeals to archaeology enthusiasts but can also catalyze repopulating the area by offering job opportunities and fostering sustainable development through cultural tourism. The blend of targeted tourism promotion, leveraging state-of-the-art technologies for archaeological site exploration, and the creation of personalized cultural paths present a promising model for enriching Madonie's archaeological heritage. This approach not only contributes to preserving history but also forges a sustainable future for local communities through economic growth and increased employment.

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Art Nouveau Style as a Discursive Strategy for Tourism Promotion. The Case of the City of Oradea

Andra-Teodora Porumb[1]
Adina Săcara Oniţa[2]
Ciprian-Beniamin Benea[3]

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Abstract: *The paper analyzes how the Art Nouveau style has become a primary element of tourism promotion and the brand of the City of Oradea, a city with a rich history and cultural tradition located on the western border of Romania, as well as the importance it occupies in building the image of this tourist destination and the city's identity. With a unique architectural heritage, the city of Oradea has become the most important Art Nouveau city in Eastern Europe, currently competing with famous cities such as Nancy, Barcelona, Brussels, and Vienna and aspires to the status of a predilection destination, to become a place tourists dream of. The speech that outlines the image of this destination is impregnated with marks of subjectivity; it appeals to elements of history, tradition, culture and music, creating bridges between people and building an effective relationship with potential tourists.*

1. INTRODUCTION

Art Nouveau was an important art movement of the late 19th and early 20th centuries that emerged as a reaction to neoclassicism and assimilated traditional art, enriching it with innovative ideas and inspiring modern art. This art movement manifested itself, especially in the fields of architecture, decorative arts and design, bringing beauty, elegance and the combination of "art & utility" into everyday life. It spread mainly in Europe, with different names from one cultural space to another: France and Belgium (Art Nouveau), Germany (Jugendstil), Austria and the Czech Republic (Secession), Italy (Liberty), England (Modern Style), Spain (Modernismo) but also in the United States (Tiffany).

The most famous architects following this style were Hector Guimard (France), Victor Horta (Belgium), Venri Van de Velde (Germany), Antoni Gaudí (Spain) and Ödön Lechner (Hungary). In their memory, the Museum of Applied Arts in Budapest proposed celebrating World Art Nouveau Day on June 10 every year, starting in 2013.

Art Nouveau aesthetics is characterized by a wealth of shapes and ornaments, curved, sinuous, fluid lines, asymmetric compositions, natural, warm and gradient colours, a sense of dynamism, and the continuity of space. The worship of nature, female silhouettes, or Japanese art are sources of inspiration for architects and artists. The buildings, decorations and furniture items are decorated with motifs borrowed from the plant and animal world (flowers, leaves, birds, feathers, insects, shells), having symbolic meanings. The artists use the most diverse materials, traditional and modern: carved wood, wrought iron, stained glass, mosaic, ceramics or concrete. The richly ornamented facades, bas-reliefs and murals of palaces built in the Art Nouveau

[1] Faculty of Economic Sciences, University of Oradea, Universităţii Street, 1, 410087, Oradea, Romania
[2] Faculty of Economic Sciences, University of Oradea, Universităţii Street, 1, 410087, Oradea, Romania
[3] Faculty of Economic Sciences, University of Oradea, Universităţii Street, 1, 410087, Oradea, Romania

style make the historic centers of many European cities a special attraction for tourists who love culture, history, art and beauty.

The first Art Nouveau buildings were erected in Brussels, following in the footsteps of the great European capitals, but also in cities that aspired to an artistic identity to build such palaces, residences and hotels.

2. ART NOUVEAU OR ART OF THE 1900s IN ROMANIA

At the end of the 19th century, in Romania, especially in the region of Transylvania, under the guidance of Austrian and Hungarian architects and their Romanian disciples, imposing richly decorated buildings began to be erected, where classical elements (columns, capitals, frames, geometric ornamental motifs) were combined with historical, romanticism elements and elements of the new style in vogue at that time in Europe. Most of the Art Nouveau palaces are in Oradea, a charming city on the western border of Romania, nicknamed "Little Paris" in the early 20th century.

The architects of the Viennese School (Valer Mende), the graduates of the Budapest Polytechnic School (Jakab Dezső, Komor Marcell, Vágo Lászlo, Vágó Józef, Löbl Ferenc) and the graduates of the Polytechnic School from Berlin (Rimanóczyi Kálmán jr.) born in Oradea left their mark on the architectural projects, so that the Art Nouveau style of Oradea also has its own characteristics, a very specialized iconography, combining plant, anthropomorphic and zoomorphic elements with geometric elements, while maintaining the dynamism of fluid, elegant and rhythmic lines and adopting new construction techniques with modern materials (concrete).

The numerous palaces built at that time in Oradea represent unique heritage assets which, together with buildings and monuments erected in previous centuries (in the Renaissance, Baroque, Romantic, and Classical styles), make the city one of the most important cultural and historical and tourist centres in the Transylvania region. Among the main Art Nouveau buildings and monuments built in Oradea are: Black Eagle Palace (1907-1908) with its famous stained-glass passage, the Adorján I House (1903-1907), the Adorján II House (1903-1907), Stern Palace (1908-1909), Fuchsl Palace (1904), Guliver Store (1906-1910), Bihor County Savings Bank (1909), Moskovitz Palace (1912), Vágó House (1905), Apollo Palace (1912-1914), Ullmann Palace (1913), Astoria Hotel (1902), Poynar House (1911) and Transilvania Hotel (1903-1904).

According to the data available on the website of the City Hall of Oradea, 77 of the buildings are listed by the National Commission for Historical Monuments.

3. ORADEA – TOURIST DESTINATION

In recent years, the municipality has invested large sums of money in renovating heritage buildings and restoring the historic city centre. The City Council has been actively involved in promoting the city as a cultural tourism destination, by attracting European funds for the rehabilitation of infrastructure and major historical monuments, creating bodies whose main objective is tourism promotion, by supporting small local businesses in the field of tourism and handicrafts and by organizing numerous trade fairs. All of this has encouraged investment in the construction of accommodation units, with significant growth in this sector.

As noted by Demiraj et al. (2022) tourism is an important economic activity that can generate significant income, jobs, and social and cultural development, therefore all efforts to promote the city as a tourist destination would bring benefits on multiple levels.

According to the information published by the National Institute of Statistics, in Romania, in 2022 there was an increase in the number of Romanian and foreign tourists compared to 2021. And the tourist accommodation capacity was higher by 3,7% compared to 2021. There were 12696,8 thousand arrivals of foreign visitors in Romania in 2022, of which 75,2% used road transport. The upward trend was maintained throughout 2023, so that in September 2023, compared to September 2022, the arrivals of foreign visitors increased by 15,8%. The average length of stay in September 2023 was 2,2 days for Romanian tourists and 2 days for foreign tourists. The city of Oradea can attract many foreigners, especially those who prefer city breaks and road transport, not only because of the tourist attractions and the many organized events but also because of its geographical position.

4. METHODOLOGY AND CORPUS

If for many years the city of Oradea and its surroundings were known especially as a spa destination, the city gradually became a cultural tourism attraction, and its architectural heritage is currently one of the central themes of the tourist discourse, an element of the brand identity. Manfredini (2019) defines the brand image as the reputation of a destination based on a territorial identity whose components are history, heritage, symbols and representations, adopted by residents and recognized by tourists. We subscribe to both Lebrun and Corbel's (2019) view that the development of destination brands becomes essential for the survival of cities. For Oradea, it is therefore important to create a specific identity, diversify the tourist offer and transform the city into a real tourist destination.

The work aims to trace how Art Nouveau has managed to become an emblem of the city, being an essential element of the identity discourse and the discourse of the promotion of the city and giving them the imprint of a distinctive and exceptional character. We hypothesize that the main promotional strategy of the different players (public and private) is to carry out communication campaigns centred on the exceptional character of the city's architecture, in which the "informative function" of the discourse harmoniously combines with the "capturing function" (Charaudeau 2005) and the texts are impregnated with marks of subjectivity.

Analyzing a corpus made up of websites of public institutions and bodies promoting Oradea as a tourist destination, we will show that one of the main discursive strategies is to select, focus and reformulate information about the city's architecture, with an emphasis on real estate dating back to the end of the 19th century. We will show that the Art Nouveau style is both an argument of the destination promotion discourse, a red thread of the visit itinerary, an indication of the exceptional character, an element of the city's identity and a true brand of the destination Oradea.

We will describe the thematic construction of the discourse on the websites of some Romanian public and private institutions and bodies, more precisely the page layout, titration, selected information, their arrangement and ranking, using an approach specific to the French school of discourse analysis (Florea 2007). We have chosen as discursive support the website, which is not only a physical entity, "a single cluster of files", but is also "a semiotic entity" (Stockinger 2005), more precisely "a meaning-construction" device (Meunier 1999). The website can host a lot of information that can be constantly updated and that comes from many advertisers. We believe, as Rouquette (2017) does, that the website can give very good visibility to the work of the organization.

We will show that some of the sites we have analyzed have many features in common with the tourist guides. As Seoane (2013) points out, the functions reserved for the tourist guide have spread to other discursive media, just as the new media have influenced the discursive practices of tourist guides. We will also mention the languages in which the websites can be consulted, as these are relevant for the reception of information by as many tourists as possible. For space reasons, we will present only a few of the sites we have analyzed.

Recent linguistic analysis studies of the tourist discourse, which, according to Yanoshevsky (2021), constitutes a "privileged object" for this field of study, have focused on the description of discourse genres, the objectivity/subjectivity dichotomy and the concept of "ethos".

Many of the papers had tourist guides as their object of analysis: the evolution of tourist guides from a comparative perspective (Bălăuţă 2019), the qualitative and quantitative analysis of some corpora consisting of tourist guides (Skëndo, 2021), the evolution of the guides against the background of "contamination" phenomena by the internet, print media, television (Seoane 2013). This type of discourse attracts because it conveys a multitude of texts, images and interactions, it is characterized by interdiscursiveness and interdisciplinarity. However, we consider that not only information from tourist agencies and bodies or brochures and tourist guides is relevant for the study of tourist discourse, but also information from non-tourist sources.

5. THEMATIC CONSTRUCTION OF THE DISCOURSE PROMOTING ORADEA AS A TOURIST DESTINATION

Oradea is mentioned on international tourism platforms. Thus, in 2012 the city was included in the Art Nouveau cities network, and 2022, the European travel website Best Destination awarded Oradea the title of the most beautiful Art Nouveau destination in Europe, creating a special page entitled "Oradea - Art Nouveau - Life Nouveau". The city is on the list of recommended cultural destinations and has a comprehensive description on a dedicated page. Being a multilingual site (43 languages), the tourism promotion speech reaches a very large number of online tourists. The website also promotes destinations in numerous travel magazines (Forbes USA, Condé Nast, Geo, Corriere Viaggi, National Geographic) and has been featured in many of the world's leading travel magazines.

The information was picked up by the press, so that important national daily newspapers (Adevărul, Ziarul Financiar) and local daily newspapers (Crişana, Bihoreanul) dedicated a series of articles to the city of Oradea, mentioning the title awarded by the European Best Destination website and the fact that the city was included among the 10 cities worth visiting in 2022.

This information has also been picked up by national and local televisions and is featured on the website of Oradea City Hall, which describes the city as "the gateway to the central and western European world". Therefore, the awards received by the city are an important argument for its choice as a tourist destination.

On the City Hall's website, www.oradea.ro, along with sections dedicated to legislation, organizational structure, development programs and strategies, and financial information, a special section dedicated to cultural tourism has been created, named "Cultural and touristic Oradea". The town hall's website is bilingual, available in Romanian and Hungarian, and is mainly addressed to the local community. In this geographical region, the main minority is the Hungarian one.

The section „Cultural and tourist Oradea" includes pages with information about the history of the city, the Oradea Autumn Festival, Tourism in Oradea and pages devoted to the main monuments of the city: the Fortress, which dates from the 13th century and the Darvas La Roche House (Art Nouveau Museum) built between 1909 and 1912. The selection of an Art Nouveau building (Darvas La Roche House) from among the many monuments and architectural ensembles, which has an extensive description and a photo gallery, indicates the importance of the Art Nouveau movement in the creation and development of the city's identity. Along with the descriptive text and the photo gallery, you will find practical information (visiting times, fares), just like on the pages of tourist guides. Thanks to this section, the town hall can increase the visibility of the town as a heritage tourist destination.

Another important player in promoting the city is APTOR, the Association for the Promotion of Tourism in Oradea and the Region (Visit Oradea), a destination management organization created through a public-private partnership between the city hall, the industrial park, shopping centres and hotels. The organization's website can be consulted in Romanian, English, German and Hungarian so that a larger number of internet users have access to the information they provide.

As for the thematic construction of the site, the Home Page opens with a photo representing the central square of the city and the Black Eagle Palace. At the top left, we find the graphic symbol of the Oradea brand, created in 2019, the Supercrown, "a metaphorical transposition through drawing of the stature, uniqueness and prestige of the city", which refers to the historical past, the Art Nouveau architecture of the city, nature, cults, the multicultural community and inhabitants. Among the first sections of the site is the 'What to see' section, which contains photos of the main monuments and streets with Art Nouveau buildings. By selecting a photo, the visitor is directed to a detailed page dedicated to that monument. They can choose the order in which they consult the information relating to the tourist destinations. Of the 89 Art Nouveau buildings, the Darvas La Roche House is widely described. This museum, along with the Black Eagle Palace, is also mentioned on the "Top 10 Oradea" page and the "Guided Tours" page. The 'What to do' section dedicates one of the pages to excursions and guided tours. The very names of the routes are representative of the importance of museums and monuments for the beauty-loving tourist: "Oradea, Architectural Treasures", "Oradea, Art and Culture", "Oradea, Multicultural City". "The Cultural Oradea" page offers lovers of art, architecture and culture routes through the areas of the old city centre, where most of the heritage buildings are located. The site contains a wealth of practical information, such as restaurant and hotels addresses, making it a true city guide.

The slogan of the city "Art Nouveau – Life Nouveau" and the way the city is named indicate the high degree of subjectivity of the discourse on this site. Oradea is called "the capital of Art Nouveau", "a museum city", "an architectural jewel", "a welcoming, fresh and lively city", "a city of relaxation and health", "a paradise of thermal waters" or "a SlowLivingCity".

Each year (since 2015), APTOR publishes official documents, such as activity reports, on its website. According to the APTOR 2022 report, after the decrease in the number of tourists due to the COVID-19 health crisis, the number of tourists has steadily increased but has not yet reached the pre-crisis level. In general, it is about Romanian tourists. In 2022, only 10,5% of the total tourists were foreign tourists from European countries. According to the same report, the average degree of occupancy rate was 36%, increasing compared to 2021, excluding accommodation rented through platforms such as Booking.com or Airbnb.com. The report presents the projects in which APTOR has been involved and the events organised during the year (31 events in 2022). Moreover,

the city is well known nationally and internationally for the cultural events that take place annually and attract many tourists: the festival celebrating the anniversary of the municipality of Oradea (FestiFall), the international theatre festival (FITO), the music festival (Sounds of Oradea festival), the film festival (Oradea Summer Film), book fairs. According to the APTOR 2022 report, the Art Nouveau Days (June 9-12) were attended by around 4000 persons who appreciated the guided tours, the film screenings, the exhibitions and the concerts.

In addition to its informative and promotional function, this site has what Seoane (2013) calls a "teaching vocation". Like tourist guides, it contains the description of monuments and recommends itineraries, activities, hotels and restaurants. The weight of information on Art Nouveau monuments is greater than that of other information and it is found in almost all sections and pages of this site.

The website of the Foundation for the Protection of Historical Monuments of Bihor County, oradeaheritage.ro, dedicates two of the five sections to the palaces of Oradea and the International Art Nouveau Day. The home page contains colour photos of the most beautiful Art Nouveau buildings. The website has a page layout where photography predominates. The home page has more of a capture function than an informative one. The "Heritage" section devotes a page to each important palace (mostly Art Nouveau palaces), where the presentation text blends harmoniously with the photos. The website is in Romanian and it is not available in other languages. Instead, the first page presents a three-volume album entitled "The Story of the Palaces from Oradea" created in three languages: Romanian, Hungarian and English, which tourists can purchase when visiting the main sights of the city.

In recent years, the city has benefited from promotion at international tourism fairs. In 2023, Visit Oradea was present at the World Tourism Fair in London and the Polish Tourism Fair, aiming to promote Oradea as a "perfect city-break destination", "a first-rate tourist destination" and to attract more foreign tourists. Also, due to the area's natural resources and wellness and spa services, Oradea was promoted at the European Medical Tourism Fair 2023 as a spa tourism destination.

The exceptional architecture of the city, the particularly rich cultural agenda, the local cuisine and numerous spa centers make the city a favorite destination for this part of Europe. The promotional speech of this destination aims to raise the profile of a destination which, although in the second half of the 19th century and the first years of the 20th century experienced strong development, had a long period of stagnation due to the events of the time and after the two world wars.

After the 1990s, cultural tourism became a growing phenomenon, and Oradea aligned itself with this trend. The way in which the discourse about Oradea is constructed on the websites of public and private urban institutions, the efforts to rediscover and revalue the architectural and cultural heritage, the numerous articles dedicated to the city which appeared in the local and national press, the promotion on an international level thanks to tourism fairs, the awareness of the quality and diversity of the tourist offer, all this leads to the creation of an image of a tourist destination that is worth visiting, with a reputation as a cultural city.

The analysis of the thematic construction of the sites described above allowed us to identify discursive strategies staged to create the image of a special tourist destination, to include it among the world reference destinations and to identify the place and role that cultural heritage, especially in the Art Nouveau style, has in shaping this tourist brand.

In short, the Art Nouveau style is:

- a component of the discourse of building the identity of the city of Oradea;
- an element of meaning;
- a symbol of history, art and culture;
- a mark of distinction and authenticity;
- an indication of the exceptional character and how a destination can differentiate itself from others;
- an indication of the quality of tourist and cultural experiences;
- an added value for the notoriety and reputation of the city;
- an image-building strategy for a cultural destination;
- a territorial marketing strategy;
- a favorite theme of the discourse for the promotion of tourism in the city;
- an element of subjectivity, with emotional impact among tourists;
- a brand of the destination.

6. FUTURE RESEARCH DIRECTIONS

The present study has selected websites as a corpus, but discourse analysis offers the possibility to study the most diverse corpora, such as print media, online media, messages on social networks, blogs, television programs, brochures and guides tourism, reviews made by tourists, etc.

It would also be relevant to continue this study on a corpus of websites of European travel agencies to see if this tourist destination is included in the list of tourist offers, what is the importance of the destination in relation to the other European cultural destinations, which rank in the top of the preferences of customers.

Last but not least, the study of tourism discourse can focus on the experiences of tourists visiting the tourist destination of Oradea and their interactions with the local community; the role and involvement of the local community in the preservation of cultural heritage is also important.

7. CONCLUSION

We believe that the perspective of discourse analysis can contribute to the understanding of tourism communication, along with the studies of specialists in economics, management, marketing, and tourism. The analysis of the thematic construction of the discourse on the support of the websites of some public and private bodies showed how an art movement, in this case, the Art Nouveau art movement, can become an element of a city's identity, a marketing tool, a brand of the destination.

Also, given the speed and complexity of changes in society, we cannot help but reflect on the need to protect cultural heritage, to take into account local interests, as well as the challenges that cultural tourism will have to overcome in the future:

"Looking towards the future, the challenge is to develop cultural tourism in a way that is resilient to crises and at the same time contributes to long-term sustainable destinations and heritage protection" (Calvi et al., 2020, p. 35).

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Application of Environmental Indicators of Sustainable Tourism in City Omiš

Slađana Pavlinović Mršić[1]
Andrea Ćosić[2]

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Abstract: *This work elaborates on the applicability of environmental indicators of sustainable tourism CROSTO at the destination of the city Omiš (Croatia). Criteria of availability, reliability, clarity and feasibility were considered. Tourism share in energy consumption, water consumption, waste and wastewater generation, as well as the number of eco-certified firms, were analyzed. Findings suggested that CROSTO indicators are applicable for sustainable destination management in the city Omiš. However, additional efforts are indispensable in order to improve their availability and visibility. Finally, although a certain level of environmental sustainability of tourism activities in the city Omiš was detected, further improvements are required.*

1. INTRODUCTION

Tourism nowadays is a leading economic sector in Croatia, and city Omiš is also aligned with such a trend. The seasonality of tourism activities is pronounced in city Omiš since the most attractive factors are geographical location and natural beauties (sun, sea and sand). Such trends create pressures on natural resources, water supply, electricity and waste management systems. On the other hand, Kružić (2004) points out that such pressures may be diminished by adequate public infrastructure. Additional pressures are formed since tourism activities usually take place within a narrow coastal strip (Vojnović, 2014). Therefore, a careful consideration of its impacts and externalities is needed. For that reason, Kožić and Mikulić (2011) suggest implementing the principles of sustainability in tourism management.

Burtland's commission, „Our Common Future (1987) defines sustainable development as a development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987, paragraph 27). Different authors further operationalized and adapted the initial definition to a specific research context (Drljača, 2012; Smolčić Jurdana, 2003). In this context, Costanza (2020) points out that the influence of natural capital on sustainable human well-being is not straightforward, but it requires interactions with other three types of capital: social, human and built capital.

The World Tourism Organization defines sustainable tourism as "tourism that takes full account of its future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities" (World Tourism Organization, 2005, p. 13 in World Tourism Organization, 2022, p. 15).

In order to support the development of sustainable tourism, the Croatian institute of tourism developed a system of sustainable tourism indicators CROSTO (Croatian Sustainable Tourism

[1] University of Split, Faculty of Economics, Business and Tourism, Cvite Fiskovića 5, 21 000, Split, Croatia
[2] University of Split, Faculty of Economics, Business and Tourism, Cvite Fiskovića 5, 21 000, Split, Croatia

Observatory) based on the relevant UNWTO methodology which provides a set of sustainable tourism indicators further modifiable depending on specific needs (Klarin, 2017).

This research aims to investigate the current relationship between tourism and the environment concerning water and electricity consumption, and waste and wastewater generation by applying CROSTO indicators in city Omiš. Relevant data availability is examined to consider further monitoring of sustainable tourism management in the destination. It is further elaborated if the selected CROSTO indicators are applicable in the city Omiš at all. Finally, the seasonality character of resource use and the application of eco-friendly certification are considered.

The methodology of CROSTO with respect to data collection is applied. Required secondary data were collected and criteria of availability, reliability, predictivity, clarity and measurement feasibility were taken into account. For the matter of tractability, only CROASTO environmental indicators were considered to evaluate the existing scale of tourism impact on the environment in city Omiš. Data of HEP (HEP Group), Vodoopskrba grada Omiša (Water utility company of city Omiš), Turistička zajednica (Tourist Board) and waste management company Peovica were used to construct the following environmental indicators of sustainable tourism:

1. Tourist energy consumption over resident energy consumption (by overnight stay);
2. Water consumption over resident water consumption (by overnight stay);
3. Percentage of wastewater treated by at least second level prior to discharge (by overnight stay);
4. Communal waste generation by tourists over communal waste generation by residents (by overnight stay);
5. The share of tourism enterprises that apply voluntary eco-friendly certification schemes.

The findings of this research will contribute to the knowledge about sustainable tourism management in Croatian coastal tourism destinations at the municipality level.

2. SUSTAINABLE TOURISM

As pointed out by World Tourism Organization (2023) „Tourism can directly or indirectly contribute to all 17 goals of the SDGs“. Tourism is explicitly mentioned in Target 8.9. which refers to sustainable economic growth, Target 12.b on sustainable consumption and production, Target 14.7. on sustainable use of oceans and marine resources (Table 1).

Table 1. Targets of SDG where sustainable tourism is explicitly mentioned

SDG	**8. Inclusive and sustainable economic growth**
Target	8.9. “by 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products”
SDG	12. Sustainable consumption and production
Target	12.b. “develop and implement tools to monitor sustainable development impacts for sustainable tourism which creates jobs, promotes local culture and products”
SDG	The sustainable use of oceans and marine resources
Target	14.7: “by 2030 increase the economic benefits to SIDS and LDCs from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture, and tourism”

Source: World Tourism Organization, 2023

As it is noted, Target 12.b. specifically refers to monitoring sustainable tourism impacts. One of the suggestions is to consider already developed tools of Tourism Satellite Account (TSA)

and the System of Environmental-Economic Accounts, as well as the Statistical Framework for Measuring the Sustainability of Tourism (World Tourism Organization, 2023, p. 207).

Smolčić Judrana (2003, p. 15) lists four spheres of sustainability: environmental, social, economic and technological. Angelevska-Najdevska and Rakicevik (2012, in Mičetić Fabić, 2017, p. 27) list the next sustainability principles: environmental, social, cultural and economic, while Čavlek (2011) lists even eleven of them. Sustainable development implies that three types do not decrease. Environmental sustainability refers to the preservation of natural capital.

Sustainable tourism indicators are discussed in the remaining part of the paper. They can be defined as „empirical, quantitative and qualitative measurements and evaluations used to detect state and represent valuable information for the creation of development plans and decisions related to tourism" (Blažević et al., 2013, p. 148). Črnjar and Črnjar (2009) point out the following good properties of tourism indicators: specific, measurable, usable, flexible, available and effective. Dresner (2008, p. 28) mentions that indicators can follow the logical of the DPSIR framework that there are four groups of indicators related to pressures, state, impact and responses (Črnjar & Črnjar, 2009, p. 105) while Vojnović (2013) develops a set of sustainability indicators customized for the specific research aims which consist of three groups: environmental, economic and social indicators.

European Commission suggests seven steps of sustainable tourism indicators implementation applicable to ETIS (The European Tourism Indicator System, 2016):

1. awareness raising,
2. development of the destination profile,
3. establishment of the stakeholder workgroup,
4. identification of roles and responsibilities,
5. data collection and processing,
6. analysis of results,
7. enabling further development and continuous monitoring.

Table 2. Overview of the basic CROSTO indicators by categories

Category	Indicator
Social	Number of tourist overnights by a hundred residents
	Share of destination residents who are satisfied with tourism
	Share of tourist who are satisfied with their overall experience in a destination
	Percentage of repeated/permanent tourists in a destination
Economic	Number of tourists overnight stay in the destination
	Direct employment in tourism as a share of the total employment
	Percentage annual bruto occupancy of tourist commercial accommodation
	Average daily tourist consumption in Euros
Environmental	Tourist energy consumption over resident energy consumption (by overnight stay)
	Water consumption over resident water consumption (by overnight stay)
	Percentage of wastewater treated by at least second level prior to discharge (by overnight stay)
	Communal waste generation by tourists over communal waste generation by residents (by overnight stay)
	The share of tourism enterprises that apply voluntary eco-friendly certification schemes
Spatial	Share of destination non-construction area occupied by facilities for catering and tourism
	Number of beds in the household per km^2 of the total built-up area of the construction area of the settlement

Source: CROSTO, n.d.

Sustainable tourism indicators proceed from principles presented in Agenda 21 as well as from the work of UNWTO (Mičetić Fabić, 2017, p. 77). CROSTO is a Croatian observatory for sustainable tourism development that developed a manual with sustainable tourism indicators in 2016 which are based on ETIS presented in Table 2.

This work contributes to the previous work by assessing the possibility of implementing CROSTO environmental indicators in city Omiš where July, August and September belong to peak tourist season due to the focus on 3S tourism.

3. APPLICABILITY OF CROSTO ENVIRONMENTAL INDICATORS TO MEASURE TOURISM SUSTAINABILITY IN CITY OMIŠ

This part presents the results of the application of the CROSTO environmental indicators to city Omiš. Data needed for this study were obtained from the following sources: Croatian Bureau of Statistics, Tourist Board of City Omiš, public utility companies, and Croatian financial agency FINA. The following CROSTO environmental indicators were calculated. The monthly data were analyzed for two months: January and August. The monitored values usually reach their minimums in January and maximums in August. The instructions of the CROSTO manual were applied and adjusted to the local level to calculate the intended indicators. The short-run period of measurement would not allow for drawing a conclusion about environmental sustainability in the city Omiš.

3.1. Tourist Energy Consumption over Resident Energy Consumption (By Overnight Stay)

The following data were used:
- Total final energy consumption in MWh in January,
- Total final energy consumption in MWh in August,
- Total number of realized tourist nights in January,
- Total number of realized tourist nights in August,
- Population.

Electricity consumption data were obtained from Croatian public electricity supplier HEP, while the data about tourist overnight stays were obtained from the Tourist Board of City Omiš. Furthermore, only the information about commercial tourist overnight stays was applied due to the unreliability of the datasets about non-commercial accommodation.

Table 3. Tourist energy consumption over resident energy consumption

Tourist energy conspution over resident energy consumption (by overnight stay) = (MWh by tourist overnight stay) / (MWh by resident overnight stay)				
Year	**2019**	**2020**	**2021**	**2022**
GWh by tourist overnight stay	0,0040	0,0042	0,0046	0,0044
GWh by resident overnight stay	0,01587	0,0132	0,0150	0,0144
Energy consumption ratio between tourists and residents	0,25	0,32	0,30	0,3014

Source: Own calculations

Due to the constraints in data collection, the electricity consumption for city Omiš was estimated by applying a rate of 60% (based on the population share) of electricity consumption of the whole distributive area which includes local governmental units Omiš, Dugi Rat, Zadvarje and

Šestanovac. The following formula was applied following the detailed CROSTO methodology for the calculation of the indicators and the results are presented in Table 3.

3.2. Water Consumption over Resident Water Consumption (By Overnight Stay)

Water resources play a very important role in the quality of the tourism supply, but they are under pressure due to climate change, in particular in the sensitive karstic area of the Croatian coast. Apart from significant losses in water supply systems, tourism seasonality represents additional pressure on water supply infrastructure, in particular in small tourist destinations such as Omiš.

Public provider Vodovod d.o.o. supplies Omiš with water from the water source Vrilo and river Cetina. The hinterland area of the city Omiš is supplied by water systems of cities Sinj, Split, Makarska and source Studenac.

The following indicators were used to calculate the relevant indicator:
- Total final water consumption in January,
- Total final water consumption in August,
- Total number of overnight stays in January,
- Total number of overnight stays in August,
- Number of residents.

The following formula was applied following the detailed CROSTO methodology for calculation of the indicators and the results are presented in Table 4.

Table 4. Water consumption over resident water consumption

Water conspution over resident water consumption (by overnight stay) = (Water volume by tourist overnight stay) / (Water volume by resident overnight stay)				
Year	**2019**	**2020**	**2021**	**2022**
Liter by tourist overnight stays	0,42	0,53	0,46	0,44
Liter by resident overnight stays	0,13	0,12	0,14	0,14
Water consumption ratio between tourists and residents	3,10	4,46	3,29	3,08

Source: Own calculations

The calculated indicators demonstrate, except for 2020, that the water consumption of a tourist is 3 times larger than the water consumption of a resident.

3.3. Percentage of Wastewater Treated by at Least Second Level Prior to Discharge (By Overnight Stay)

Wastewater management systems are under high pressure during summer months due to tourism seasonality. This issue is additionally pronounced in destinations with beaches and sea as the main tourist attractions.

The coverage by the water sewage water system in Omiš is only 35%. Part of the reason is also the fact that the part of the space is sparsely populated and thus, the construction of a standard sewage water system is not economically viable. Thus, alternative models of sewage water treatment need to be considered. Public company Vodovod d.o.o. provided the necessary data for the calculation of the corresponding indicators presented in Table 5.

- Untreated water discharge in cubic meters.
- Treated water discharge in cubic meters: first degree, second degree and third degree.
- The share of the population is connected to wastewater purification systems.

Table 5. Percentage of wastewater treated by at least second level prior to discharge

% of waste water treated by at least second level prior to discarge (by overnight stay) = (Water purified to at least 2nd stage in m3) / (Discharged waste water in m3)				
Year	**2019**	**2020**	**2021**	**2022**
Water purified to at least 2nd stage in m3	0	0	0	0
Discharged wastewater in m3	830.000	710.000	770.000	757.000
% of wastewater treated by at least second level prior to discharge (by overnight stay)	0	0	0	0

Source: Own calculations

There are no communal waste water purification systems to at least 2nd degree installed for now in the administrative area of city Omiš, and thus the value of this indicator was zero for the last four years.

3.4. Communal Waste Generation by Tourists over Communal Waste Generation by Residents (By Overnight Stay)

Communal waste management in Omiš is operated by Peovica d.o.o. which provided the following data needed for the calculation of the relevant indicator presented in Table 6:

- total final waste generation in January,
- total final waste generation in August,
- total number of tourist overnight stays in January,
- total number of tourist overnight stays in August,
- population number.

Table 6. Communal waste generation by tourists over communal waste generation by residents

Communal waste generation by tourists over communal waste generation by residents = (Kg of waste by tourist overnight stay) / (Kg of waste by onvernight stay of resident)				
Year	**2019**	**2020**	**2021**	**2022**
Kg by tourist overnight stays	1,40	1,21	1,34	1,16
Kg by resident overnight stays	0,90	0,91	0,72	0,75
Communal waste generation by tourists over communal waste generation by residents	1,55	1,33	1,86	1,56

Source: Own calculations

Previous analysis indicated that waste generated by tourists during an overnight stay is about 50% larger than waste generated by residents during an overnight stay.

3.5. The Share of Tourism Enterprises That Apply Voluntary Eco-Friendly Certification Schemes

Environmentally friendly certification schemes are designed to enable differentiation of producers or service providers who apply practices in their operations that are not harmful to the environment. Such schemes are developed for various economic activities: agriculture, manufacturing, tourism services, etc. Apart from environmental concerns, also other aspects of sustainability are considered within those schemes. A widely applied environmentally friendly

certification scheme is EU Ecolabel. However, other certification schemes are also relevant in the context of sustainable tourism development in Croatia such as Travelife, Green Key, Eco-Camping, Dalmatia Green and Biosphere Sustainable, etc.

The share of tourism enterprises that apply voluntary eco-friendly certification schemes was calculated by dividing the number of enterprises that apply voluntary certification schemes or environmentally friendly labeling by the total number of tourist enterprises. Due to the lack of official statistics on environmentally friendly certified enterprises in Omiš, only the anecdotal presentation was possible. The total number of firms acting in the sector of accommodation was 55 in Omiš, while there were 41 firms registered as main activity for tourism agency services and reservations (FINA, 2023).

According to anecdotal information, a few tourism services providers applied some type of environmentally friendly certification schemes. Dalmatia Green, a certificate issued by the Association for nature, environment and sustainable development Sunce for small tourist accommodations that apply principles of sustainability, is possessed by three accommodation units: Villa Carica in Mimice, and Apartman Petea and Boutique hotel Villa Dvor in Omiš (Dalmatia Green, n.d.). Hotel Villa Dvor also obtained a Travelife certificate for accommodation.

However, the implementation of systematic monitoring and overview of enterprises that apply voluntary certification schemes or environmentally friendly labeling is required in order to reliably determine their share in the total number of firms related to tourism. Also, as an initial step, it would be necessary to develop procedures for the identification of tourism enterprises. Additionally, as could be noted above, the eco-friendly certificate Dalmatia Green is assigned to accommodation units including family-run apartments which are not included in the official statistics of crafts or firms. Thus, as one of the initial steps, a careful approach to date framing needs to be designed.

Also, the information presented on eco-certified tourism activities in the destination is anecdotal. Instead, firstly, it would be necessary to identify and list potential certification schemes. The next step would involve collection of the official information from the certification bodies about a precise number of firms in city Omiš that possess those certificates at a given moment. Namely, issued certificates are usually valid until specific dates and they are not unlimited. Thus, certificated tourism units may vary from year to year.

To conclude, the information needed for this indicator seems the most heterogeneous and the least standardized. The existing global efforts in sustainable tourism development might suggest that more standardized and globally harmonized approaches might be proposed in the future supporting further methodological development of the relevant indicator.

4. DISCUSSION

The analysis of collected data indicates that the basic environmental CROSTO indicators are generally implementable in city Omiš since public utility companies in general collect row data which serve as input for the investigated indicators. Limitations were observed concerning the indicator measuring the share of tourism enterprises that apply voluntary eco-friendly certification schemes. Namely, the data collection framework should be further elaborated, firstly in order to provide an adequate definition of the business entities operating in the tourism sector,

and secondly, in order to systematically monitor relevant eco-friendly certification schemes relevant for tourism.

Thus, the existing information database would represent a satisfactory basis for further monitoring of sustainable tourism in city Omiš based on CROSTO indicators. Considerable seasonality in water consumption is observed between January and August. It can be discussed which is the contribution of tourism in the water consumption peaks during the summer. Namely, additional water demand for farming can also contribute to the detected disparities.

While tourists spend about 3 times more water than residents, the main consumers of electric energy were residents according to CROSTO indicators which is interpreted by the dominance of beach tourism which does not require a significant consumption of electric energy. The waste production of tourists is half above the quantity of waste produced by residents.

Application of eco-friendly certification and labels by tourism firms is very low with an exceptional case of Hotel Villa Dvor. On the other hand, the global trends on sustainable business practices (for example CSRD and the EU taxonomy) might as well shift the practices of tourism enterprises operating in the city Omiš. Finally, in line with the new sustainability reporting frameworks for businesses, it may be questioned if the existing indicator can be complemented by additional indicators showing the sustainability practices of tourism enterprises in city Omiš.

This paper adds to the existing knowledge on the application of sustainable tourism indicators at the municipal level. Marinello et al. (2023, p. 10) conducted a systematic literature review and found that only one study of sustainable tourism indicators refers to the municipal level. Those authors also point out that despite a very rich literature on sustainable tourism indicators there is a limited comparability of the results obtained. McLoughlin et al. (2020) applied an ETIS questionnaire to assess the state of tourism in County Clare, Ireland. They find that there is a need for additional improvement of environmental indicators of sustainable tourism.

5. CONCLUSION

The application of sustainable principles in the management of tourism destinations has been considerably advanced since the initial definition of sustainable development in 1987. The methodology for monitoring sustainability in tourism destinations has been considerably advanced in the last decades resulting in systems of indicators related to various dimensions of sustainability. City Omiš is an example of a destination whose strengths rest on natural beauties and preserved local traditions. This paper examined if the environmental CROSTO indicators can be applied in such a case.

This research confirms that there is an appropriate information basis for the calculation of the indicators which indicate that tourists in Omiš contribute considerably more to water consumption and generation of communal waste. The waste water treatment indicator was zero suggesting that Omiš might consider the implementation of waste water purification systems. Also, the data tourism enterprises that apply eco-friendly certification schemes were limited suggesting that further advancement in this area is needed.

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Unearthing the Potential: Energy Metals as Hedging Assets in Portfolio Rebalancing Strategies

Rui Dias[1]
Mariana Chambino[2]
Paulo Alexandre[3]

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Abstract: *This article analyzes energy metals, specifically Aluminum (MAL3), nickel futures (NICKELc1), and copper futures (HGU3), concerning 3 clean energy indexes: the S&P Global Clean Energy Index (SPGTCLEN), the Nasdaq Clean Edge Green Energy (CEXX), and the WilderHill Clean Energy Index (ECO). It focuses on a significant period during which investments in clean energy increased significantly, with capital allocations tripling from the previous decade. The study's findings are of great significance, given the recent surge in clean energy investments. As the world increasingly embraces cleaner energy sources, understanding how these assets relate to clean energy indexes becomes crucial for investors navigating this dynamic landscape. Moreover, the study's relevance is underscored by recurring market uncertainty, making it a valuable resource for investors seeking to make informed decisions and manage portfolio risks in an era marked by economic uncertainty, policy shifts, and environmental concerns. This work contributes to academic discourse and has practical implications for financial markets.*

1. INTRODUCTION

The acknowledgment of climate change as a worldwide concern has resulted in substantial transformations in energy and investment practices. This encompasses the implementation of regulations that prioritize clean energy, increased allocation of resources towards clean technology, the expansion of the clean energy industry, and heightened attention from the financial market. Investors are actively seeking sustainable alternatives and divesting from fossil fuels due to apprehensions about their long-term viability. The economic competitiveness of clean energy has increased, leading to the emergence of specialized investment vehicles and the potential for favorable financial returns. This trend lines up with the worldwide shift towards more sustainable energy sources in response to the challenge of climate change (Dias et al., 2023, 2023a, 2023b).

The expansion of the clean energy sector has resulted in an increasing need for crucial raw materials utilized in the production of clean energy solutions. The demand for certain commodities, particularly metals, is very high as a result of the extensive implementation of sustainable energy technology. As a result, it is anticipated that there will be notable alterations in the prices and market dynamics of these energy metals, hence impacting their association with the clean energy markets. Investors with substantial financial resources are keen on comprehending the relationship between clean energy companies and energy metals. Understanding this information is essential for effectively diversifying risks within the clean energy asset class, which is known for its volatility. This comprehension not only confers advantages to investors but also holds considerable importance for policymakers. The development of suitable covering strategies to manage risks stemming from unpredictable commodities

[1] Polytechnic Institute of Setúbal, ESCE, Portugal
[2] Polytechnic Institute of Setúbal, ESCE, Portugal
[3] Polytechnic Institute of Setúbal, ESCE, Portugal

markets is crucial to guaranteeing the stability of clean energy initiatives within a broader context (Ahmad et al., 2018; Asl et al., 2021).

In this manuscript, we will look at how the covering characteristics of energy metals assets like Aluminum (MAL3), nickel futures (NICKELc1), and copper futures (HGU3) relate to three clean energy indexes: the S&P Global Clean Energy Index (SPGTCLEN), the Nasdaq Clean Edge Green Energy Index (CEXX), and the WilderHill Clear Energy Index (ECO). The findings indicate that energy metals exhibited enhanced coverage attributes across the 2020 and 2022 occurrences. Consequently, it can be deduced that metals have the potential to provide a more favorable hedge opportunity for clean energy indexes such as SPGTCLEN, ECO, and CEXX.

In our perspective and based on the reviewed literature, there has been a lack of comprehensive investigation of coverage strategies for investors that possess assets in clean energy markets. The current body of research has overlooked the efficacy of energy metal coverage and the associated risks of portfolios that adopt clean energy assets. While there exists an increasing body of literature pertaining to material flows, supply limitations, and the significance of metals in the context of energy transition, limited research has delved extensively into the connection between clean energy assets and metals. Furthermore, it is worth noting that these studies often overlook the significance of energy metals and clean energy markets, despite the considerable reliance on metals as crucial components in clean energy technology.

The subsequent components of the study are divided into 4 distinct parts. Section 2 of this study delves into an analysis of the current body of literature on clean energy stocks. Additionally, it explores the properties of metals as both a means of hedging and a safe haven. Furthermore, it investigates the link between clean energy stocks and metals. In Section 3, the data and methodology are described. Section 4 provides a comprehensive presentation and analysis of the obtained results. Lastly, Section 5 concludes.

2. LITERATURE REVIEW

Green investors express apprehension regarding the adverse environmental consequences associated with the utilization of dirty energy sources and seek to harmonize their investment decisions with objectives about long-term ecological viability. In this study, the focus is on analyzing the performance of stock indexes related to clean and dirty energy. Clean energy indexes typically include renewable and sustainable technology companies, while dirty energy indexes encompass fossil-fuel corporations that are known to contribute to environmental damage. This study facilitates educated financial decision-making for investors, enables anticipation of regulatory changes, and helps the exploitation of emerging opportunities within the energy markets. Investors can evaluate the environmental impact of their investments through the assessment of financial performance, regulatory scenarios, and the challenges of the energy transition (Dias et al., 2023, 2023a, 2023b; Santana et al., 2023).

Numerous academic studies have examined the connections between clean energy indexes and dirty energy stock indexes, as well as how these relationships interact with oil prices and other pertinent factors, including those by Bondia et al. (2016), Vrînceanu et al. (2020), Asl et al. (2021), and Kanamura (2022). In their study, Bondia et al. (2016) investigated the enduring association between stock prices of alternative energy and oil prices. They employed threshold co-integration tests to analyze the data and observed a lack of sustained disturbances between the prices of alternative

energy reserves. According to the findings of Vrînceanu et al. (2020), there is a limited association between oil markets and renewable energy markets. This suggests that fluctuations in oil prices have a relatively minor impact on the growth and progress of the renewable energy sector. The study conducted by Asl et al. (2021) examined the transmission of volatility across different energy and commodity indexes. The findings indicated that SPGCE and SPGO shares exhibited the highest average ideal weight and hedge effectiveness. This suggests that the positive performance of SPGSE counterbalances the negative performance of SPGO. In their study, Kanamura (2022) conducted an analysis to examine the correlations existing between several energy-related stock indexes and energy prices. The findings of the study indicated significant positive correlations between clean energy indexes, specifically the GCE and ECO, and the prices of WTI crude oil and natural gas. These interactions were deemed reasonable, as the rising trend of energy prices has a positive impact on the market value of renewable energy firms engaged in the sale of power through spot markets.

The authors, Farid et al. (2023), Dias, Teixeira, et al. (2023), and Dias, Alexandre, et al. (2023) recently investigated the relationships between clean energy stock indexes and assets classified as dirty energy. During the COVID-19 pandemic, Farid et al. (2023) investigated the co-movements of clean and dirty energy indexes. They discovered short-term weak linkages between clean and dirty energy stocks, as well as a few instances of high long-term co-movements. Dias, Teixeira, et al. (2023) evaluated movements between clean and dirty energy markets and discovered significant shocks between the energy indexes studied, calling the portfolio diversification concept into question. Dias, Alexandre, et al. (2023) investigated if the greater correlation caused by events in 2020 and 2022 resulted in volatility repercussions between clean energy indexes and dirty cryptocurrencies. Their findings suggested that clean energy stock indexes could serve as a potential safe haven for dirty energy cryptocurrencies, although associations differed depending on the cryptocurrency.

In summary, these studies contribute to the comprehension of the complex relationships between clean and dirty energy stock indexes, oil prices, and various other aspects. They offer valuable insights into diversification strategies and shed light on the influence of energy prices on renewable energy markets.

3. DATA AND METHODOLOGY

3.1. Data

The rationale behind including energy metals, namely Aluminum, copper, and nickel, lies in their status as widely traded commodities with transparent price processes. Moreover, the anticipated impact in the pursuit of sustainable energy solutions has substantial importance in rationalizing the incorporation of these metallic elements into the research. Aluminum, copper, and nickel play crucial roles as essential constituents in a diverse range of sustainable energy technologies, including electric vehicles (EVs), wind turbines, solar panels, and energy storage equipment.

The study used data spanning from July 13, 2018, through July 11, 2023, which was obtained from the Thomson Reuters Eikon database. To maintain consistency in comparing various assets and indexes, the study employs US dollars as the currency for all cited values, thereby mitigating the impact of currency fluctuations. The sample was partitioned into two distinct subperiods. The initial subperiod, referred to as "Tranquil," encompasses the time span from July 2018 to December 2019. The subsequent subperiod, denoted as "Stress," covers the years from

January 2020 to July 2023, during which significant events such as COVID-19 and the Russian invasion of Ukraine in 2022 occurred.

Table 1. Energy metals and Clean Energy Stock Indexes used in the manuscript

Indexes		Characteristics
WilderHill Clean Energy	ECO	This is a stock market index that tracks the performance of clean energy companies in the US. ECO was designed to provide investors with a benchmark to measure the performance of clean energy-related stocks in.
S&P Global Clean Energy	SPGTCLEN	This financial market index tracks the performance of global clean energy companies. This index from S&P Dow Jones Indexes reflects the world economy's rising reliance on clean and renewable energy.
Nasdaq Clean Edge Green Energy	CEXX	is a stock market index for clean energy and green technology companies. This index provides investors with insight into the financial performance of companies leading the clean energy transition.
Aluminum	MAL3	Aluminum is a metal used for a range of industrial and consumer applications, but its primary market commercialization occurs through futures and options in the primary material markets.
Nickel Futures	NICKELc1	Nickel is a metal used in a variety of industrial applications, including the manufacture of stainless steel and batteries, and its price is influenced by a range of factors, including industrial demand, supply, and global demand.
Copper Futures	HGU3	Copper futures are traded on commodity markets and have distinctive symbols like "HGU3." The symbol "HG" represents copper, while "U3" represents the month and year in which the futures contract expires. In this case, "U3" could represent a copper futures contract with a maturity date of September 2023, but it is critical to double-check the maturity date because these contracts have various maturities during the year.

Source: Own elaboration

3.2. Methodology

The present study is conducted in multiple phases. We will use core descriptive statistics and the Jarque and Bera (1980) adherence test to describe the sample in the first step. This test is based on the idea that the data is normally distributed. To assess the validity of the assumption of stationarity in the time series, we will employ a summary table with Breitung (2000), Levin et al. (2002), and Im et al. (2003). Additionally, to validate the results, we will use the tests of Dickey and Fuller (1981) and Perron and Phillips (1988) with the Fisher Chi-square transformation and Choi (2001). The test statistic in question conforms to a chi-square distribution, and its significance level is employed to ascertain the existence of a unit root. In contrast, the Choi Z-stat version of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests presents an alternate methodology wherein the test statistics are obtained using the maximum likelihood estimation of the autoregressive model. To answer the research question, specifically the assessment of energy metals as hedge assets for clean energy stock indexes during the periods of 2020 and 2022, we will employ the ρDCCA estimation method proposed by Zebende (2011). This approach will enable us to quantitatively measure the degree of cross-correlation between energy metal and clean energy share indexes. The coefficient of Detrended Cross-Correlation analysis (DCCA) has a range of $-1 \leq \rho DCCA \leq 1$. In this context, a value of 1 indicates a state of perfect cross-correlation between the two signs, while a value of -1 signifies perfect anti-cross-correlation. A value of 0 denotes the absence of correlation between the time series. To enhance comprehension of the econophysical model in question, we recommend consulting the scholarly works authored by Zebende et al. (2022), Guedes et al. (2022), and Santana et al. (2023).

4. RESULTS

Figure 1 shows the evolution, in returns, of energy metals such as Aluminum (MAL3), nickel futures (NICKELc1), copper futures (HGU3), and clean energy stock indexes such as the S&P Global Clean Energy Index (SPGTCLEN), NASDAQ Clean Edge Green Energy (CEXX), and WilderHill Clean Energy Index (ECO) from February 16, 2018, to February 15, 2023. The examination of the indexes under discussion provides a clear and convincing indication of these markets' major fundamental disturbances. These disruptions, which became apparent in the first months of 2020, coincided with the onset of the first wave of the COVID-19 pandemic and the ensuing oil price war between Russia and Saudi Arabia. Furthermore, 2022 saw significant fluctuations in the time series, indicating new structural breakdowns. The Russian invasion of Ukraine and subsequent concerns about the resultant inflation fueled this particular volatility. For international financial markets, the authors Dias, Horta and Chambino (2023), Dias et al. (2023), Chambino et al. (2023), and Dias et al. (2023a) corroborate these findings.

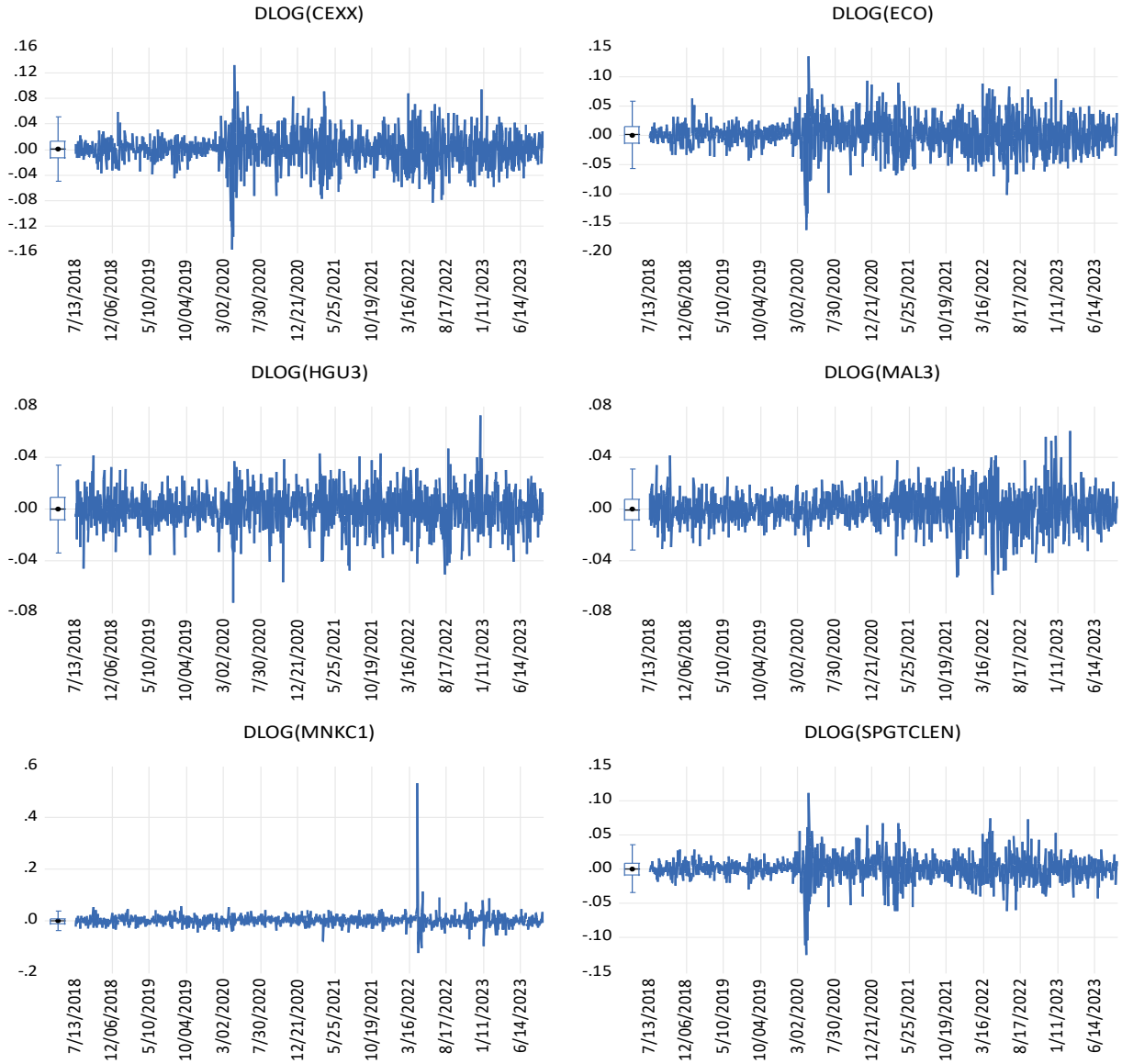

Figure 1. Evolution, in returns, of the financial markets under review, in the period from July 13, 2018, to July 11

Source: Own research

Table 2 shows a summary of the main descriptive statistics for the returns of different time series, namely Aluminum (MAL3), Nickel Futures (NICKELc1), Copper Futures (HGU3), S&P Global Clean Energy Index (SPGTCLEN), NASDAQ Clean Edge Green Energy (CEXX), and WilderHill Clean Energy Index (ECO). The period covered in this analysis spans from February 16, 2018, to February 15, 2023. When examining the mean return, it becomes evident that the financial markets exhibit positive values. However, when considering the standard deviation, it becomes apparent that the ECO stock index demonstrates the greatest value (0.027667), indicating a greater level of dispersion in contrast to the average. To determine if we were dealing with a normal distribution, we assessed the skewness and kurtosis. We observed that the skewness values deviated from zero, indicating asymmetry, while the kurtosis values deviated from 3, indicating non-normality. To establish validity, we conducted the Jarque and Bera (1980) and observed that the null hypothesis $H_0$was rejected at a significance level of 1%.

Table 2. Table overview of descriptive statistics in returns for the markets under consideration from July 13, 2018, to July 11, 2023

	CEXX	ECO	HGU3	MAL3	MNKC1	SPGTCLEN
Mean	0.000818	0.000412	0.000242	5.46E-05	0.000491	0.000639
Std. Dev.	0.025233	0.027667	0.014330	0.013571	0.024283	0.018158
Skewness	-0.344916	-0.303020	-0.182271	-0.042690	8.135917	-0.439446
Kurtosis	6.583154	5.930867	4.602964	5.078401	185.9311	9.671195
Jarque-Bera	699.0304	470.2566	141.8751	227.1697	1770749.	2377.058
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1260	1260	1260	1260	1260	1260

Source: Own elaboration

To assess the validity of the assumptions of stationarity in the time series, we conducted panel unit root tests. Specifically, we applied the Breitung (2000), Levin et al. (2002), and Im et al. (2003) tests. Additionally, we validated the results using the Dickey and Fuller (1981) and Phillips and Perron (1988) tests with a Fisher Chi-square transformation. The time series used for these tests included the price index of Aluminum (MAL3), nickel futures (NICKELc1), copper futures (HGU3), the S&P Global Clean Energy Index (SPGTCLEN), NASDAQ Clean Edge Green Energy (CEXX), and the WilderHill Clean Energy Index (ECO). To ensure stationarity, the original data is transformed into first-order logarithmic differences. Stationarity is then confirmed by rejecting the null hypothesis (H_0) at a significance level of 1%, as indicated in Table 3.

Table 3. Summary table of unit root tests, in returns, for the markets under review, in the period from July 13, 2018, to July 11, 2023.

Group unit root test: Summary				
Method	**Statistic**	**Prob****	**Cross-sections**	**Obs**
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-144.615	0.0000	6	7545
Breitung t-stat	-69.4811	0.0000	6	7539
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-93.5172	0.0000	6	7545
ADF - Fisher Chi-square	1580.34	0.0000	6	7545
PP - Fisher Chi-square	1580.34	0.0000	6	7548

Notes: **Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Source: Own elaboration

Table 4 presents the Detrend Cross-Correlation Coefficient (ρDCCA) values for different price indexes, namely Aluminium (MAL3), Nickel Futures (NICKELc1), Copper Futures (HGU3), S&P Global Clean Energy Index (SPGTCLEN), NASDAQ Clean Edge Green Energy (CEXX), and WilderHill Clean Energy Index (ECO). The data covers the period from July 13, 2018, to July 11, 2023. Concerning the Tranquil period, it is observed that Aluminum (MAL3) has hedging properties in relation to the SPGTCLEN index. However, when considering the clean energy indexes ECO and CEXX, the hedging characteristics of Aluminum are found to be relatively weak. Regarding Copper Futures (HGU3), it was seen that it lacks the attributes necessary to align with the clean energy stock indexes. Conversely, Nickel Futures (NICKELc1) were discovered to serve as a suitable asset for all the 3 stock indexes under consideration (ECO, SPGTCLEN, and CEXX). During the stress period, there is a notable alteration in the coverage properties of energy metals about energy indexes. Specifically, Aluminum (MAL3), nickel futures (NICKELc1), and copper futures (HGU3) exhibit coverage asset characteristics for the clean energy equity indexes ECO, SPGTCLEN, and CEXX. The findings of this study hold significant implications for portfolio diversification and risk management strategies employed by investors in clean energy markets. They underscore the importance of meticulous evaluation of asset selection and market conditions.

Table 4. Summary of the ρDCCA coefficients, relating to the markets under analysis, in the Tranquil and Stress subperiods

Indexes	Tranquil			Stress		
	ρDCCA	Period (days)	Trend	*ρDCCA*	Period (days)	Trend
MAL3 | HGU3	0.41	n > 16	medium	0.60	n > 13	weak
MAL3 | MNKc1	0.27	n > 7	weak	0.44	n > 136	weak
MAL3 | ECO	0.37	n > 76	medium	0.19	n > 11	weak
MAL3 | SPGTCLEN	0.21	n > 11	weak	0.20	n > 16	weak
MAL3 | CEXX	0.35	n > 76	medium	0.17	n > 9	weak
HGU3 | MNKc1	0.36	n > 13	medium	0.15	n > 6	weak
HGU3 | ECO	0.50	n > 63	medium	0.27	n > 9	weak
HGU3 | SPGTCLEN	0.44	n > 35	medium	0.29	n > 9	weak
HGU3 | CEXX	0.57	n > 76	weak	0.30	n > 9	weak
MNKc1 | ECO	0.10	n > 10	weak	0.06	n > 6	weak
MNKc1 | SPGTCLEN	0.20	n > 9	weak	0.21	n > 52	weak
MNKc1 | CEXX	0.10	n > 11	weak	0.09	n > 43	weak
ECO | SPGTCLEN	0.79	n > 9	strong	0.88	n > 13	strong
ECO | CEXX	0.92	n > 6	strong	0.96	n > 6	strong
SPGTCLEN | CEXX	0.73	n > 9	strong	0.87	n > 6	strong

Note: Data collected by the author (Zebende Algorithm).

Source: Own elaboration

5. CONCLUSION

This study examined the potential of energy metals, specifically Aluminum (MAL3), nickel futures (NICKELc1), and copper futures (HGU3), to act as hedge assets during both tranquil and stressful periods. The analysis focused on their relationship with 3 clean energy indexes: the S&P Global Clean Energy Index (SPGTCLEN), Nasdaq Clean Edge Green Energy (CEXX), and WilderHill Clean Energy Index (ECO). The investigation spanned from 13 July 2018 to 11 July 2023. The findings indicate that energy metals exhibited enhanced coverage attributes in the periods of 2020 and 2022. Consequently, it can be deduced that metals may present a more favorable chance for hedging in clean energy indexes such as SPGTCLEN, ECO, and CEXX. Nevertheless, it is crucial to acknowledge that these findings are limited in their applicability to the conducted research and the analyzed period. Additional examination and the inclusion of other variables may be required in order to substantiate and extrapolate these results.

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Strength in Transition: Resilience of Sustainable Energy vs. Fossil Energy

Rui Dias[1]
Mariana Chambino[2]
Paulo Alexandre[3]

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Dirty energy;
Dependency

Abstract: *Promoting clean energy sources necessitates global cooperation through cross-border collaboration, knowledge sharing, and resource allocation. A global imperative exists to transition towards a cleaner, sustainable energy mix to combat climate change and maintain environmental equilibrium. This study assesses the influence of fossil energy prices (Brent Crude Spot, WTI, FTSE 350 Oil, Gas & Coal, EURO STOXX Oil & Gas) on sustainable energy prices (Geothermal Index, Solar Energy Index, NASDAQ OMX Bio Clean Fuels Index, Wind Energy Index, WilderHill Clean Energy Index) in both stable and turbulent market conditions. This study suggests that sustainability and innovation in green energy significantly impact fossil fuel-related indexes. During challenging periods, sustainable energy markets gain prominence, while "dirty" energy indexes exhibit varying degrees of influence. Remarkably, the WilderHill Clean Energy Index plays a central role in shaping both fossil fuel and sustainable energy indexes. These findings underscore the growing trend towards greener and more sustainable investments, emphasizing sustainability's substantial sway over financial markets.*

1. INTRODUCTION

Concerns about oil shortages and climate change are driving tremendous growth in the renewable energy industry. Government support is increasing demand for experienced expertise in the design, installation, and maintenance of renewable energy systems (Duraiappah, 2018). Clean energy innovation can bring about significant social and economic developments, such as job creation in local communities and economic growth in underserved areas, in addition to environmental advantages. As a result, those engaging in clean energy initiatives, whether entrepreneurs or inventors, must emphasize not only profit but also the promotion of beneficial social change (Dias, Alexandre, et al., 2023; Dias, Horta, et al., 2023; Dias, Teixeira, et al., 2023).

This study adds to the existing literature in a variety of ways. For starters, it goes beyond the earlier study, which focused on the relationship between crude oil markets and sustainable energy. Unlike prior assessments, this one considers the interactions between renewable energy sources and other fossil fuels such as natural gas and diesel. This study looks at how dirty and clean energy markets interact. It employs a broader data set, including numerous fossil fuel markets, namely Brent Crude Spot (BRENT) WTI, FTSE 350 Oil, Gas & Coal (FTSE 350 OG & Coal, and EURO STOXX Oil & Gas (SXEP); and specific sustainable energy subsectors: Geothermal Index (GRNGEO), Solar Energy Index, NASDAQ OMX Bio Clean Fuels (GRNBIO), Wind Energy, and WilderHill Index (ECO). Second, this study is groundbreaking in its examination of how important events in 2020 and 2022 influenced structural dynamics and linkages across dirty and clean energy markets. Although earlier studies have investigated the impact of the 2020 pandemic on energy prices and

[1] Polytechnic Institute of Setúbal, ESCE, Portugal
[2] Polytechnic Institute of Setúbal, ESCE, Portugal
[3] Polytechnic Institute of Setúbal, ESCE, Portugal

market indexes, there is still much to learn about how these events influence energy price formation as well as the impact of fossil fuel costs on sustainable energy prices. Third, this study is notable for using a time-frequency perspective to strengthen the interconnectedness of dirty and clean energy markets. The data collection is separated into two distinct subperiods: "Tranquil", which spans the period from May 17 to December 31, 2019, and "Stress", which spans the period from January 1, 2020, to April 28, 2023, and includes occurrences from 2020 and 2022. This method enables a dynamic investigation of the changing link between clean and dirty energy markets, capturing changes in market dynamics and correlations over time and thus providing significant value to research.

The manuscript is organized as follows: in Section 2, we discuss the relevant literature. Section 3 presents the data in detail and describes the econometric methodologies used in the study. Section 4 illustrates the empirical findings and related discussion. Section 5 presents the study's primary findings as well as future directions.

2. LITERATURE REVIEW

In recent years, there has been a surge of interest in the fields of innovation and sustainability, with a changing narrative centered on determining the price movements of conventional and sustainable energy sources. This exploitation has gained momentum in recent years, fueled in part by key events like the global COVID-19 pandemic in 2020 and the turmoil in energy markets caused by Russia's invasion of Ukraine in 2022.

The importance of renewable energy options in addressing energy and climate concerns has been emphasized. However, the traditional prices of fossil fuels continue to influence renewable energy progress. It is consequently critical to strengthen the synergies between these opposing energy paradigms. This study is a critical component in propelling renewable energy forward, ultimately leading to the achievement of sustainable energy targets.

Several studies have explored the relationships between energy markets, renewable energies, and economic variables in terms of sustainability. According to Vrînceanu et al. (2020), there is no strong link between oil markets and renewable energy markets, implying that oil price shocks have less impact on the development of renewable energy companies. Ren and Lucey (2021), on the other hand, investigated the association between clean energy stock indexes and cryptocurrencies based on their energy consumption levels. The authors discovered that in times of uncertainty, clean energy tended to function as a safe haven for "dirty" cryptocurrencies rather than "clean" crypto. He et al. (2021) explored how changes in oil prices, gold prices, and financial stress affect clean energy returns in the US and European economies. Long-term results show that financial stress has a major detrimental impact on US and European clean energy stock indexes in less optimistic market conditions. Furthermore, gold prices have a negative impact on clean energy stocks in Europe when the market is up and in the US under varied market conditions. In addition, during the COVID-19 epidemic, Ghabri et al. (2021) investigated the influence of fossil energy market shocks on clean energy stock indexes. Following the collapse of crude oil prices, they detected major shocks in clean energy. However, the proclamation of COVID-19 as a global pandemic caused natural gas and renewable energy prices to rise after initially falling.

Hoque and Batabyal (2022), Attarzadeh and Balcilar (2022), and Shakhabiddinovich et al. (2022) provide insights into the behavior of carbon futures, clean energy stocks, and their relationships with market conditions and political uncertainties. According to Hoque and Batabyal (2022), carbon

futures provide a strong safe haven based on market conditions and levels of uncertainty, whereas clean energy equities provide limited covering capacity and a robust haven during high market phases. In addition, the authors Attarzadeh and Balcilar (2022) investigate the effects of volatility on the renewable energy, oil, and technology stock markets over 16 years, highlighting the two-way effects of volatility on the oil and clean energy markets, with the oil market absorbing the majority of the volatility. Shakhabiddinovich et al. (2022) contribute to a better understanding of renewable and clean energy shocks and their impact on green economy stock prices. Their study, which spans the years December 2010 to July 2021, highlights the prevalence of negative shocks in renewable and clean energy production as well as the nuanced relationship between renewable production prices and green economy share prices, which can be both positive and negative.

In more recent studies, Farid et al. (2023) examined a variety of energy sources, including crude oil, heating oil, diesel, gasoline, natural gas, and clean energy represented by indexes. Their analyses revealed a few shocks between clean energy stocks and dirty energy indexes, highlighting a significant distinction between both markets. This discrepancy was prominent during the pandemic, emphasizing the benefits of diversifying investment portfolios in the clean and dirty energy markets. Furthermore, Lu et al. (2023) investigated the interplay between profitability and volatility in green financial markets, including green bonds, clean energy, and socially responsible acts, with a particular focus on the influence of the COVID-19 pandemic. The authors identified specific indexes as net transmitters of volatility effects. This research provides useful insights for both investors and regulators, boosting understanding of the mechanics of sustainable financial markets.

It became obvious in the recent years of 2020 and 2022 that it is critical to focus on the relationship between clean and dirty energy share indexes in the context of sustainable energy and innovation. According to studies, the short-term connections between these energy categories are minimal, but significant changes emerge over longer periods. Furthermore, disturbances in fossil energy markets can have a considerable impact on clean energy stock indexes, emphasizing the significance of understanding these linkages. In short, recognizing that there is a link between clean and dirty energy is critical for improving renewable energy solutions and reaching sustainable energy goals. In the face of global concerns such as climate change and pandemics, this becomes critical since it directs the creation of new sustainable energy and resilience solutions in an ever-changing global setting.

3. DATA AND METHODOLOGY

3.1. Data

The daily price indexes have been used in this study. The sample includes 4 dirty energy indexes (fossil fuels): Brent Crude Spot (BRENT) WTI, FTSE 350 Oil, Gas & Coal (FTSE 350 OG & Coal, and EURO STOXX Oil & Gas (SXEP), as well as 4 sustainable energy subsectors: Geothermal Index (GRNGEO), Solar Energy Index, NASDAQ OMX Bio Clean Fuels (GRNBIO), Wind Energy Index, and WilderHill Index (ECO). Examine the subsectors of sustainable energy that have significant importance from the point of view of sustainability and innovation. These subsectors collectively represent the diverse scenario of sustainable energy solutions, and their research contributes to several critical aspects, including innovation catalysts, diversification, resource optimization, market insights, environmental impact, policy alignment, and technological convergence. The period under consideration ranges from May 17, 2018, to April 28, 2023. To increase the robustness of

the results, the sample was divided into two subperiods: a quiet period of apparent stability in international financial markets, which lasted from May 2018 to December 2019. The stress period runs from January 2020 to April 2023, and it includes high-complexity events in the global economy, such as the global pandemic of COVID-19, followed by an oil price war between OPEC members (Russia and Saudi Arabia) and, starting in 2022, an armed conflict between Russia and Ukraine. The data obtained via the Thomson Reuters Eikon platform is in US dollars.

3.2. Methodology

The research will be conducted in multiple stages. In the first stage of sample characterization, descriptive statistical metrics are used. Additionally, the Jarque and Bera (1980) adherence test is conducted to assess the normality of the data based on the null hypothesis. To assess the stationarity of the time series, particularly with regard to its adherence to a white noise process characterized by a mean of 0 and constant variance, panel unit-root tests are employed. The tests employed in this study consist of the Dickey and Fuller (1981) method, which incorporates Fisher's Qui-square transformation, as well as Choi (2001) unit root tests. Both tests assume the null hypothesis of a unit root. To validate the evidence, we employ the Hadri (2000) test, which tests the null hypothesis of stationarity. The convergence of these tests enhances the reliability of the determination concerning the stationarity of the time series. The Augmented Dickey-Fuller (ADF) test is a commonly used method in the examination of financial time series. It encompasses different versions, including the ADF Fisher Qui-Square test and the ADF Choi Z-stat test. The first strategy used test statistics that were derived from the discrepancy between the estimated coefficients and the hypothetical coefficients in the regression model. On the other hand, the second approach employed an alternate methodology by utilizing estimates of maximal verisimilitude from the autoregressive model. Both versions evaluate if there is a unit root present or absent in the time series. Moreover, the Hadri (2000) test relies on estimating the regression coefficient between variations in series and a certain set of instrumental variables. The variables are employed for the purpose of identifying deterministic trends within time series data. Furthermore, stability analyses were conducted on the waste generated by the clean and dirty energy stock indexes. The objective of these stability tests is to identify fluctuations in variance, particularly substantial changes in variance throughout the sample period while considering occurrences in 2020 and 2022. To comprehensively address the study question, we will utilize the Granger Vector Autoregressive Causality Econometric Model (VAR). This paradigm enables the examination of causal interactions among variables within the framework of time series multivariate data. Granger's causality, a fundamental concept in the field of vector autoregressive (VAR), is predicated on the notion that the historical values of a certain variable enhance the prediction capacity of another variable. Therefore, if the initial variable contributes to the enhancement of predictions for the second variable, it is regarded as the Granger causality of the latter. The notion of causality, sometimes referred to as Granger's causality, enables us to evaluate not only the existence but also the orientation and magnitude of causal connections among variables.

4. RESULTS AND DISCUSSION

Figure 1 shows the evolution, in daily returns, of the Brent Crude Spot (BRENT) WTI, FTSE 350 Oil, Gas & Coal (FTSE 350 OG & Coal, and EURO STOXX Oil & Gas (SXEP), as well as sustainable energy subsectors including the Geothermal Index (GRNGEO), Solar Energy Index, NASDAQ OMX Bio Clean Fuels (GRNBIO), Wind Energy Index, and WilderHill Index (ECO). The observed period spans from May 17, 2018, to April 28, 2023. Through visual analysis, it can

be shown that the mean return exhibits a certain degree of stability, as indicated by the values being near zero. Nevertheless, the time series exhibits noteworthy fluctuations, indicating the inherent instability experienced by these markets, particularly during the initial months of 2020, coinciding with the repercussions of the COVID-19 pandemic on the global economy.

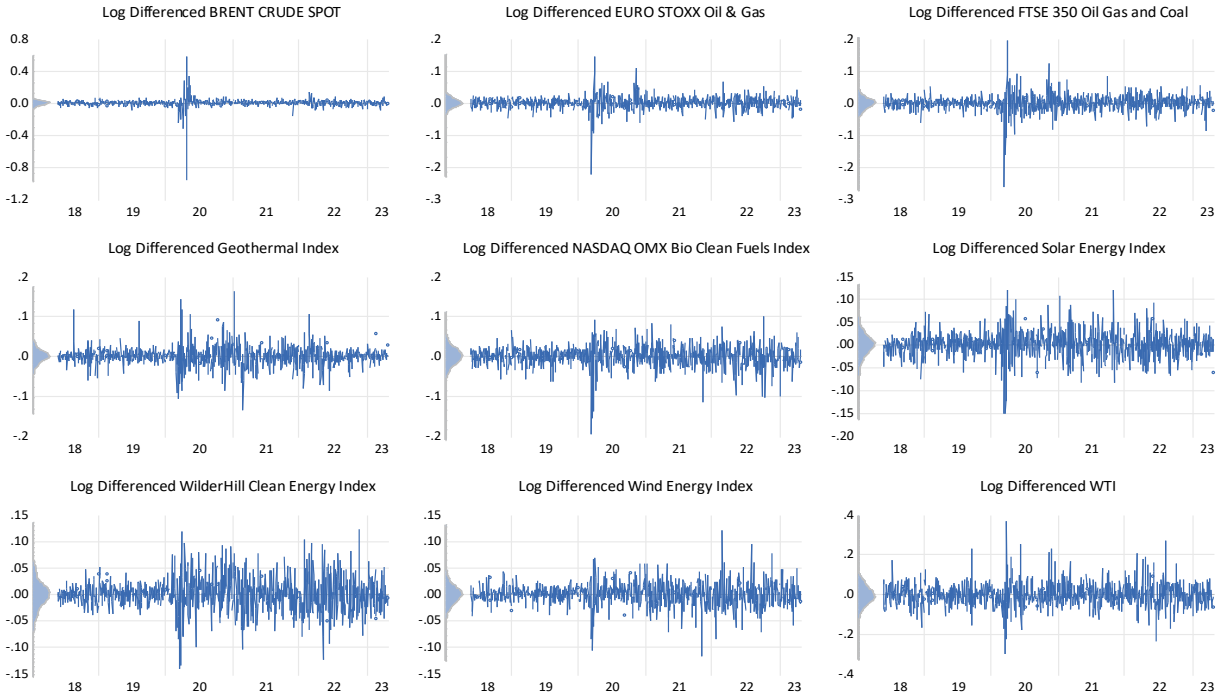

Figure 1. The evolution, in returns, of the dirty and clean energy stock indexes, from May 17, 2018, to April 28, 2023

Source: Own research

Table 1 presents the statistical summary metrics, which reveal that the average returns exhibit a positive trend, except for the ECO (-0.000263) and the WTI index (-0.000346). Notably, the ECO demonstrates the highest standard deviation (0.027018) among the stock indexes analyzed. To ascertain the presence of Gaussian distributions, it is observed that the asymmetries exhibit non-zero values, and it is noted that the BRENT distribution (-1.182660) displays the highest magnitude among these values. Furthermore, all stock indexes have kurtosis values exceeding 3, with particular significance placed on the GRNBIO stock index, which stands at 10.46391. To validate the findings, the Jarque and Bera (1980) adherence test additionally indicates the rejection of the null hypothesis at a significance level of 1%. The anticipated outcomes can be attributed to the existence of fat tails, namely extreme values, arising from the occurrences in 2020 and 2022.

Table 1. Table summary of the core statistics metrics, in returns, relating to the clean energy stock indexes under analysis, from May 17, 2018, to April 28, 2023

	GRNGEO	GRNBIO	SOLAR ENERGY	ECO	WIND ENERGY
Mean	0.000169	0.000266	0.000963	-0.000263	0.000242
Std. Dev.	0.022783	0.024585	0.026279	0.027018	0.019379
Skewness	0.147747	-1.182660	-0.661870	-0.127951	0.047109
Kurtosis	9.613298	10.46391	8.942274	5.483255	7.285361
Jarque-Bera	1659.797	2321.916	1403.758	236.0386	695.8847
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	909	909	909	909	909

Source: Own elaboration

Table 2 shows the descriptive statistics of the "dirty" energy stock indexes, and we can see that the mean returns are positive, except for WTI (-0.000346). BRENT has the highest standard deviation (0.054528), asymmetry (-8.335251), and kurtosis (220.5009), suggesting that it is the riskiest market. The other markets likewise illustrate that we are dealing with non-Gaussian distributions, as they have values different from 0 (asymmetry) and 3 (kurtosis). The Jarque and Bera (1980) adherence test was used to confirm that we are dealing with deviations from normal distributions.

Table 2. Table summary of the core statistics metrics, in returns, relating to the dirty energy stock indexes under analysis, from May 17, 2018, to April 28, 2023

	BRENT	SXEP	FTSE 350 OG & COAL	WTI
Mean	0.000796	1.83E-05	0.000133	-0.000346
Std. Dev.	0.054528	0.017505	0.023261	0.051376
Skewness	-8.335251	-0.466404	-0.516129	0.304305
Kurtosis	220.5009	20.67552	19.22784	7.918369
Jarque-Bera	1802265.	11866.02	10014.47	930.2389
Probability	0.000000	0.000000	0.000000	0.000000
Observations	909	909	909	909

Source: Own elaboration

To assess the assumption of stationarity for various stock indexes, including Brent Crude Spot (BRENT) WTI, FTSE 350 Oil, Gas & Coal (FTSE 350 OG & Coal, and EURO STOXX Oil & Gas (SXEP), as well as subsectors of sustainable energies such Geothermal Index (GRNGEO), Solar Energy Index, NASDAQ OMX Bio Clean Fuels (GRNBIO), Wind Energy, and WilderHill Index (ECO), we conducted unit root tests. Specifically, we employed the Dickey and Fuller (1981) - Fisher Chi-square and Choi Z-stat tests, along with the Hadri (2000) test. This analysis was conducted for the period from May 17, 2018, to April 28, 2023. The robustness of the intersection of the tests with contradictory null hypotheses allows for the measurement of the level of lag of each time series until it achieves equilibrium, characterized by an average of 0 and a variance of 1. The findings indicate that the time series exhibits unit roots when estimating the original price series. To achieve stationarity, a logarithmic transformation was applied to the first differences. This transformation facilitated the rejection of the null hypothesis in the Dickey and Fuller (1981) test, specifically through the Fisher Chi-square and Choi Z-statistic. About the Hadri (2000) test, it is seen that the null hypothesis is not rejected, thereby confirming the basic assumptions for the estimation of VAR models (see **Tables 3** and **4**).

Table 3. Dickey and Fuller (1981) panel unit root test, in returns, relating to the stock indexes under analysis, for the period from May 17, 2018, to April 28, 2023

Null Hypothesis: Unit root (individual unit root process)		
Method	Statistic	Prob.
ADF - Fisher Chi-square	2245.91	0.0000
ADF - Choi Z-stat	-46.4970	0.0000

Source: Own elaboration

Table 4. Hadri (2000) panel unit root test, in returns, relating to the stock indexes under analysis, for the period from May 17, 2018, to April 28, 2023

Null Hypothesis: Stationarity		
Method	Statistic	Prob.
Hadri Z-stat	-0.18385	0.5729
Heteroscedastic Consistent Z-stat	-0.07167	0.5286

Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.

Source: Own elaboration

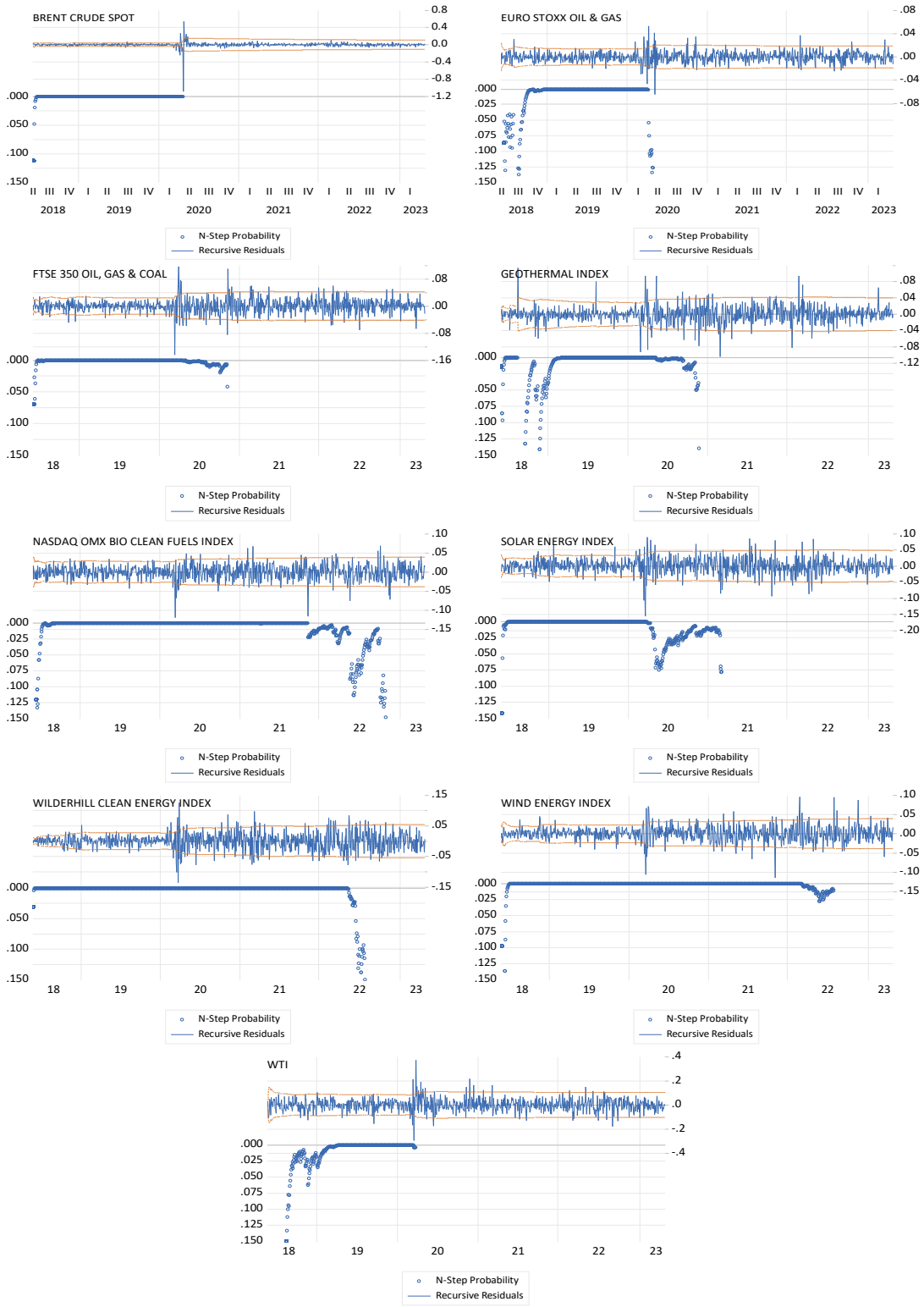

Figure 2. Stability tests for residues, in returns, relating to the stock indexes under analysis, for the period from May 17, 2018, to April 28, 2023

Source: Own research

Figure 2 depicts residue stability charts based on the stock indexes Brent Crude Spot (BRENT) WTI, FTSE 350 Oil, Gas & Coal (FTSE 350 OG & Coal, and EURO STOXX Oil & Gas (SXEP), as well as sustainable energy subsectors Geothermal Index (GRNGEO), Solar Energy Index, NASDAQ OMX Bio Clean Fuels (GRNBIO), Wind Energy, and WilderHill Index

(ECO). We may examine the presence of disturbances in the variance of the residues using the graphical analysis of the stability charts in Figure 3. Furthermore, violations of the 95% confidence limits demonstrate the presence of unstable behavior in the time series. These findings suggest that the stock indexes studied are vulnerable to fluctuating and unpredictable patterns, emphasizing the need to take these elements into account when making investment decisions.

In this study, we intended to see if fossil fuels influenced the establishment of prices for sustainable energy, especially during times of global economic instability, in particular during the events of 2020 and 2022. We looked at the clean energy stock indexes, specifically the subsectors Geothermal Index (GRNGEO), Solar Energy Index, NASDAQ OMX Bio Clean Fuels (GRNBIO), Wind Energy, and WilderHill Index (ECO), as well as the price indexes Brent Crude Spot (BRENT) WTI, FTSE 350 Oil, Gas & Coal (FTSE 350 OG & Coal, and EURO STOXX Oil & Gas (SXEP). To increase robustness, we divide the sample into two subperiods: Tranquil (the period from May 17, 2018, to December 31, 2019) and Stress (the period from January 2020 to April 2023).

Upon comparing the two subperiods, it becomes evident that there was a substantial rise in the number of influential movements between the Tranquil and Stress subperiods, with the count rising from 18 to 49 moves. The GRNGEO, Solar Energy Index, GRNBIO, and Wind Energy Index are examples of sustainable energy subsectors that did not have an impact on the prices of fossil fuels and sustainable energy pairs during the Tranquil Period. Upon analyzing the Stress subperiod, it became evident that the GRNGEO and Wind Energy Index subsectors have begun to exert an influence on the price development of BRENT and WTI. The Solar Energy Index has a significant impact on the prices of Brent, WTI, Wind Energy, and ECO. Similarly, the GRNBIO has a notable influence on the prices of BRENT, WTI, SXEP, the ECO index, as well as the subsectors of the Solar Energy and Wind Energy Index. During a period of relative stability, the ECO had a significant impact on the prices of most comparable indexes, except for BRENT. However, during a period of heightened stress, the ECO index influenced the development of prices across all energy markets, including both fossil fuels and sustainable energy.

When we started examining "dirty" energy markets during the Tranquil period, we discovered that WTI (6) was the most significant emitter, followed by BRENT (4), FTSE 350 OG & Coal (1), and finally the SXEP, which did not influence the formation of any index's prices. When we analyze the Stress period, we observe that the SXEP influences the prices of all its peers (8 out of 8 possibilities), and the BRENT influences the prices of their peers, except the Wind Energy Index. Similarly, the WTI has an impact on its peers, except for the GRNGEO, whilst the FTSE 350 OG & Coal has an impact on the WTI, GRNGEO, Solar Energy Index, and ECO.

Table 5. Summary table of short-term shocks in relation to the stock indexes under analysis during the Tranquil and Stress subperiods

Market	Tranquil Subperiod	Stress Subperiod	Evolution
GRNGEO	0 / 8 possibilities	2 / 8 possibilities	↑
SOLAR ENERGY	0 / 8 possibilities	4 / 8 possibilities	↑
GRNBIO	0 / 8 possibilities	6 / 8 possibilities	↑
WIND ENERGY	0 / 8 possibilities	2 / 8 possibilities	↑
ECO	7 / 8 possibilities	8 / 8 possibilities	↑
BRENT	4 / 8 possibilities	7 / 8 possibilities	↑
FTSE 350 OG. & COAL	1 / 8 possibilities	5 / 8 possibilities	↑
SXEP	0 / 8 possibilities	8 / 8 possibilities	↑
WTI	6 / 8 possibilities	7 / 8 possibilities	↑

Source: Own elaboration

In summary, the dynamic relationship between sustainability and innovation in the realm of green energy is significantly influencing indexes related to fossil fuels. During periods of adversity, there is an increased importance placed on sustainable energy subsectors, while indexes associated with "dirty" energy exhibit differing levels of influence. The WilderHill Clean Energy Index (ECO) plays a key role in shaping the price formation of fossil fuels and sustainable energy indexes.

5. CONCLUSION

The objective of this study is to examine the impact of fossil fuels on the development of sustainable energy prices in the context of global economic instability, specifically focusing on the occurrences of 2020 and 2022. A comprehensive study was conducted on various clean energy indexes, namely Geothermal Index (GRNGEO), Solar Energy Index, NASDAQ OMX Bio Clean Fuels (GRNBIO), Wind Energy, and WilderHill Index (ECO). Additionally, the prices of Brent Crude Spot (BRENT) WTI, FTSE 350 Oil, Gas & Coal (FTSE 350 OG & Coal, and EURO STOXX Oil & Gas (SXEP) were included in the analysis. In order to enhance the reliability of our results, we partitioned the sample into two distinct periods: Tranquil (May 17, 2018, to December 31, 2019) and Stress (January 2020 to April 2023). The research indicated a notable rise in the occurrence of influence movements across these indexes, increasing from 18 to 49 during the transition from the Tranquil to Stress subperiods. During a time characterized by relative stability, the subsectors associated with sustainable energy exhibited a constrained impact on the pricing dynamics of fossil fuels and durable energy sources. Nevertheless, during the stress subperiod, a notable change occurs as the GRNGEO subsector and Wind Energy Index begin to exert influence on the formulation of BRENT and WTI prices. The emergence of Solar Energy and the GRNBIO has had a notable impact on many price indexes, such as BRENT, WTI, SXEP, ECO, Solar Energy Index, and Wind Energy Index. In summary, this research emphasizes the significant effects of sustainability and innovation in the field of green energy on the dynamics of influence pertaining to indexes related to fossil fuels. During periods characterized by economic tension, there is an increased importance of sustainable energy subsectors, but the influence of "dirty" energy indexes exhibits various degrees. The WilderHill Clean Energy Index (ECO) holds significant influence in affecting the formation of fossil fuels and sustainable energy indexes. These findings not only draw attention to the continuous trend towards investments that are both environmentally benign and economically sustainable but also underscore the increasing significance of sustainability within the domain of financial markets. With the growing global consciousness regarding the pressing necessity to tackle climate change and encourage ethical industry practices, there is an escalating recognition among investors of the enduring advantages associated with integrating sustainability into their investment plans. The results shed light on the fact that sustainability has transcended its status as a mere buzzword or a niche market. The impact of this aspect on the performance and stability of financial markets has gained substantial importance.

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A Short Guidance for SME Sustainability Reporting at the EU Level

Dominika P. Gałkiewicz[1]
Veronika Gaßner[2]

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Reporting

Abstract: *Environment, Social and Governance (ESG) related regulations such as the Non-Financial Reporting Directive (NFRD) or the upcoming Taxonomy Regulation of the European Union (EU) combined with the Corporate Sustainability Reporting Directive (CSRD) had and will have a lasting impact on various market participants including small and medium-sized enterprises (SMEs). Among these market participants, SMEs face difficulties in complying with sustainability reporting due to limited resources and the absence of SME-specific guidelines. To address this issue, a framework for SME sustainability reporting in the EU is proposed in this study. The framework consists of a seven-step process that helps companies and stakeholders prioritize relevant sustainability topics. The proposed framework is easy to implement and cost-effective, considering the unique characteristics and capabilities of SMEs. The study targets managing directors and decision-makers of German SMEs to assist them in preparing their sustainability reports. The minimum content elements for SME sustainability reporting include general disclosures, climate change, own workforce, and materiality assessment. The European Financial Reporting Advisory Group (EFRAG) plans to provide a digital questionnaire for SMEs to gather the necessary information. Proactive sustainability reporting can help SMEs improve stakeholder relations and optimize their internal processes, leading to competitive advantages and cost savings. However, it is important to note that authenticity, high quality, and transparency in disclosing sustainability aspects are crucial to avoid reputational damage resulting from greenwashing.*

1. INTRODUCTION

Over the past two decades, the importance of sustainability and reporting on it has grown significantly. Nowadays, people and businesses are increasingly aware of the need to combat climate change and to behave ethically when interacting with communities, customers, suppliers, and employees. Although the United Nations (UN) defined sustainability in 1987, it was not until almost thirty years later, with the creation of the 2030 Agenda for Sustainable Development and the 17 Sustainable Development Goals (SDGs) and 169 targets in the 2015 Paris Agreement, that the importance of sustainability became widely recognized. Sustainability has become a buzzword for many eco-friendly concepts and corporate responsibility. However, for investors and capital markets, the preferred term is ESG, which stands for Environment, Social, and Governance. ESG reports show the risks a company faces and how the company addresses them to sustainably act and generate long-term financial returns. Unfortunately, the information provided is sometimes difficult to follow for stakeholders due to various ESG reporting standards and frameworks, as well as non-mandatory reporting regimes. For companies, the high cost of data collection and additional reporting is a significant concern. Nevertheless, effective

[1] University of Applied Sciences Kufstein Tirol, Finance, Accounting & Auditing, Andreas Hofer-Str. 7, 6330 Kufstein, Austria
[2] University of Applied Sciences Kufstein Tirol, Finance, Accounting & Auditing, Andreas Hofer-Str. 7, 6330 Kufstein, Austria

ESG data management and sustainability reporting are essential for complying with the existing Non-Financial Reporting Directive (NFRD) and the upcoming European Taxonomy combined with the Corporate Sustainability Reporting Directive (CSRD) in 2024.

This research delves into the current state of mandatory and voluntary sustainability reporting, particularly in the European Union (EU) where the relevant laws are still in their rudimentary stages. The main objective of this study is to assist SMEs in establishing sustainable reporting structures and collecting data on sustainability-related key performance indicators (KPIs). To achieve this, a proposal was developed that encompasses the most critical components of non-financial reporting in SMEs, and a recommended procedure for data collection. The proposal considers the characteristics and capabilities of SMEs and focuses on a practical, cost-effective, and straightforward implementation, given the limited resources available to SMEs for this purpose.

In the following, section 2 provides the background on sustainability reporting regulations. Next, section 3 describes the data and methodology, while the discussion of the empirical results follows in section 4. Section 5 concludes the paper.

2. REGULATORY BACKGROUND AND LITERATURE REVIEW

In the scientific literature, no unified, globally accepted definition of sustainability reporting is provided (Dilling, 2010). This following definition is considered one of the most influential ones (Steinhöfel et al., 2019) and describes sustainability reporting as "the practice of companies disclosing the most significant economic, environmental and social impacts that arise from their corporate activities, and thereby being held accountable for these impacts and responsible for managing them" (MovingWorlds, n.d.). Usually, sustainability reporting serves as an extension of financial reporting that addresses topics such as the development of the company and its future viability (Auer et al., 2022).

The prerequisite for a company to obtain the relevant data and information is its sustainability management. In this context, the principle of materiality applies, which is of central importance in financial reporting (Harrison, 2018). This principle states that all facts that are relevant to a stakeholder's decision must be included in the sustainability report. Therefore, a materiality analysis is often carried out. This strategic tool facilitates the identification and prioritization of the sustainability issues that are relevant for a certain company and its stakeholders. The creation of a set of sustainability-related KPIs helps organizations and stakeholders to measure and evaluate the sustainability success of a company. The results can be used to derive appropriate measures for the sustainability management of the company (Auer et al., 2022). This approach is a valuable aid to internal decision-making processes and can add significant value to the non-financial corporate communications with a company's stakeholders (Meutia et al., 2021; Oprean-Stan et al., 2020).

According to the CSRD which took effect in January 2023, mandatory sustainability reporting applies to certain companies in the EU according to European standards. The aim of the CSRD is that companies disclose information on opportunities and risks relating to sustainability truthfully and transparently (Baumüller et al., 2022). Currently, a project task force of the European Financial Reporting Advisory Group (PTS-EFRAG) is developing a mandatory cross-industry European Single Reporting Standard (ESRS) to obtain uniform data and ensure standardization of sustainability reports. The intention is to make the data comparable, to regulate the scope for interpretation of the reports, and thus to promote the transformation to a more sustainable economy

(Bassen et al., 2023). By 31 October 2023, sector-specific standards and separate reporting standards for SMEs are expected to be published, which should consider the capacities and characteristics of SMEs (European Commission, 2022). With the new CSRD, almost 50,000 companies are required to report instead of around 11,700 companies previously following the NFRD (Rinke & Messner, 2022). Moreover, all non-EU companies with substantial activity in the EU (with a turnover above 150 million euros in the EU) that have at least one subsidiary (large or listed) or branch (net turnover of more than 40 million euros) in the EU will be affected by the CSRD.

Only listed SMEs are obliged to report on sustainability from January 2026 according to the CSRD. In compliance with the new CSRD (Directive [EU] 2022/2464) and the ESRS, sustainability reporting will henceforth have to be included in a separate section of the company's management report. This dedicated section where material sustainability-related information will be presented is called a sustainability statement (EFRAG, 2022a). Furthermore, all companies concerned are obliged to have their sustainability information audited by an external organization. The audit is initially carried out with limited assurance and will be extended to reasonable assurance over time. All non-listed SMEs are consequently not required to report but can voluntarily publish sustainability reports. Nevertheless, it should be mentioned that SMEs may be forced to sustainability reporting by financial institutions and significant clients in their value chain simply requiring more information (Gorgels et al., 2022). According to the CSRD, the ESRS are binding EU standards for sustainability reporting. The final draft for cross-sector reporting standards from EFRAG which is responsible for developing the ESRS was submitted to the European Commission on 23 November 2022. The EU Commission is currently consulting the EU bodies and the member states on the draft standards (EFRAG, 2022b). The first set of ESRS is based on the requirements of the CSRD and comprises twelve standards (EFRAG, 2022a).

Cross-cutting Standards		
ESRS 1 *General requirements*		
ESRS 2 *General disclosures*		
Topical Standards		
Environment	**Social**	**Governance**
ESRS E1 *Climate change*	ESRS S1 *Own workforce*	ESRS G1 *Business conduct*
ESRS E2 *Pollution*	ESRS S2 *Workers in the value chain*	
ESRS E3 *Water and marine resources*	ESRS S3 *Affected communities*	
ESRS E4 *Biodiversity and ecosystems*	ESRS S4 *Customers and end-users*	
ESRS E5 *Resources and circular economy*		

Figure 1. Overview of the Content Elements of the First Set of ESRS Drafts

Source: Own illustration based on EFRAG, 2022a

Figure 1 provides an overview of the topics covered in the first draft of the ESRS. ESRS 1 *General Requirements* sets general principles that must be applied when reporting and does not itself set specific disclosure requirements. ESRS 2 *General Disclosures* specifies essential information that must be disclosed irrespective of which sustainability matter is being considered.

Then the topical standards follow according to the ESG classification (EFRAG, 2022a). The content requirements of the ESRS highlight that the application of double materiality is a central element of the ESRS, which is mandatory for all affected companies. This means that the company's positive and negative impacts on the people and the environment (impact materiality) as well as the impacts of the people and the environment on the company's economic situation (financial materiality) must be reported (EFRAG, 2022a).

3. DATA AND METHODOLOGY

The literature review allows us to identify the current sustainability reporting requirements for SMEs, while the empirical content analysis (Mayring (2022)) helps to examine common reporting patterns of SMEs. For the latter, the ten best sustainable reports from German SMEs according to the study of the Institute for Ecological Economy Research and the business network Future were taken for an in-depth analysis (**Figure 2**).

Rank	Company	Industry
1	Assmann Büromöbel GmbH & Co. KG	Office furniture
2	Pure Taste Group GmbH & Co. KG	Food
3	Neumarkter Lammsbräu Gebr. Ehrnsperger KG	Food
4	memo AG	Trade
5	GLS Gemeinschaftsbank eG	Service provider
6	Bohlsener Mühle GmbH & Co. KG	Food
7	Entega AG	Energy and water supply
8	alstria office REIT-AG	Real estate
9	elobau GmbH & Co. KG	Electronics
10	Stadtreinigung Hamburg	Public utilities

Figure 2. List of the 10 best sustainable reports from German SMEs
Source: Own illustration

4. RESULTS

This study proposes a framework for SME sustainability reporting based on an analysis of existing sustainability reports from SMEs as well as the legal requirements under the CSRD and ESRS. The aim is to provide comprehensive recommendations for SME sustainability reporting that is both simple and cost-effective. The proposed minimum content elements for SME sustainability reporting are based on the current SME-specific standards issued by EFRAG, which consider the unique capacities and characteristics of SMEs. These standards represent a simplified version of ESRS for large corporations. According to this study, the minimum content elements for SME sustainability reporting consist of two main components, as illustrated in **Figure 3**. The SME-specific ESRS are expected to be published by EFRAG no later than 31 October 2023.

Based on **Figure 3**, SME sustainability reporting has two main content-related elements. The first element is mandatory requirements, which include General Disclosures, as well as Climate Change and Own Workforce. SMEs are required to disclose their policies, actions, targets, and metrics related to these requirements. However, the available mandatory KPIs for Own Workforce only relate to organizations employing more than 250 people (EFRAG, 2023b).

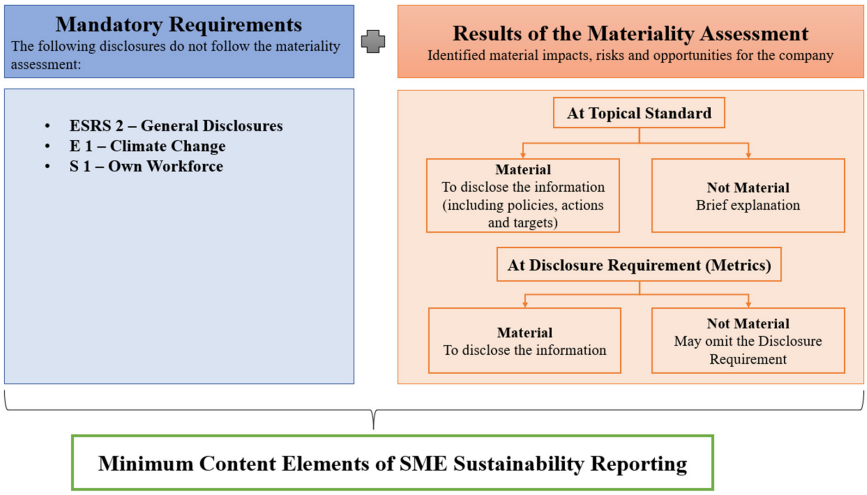

Figure 3. Content List of All Topics for SME Sustainability Reporting
Source: Own illustration based on EFRAG, 2023b

The second element is the results of the materiality assessment. Through this process, SMEs prioritize and identify the relevant topics to their stakeholders and themselves from the list of topical standards. All material topics, including their associated policies, actions, and targets, must be included in the company's sustainability statement. If a topic is deemed not material, the company must explain the reason for this. Metrics are treated differently. If a topic is material but the metric is not, then the company can omit this information. Every SME must address Climate Change, but not all SMEs are required to report on Pollution. If Pollution is deemed relevant according to the materiality analysis, then the affected company must report on it, including its policies, actions, targets, and metrics are also material. However, if Pollution is not considered a material topic, then the company only needs to provide a brief explanation as to why the issue is not relevant to the company. These elements represent the minimum standards for non-financial reporting by SMEs. They serve as a preliminary orientation, especially for listed SMEs required to report on sustainability from January 2026, to know what is expected under the CSRD. This enables the affected SMEs to start preparing for sustainability reporting as soon as possible. EFRAG plans to provide a digital questionnaire for SMEs to indicate the required information.

Recommended Procedure for the Materiality Assessment Process. To ensure simple, reliable, and cost-effective determination of sustainability indicators for SMEs, we recommend the following approach. The process begins with a materiality analysis as shown in **Figure 4** below. This analysis should be conducted as early as possible to allow sufficient time for compliance with regulations and capture all material issues and stakeholder interests. The approach consists of seven steps. First, identify the company's affected stakeholders. Second, prepare a list of material sustainability-related impacts, risks, and opportunities using various approaches or a combination of them. SMEs should evaluate which approach to take based on their available resources. However, involving stakeholders is recommended based on empirical results. Third, cluster the identified topics. Fourth, evaluate the material topics considering the stakeholders (question 1), the company's management (question 2), and the sustainability team (question 3) if it exists. A materiality matrix provides a quick overview of all material issues and should be used to present the results of the materiality analysis (fifth step). In the sixth step, conduct a management review. Lastly, integrate the findings into the corporate strategy by creating a sustainability program with policies, actions, targets, and metrics. It is essential to note that the materiality analysis is an ongoing process and should be regularly reviewed and adapted if necessary to ensure that company-specific material issues remain up to date.

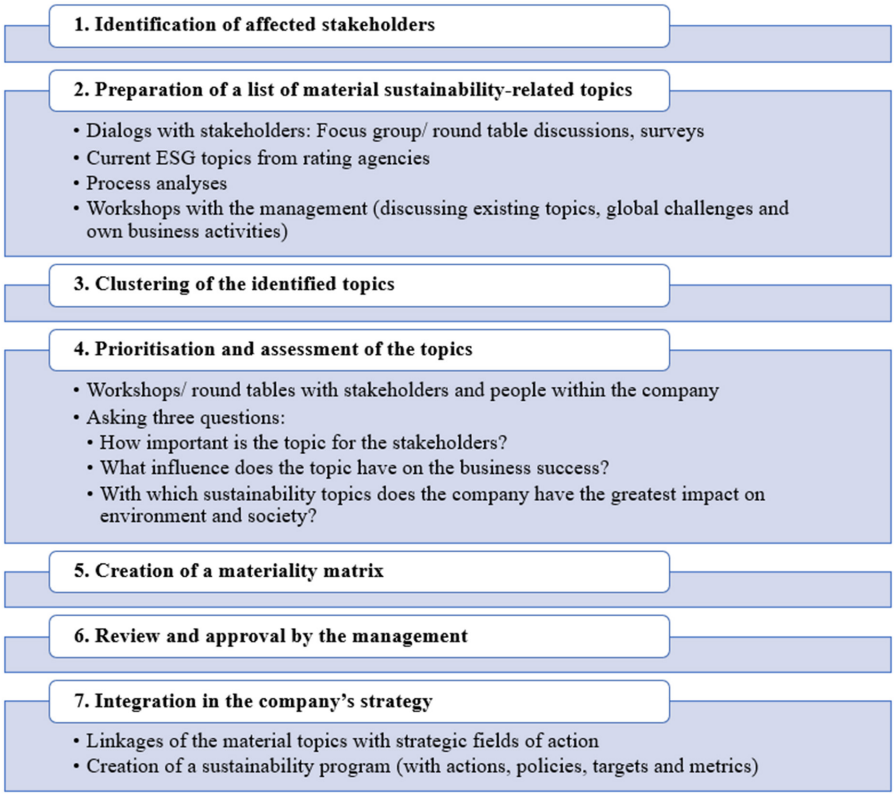

Figure 4. Procedure of the Materiality Assessment Process
Source: Own illustration

Once this process has been carried out, it only needs to be adjusted annually. The most resource-intensive part of sustainability reporting takes place in the first year. Suitable sustainability indicators must be defined to monitor the effectiveness of the measures determined in the sustainability program and achieve the set targets. Finally, the costs are amortized, and competitive advantages are generated. In the following paragraphs, we briefly explain the identification of sustainability indicators in the areas of Climate Change and Own Workforce because they comprise the mandatory disclosures.

	Retrospective				Milestones and target years			
	Base year	Comparative	N	% N / N-1	2025	2030	(2050)	Annual % target / Base year
Scope 1 GHG emissions								
Gross Scope 1 GHG emissions (tCO_2eq)								
Percentage of Scope 1 GHG emissions from regulated emission trading schemes (%)								
Scope 2 GHG emissions								
Gross location-based Scope 2 GHG emissions (tCO_2eq)								
Gross market-based Scope 2 GHG emissions (tCO_2eq)								

Figure 5. Recommended Reporting Table for GHG emissions Scope 1 and 2
Source: EFRAG, 2023a

The figures for energy consumption and production can be gathered from the utility bill. A clear representation showing the energy consumption in pie charts could resemble the following:

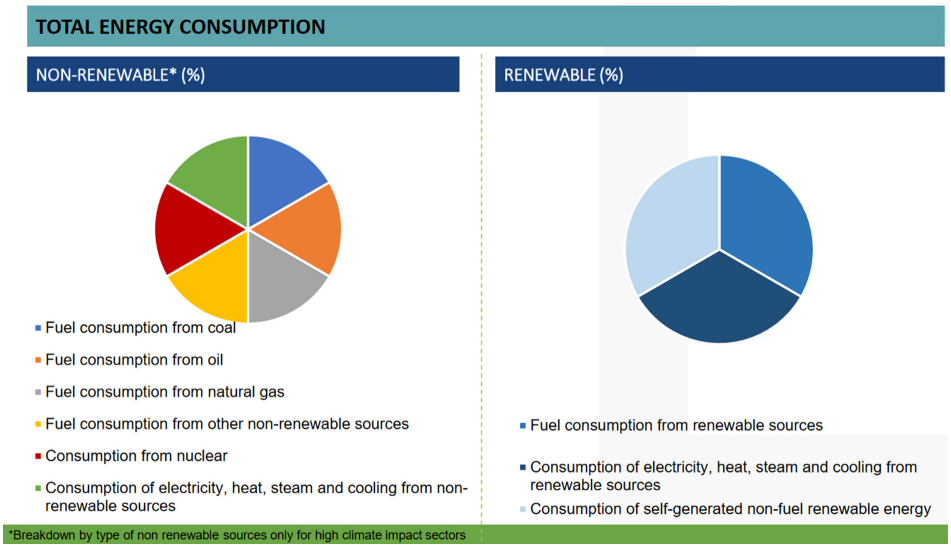

Figure 6. Recommended representation of Energy Consumption and Mix
Source: EFRAG, 2023a

Own Workforce Indicators. The data for a company's workforce can be obtained from its ERP system. It is often helpful to seek assistance from external sources such as consulting firms, chambers of trade and commerce, or software tools like KlimAktiv. Based on empirical findings, various approaches can be adopted for preparing the sustainability statement, from outsourcing the entire process to only designing parts of it through agencies. SMEs should be aware that errors discovered by auditors could be more expensive than seeking external advice beforehand. Therefore, it is up to each SME to decide which approach is suitable, based on their available resources. It is also recommended to establish a sustainability team within the company that tracks current legal requirements, prepares the annual sustainability statement, and collaborates with other departments to coordinate sustainability actions. It is crucial to note that sustainability management is a collaborative effort that should involve all departments.

In summary, it is highly recommended that SMEs strategically use sustainability reporting to gain various benefits. This involves disclosing information related to sustainability, which can make firms feel vulnerable due to the sensitive nature of the information. However, it is important to be authentic and transparent towards stakeholders to avoid any reputational damage. To address this issue, adopting a holistic approach to sustainability reporting and integrating sustainability into the company's business model is crucial. In the long run, SMEs can achieve competitive advantages, as well as improve efficiency and stakeholder relations.

5. CONCLUSION

The goal of this study is to assist German SMEs in sustainability reporting and identifying sustainability-related key performance indicators by proposing a framework for SME sustainability reporting at the EU level. The main focus of the study was to create an easy-to-implement and cost-effective approach to sustainability reporting that caters to the unique characteristics and capabilities of SMEs. Moreover, the proposed framework includes a seven-step process to determine and prioritize the relevant sustainability topics for a company and its stakeholders.

The results of this study have significant implications for SMEs. By engaging in proactive sustainability reporting, SMEs can gain a competitive edge and reduce costs through enhanced stakeholder relationships and streamlined internal processes. SMEs can use the proposed framework as a guide to develop their sustainability reporting practices. As the study highlights, the minimum requirements for SME sustainability reporting consist of the mandatory elements under the Corporate Sustainability Reporting Directive (CSRD) and the outcomes of the materiality assessment.

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Status Quo of Voluntary Sustainability Reporting by German SMEs in 2021

Dominika P. Gałkiewicz[1]
Veronika Gaßner[2]

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Sustainability;
Reporting

Abstract: *New regulations related to Environment, Social and Governance (ESG), such as the Non-Financial Reporting Directive (NFRD) or the upcoming Taxonomy Regulation of the European Union (EU), will have a significant impact on various market participants. To gain insight, a study was conducted comparing sustainability reporting patterns of the top ten voluntary small and medium-sized enterprises (SMEs) sustainability reports. The results showed that these companies do not follow a uniform approach to sustainability reporting. Though the evaluated topics were the same, their contents and level of detail differed. It was also observed that some of the examined companies selected key performance indicators (KPIs) according to their preference and explained them in detail. Moreover, the companies issued different types of sustainability reports, such as separate PDF reports, online versions, or a combination of both. The companies provided extensive information on environmental issues, especially on GHG emissions, concrete measures, and targets for reducing emissions and energy consumption. Many presented this information in detail with status and KPIs linked to their sustainability program based on their previously identified material issues. However, the topics of pollution, water and marine resources, biodiversity, and ecosystems were only marginally addressed in the examined sustainability reports. Regarding social information, the investigated companies disclosed a broad spectrum of information on their own workforce, especially on working conditions, equal treatment, and opportunities. On the other hand, the reporting of the examined companies varied widely for governance. Many firms reported on mandatory topics such as corruption, bribery, and political engagement. These findings are useful for policymakers, other companies including banks and suppliers, and individuals interested in assessing sustainability status and progress.*

1. INTRODUCTION

Climate change and environmental degradation pose significant threats to Europe and the world. To address these challenges, Europe has launched the European Green Deal, which aims to transition to a modern, sustainable, and resource-efficient economy and become the first continent to achieve climate neutrality by 2050. Similarly, the German government recognizes the importance of steering financial flows towards a more sustainable economy. It views this as a crucial lever to support the sustainability transformation of the country. In line with this, the German Sustainable Finance Strategy states that companies will be held more accountable in the future, as they represent a significant part of the German economy. Sustainability aspects, therefore, have to be considered in financing decisions.

[1] University of Applied Sciences Kufstein Tirol, Finance, Accounting & Auditing, Andreas Hofer-Str. 7, 6330 Kufstein, Austria
[2] University of Applied Sciences Kufstein Tirol, Finance, Accounting & Auditing, Andreas Hofer-Str. 7, 6330 Kufstein, Austria

The purpose of this paper is to analyze the sustainability reporting patterns of small and medium-sized enterprises (SMEs), including their key performance indicators (KPIs). To achieve this aim, we used the ten best sustainability reports from German SMEs according to the Institute for Ecological Economy Research and the business network Future, as a basis for our analysis. The Corporate Sustainability Reporting Directive (CSRD) came into effect in January 2023. This directive requires comprehensive, mandatory, and externally audited sustainability reporting from almost 50,000 European companies, instead of around 11,700 firms previously. As a result, companies are facing immense challenges, as they need to provide insights about their non-financial performance. This is particularly difficult for SMEs, given their limited resources and the lack of SME-specific guidelines on sustainability reporting. According to a study by the German Federal Statistical Office, around 99.4 percent of all companies in Germany were classified as SMEs in 2020. This highlights the enormous relevance of SMEs for the German economy and explains why they are often called the backbone of the German economy. However, SMEs face significant external pressure regarding the disclosure of sustainability-related data, as financing partners and customers in the supply chain demand information on sustainable indicators. This demand is set to increase significantly in the future, given that the CSRD will subject nearly five times as many entities to reporting requirements. Therefore, this study analyzes the current status of voluntary sustainability reporting by German SMEs and highlights the challenges they face in meeting the new reporting requirements set out in the CSRD.

In the following, section 2 provides the background on sustainability reporting regulations, while the next section 3 describes the data and methodology. The discussion of the empirical results follows in section 4, while section 5 concludes the paper.

2. REGULATORY BACKGROUND AND LITERATURE REVIEW

There is currently no universally accepted definition of sustainability reporting in the scientific literature (Dilling, 2010). Nonetheless, one of the most influential definitions of sustainability reporting comes from Steinhöfel et al. (2019), who describe it as a practice in which companies disclose their most significant economic, environmental, and social impacts resulting from their corporate actions. This allows companies to be held accountable for these impacts and to take responsibility for managing them. Sustainability reporting is often seen as an extension of financial reporting and covers topics such as the company's development and future viability (Auer et al., 2022).

To obtain the necessary data and information, a company must have a sustainability management plan in place. The materiality principle, which is central to financial reporting, also applies to sustainability reporting (Harrison, 2018). This principle requires that all facts relevant to stakeholders' decisions be included in the sustainability report. Therefore, companies often conduct a materiality analysis to identify and prioritize the sustainability issues that are most relevant to their stakeholders. The creation of a set of sustainability-related KPIs can help organizations and stakeholders measure and evaluate a company's sustainability success. This information can then be used to develop appropriate measures for the company's sustainability management (Auer et al., 2022). This approach is a valuable tool for internal decision-making processes and can significantly enhance non-financial corporate communications with stakeholders (Meutia et al., 2021; Oprean-Stan et al., 2020).

Starting from January 2023, certain European companies are required to comply with the CSRD, which is a set of European standards for sustainability reporting. The goal of the CSRD

is to ensure transparent and truthful disclosure of information about sustainability opportunities and risks. A task force of the European Financial Reporting Advisory Group (PTS-EFRAG) is currently developing mandatory cross-industry ESRS (European Single Reporting Standard), which will ensure uniform data and standardization of sustainability reports, making the data comparable and promoting the transition to a more sustainable economy. By October 31, 2023, sector-specific standards and separate reporting standards for SMEs will be published, taking into account the capacities and characteristics of SMEs.

Under the CSRD, almost 50,000 companies are required to report on sustainability, instead of around 11,700 companies previously following the NFRD. Furthermore, all non-European Union (EU) companies with substantial activity in the EU, with a turnover over 150 million euros in the EU, that have at least one subsidiary (large or listed) or branch (net turnover of more than 40 million euros) in the EU will be affected by the CSRD. Only listed SMEs are obliged to report on sustainability from January 2026 onwards according to the CSRD. However, non-listed SMEs can voluntarily publish sustainability reports, although they may be required to do so by various stakeholders.

The ESRS are EU standards for sustainability reporting, which are binding under the CSRD. The European Commission is currently consulting with EU bodies and member states on the final draft of the cross-sector reporting standards submitted by EFRAG, which is responsible for developing the ESRS. In June 2023, the final standards will be adopted as delegated acts, first by the European Commission and then by the European Parliament and the European Council. The first set of ESRS, based on the requirements of the CSRD, comprises twelve standards shown in **Figure 1** (EFRAG, 2022). The following **Figure 1** provides an overview of the topics covered in the first draft of the ESRS.

Cross-cutting Standards		
ESRS 1 *General requirements*		
ESRS 2 *General disclosures*		
Topical Standards		
Environment	**Social**	**Governance**
ESRS E1 *Climate change*	ESRS S1 *Own workforce*	ESRS G1 *Business conduct*
ESRS E2 *Pollution*	ESRS S2 *Workers in the value chain*	
ESRS E3 *Water and marine resources*	ESRS S3 *Affected communities*	
ESRS E4 *Biodiversity and ecosystems*	ESRS S4 *Customers and end-users*	
ESRS E5 *Resources and circular economy*		

Figure 1. Overview of the Content Elements of the First Set of ESRS Drafts

Source: Own illustration based on EFRAG, 2022

The ESRS 1 General Requirements outlines the fundamental principles that must be followed when reporting, without specifying any concrete disclosure requirements. On the other hand, the ESRS 2 General Disclosures mandates the essential information that should be disclosed,

regardless of the sustainability matter under consideration. The topical standards are then classified based on the ESG classification (EFRAG, 2022). The ESRS's content requirements emphasize that the application of double materiality is an integral part of the ESRS, and it is compulsory for all affected companies. This means that the company's positive and negative impacts on the people and the environment (impact materiality) and the impacts of the people and the environment on the company's economic situation (financial materiality) must be reported (EFRAG, 2022).

As per the new CSRD (Directive [EU] 2022/2464, 2023) and ESRS regulations, companies will now be required to include a separate sustainability statement in their management report. This section will contain crucial sustainability-related information. Additionally, all companies must have their sustainability information audited by an external organization. Initially, the audit will be carried out with limited assurance and will be extended to reasonable assurance over time.

3. DATA AND METHODOLOGY

The literature review allows us to identify the current sustainability reporting requirements for SMEs, while the empirical content analysis (Mayring, 2022) helps to examine common reporting patterns of SMEs. For the latter, the ten best sustainable reports from German SMEs according to the study of the Institute for Ecological Economy research and the business network future were taken for an in-depth analysis (**Figure 2**).

Rank	Company	Industry
1	Assmann Büromöbel GmbH & Co. KG	Office furniture
2	Pure Taste Group GmbH & Co. KG	Food
3	Neumarkter Lammsbräu Gebr. Ehrnsperger KG	Food
4	memo AG	Trade
5	GLS Gemeinschaftsbank eG	Service provider
6	Bohlsener Mühle GmbH & Co. KG	Food
7	Entega AG	Energy and water supply
8	alstria office REIT-AG	Real estate
9	elobau GmbH & Co. KG	Electronics
10	Stadtreinigung Hamburg	Public utilities

Figure 2. List of the 10 best sustainable reports from German SMEs

Source: Own illustration based on Institute for Ecological Economy Research, & future e.V., 2021

4. RESULTS

The study findings reveal that there is no standard approach to sustainability reporting among the companies investigated. The examined sustainability reports focus on different themes, which is positive due to the prior materiality analysis conducted in all the reports. The results can be explained by the concept of double materiality, which is a mandatory element of the ESRS for all affected companies. According to theoretical findings, the materiality analysis is a vital strategic tool for prioritizing sustainability topics that are crucial for a company and its stakeholders. However, despite companies identifying the same topics as material, their

contents, as well as the level of detail, differ. For instance, firms use different KPIs to measure their targets, and some select KPIs based on their preference and explain them in detail. This approach allows companies to influence their reputation positively, even with negative figures. Therefore, readers should engage in critical thinking while reading sustainability reports since greenwashing can be conducted through non-financial reporting. This raises questions about the purpose of sustainability reporting in achieving the EU's climate targets if companies can choose which data to disclose. Disclosing only positive topics and excluding risks or metrics that still need improvement can lead to reputational damage. Additionally, the opportunities of sustainability reporting cannot be fully exploited.

The empirical findings of this study reveal the existence of different types of sustainability reports. The companies examined present their sustainability topics in separate PDF reports, as online versions, or as a combination of both. However, none of these reporting types will be permissible under the CSRD (Corporate Sustainability Reporting Directive) since this EU directive mandates that affected companies must present their sustainability data in a separate section of the company's management report, the so-called sustainability statement. One reason for the inconsistent quality of the examined sustainability reports is the fact that SMEs are not yet legally required to publish non-financial information, and therefore, their reports are not externally audited, which means that the completeness of the content is not proven. Another reason for the different design of the sustainability reports is that 90 percent of the studied sustainability reports are based on the GRI (Global Reporting Initiative) standards. However, the GRI standards are merely guidelines for the structure and content of sustainability reports and have no binding legal character. Nevertheless, the transition to reporting based on the ESRS (European Single Reporting Standard) might pose a future challenge for the affected SMEs. The lack of uniformity in non-financial reporting will change in the future, as the CSRD, adopted on 5 January 2023, aims for standardized sustainability reporting that includes more companies and stricter requirements for mandatory non-financial reporting. As explained in the theoretical part of this study, SME-specific standards will be published by October 2023. Listed SMEs will then be required to report on sustainability from 1 January 2026.

The analysis conducted for the company reveals that not all of the investigated firms can be classified as SMEs according to the definition set by the European Commission. This could be due to the fact that the authors had to broaden the definition of SMEs to collect enough sustainability reports to make a comparison. This observation is in line with the findings in the literature which suggests that only a few SMEs have started reporting on sustainability so far. However, the research shows that the range of disclosures varies greatly. For instance, Entega AG, which has significantly more employees and generates more revenue than memo AG, provides far less detailed sustainability reports. In contrast, alstria AG presents a comprehensive representation of their office building emissions over the lifecycle in the context of sustainability due diligence. It is worth noting that carrying out such detailed descriptions, calculations, and explanations is often difficult for SMEs due to their limited financial and human resources.

Environmental Information. The findings reveal that companies provide ample information on climate change in their reports. Specifically, they present their greenhouse gas emissions, measures taken, and targets for reducing emissions and energy consumption in great detail. Most of the companies also link their sustainability program's status and key performance indicators (KPIs) to their previously identified material issues.

The examined sustainability reports only touch on topics related to pollution, water and marine resources, biodiversity and ecosystems in a limited way. This could be because the firms did not consider these topics to be important in their materiality analysis. Bohlsener Mühle, for instance, explains in their sustainability report that they only partially report on water and marine resources for this reason. It is important to note that different industries have different relevant topics and KPIs. For instance, biodiversity and ecosystems are much more important for food manufacturers than for retailers of electrical appliances. Conducting a materiality analysis can help identify relevant topics, but it is even more helpful that EFRAG plans to release sector-specific reporting standards.

Social Information. The companies under investigation have disclosed a wide range of information about their own workforce, particularly regarding working conditions, equal treatment, and opportunities. This is likely because this information is readily available through the human resources department or the time-recording system. Collecting data about their own workforce provides an opportunity for companies to plan their workforce better. For example, Entega AG provides essential figures about the number of employees who will retire in the next five to ten years, which enables them to plan employee replacements and helps with human resources planning.

Based on the empirical results, it can be inferred that companies do not provide significant information about workers in their value chain. Furthermore, they only give minimal details about the affected communities in their reports, with a focus on local communities rather than those living farther away. This could be due to the resource-intensive and costly nature of gathering such information, especially when dealing with globally dispersed suppliers. Alternatively, companies may choose not to disclose this information due to its negative impact on their reputation. As for the disclosure of information about consumers and end-users, the analyzed firms do not provide much detail, seemingly only sharing the information they have collected anyway.

Governance Information. In relation to how companies are run, the way that information is reported varies greatly. Many companies report on mandatory topics such as corruption, bribery, and political involvement. It's worth noting that small and medium-sized businesses may have fewer resources for compliance and anti-corruption measures compared to larger organizations. The findings show that the management of relationships with suppliers is reported in greater detail. This may be because most companies already have set standards for suppliers such as a code of conduct, so they only need to provide these policies and their approach to supply chain management without having to gather new data.

It is important to highlight that a company's sustainability statement can serve as a comprehensive source of information for various stakeholders. Prospective employees, for instance, can access detailed information about working conditions in different organizations and use this information to compare employers. Similarly, companies can benefit by attracting and retaining top talent if they provide accurate and helpful sustainability statements.

5. CONCLUSION

This study has investigated the sustainability reporting practices of SMEs in Germany. The research has revealed that there is no standardized approach to non-financial reporting among SMEs. The analysis of the data has shown that the content and extent of disclosures in the sustainability reports of these SMEs vary considerably. As the literature suggests, this issue will be addressed by the CSRD, which mandates listed SMEs to disclose sustainability information.

Starting in 2026, listed SMEs will have to report using the standardized ESRS framework, and their reports will need to be audited with limited assurance. However, these strict legal requirements pose a significant challenge for SMEs, given their limited resources.

In the coming years, both listed and unlisted SMEs are likely to face increasing pressure from stakeholders such as banks, suppliers, and consumers to demonstrate their sustainability performance and progress. As a result, sustainability reporting will remain a major concern for SMEs. The extent to which the SME-specific ESRS will be both comprehensive and practical remains to be seen. However, for the time being, SMEs that report on their sustainability can gain a competitive edge. Further research could explore and validate the voluntary compliance of SMEs with regulatory standards.

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A Comparative Analysis of ESG Measures in Real Estate in Germany, Austria, and Switzerland for 2019-2021

Dominika P. Gałkiewicz[1]
Bernd Wollmann[2]

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Abstract: *In recent years, the issue of sustainability has evolved from a voluntary environmental issue to an increasingly comprehensive set of regulations. The Non-Financial Reporting Directive (NFRD) and the upcoming Taxonomy Regulation of the European Union (EU) are two examples of such regulations. EU taxonomy reporting is gradually becoming mandatory for more and more companies – these regulations include rules for environmental, social, and governance (ESG) factors, and have a significant impact, especially on the real estate industry and its stakeholders. The goal of this study is to evaluate how consistently the 55 largest real estate companies in three European countries have disclosed information on topics such as employees, social factors, and governance issues, in addition to environmental concerns, between the years 2019 and 2021. Large companies are often better prepared for this because they have the resources and expertise for professional reporting. Regardless of the size of the company, however, the biggest challenge is still the lack of standardization. The reporting on the following metrics has undergone significant changes during the observed period (2021 compared to 2019): E-measures: which standards are used (+260%), EPRA recommendations (+180%), Scope 3 t CO_2e (+120%), S-measures: employee satisfaction (+100%), employees with permanent contracts (+67%), salary ratio of woman to man (+55%), G-measures: own Sustainability Performance Index (+350%), UN SDG's included in the report (+300%), and Board Compensation tied to Sustainability measures (+150%). It is crucial for individuals, organizations, and politicians proposing new sustainability reporting regulations in Europe to recognize that overly complicated rules may not be followed entirely. Additionally, it is essential to maintain a consistent EU taxonomy reporting approach that is simple to implement in the future, regardless of the industry and the size of the company.*

1. INTRODUCTION

The development and recognition of sustainability reporting have grown rapidly over the last two decades. The need to combat climate change and apply ethical practices in customer, supplier, and employee relations has become mainstream. Sustainability has evolved into a comprehensive term that, in addition to the well-known "green" initiatives, increasingly encompasses the responsibilities of companies in the areas of social, legal, and diversity issues. At the same time, the acronym ESG (for Environment, Social, and Governance) has gained importance, particularly among investors and in the capital markets. ESG reporting describes the identified risks and performance of a company.

The EU taxonomy pursues an objective of the European Union's "Green Deal". It is intended to "reward" companies that do more for sustainability and climate protection. The new

[1] University of Applied Sciences Kufstein Tirol, Finance, Accounting & Auditing, Andreas Hofer-Str. 7, 6330 Kufstein, Austria
[2] University of Applied Sciences Kufstein Tirol, Finance, Accounting & Auditing, Andreas Hofer-Str. 7, 6330 Kufstein, Austria

Corporate Sustainability Reporting Directive (CSRD) of the EU aims to standardize and strengthen sustainability reporting for companies. It builds on the existing NFRD and extends its scope of application to additional companies. A key change compared to the previous NFRD is the double materiality that now applies. This means that topics that have a direct impact on sustainability and those sustainability aspects with a financial impact on the company are reported. Companies should conduct a materiality analysis (material/financial) to determine the content of their reports, focusing on material or financial information. However, challenges persist among diverse stakeholder groups due to the coexistence of multiple ESG reporting standards and frameworks, compounded by the absence of mandatory reporting requirements. Companies, in particular, grapple with the considerable expenses associated with data collection and additional reporting obligations. Effective management of ESG data and sustainability reporting stands as a critical need for compliance with extant regulations such as the NFRD and the forthcoming European Taxonomy set to merge with the CSRD by 2024.

The study aims to show what kind of information related to the environment, employees, and other social and governance issues is provided by how many companies (this corresponds to "E", "S" and "G" of the ESG dimensions). A key success would be to fix the traceability of ESG information provided in annual reports and other sustainability reports as this is essential for decision-making. The focus of this study is, therefore, on how comparable the ESG measures from large listed real estate companies from Germany, Austria, and Switzerland are. Real estate has one of the highest carbon footprints of any sector – it produces around 30% of the world's annual greenhouse gas emissions and consumes nearly 40% of the world's energy. Maybe that´s why the European Public Real Estate Association (EPRA) has issued recommendations on which measures to report and how to calculate them in advance, especially the environmental indicators. The focus lies on 55 listed companies with a market capitalization of more than 100 million EUR in 2019 and 2021.

Contrafatto (2014), O'Dwyer and Unerman (2016) conducted studies that reveal the factors prompting mandatory corporate social responsibility (CSR) reporting among unlisted companies. Herndon (2022) explored whether firms with established CSR practices exhibit higher stock valuations compared to those without CSR initiatives. The findings indicate a modestly positive to neutral impact of CSR on stock prices, attributed primarily to social capital, community relations, public perception, and market sentiment, rather than company performance. Currently, there are no studies that explicitly address environmental, social, and governance reporting by real estate companies in Germany, Austria, and Switzerland.

Sustainable finance and ESG investing-related operations deal with large amounts of non-financial data and scientific performance metrics, such as GHG emissions, biodiversity loss, hydrology, atmospheric science, etc. Many of the global ESG frameworks and national sustainable finance strategies do not sufficiently address the discrepancy between the claim of professional ESG expertise and the actual gaps in the expertise of many so-called ESG experts. The results of the underlying study guide companies from different industries for their reporting on sustainability, especially about their environmental, social, and governance issues based on best practices from the real estate industry in Germany, Austria, and Switzerland. Additionally, it contributes to the literature by showing how patchy voluntary sustainability reporting still is in the real estate industry between 2019 and 2021. Implications for various stakeholder groups and more political action arise from these differentiated findings.

Section 2 provides the history of sustainability regulations, and section 3 describes the data and methodology. The discussion of the empirical results follows in section 4, while section 5 concludes the paper.

2. HISTORY OF SUSTAINABILITY REGULATIONS AND REPORTING REQUIREMENTS

After the initial UN Conference on the Environment held in Stockholm in 1972 and with increasing public and scientific concerns regarding the limits to growth, the Commission took action to initiate a new environmental policy for the European Community. In November 1973, based on the European Council's commitment to establish a Community environmental policy in 1972, the first European Action Programme (EAP) was decided upon (Hey, n.d.). Although the UN defined "sustainability" as early as 1987 (United Nations, 1987) it took until the Paris Agreement of 2015 to formulate the so-called 2030 Agenda for Sustainable Development. The result is 17 Sustainable Development Goals (SDGs) with 169 specific targets. In 2005, the UN World Summit recommended the use of the model with the three "E", namely Environment, Economy, and Equity/Social Justice, and the intersection S (Sustainability). This was the turning point as CSR and the triple bottom approaches were substituted. The 2030 Agenda underlines the joint responsibility of politics, business, science, and civil society including every individual for a future living (Thaler, 2021). In line with this argument, authors like Edmans (2018), stress that the primary goal of businesses is serving society, rather than focusing solely on profit maximization.

EU Sustainability Reporting Regulation. In 2001, the European Commission (EC) referred to activities carried out voluntarily in its first policy paper on CSR. In 2011, the EC recommended improving the reporting and disclosure of corporate social and environmental activities (European Commission, 2011). Subsequently, Directive 2014/95/EU, known as the CSRD or NFRD, required public interest entities to improve the comparability of non-financial disclosures starting in 2017. In 2017 and 2019, the EC published guidelines for non-financial reporting and expanded them to include applicable sustainability standards such as the Carbon Disclosure Project (European Commission, 2021b; Thaler, 2021). Finally, on April 21, 2020, the EU Commission adopted a proposal for a CSRD to apply from 2024 on. It aims to amend and supplement existing directives to include a wider range of companies (and audits) and to refine reporting requirements (European Commission, 2021b). On November 3, 2021, the IFRS Foundation's Trustees established the International Sustainability Standard Board (ISSB) with a headquarters in Frankfurt, Germany. Its goal is to develop a global basis for sustainability-related disclosure standards. To have comparable information, EU sustainability reporting standards are being created and published in a delegated act of the EC (supplementary guidelines followed by Oct. 31, 2023). International frameworks such as the Global Reporting Initiative (GRI), Sustainability Accounting Standard Board (SASB), International Accounting Standards Board (IASB), Task Force on Climate-Related Disclosures (TCFD), as well as UN Global Compact (UNGC) and the SDGs need to be considered.

Sustainability Reporting Requirements. Until the end of 2023, companies with more than 500 employees and/or net sales of 40 million EUR and/or total assets of 20 million EUR are required to report on environmental, social, and employee issues, human rights, anti-corruption and anti-bribery measures, as well as diversity policies. The company's business model, policy, risks, and risk management about these aspects must also be disclosed. Its due diligence policies, the results of these policies, and non-financial performance indicators should be reported.

Organizations are advised to use recognized national and international standards when reporting and to specify which standard they have used (Directive 2014/95/EU). The NFRD recommends using standards such as the Eco-Management and Audit Scheme (EMAS), the UNGC, the Guiding Principles on Business and Human Rights, the Organization for Economic Cooperation and Development (OECD) Guidelines for Multinational Enterprises, the International Organization for Standardization ISO 26000 Social Responsibility Framework, and the GRI. Similar regulations apply to Austrian companies. In April 2020, the EC proposed the CSRD, which also applies to Germany and Austria from 2024 onwards.

The CSR Directive will become relevant from 2024 onwards. The CSRD was published in the Official Journal of the European Union on December 14, 2022, and it amends the existing NFRD of 2014. The directive specifies uniform European reporting standards and rules for reporting, following the principle of double materiality. The CSRD also introduces an audit requirement for sustainability reporting, and it aims to improve accessibility of information by requiring its publication in a digital and machine-readable format in the management report. The EU rules will apply to all large companies that meet at least two of the following criteria: 250 employees, net sales of 50 million EUR, and total assets of 25 million EUR. The rules will also apply to all companies listed on regulated markets, except listed micro-enterprises. A subsidiary will be exempted from the CSRD if the parent company includes the subsidiary in its consolidated CSRD-compliant management report. Companies that currently apply for the NFRD must implement the CSRD starting in 2024, while others will follow in later years (European Commission, 2021a).

Swiss Regulation. There is still no legal obligation for reporting sustainability measures in Switzerland, even though discussions are going on. ESG recommendations were already added to the Swiss Code of Best Practice for Corporate Governance in 2014. The Six Swiss Exchange even introduced the option for sustainable reporting (an opt-in option). Currently, four standards are accepted by the exchange: GRI, UNGC, SASB, and EPRA (Kleibold & Veser, 2019). GRI is currently working with the European Financial Reporting Advisory Group and the International Sustainability Standards Board to align their respective sustainability reporting standards (Flach, 2022). It is expected that non-EU companies that generate net sales of more than 150 million EUR in the EU and have at least one subsidiary or branch in the EU will be subject to the new EU sustainability reporting obligation starting from 2028. Apart from the approximately 50,000 companies in the EU that are currently estimated to be affected by the new CSRD regulation, several large Swiss companies will also be affected in the future. Switzerland is lobbying for the adoption of disclosure recommendations consistent with other international standards in the context of the updating process of the OECD Guidelines for Multinational Enterprises (Thaler, 2021).

3. DATA AND METHODOLOGY

The study examines the annual or sustainability reports of the top 55 listed real estate companies in Germany, Austria, and Switzerland. All these companies had a market capitalization of more than 100 million EUR in 2019. The goal is to provide an overview of common sustainability reporting practices between 2019 and 2021 by applying content analysis (Wooldridge, 2013) to the relevant sustainability-related reports' parts. The recommendations of the EPRA give guidance regarding the usage of the appropriate ESG measures. In the results section there will be tables presented showing how many firms provided which ESG measures in their reports. Some entities with more than 500 employees must comment – following EU regulations

– on environmental, social, and labor issues, diversity, human rights, anti-corruption, and anti-bribery policies (mandatory disclosure). Others do so voluntarily. The development over the two years gives insight into the ESG reporting dynamics in the real estate industry.

4. RESULTS

What sustainability reporting advancements did real estate companies make within 2 years between 2019 and 2021? Examining the environmental aspects of ESG measures presents a positive outlook. **Table 1** displays the EPRA-recommended environmental measures and how many firms reported each. The reporting frequency of the following information increased: number of rented units (by 50%), Scope 1 t CO_2e (by 38%), Scope 2 t CO_2e (by 20%), Scope 3 t CO_2e (by 120%), environmental standards used (by 260%) and following the EPRA Recommendations (2022) (by 180%). However, the baseline figures were often below 10 reporting entities. It was found that in 2021, half of the environmental measures were reported at least 20% more often than they were reported in 2019. This is a positive sign, as all other E-measures were reported by the same number of firms or 5-20% less often in 2021 compared to 2019.

Table 1. Overview of the Changing Number of Firms Reporting Environmental Measures in 2019 and 2021 (55 Sample Firms)

Information type	Number of reporting firms in 2019/2021	Information type	Number of reporting firms in 2019/2021
Number of rented units	22/33 (+50%)	Emission intensity of rentable area kg CO_2e/m^2	17/16 (-6%)
Total Energy Consumption MWh	21/18 (-14%)	Scope 1 t CO_2e	13/18 (+38%)
Energy intensity of rentable area kWh/m^2	17/16 (-6%)	Scope 2 t CO_2e	15/18 (+20%)
Heating consumption in portfolio MWh	16/16 (+/-0%)	**Scope 3 t CO_2e**	**05/11 (+120%)**
Water consumption million m^3	19/19 (+/-0%)	Emission intensity of BOP kg CO_2e/m^2	08/07 (-13%)
Waste volume t	15/12 (-20%)	Limited engagement opinion by auditors	01/02 (+100%)
Energy consumption BOP MWh	05/04 (-20%)	**Which Environ. Standards are used (e. g. GRI)?**	**05/18 (+260%)**
		EPRA Recommendations are applied	**05/14 (+180%)**

Source: Own research

Table 2 shows how many firms reported which kinds of social measures recommended by the EPRA. The reporting frequency of the following S-measures – the "S" dimension of ESG – increased: number of employees (by 10%), the share of women in % (by 32%), employees with permanent contracts in % (by 67%), the proportion of female executives in % (by 29%), the proportion of women on the board of directors/executive committee (by 29%), the salary ratio of women to men in % (by 55%), staff turnover rate in % (by 20%), new hired employees in % (by 33%), average sick days per year (by 15%), executive pay ratio women and men in % (by 20%), total occupational and commuting accidents (by 33%), average age in years (by 25%), full-time employees (by 30%), part-time employees (by 21%), and employee satisfaction measured via a survey etc. (by 100%). In 2019, most of the baseline figures were reported by more than 10 entities. In 2021, the only employee-related information that was reported 12% less often than in 2019 was the total number of trainees. This indicates that the companies involved in reporting have become more active in sharing employee-related information.

Table 2. Overview of the Changing Number of Firms Reporting Employee, Other Social and Governance Information in 2019 and 2021 – Part I (55 Sample Firms)

Information type	Number of reporting firms in 2019/2021	Information type	Number of reporting firms in 2019/2021
Number of employees	41/45 (+10%)	Average sick days per year	13/15 (+15%)
Share of women	25/33 (+32%)	Total number of trainees	17/15 (-12%)
Employees with permanent contracts	**12/20 (+67%)**	Executive pay ratio	10/12 (+20%)
Proportion of female executives	28/36 (+29%)	Total occupational and commuting accidents	15/20 (+33%)
% of women on the board of directors	25/32 (+28%)	Average age	17/21 (+24%)
Salary ratio of woman to man	**11/17 (+55%)**	Full-time employees	20/26 (+30%)
Staff turnover rate	20/24 (+20%)	Part-time employees	19/23 (+21%)
New hired employees	18/24 (+33%)	**Employee-satisfaction**	**08/16 (+100%)**

Source: Own research

Table 3. Overview of the Changing Number of Firms Reporting Employee, Other Social and Governance Information in 2019 and 2021 – Part II (55 Sample Firms)

Information type	Number of reporting firms in 2019/2021	Information type	Number of reporting firms in 2019/2021
Proportion of employees with Code of Conduct training	09/15 (+67%)	ESG specific training	09/16 (+78%)
Violations of the Code of Conduct	13/10 (-23%)	Customer survey	08/15 (+88%)
Regional sponsoring projects	09/14 (+56%)	Well-being certificate	04/04 (+/-0%)
Supervisory Board members	29/41 (+41%)	Business Partner Code of Conduct/ Supplier Code of Conduct	13/16 (+23%)
Proven case of corruption	22/21 (-5%)	**Own Sustainability Performance Index**	**02/09 (+350%)**
Incidents of discrimination	17/19 (+12%)	**Board compensation tied to sustainability measures**	**02/05 (+150%)**
Safety inspection of buildings	11/11 (+/-0%)	Anti-corruption processes implemented	20/23 (+15%)
Total number of suppliers	06/07 (+17%)	Human-rights issues commented/followed	11/13 (+18%)
Share of expenses for local suppliers (in %)	02/03 (+50%)	Sustainability certificates	13/20 (+54%)
		UN SDGs included in the report	**07/28 (+300%)**

Source: Own research

Table 3 shows how many firms reported which kinds of other social and governance measures recommended by the EPRA. The reporting frequency of the following SG-measures – the "SG" dimension of ESG – increased: proportion of employees with Code of Conduct training (by 67%), regional sponsoring projects (by 57%), Supervisory Board members (by 41%), incidents of discrimination (by 12%), total number of suppliers (by 17%), share of expenses for local suppliers in % (by 50%), ESG specific training (by 78%), customer survey implemented (by 88%), business partner or supplier Code of Conduct (by 23%), own sustainability index (by 350%), board compensation tied to sustainability measures (by 150%), anti-corruption processes implemented (by 15%), human-rights issues followed (by 18%), sustainability certificates (by 54%) and UN SDG's included in the report (by 300%). Concerning the latter 10 or more entities related their business activities to the following SDG's (not separately reported): SDG 3 (17 in 2021), SDG 5 (15 in 2021),

SDG 7 (26 in 2021), SDG 8 (20 in 2021), SDG 9 (15 in 2021), SDG 10 (10 in 2021), SDG 11 (24 in 2021), SDG 12 (21 in 2021), SDG 13 (30 in 2021), SDG 17 (12 in 2021). Many of the increases in reporting frequency are very high because most of the baseline figures from 2019 lie below 10 reporting entities. The SG-measures safety inspection of buildings and well-being certificate was reported by the same number of firms, while only proven cases of corruption and violations of the Code of Conduct were mentioned at 5% and 23% respectively, less often than in 2019.

Overall, a significant number of real estate companies started to comment on various ESG dimensions – this indicates a positive trend in the real estate industry between 2019 and 2021 and the recognition of the urgency to act towards sustainable practices.

5. CONCLUSION

This study shows that the frequency of reporting has increased due to the rise in the adoption of international sustainability standards (+260%), SDGs (+300%), and EPRA recommendations (+180%), which demonstrates an increased awareness of sustainability issues. As a result, more ESG measures have been reported, particularly social and governance measures. This has made it easier to compare the sustainability practices of companies from different countries in Europe. Many companies have created their own Sustainability Performance Index (+350%), are even tying board compensation to these measures (+150%), and report about employee satisfaction (+100%). Sustainable practices are becoming a standard business practice for the largest real estate companies in Germany, Austria, and Switzerland.

While these findings provide a good indication of the situation, the analysis was based on only two years of data from a relatively small sample of a single industry. Future research could conduct, for example, a content analysis across various industries over several years. The introduction of new sustainability standards and the focus on relevant sustainability measures for different industries at the EU level from 2024 onwards may improve reporting quality. Policymakers, lobbyists, and regulators should consider the findings of this study and reduce the level of complex bureaucracy imposed on businesses to promote a greener environment.

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Breaking the Barriers to Services Trade in Central and Eastern Europe

Jasna Tonovska[1]

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Services;
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Abstract: *Rapid technological advancements have caused profound shifts in the global economy, establishing services and their trade as pivotal components within the framework of economic transformation. The study investigates developments in international trade in services within five CEE countries over the last two decades, using various data sources - the Balance of Payments (BOP), the overall and the digital services trade restrictiveness index (STRI) and trade in value added. Despite CEE countries being net-exporters of services, the share of services in total external trade remains limited. Also, several 'modern services' exhibit an increase in their exports and services supplied internationally through mode 3 are substantial. As reflected in the modest share of services exports in GDP, services in CEE exhibit low tradability. Both STRI and Digital STRI data suggest that services sectors in CEE have open regulatory environment for trade. The findings highlight the importance of prioritizing digitalization and leveraging technological advancements to enhance services trade and foster economic growth in the CEE region.*

1. INTRODUCTION

The profound changes in the global economy resulting from swift technological advancements have positioned services and the trade thereof as central elements in the process of economic transformation. These transformations pose a direct challenge to conventional perspectives that have historically regarded services as an inferior avenue for achieving economic growth and development. Today, the services sector not only surpasses agriculture and industry combined in terms of job creation (constituting 50% of global employment) and economic output (comprising 67% of the world's GDP), but it is also increasingly assuming this role in economies at earlier stages of development (WTO & World Bank, 2023). Therefore, the trade of services and the formulation of pertinent policies play a pivotal role in harnessing the potential of a services-driven approach to development.

Fueled by advancements in information and communications technologies (ICT), the global export of commercial services experienced an almost threefold increase between 2005 and 2022. This period was marked by significant shifts in the composition of the services trade, notably with a nearly fourfold growth in exports of digitally delivered services. Within this timeframe, developing economies progressively contributed a larger portion of less conventional services exports. The expansion of these exports in developing economies is increasingly linked to services provided across borders through digital channels, a phenomenon often referred to as the 'servicification' of the global economy. While the services trade sector endured severe setbacks due to the COVID-19 pandemic, digitally delivered services played a pivotal role in leading the recovery of global services trade and proved to be fundamental in enhancing economic resilience.

[1] Faculty of Economics – Skopje, Ss. Cyril and Methodius University in Skopje, Bul. Goce Delcev 9V, 1000 Skopje, Republic of North Macedonia

The countries in Central and Eastern Europe (CEE) have traversed a three-decade journey of transitioning to market capitalism and striving for convergence with Western Europe. However, it is evident that the convergence process, particularly for the more advanced CEE nations, has decelerated since 2007. This slowdown suggests that the current growth model may be approaching its limitations, prompting the need to contemplate a new growth paradigm for the region. In that sense, the policymakers in CEE countries should consider designing policies that would enable moving from the existing specialization in various manufacturing-oriented functions across the value chains to more profitable segments encompassing mainly services - design, research and development, marketing, and various contemporary business services.

This research investigates the international trade in services among CEE countries and assesses the prospects for deepening this trade by addressing existing regulatory constraints. The remainder of the paper is structured as follows: Section 2 offers a brief empirical and historical background on trade in services and its relevance for the CEE countries as a new engine for economic development. Section 3 provides more details on the developments in various aspects of the services trade in the CEE region from the data on Balance of Payments (BOP) and trade-in value added. Section 4 analyses the results of the Services Trade Restrictiveness Index (STRI) and Digital Services Trade Restrictiveness Index provided by the Organization for Economic Co-operation and Development (OECD), whereas section 5 discusses the policy recommendations that could provide an impetus for further growth in services and services trade. Section 6 concludes.

2. BACKGROUND

This study relates to two broad streams of literature. First, the topic of the paper is closely linked to the ever-evolving body of research on international trade in services and the impact of the policies. Second, it is linked to the research on the determinants of trade and economic development in the economies of CEE.

The newer studies collectively highlight the complex and interrelated factors shaping international trade in services. They underscore the importance of regulatory coherence, digital policies, evolving trade restrictions, and external shocks in understanding this dynamic landscape. Lawless (2021) emphasizes regulatory frameworks and policy coordination as key to promoting international trade in services, particularly in the digital age. This is in line with Van der Marel and Ferracane (2021), who highlight the impact of restrictive data policies, showing that they reduce imports of data-intensive services, particularly in countries with less advanced digital networks. Benz et al. (2020) provide a broader perspective, showing that trade restrictions vary significantly across countries and sectors. Recent years have witnessed an increase in services trade restrictions, with a focus on limiting the movement of people and tightening investment screening. Their research establishes a strong negative relationship between STRI and trade in services. Examining the impact of global events, Ando and Hayakawa (2022) reveal that the COVID-19 pandemic had a more pronounced negative impact on services trade than on goods trade, particularly in services reliant on international movement. In contrast, cross-border supply services, like computer services, were less affected. Finally, Hoekman and Shepherd (2021) use machine learning to recreate the STRI, finding that services policies are typically more restrictive than tariffs on goods imports. The resulting Services Policy Index (SPI) is a powerful predictor of bilateral trade in services at sectoral and aggregate levels.

The literature on CEE countries' trade and economic development provides a comprehensive view of the challenges and opportunities in the CEE region's economic development. Römisch (2001)

emphasizes the role of services trade as a catalyst for modernizing CEE economies and offers both theoretical and empirical perspectives on services trade in several CEECs, with a specific focus on the Czech Republic, Hungary, and Poland. Vidovic (2002) extends this analysis to seven CEE transition countries, examining developments in their services sectors, comparing them to European Union (EU) countries, and highlighting the impact of foreign direct investment (FDI) on the services sector's growth. The accession to the EU and the implementation of highly permissive trade and FDI policies enabled the CEE countries to integrate themselves into European production networks. Consequently, this integration resulted in an alignment in their production and export structures. This convergence underscores that the manufacturing capabilities of the CEE region extend beyond low-tech sectors (e.g., food and beverages) or resource-intensive industries (e.g., wood or basic metals) and encompass more sophisticated sectors, such as electronics and motor vehicles, which have gained particular significance for the region.

Nevertheless, the IMF (2016) reports that TFP growth in CESEE countries slowed post-crisis due to various factors like stagnant potential growth in advanced Europe and reduced global trade and supply chain expansion. Specifically, the CEE countries, notably those within the Viségrad group, exhibit a pronounced specialization as manufacturing-oriented economies, emphasizing production, which represents the least financially rewarding segment of the value chain. Given their income levels, the CEE countries within the EU should have, by now, transitioned towards greater specialization in the more profitable segments of the value chain. This entails areas that are by their nature, predominantly services, encompassing design, research and development, marketing, and various contemporary business services. McKinsey Global Institute (2013) offers a growth model for CEE economies that emphasizes investment-led growth, export expansion, productivity enhancement, and institutional reforms as key drivers for future development, aiming to attract FDI. According to WIIW (2021), digital transformation possesses the potential to invigorate economic growth in CEE countries. Specifically, the Czech Republic, Hungary, Poland, Romania, and the Slovak Republic are better positioned than other CEE nations to forge a new growth model anchored in value chains linked to advanced digital production technologies. Quality educational systems and digital proficiencies of the young population would serve as advantageous human capital foundations in many CEE countries, which, in turn, could provide the impetus for economic growth built upon innovative digital services.

3. SERVICES IN BOP DATA AND BEYOND

We proceed by examining the stylized facts of services trade in the CEE region. This research covers the sample of 5 CEE countries: Czech Republic, Hungary, Poland, Slovak Republic, and Slovenia, for the period from 2000 to 2022. The principal source for services trade data that is used is the Balance of Payments. In addition, we scrutinize other datasets, to complement the general analysis and provide deeper insights into different aspects of services and their role in economy and international trade.

Albeit services in general play an important role in the domestic economy, their importance for international trade considerably lags. For the CEE countries, trade in services represents only a marginal component of the total external trade. Trade in goods consists of the majority of trade, with a notable rise in its share across the sub-periods. On the other hand, the participation in services trade is modest and broadly amounts to 20% of GDP and with a stable relative share in total trade. Regarding the balance of trade, all the countries are net-exporters of services. In contrast, the results with goods are heterogeneous in the most recent period, with the Czech Republic and Slovenia being net-exporters and Hungary, Poland and the Slovak Republic being net-importers of goods.

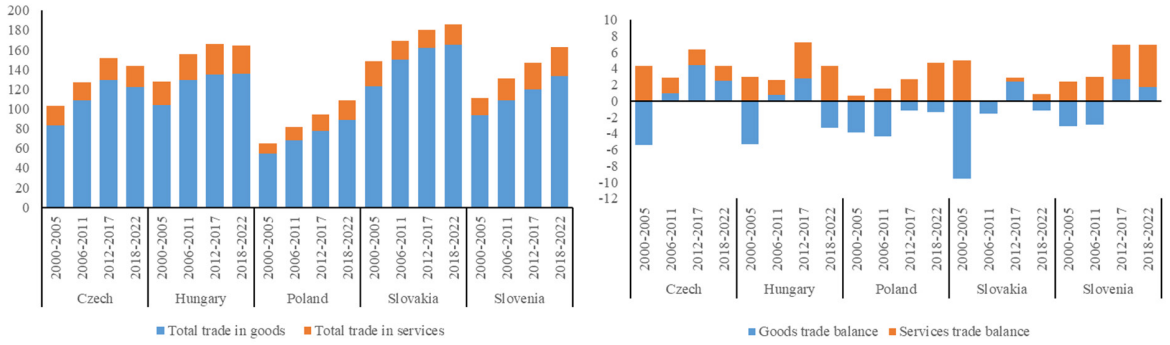

Figure 1. Total trade and balance of trade in goods and services (% of GDP)

Source: IMF, 2023; Own calculations

The sectoral distribution shows that services exports across CEE countries in 2022 are dominated by transport and travel services, which is a usual pattern in global services trade. In addition, 'other business services' and 'telecommunication, computer and information services' comprise an important component of the services exports for the CEE countries. These categories reflect the technological advances in the period under review and represent segments of modern services – services that can be supplied electronically and are generally associated with higher sophistication and productivity. Compared to 2000, the largest increase is registered in transport services. Within modern services, the fastest growing subsectors are 'telecommunication, computer and information services', 'charges for use of the intellectual property' and business services.

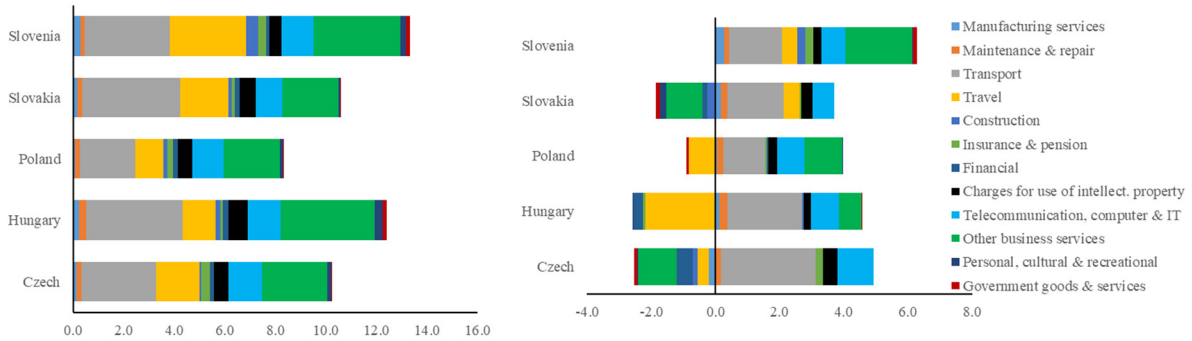

Figure 2. Sectoral decomposition of exports in services, 2022 (% of GDP) and change in the sectoral decomposition of exports in services, 2022 -2000 (p.p.)

Source: IMF, 2023; Own calculations

The comparison of the share of services value added with the share of services exports in GDP indicates whether the importance of the services sector for the domestic economy translates into competitiveness externally. In the CEE countries, the share of services value added in GDP has been stable across the sub-periods and now accounts for the most total value added (about 60%). On the other hand, relatively limited and stable services exports (less than 10% of GDP) suggest that services in this region exhibit low tradability. Further diagnostics might reveal whether the reason is the nontradable nature of services produced in the region or other causes, such as the presence of regulatory obstacles.

Services supplied internationally through mode 3 are rather substantial, which is signaled by the developments in FDI in services worldwide. In CEE countries, services sectors are now the predominant destination of FDI, or in other words, FDI is becoming the most common channel

for foreign suppliers to provide services. For the period 2017-2022 on average, services account for about two-thirds of total inward FDI in the region, which is in line with the contribution of services FDI in global FDI as of late. Due to the presence of FDI, the region may in the future reap benefits in the form of the transfer of services-related know-how and technology, as foreign firms introduce new types of services that may be better suited to the needs of clients or provide existing services at lower cost than was available before they entered the market.

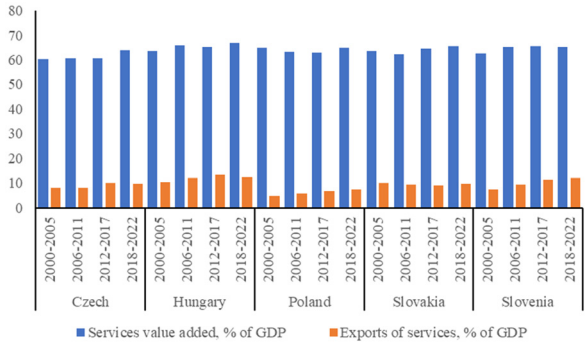

Figure 3. Exports of services (% of GDP) and services value added in GDP (in %)

Source: IMF, 2023; Own calculations

To provide more systemic and comprehensive empirical evidence about the real contribution of services in world trade we must examine services that are exported indirectly, namely services that are embodied in other goods or services. Trade in value-added statistics enables highlighting the reliance on domestic versus foreign inputs of production destined for domestic and foreign markets. When exports are measured in value added terms rather than gross terms, services account for more than half of the total exports. Disentangling between value added from gross figures provides insights into the importance of the domestic content of trade. For the period 2018-2022 on average, the share of services value added in gross exports in CEE countries amounts to about 50%. The data on trade in value added demonstrate the important implications for services trade by the servitization of the manufacturing sector – referred by Baldwin et al. (2015) as "changes in the sources of value in manufacturing, specifically the increased role of services in manufactured goods".

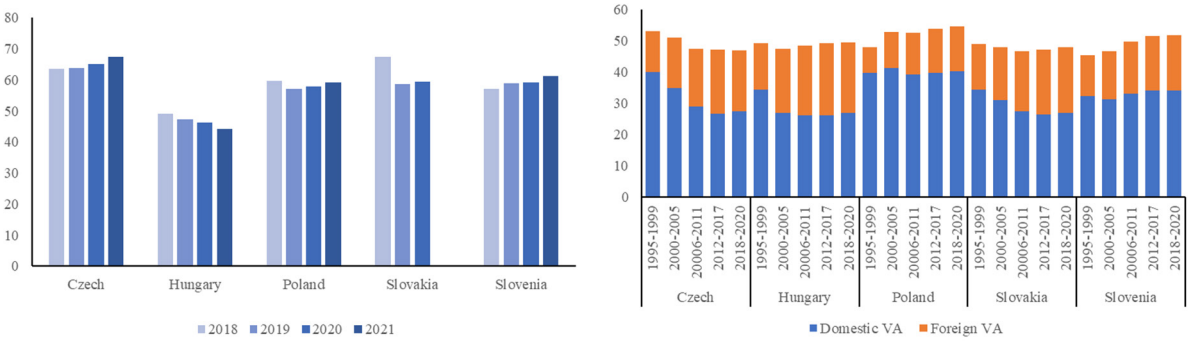

Figure 4. FDI in services (% of GDP) and services content of gross exports (in %)

Source: IMF, 2023; OECD, 2023a; Own calculations

4. SERVICES TRADE RESTRICTIVENESS

The following diagnostics should reveal whether the reason for the modest results in services trade in CEE countries is the nontradable nature of services produced in the region or other causes, such as the presence of regulatory obstacles. To tackle this issue, the study primarily

relies on the STRI and the Digital STRI data, provided by the OECD. This data encompasses de jure services trade policy restrictions.

The STRI scores serve as a distinctive empirical instrument, collecting pertinent information about services trade constraints across 19 key service sectors. Utilizing qualitative information available within the database, composite indices are computed to quantify the identified restrictions within five standard policy categories (Restrictions on foreign entry, Restrictions on movement of people, Other discriminatory measures, Barriers to competition and Regulatory transparency). These indices produce values ranging from zero (indicating complete openness to international trade) to one (indicating complete closure to trade).

The STRI data provide evidence that, on average, services sectors in CEE countries have an open regulatory environment for trade in services, especially the Czech Republic. Nevertheless, there are two areas with noticeably higher barriers to trade and competition - legal services and air transport.

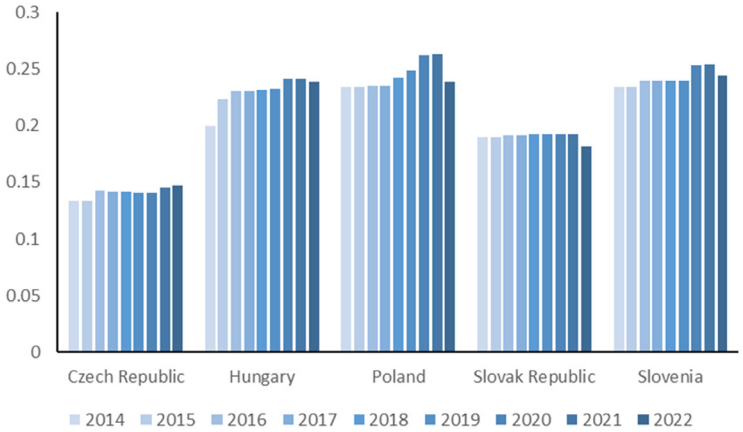

Figure 5. Services Trade Restrictiveness Index

Source: OECD, 2023b

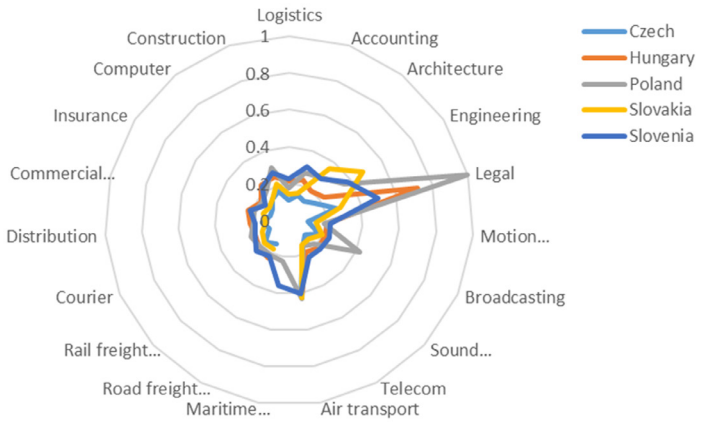

Figure 6. Services Trade Restrictiveness Index decomposition, 2022

Source: OECD, 2023b

In all countries, albeit to a varying degree, conditions on the entry of natural persons seeking to provide legal services in the country temporarily as contractual services suppliers remain the most cumbersome. This implies some potential for a further rise in exports of services in these economies, driven by a diminishment of the remaining barriers to services trade.

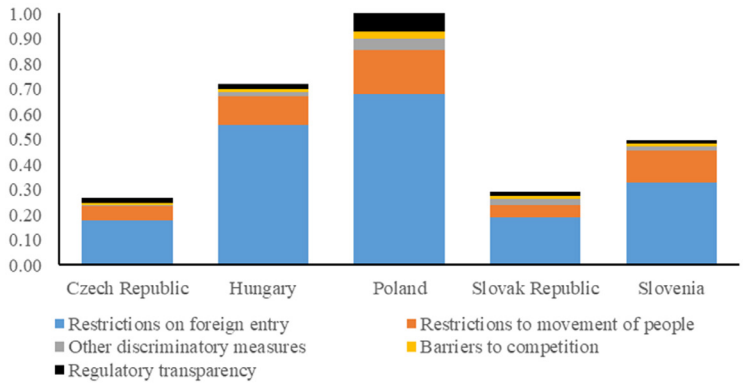

Figure 7. Services Trade Restrictiveness Index decomposition barriers for legal services, 2022

Source: OECD, 2023b

The analysis that follows is focused on the developments of the Digital STRI for the sample of CEE countries. The Digital STRI identifies and quantifies barriers that affect trade in digitally enabled services. The Digital STRI captures cross-cutting impediments that affect all types of services that are traded digitally. The Digital STRI framework is categorized in the following areas: Infrastructure and connectivity, Electronic transactions, Payment systems, Intellectual property rights and Other, and, similarly to STRI, it ranges from zero to one (implying closure to digitally enabled trade).

The results for CEE countries point to an open regulatory setting for trade in digitally enabled services. The Digital STRI score for Poland stands out, pointing to more closed trade in digitally enabled services for the country. The results are driven by measures affecting infrastructure and connectivity. This is due to the lack of efficient regulation on interconnection as well as burdensome conditions on cross-border data flows beyond those imposed to ensure the protection and security of personal data.

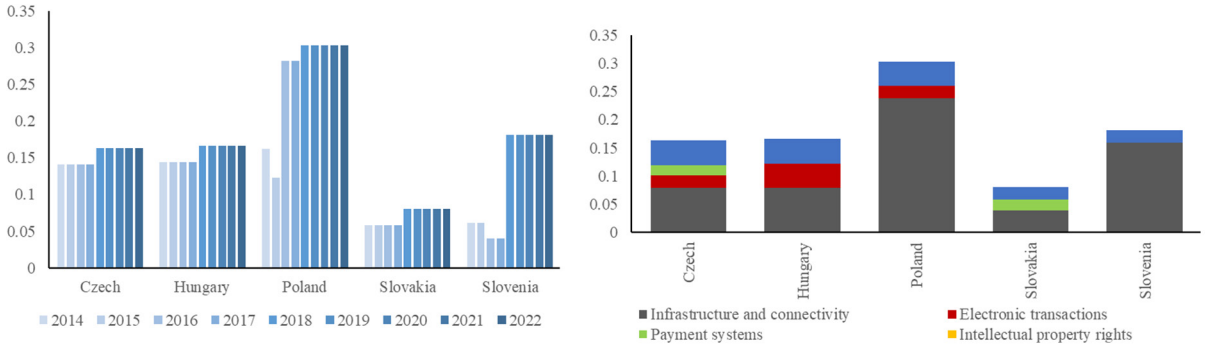

Figure 8. Digital Services Trade Restrictiveness Index and decomposition, 2022

Source: OECD, 2023b

In summary, trade in services represents only a marginal component of the total external trade for the CEE countries, whereas all the countries are net-exporters of services. Within the last two decades, several services sectors that account for 'modern services' exhibit an increase in their exports. Still, as reflected in the modest share of services exports in GDP, services in this region exhibit low tradability. Both STRI and Digital STRI data suggest that, on average, services sectors in CEE countries have a fairly open regulatory environment for overall trade in services and in digitally enabled services. Still, there are discernible areas where barriers to trade and competition still exist.

5. POLICY RECOMMENDATION

Considering the findings presented so far, the primary reason for the limited export performance of services in CEE countries is the low tradability of these services, rather than the regulatory barriers which present only a secondary hindrance to trade. Therefore, prioritizing digitalization and leveraging technological advancements is vital for boosting trade and economic growth. To this end, we suggest several recommendations for policymakers in the CEE region:

First, the process of digital transformation holds substantial potential for significantly augmenting economic growth within the CEE region. Several countries in this region possess the capacity to establish a fresh growth model that centers around value chains connected to advanced technologies. These developments present an opportunity to broaden specialization towards digital services crucial for facilitating advanced technologies. The region's relatively robust education systems, coupled with the advanced digital competencies of its youthful demographic, serve as assets in this endeavor. Nevertheless, this transformative journey faces a critical challenge in the form of IT professional shortages resulting from substantial outward migration.

Secondly, positive expected outcomes may occur because of reorienting the specialization of the CEE countries towards more profitable segments of the value chain. In that sense, the countries from this region should actively attract and host a greater number of corporate headquarters, encompassing functions like design, research and development, marketing, and various modern business services. A heightened focus on logistics, marketing, research and development, and other non-production tasks within the CEE region is paramount.

Thirdly, another crucial priority revolves around the complete embrace and effective utilization of the ongoing digital revolution, which has received considerable momentum from the COVID-19 pandemic. The barriers to entry in the digital realm are generally lower, as the infrastructure required for a modern digital economy is comparably more straightforward to implement than that for traditional manufacturing. Human capital plays a paramount role in the digital economy, and this stands as a realm of relative strength for much of the CEE region.

6. CONCLUSION

This study investigates the international trade in services among CEE countries and assesses the prospects for deepening this trade by addressing existing regulatory constraints. Specifically, the services trade for five CEE countries is dissected: Czech Republic, Hungary, Poland, Slovak Republic, and Slovenia, over the period from 2000 to 2022.

The analysis points to several relevant findings. First, trade in services represents only a marginal component of the total external trade for the CEE countries, whereas all the countries are net-exporters of services. Also, several services sectors which account for 'modern services' exhibit increases in their exports. In addition, services supplied internationally through mode 3 are substantial. As reflected in the modest share of services exports in GDP, services in CEE exhibit low tradability. Moreover, the empirical findings derived from the STRI data reveal that, on average, services sectors in CEE countries exhibit a relatively open stance towards international trade. Nevertheless, there are discernible areas where barriers to trade and competition are notably elevated, specifically in the domains of legal services and air transport. Similarly, the results from the Digital STRI point to an open regulatory setting for trade in digitally

enabled services. The results are driven by measures affecting infrastructure and connectivity, which could be due to the lack of efficient regulation on interconnection as well as burdensome conditions on cross-border data flows. These observations imply the presence of untapped potential for a further expansion of services exports in these economies. Such expansion could be driven by the reduction of the remaining impediments to services trade within these sectors.

These findings hold significant relevance for policymakers in CEE countries in the realm of trade, and economic development, as well as researchers. They emphasize the need to prioritize digitalization and harness technological advancements to boost services trade and stimulate economic growth in the region.

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Market Analysis of FCEV Strategies for European OEMs

Abdurrahman Bekar[1]
Milan Fekete[2]

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Keywords:
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International automotive market;
Fuel cell technology;
Alternative drive infrastructure

Abstract: *This paper assesses the potential feasibility of a stand-alone fuel cell electric vehicle market for Europe to be evaluated as a possible alternative to battery electric vehicles (BEVs) in the global automotive industry. Here, the availability of hydrogen as well as the potential of the infrastructure associated with a fuel cell strategy must be considered. Taking into account the internal and external situations in the area of geopolitics, raw material production and import dependencies as well as the social acceptance of fuel cell vehicles (FCEVs), an actual situation is to be derived that shows what opportunities FCEVs have in a European and international market. The aim is to make clear which entry barriers exist in the industry, but at the same time which potentials a European OEM entry has. As a result, it can be shown that an FCEV strategy in the current situation would theoretically be well achievable.*

1. INTRODUCTION

Europe is to become the first climate-neutral continent. This is how the EU has formulated its objectives for climate policy and the resulting measures. This goal is to be achieved by 2050, and by 2030 a partial target has been set to reduce emissions by 55% compared to the reference year 1990. The EU policy sees an important share in the mobility sector, and here in the automotive industry. To this end, the Commission has decided that from 2035 onwards no more cars may be manufactured that are powered by fossil fuels (EU Commission, 2021).

The dominant alternative to fossil fuels so far is seen by OEMs in purely battery-powered vehicles (BEV), which are considered zero-emission vehicles in the emissions balance for engine technology. The breakthrough to a large-scale rethinking by customers has not been brought about, even though the number of BEVs is increasing. Other alternatives, such as fuels from agricultural products or hydrogen, are not yet implemented in Europe for a nationwide strategy, even though progress has already been made in the area of research and use in the truck sector.

However, the German Association of the Automotive Industry called for 2020 (VDA, 2020), "Especially in view of the major goal of climate-neutral transport, however, we will need all drive options - for example, also e-fuels and hydrogen. The great challenge of combating climate change will only succeed if we are open to all technologies. In our view, a tightening of the climate targets means that hydrogen and renewable fuels will have to be used much more in the future than they have been so far" (p. 3).

The reasons are seen in the not yet fully developed technology, which must first be built up through further research and development. In addition, no major progress has been made in

[1] Comenius University Bratislava, Odbojarov 10, 820 05 Bratislava, Slovak republic
[2] Comenius University Bratislava, Odbojarov 10, 820 05 Bratislava, Slovak republic

the infrastructure of refueling facilities across Europe that would enable a nationwide strategy. Compared to the rest of the EU, Germany still has the largest refueling infrastructure, which, however, cannot be used by customers without problems (Hagendorn et al., 2019, p. 43).

In addition to the technical challenges, building a functioning hydrogen infrastructure is also economically demanding. The construction of hydrogen filling stations is expensive. Moreover, once the technical issues for hydrogen vehicles have been solved, a "chicken-and-egg" problem could loom: as long as there is no nationwide network of hydrogen filling stations, sales of hydrogen-powered vehicles will be slow. Conversely, no one feels motivated to invest in hydrogen filling stations as long as there is no significant population of hydrogen vehicles. (Hilgers, 2016, p. 61).

In the meantime, however, it has been increasingly recognized in electric car development that a pure BEV strategy poses problems for the European market due to various parameters. First of all, there is a high dependence on raw materials for battery production, the battery production itself, and the resilience of the supply chains. In addition, it is increasingly recognized that the recycling system for car batteries does not yet appear to be sufficiently developed (NPM, 2021, p. 10).

On this basis, the possibilities of the European OEMs are to be assessed as to whether a hydrogen strategy for vehicles can create an opportunity for improvement in the problem factors. For this purpose, the market must be recorded in its current situation and the possibilities of all relevant industrial factors for FCEVs must be estimated.

2. RESEARCH METHODOLOGY

The most popular market-oriented approach is associated with the research and findings of Michael Porter, whose well-known five forces model determines the factors for a market entry of new companies or the strategic reorientation of existing companies. In his model, Porter has thereby transferred the observation level of economic theories into an industry analysis model and considered the most important determinants acting on the industry as influencing factors on the existing companies. Porter´s five forces model is used within the desk research conducted for writing this article.

The model dates back to the 1980s and is still considered a stable cornerstone for market and sector analysis today. Thus, for the analysis of the FCEV market, despite existing criticisms of Porter's model, by pointing out usable possibilities for taking up the criticisms and omissions, Porter still has a substantial function.

3. MARKET ANALYSIS OF THE AUTOMOTIVE INDUSTRY FOR FCEVS

Asian automakers have established themselves as leaders in the global FCEV market due to their remarkable contributions to the field of technological advancement. The companies have made significant investments in R&D and production, giving them a competitive edge. Due to their extensive investment in R&D, Japan, South Korea and China now dominate the global FCEV market and are the main producers of FCEVs (Lou et al., 2020). The statistical data show that almost 2/3 of all FCEVs registered worldwide are in Asian countries, with South Korea representing the main national sales market with approx. 3/4. Japan follows with the remaining statistically recorded FCEV of approx. 1/4. China will offer its own FCEV models in the future (Wang, 2021), and therefore does not appear in the statistics, as Korean and Japanese models have dominated the range so far.

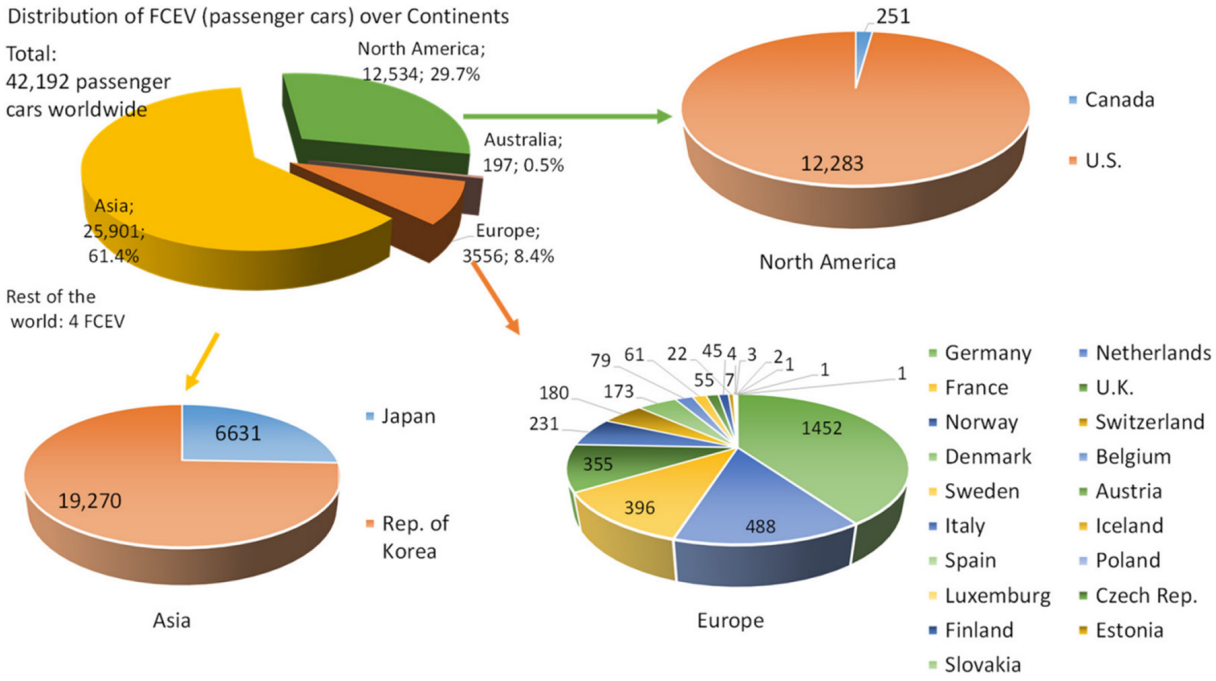

Figure 1. FCEVs in absolute numbers worldwide

Source: Samsun et al., 2022, p. 6

Assuming that there are more than 48 million registered passenger cars in Germany alone and that 2.7 million of them have an alternative drive to fossil combustion (DENA, 2022, p. 1), it is impossible to speak of a real market segment. A comparison with 2020 shows an increase in European registrations of FCEVs, but the share is still very low at 3,556 vehicles and remains below 1% of all vehicles.

For the sector of larger automobiles in the area of buses and trucks, the use of fuel cell technology seems to be most efficient at the current state of the art, as the construction sizes of fuel cells and tank sizes are easier to implement. This vehicle segment is also expected to have the greatest market potential for fully dedicated market segments in the near future (Belmer et al., 2019, p. 13). Outside China, there were still almost no commercial vehicles equipped with fuel cell drive systems in 2020. In addition, the continuous increase in the performance of batteries in terms of range and charging time further limits the market opportunities for fuel cell commercial vehicles (Clausen, 2022, p. 39).

In 2022, the statistical data confirms the clear dominance of registered vehicles in the Asian region. With its expanding strategy of hydrogen use, China has developed a wide lead here that exceeds the use of other Asian markets many times over. The commitment to research and development and its strategic, long-term approach have helped China to achieve a significant share of global supply (Zhang et al., 2017). This is also related to the possibilities of hydrogen production, which in China is based on fossil fuels (coal and natural gas). Of the global share of 63 million tonnes of hydrogen, China accounted for 22 million tonnes (WKÖ, 2022, p. 31). This means that there is a high potential, but the energy balance is sobering due to the production of 'black' (coal-based) and 'grey' (natural gas-based) hydrogen (Clausen, 2022).

The figures for FCEV truck registration show the following statistical distribution by selected countries.

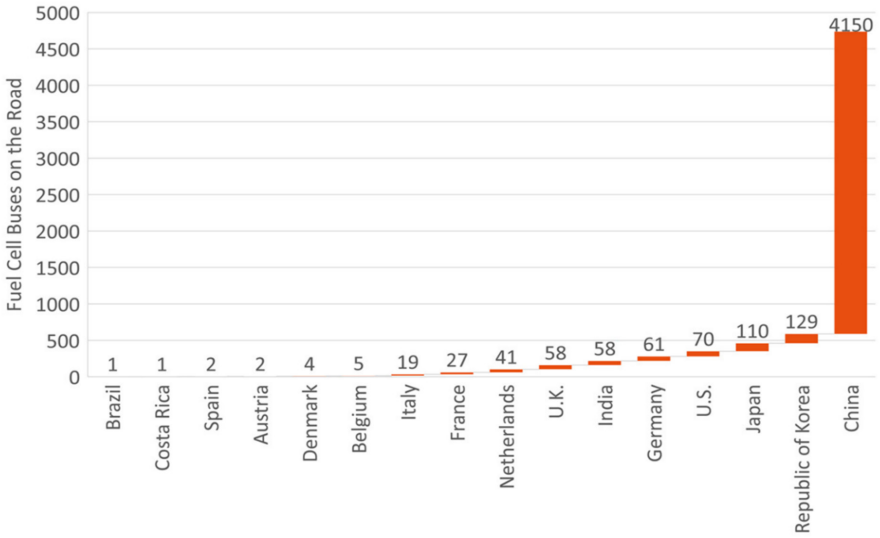

Figure 2. Registered buses on the road as FCEVs

Source: Samsun et al., 2022, p. 8

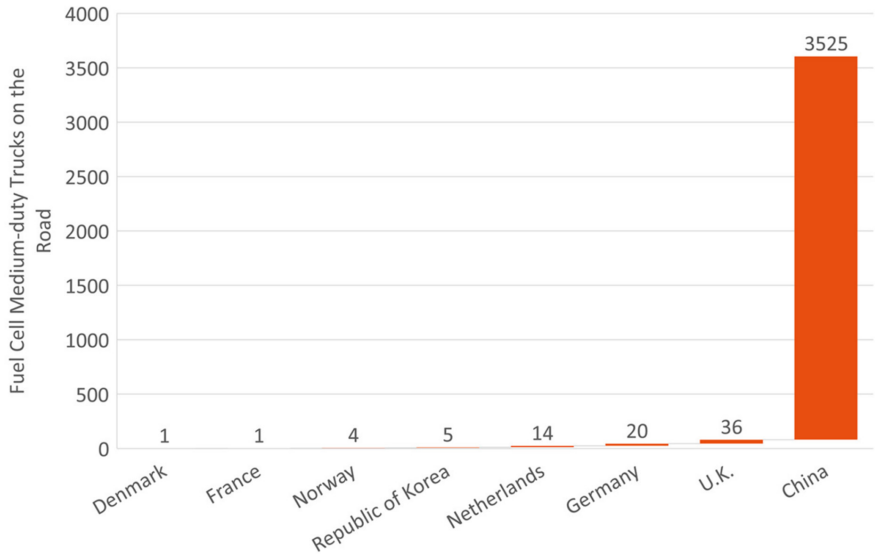

Figure 3. Registered commercial vehicles on the road as FCEVs

Source: Samsun et al., 2022, p. 8

In the past, Asian FCEV manufacturers have focused on meeting domestic demand. Instead of looking outside for economic opportunities, several Asian countries have chosen to focus first on expanding their own economies and supplying their domestic markets (Yang et al., 2020). They have been able to get a head start in manufacturing and expanding FCEV infrastructure, thus creating a solid foundation.

China started the internal expansion of an FCEV infrastructure in 2019 and has provided various government support programmes for this purpose in 2020 (WKÖ, 2022, p. 38). In doing so, China is also relying on market leadership in battery production, which is necessary for FCEVs. The previous autonomy in this area could be maintained through far-reaching state subsidies. In 2020, the subsidies were suspended and the Chinese domestic market was also opened to international battery manufacturers. Korean and Japanese companies have since established themselves in the market.

The widespread adoption of FCEVs requires the development of a comprehensive hydrogen infrastructure that includes an extensive network of hydrogen refueling stations and increased capacity for hydrogen production. The effectiveness of export efforts depends on the availability of the necessary infrastructure for the widespread acceptance of FCEVs by foreign buyers (Xuesong et al., 2005).

There is potential for collaboration between non-Asian stakeholders and Asian manufacturers to jointly increase the attractiveness and stimulate demand for FCEVs in markets outside Asia. Cooperation could bring benefits in several areas, such as FCEVs, hydrogen refueling networks, technological standards and sharing of best practices (Saadi et al., 2020). Building bilateral alliances and joint efforts can also help advance the goals of Asian FCEV manufacturers in exporting their products. Improving international cooperation increases the potential for mutual benefits through the exchange of information, expertise and resources between participating nations. The establishment of these groups can accelerate the development of infrastructure for FCEVs in markets outside of their own country, thus promoting the globalization of the FCEV industry (Raminosoa et al., 2010).

Asian manufacturers are currently investing in the research and development of FCEVs as a viable replacement for battery electric vehicles (BEVs). These manufacturers are particularly focused on the markets in Japan, South Korea and China. These countries are keen to reduce their dependence on fossil fuels and see the development of FCEVs as an important means of achieving this goal. Japan is making significant investments in research and development of fuel cell electric vehicles (İnci et al., 2021) to address energy security and environmental sustainability issues. The Japanese government hopes to have 80,000 FCEVs on the road by 2030. To achieve this goal, all major Japanese manufacturers, led by Toyota, have invested heavily in the development of FCEVs (Akinyele et al., 2020).

Thanks mainly to South Korea's financial investments, (FCEV) technology has made considerable progress (Panday & Bansal, 2014). South Korean car manufacturers Hyundai and Kia were among the first to produce FCEVs (fuel cell electric vehicles). To this end, the South Korean government has invested heavily in hydrogen refueling stations so that citizens can use FCEVs. The result of all these efforts is an increase in sales of FCEVs, making them more competitive with BEVs (Mokrani et al., 2014).

China, which leads the world in automobile consumption, recognizes the inherent opportunities of FCEVs to reduce the country's dependence on non-renewable energy sources. The Chinese government has set a strategic goal of achieving parity between the production of FCEVs and battery electric vehicles (BEVs) within the next decade. Chinese manufacturers, such as BYD and Geely, are actively engaged in the research and development (R&D) of FCEVs to meet growing demand in the domestic market and build a future competitive advantage in international markets (Pei & Li, 2019). For the time being, the Chinese government is planning to increase the number of FCEVs in the commercial vehicle sector. To this end, 100,000 FCEVs are to be produced by 2025 (WKÖ, 2022, p. 42).

The promotion of FCEVs is in line with the long-term goals of these three countries to reduce greenhouse gas emissions, improve energy security and combat climate change (Zhang et al., 2018). Asian manufacturers recognize that FCEVs have the potential to compete with battery electric vehicles (BEVs) due to their advantages in terms of longer range, shorter refuelling time and the ability to use renewable hydrogen as a fuel source.

South Korea is likely to set more ambitious targets for the widespread adoption of FCEVs in the near future. The goal is to sell 700,000 fuel cell electric vehicles by 2030. The government is working on a strategy to achieve this goal by offering financial incentives to promote the use of FCEVs and supporting the expansion of hydrogen refuelling stations (Samsun et al., 2022, p. 14).

In recent years, both the production of FCEVs and the widespread use of this technology have not increased in Europe until 2021. While there was significant development of FCEV technology in the region in the late 1990s and early 2000s (Mohrdieck et al., 2017, p. 64). In contrast, however, battery electric vehicles (BEVs) have emerged as market leaders in recent years (Mitzel & Friedrich, 2018, p. 131). As a result of this shift, Europe fell behind other regions in the development of FCEVs. Several European countries investigated the feasibility of fuel cell vehicles. Some European car manufacturers have developed fuel cell prototypes or produced fuel cell cars in small numbers. BMW, Mercedes-Benz, Peugeot, Renault and Volkswagen are just some of these manufacturers. The purpose of these tests was to evaluate the performance of FCEVs under realistic conditions (Weider et al., 2003, p. 14).

The number of FCEV registrations in Europe has remained shockingly low despite pioneering efforts and technical achievements. There are currently less than 4,000 FCEVs on the road in Europe. One problem area is the infrastructure for refuelling FCEVs. Hydrogen refuelling stations have not become widespread for many reasons, including a lack of supporting infrastructure, high costs and complicated logistics.

In the meantime, however, the efforts to achieve the climate goals as well as energy supply problems are being expanded by geopolitical tensions in the European markets. The looming energy crisis caused by Russia's attitude towards massive European support with military goods for Ukraine as well as a threatening conflict with China over the Taiwan issue are currently massive triggers here.

The expansion of hydrogen infrastructure will thus continue, which will also lead to an increase in the number of hydrogen filling stations worldwide. Asia leads the way with 275 hydrogen filling stations, followed by Europe with about 200, of which almost 100 are in Germany. In North America, 75 hydrogen filling stations are in operation, 50 of which are in California alone, where the implementation of climate change in the USA has progressed the furthest (H2-Mobility, 2021, p. 7).

The shift in thinking has become more apparent, especially currently. The ongoing crisis in Ukraine since 2014 has led to a looming reduction in the availability of natural gas, an energy source that has long been crucial for Europe (Chaitanya & Rambabau, 2014). Following recent disruptions in natural gas supplies, demand for reliable alternatives has increased as prices have risen significantly (OECD, 2022, p. 5). These factors have led Europeans to invest in researching and developing alternative energy sources, as well as in upgrading their energy infrastructure. Cooperation between European countries and energy-rich countries such as Qatar and Abu Dhabi to build liquefied natural gas (LNG) facilities is crucial. The use of these terminals is crucial for the production of hydrogen, which acts as a flexible and environmentally friendly energy carrier (Huang et al., 2019).

The introduction of FCEVs in Europe has the potential to increase the region's competitiveness, reduce its dependence on fossil fuels and make a significant contribution to the decarbonisation of transport (Uzunoglu & Alam, 2007). Moreover, the global automotive sector provides a highly competitive environment for the effective introduction and diffusion of FCEVs, as well as for solving energy supply problems (Gautam et al., 2021). In comparison, the European market for

FCEVs records a much lower number of registrations (Ahmadi et al., 2018; Samsun et al., 2022). In contrast to the established standards in the Asian market, one problem that is hampering the progress of truck and bus manufacturers towards widespread series production is the inadequate infrastructure (García et al., 2013; H2-Mobility, 2021).

Passengers cars	BMW	FCEV passenger car (2022) iHydrogen Next as technology project
Light commercial vehicles	Opel	Vivaro-e-Hydrogen (end of 2021) and two similar models Peugeot/ Citroën as small series, produced in Rüsselsheim (Germany)
Heavy commercial vehicles	Daimler/Volvo Joint-Venture (Found March 2021)	Develpoment of FCEV lorry, serial production from 2025
Busses	Different manufacturers	Actual projects in Europe, e.g., Solaris (Poland), Safra (France), Van Hool (Netherlands), CaetanoBus (Portugal)
Automobile suppliers	Different companies	• e.g., Bosch (inclusive a Joint Venture with Chinese Commercial vehicles manufacturer) • e.g., Joint Venture Elring/Klinger/ Plastic Omnium • e.g., Joint Venture Michelin/ Faurecia • e.g., Mahle

Figure 4. Projects for the production of FCEVs in Europe
Source: AT-Thuringia, 2021

4. RESULTS

If one first considers the internal competition of the OEMs in Europe and the existing possibilities for using fuel cell technology, then a concentration on commercial vehicles would be worthwhile for Europe, similar to China. The technology has been researched and can be classified as proven in numerous test series (Blaumeiser & Artz, 2022, p. 4). Since long-distance transport accounts for a large part of the traffic volume, concepts here are also worthwhile in terms of climate balance. Similarly, the expansion of the public transport sector in the area of public passenger transport would be a planning model that, with government support, would mean a push factor for fuel cell technology.

An expansion of the refuelling infrastructure would thus be worthwhile with government support if a large number of trucks and buses have a fuel cell drive. Within an infrastructure plan, primary areas can thus be identified that could be served with infrastructure. The NPM (2021) recommends, "In principle, the filling stations must be set up primarily to meet demand. This means that close cooperation with the relevant vehicle manufacturers should take place on the first pilot routes" (p. 14).

These include motorways, major cities and transport interfaces between road and rail, water transport and airports. Similarly, regions with strong industries can also be planned into the

networks in a reach-oriented infrastructure. In addition, urban areas would have to be developed to make public transport by bus profitable. To this end, natural gas pipelines could also be converted into a hydrogen pipeline system in the existing infrastructure, which would accelerate the development of the supply infrastructure (NPM, 2021, p. 12).

Commercial vehicle manufacturers in Europe include numerous manufacturers in a wide range of countries that could participate in an expansion. Mercedes, VW, MAN, Steyr, Volvo, etc. are spread across the continent and the use of the infrastructure can be exploited throughout Europe. In the passenger car segment, an expansion of the infrastructure of refuelling stations would also increase, as demand can increase among customers since fuel cell vehicles have clear advantages in areas that customers perceive as important in their utility behaviour. Here they are similar ranges to fossil drives, fast refuelling and zero emissions in terms of climate-relevant morals (H2-Mobility, 2021).

When considering suppliers, hydrogen is an important area to include in strategies in Europe, in addition to technical goods. Nations in Europe with large OEM market shares such as Great Britain, France and Germany are dependent on imports of hydrogen. Other countries, Norway, Spain and Portugal, rely on the export strategy, although the quantities will not be sufficient for European consumption. This is also dependent on the further development of natural gas supplies from Russia, which are currently failing and cannot be rebuilt in the foreseeable future. Therefore, new supply chains for natural gas and liquefied petroleum gas are being established that focus on the Middle East, Canada and Australia. However, these solutions are also linked to other conditions, as Australia and Canada rely on grey and black hydrogen, respectively, which cannot be considered conducive to climate goals.

In addition, the UK, Germany and France have already passed a supply chain law that places strict requirements on companies in terms of sustainability, so that theoretically certain nations are excluded from the conditions (Grünewald, 2022). This would include Australia and Canada, which do not comply with the concept and principles of the law due to the high energy requirements for hydrogen production. In addition, there are long delivery routes via the sea, which is not resilient and is also reflected in the eco-balance. Green hydrogen is not yet available in sufficient quantities in production to gain an overall advantage in the life cycle assessment.

Moreover, in terms of supplier structures and power influence on OEMs, the battery also remains a factor to be considered. Already in the BEV sector, the battery was seen as one of the weak points in the resilience of European value creation for the entire continental automotive industry. High dependencies on Asian manufacturers, with China in the lead, must also be taken into account in a hydrogen strategy. These are mainly due to the large demand, which is expanding faster than Europe's and thus forcing networks worldwide, which can restrict Europe (Heuser et al., 2020).

The power of customers in the FCEV scenario can be seen as significant in that a corresponding offer would always be popular and FCEVs would generate a demand that would consolidate a market maturity. However, similar to what was the case with BEVs, the factors of private mobility and cost are decisive. For customers, however, the FCEV seems to be an alternative to the BEV. One-third of Germans, as one of the largest demand markets in Europe, would like to see an FCEV on offer (Clausen, 2022, p. 1). However, it has already been shown with pure BEVs that customers are increasingly investing in model segments that provide larger car models, despite a greater awareness of sustainability.

5. DISCUSSION

Europe is in a difficult position when it comes to the question of climate neutrality. This is particularly evident in the area of public mobility, where dependencies on other nations as suppliers of energy and important components and groups can be described as high. The transport sector is important here in that it is seen as having great potential for achieving the climate neutrality targets, but these have not been met. Other sectors are already on a more successful path here, as the data show. In Figure 5, the dotted line above is the EU's intended reduction targets in the transport sector (Corneille & Maier, 2021).

The requirements for fully aligned green infrastructures in the areas of energy, electricity and mobility can currently only be met to a small extent. Hydrogen production is dominated by energy-intensive and emission-intensive processes (IEA, 2019; World Energy Council Europe, 2021). There is a need for generally intensive investment to lay the foundations.

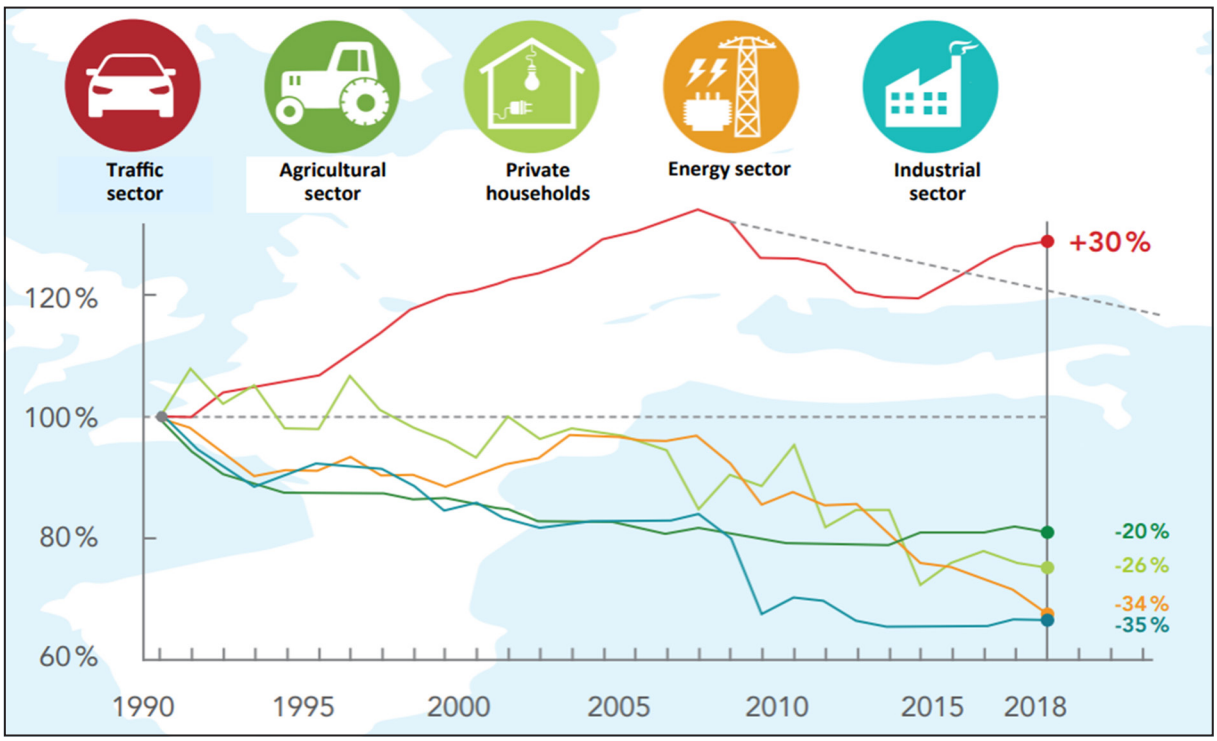

Figure 5. Greenhouse gas emissions in Europe by sector 1990 to 2018

Source: Pro-Rail Alliance; in: Corneille & Maier, 2021, p. 7

Possibilities of intensive production for green hydrogen are already seen, but implementations so far have not been tackled. Heuser et al. (2020) have shown in studies that the possibilities would be possible using photovoltaic and wind energy in certain nations. In Europe alone, Norway, Ireland, Great Britain and Iceland would use wind energy, which could cover a large part of the demand (p. 14). In addition, large quantities of emission-free hydrogen could be produced through photovoltaics in African states in the north and south, as well as in the Middle East. This also includes Libya and Egypt, which as Mediterranean countries would be in direct contact with Europe (Heuser et al., 2020, p. 16).

However, the production routes to date are concentrated in the use of natural gas and coal. Particularly important is the development of economic relations with Russia, which are currently at

a minimum. As an energy supplier of natural gas and in some areas of raw material extraction of ores, Russia has so far been the most important trading partner (CEPR, 2022). After the war of aggression on Ukraine, a reorientation has become necessary.

China is also an important trading partner in many areas of supply and production of necessary industrial goods, but here too the future basis for cooperation is very uncertain. The situation surrounding the Chinese attitude towards Taiwan can quickly turn into a military intervention, forcing Europe into a stance like the one it already has towards Russia today. Waiting is a bad option, so intensifying the disengagement from Chinese imports must be considered at a higher level now.

If Europe decides to maintain BEV production to meet mobility needs, the following points must be taken into account.

- Detachment from battery production in the international area through intra-European production.
- Obtaining sufficient quantities of raw materials for the production of batteries as a key technology, lithium, graphite and cobalt are the critical factors here (Bünting et al., 2023, p. 41).
- Supply chain legislation as an alignment criterion of supply chains according to the guidelines of humanity and climate protection (Frieske et al., 2022; Grünewald, 2022).
- Sufficient capacities in the electricity grids to be able to meet the increasing demand (risk of overloading existing grids) (Hagendorn et al., 2019, p. 150; Korzynietz et al., 2023; Zapf, 2020).
- Climate balances by producing more electricity from renewable/alternative sources (Korzynietz et al., 2023).

When expanding the possibilities of an FCEV strategy, necessary points of consideration for European OEMs are:

- Hydrogen imports from geopolitically safe regions.
- Import from nations that meet delivery law requirements.
- State and industrially supported hydrogen production in Europe.
- Requirement for climate neutrality by means of expanding the production of green hydrogen.
- Autonomous battery production in Europe for FCEV technical requirement.
- Commodity security from geopolitically secure regions.
- Expansion of the infrastructure
- Cooperation with petrol station operators and new providers in the fuelling segment.

These points represent the core elements but are further development moments for a fuel cell strategy due to other - also still to be researched - influencing factors.

6. CONCLUSION

An introduction of hydrogen as an alternative to pure BEVs is technically possible. However, it depends on many factors that need to be addressed now in order to achieve greater continental independence. For this, the own continental resources and production potentials must be better utilized, but this directly follows from the requirements for sustainable productions. Grey, black and brown hydrogen are options here that could still be used in a transitional phase for a time in order to build up the possibilities of green production during this period. Wind and photovoltaics are factors to be used here.

In general, due to current uncertainties in the geopolitical situation, Europe needs to think about a so-called Plan B with nations that have supported the current BEV strategy. Russia and China, as economic giants, are at the forefront of this. Russia's economy is already decoupled from Europe in many areas and China could follow with a military intervention in Taiwan. It would therefore be negligent if the consequences were only assessed when the worst comes to the worst. Europe should therefore intensively detach itself from many currently existing dependencies now and build up a continental strategy that is resilient and at the same time can also build up renewed market leadership. The FCEV market still offers great potential in this regard, as it is still being built up worldwide, but can in turn become a disadvantage for European OEMs due to Asian efforts, as is already the case with BEVs.

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Analysis of the Probability of Meeting the Zero CO_2 Emissions Target for All New Passenger Vehicles by 2035 in EU Countries

Darko Pirtovšek[1]
Sonja Boštjančič[2]

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Analysis

Abstract: *In this paper, the authors undertook an analysis of the likelihood that EU Member States will meet the commitments made by the European Parliament in adopting the »Fit for 55« strategy, which sets the target of making all new passenger cars and light commercial vehicles zero-emission by 2035. The analysis itself was based on the data obtained on the increase in the share of passenger plug in electric vehicles (PEVs) from individual EU countries over the last 5-year period 2017-2022. This data was then used to calculate the trends in the increase in the share of PEVs in each EU country up to 2035. The results of the analysis itself showed that the targets set by the European Parliament are too ambitious and unrealistic, with only 4 countries - Sweden, Denmark, Luxembourg and the Netherlands - expected to reach them. All other countries are more or less far from them.*

1. INTRODUCTION

Five years ago, one of the authors of this paper carried out a review and analysis of the number of plug in electric vehicles (PEVs) in the countries of the European Union (Pirtovšek, 2018, p. 356-366), based on the European Commission's 'White Paper', issued by the Commission in 2011, which envisaged a 60 % reduction in greenhouse gas emissions from transport by 2050, with one of the main measures to achieve this target being related to halving the use of 'conventional fuel' cars in urban transport by 2030 or by phasing out the use of such cars by 2050 (European Commission, 2011, pp. 9-10). The author's analysis at the time showed that, for the time and the number of plug in electric cars, they were far too optimistic and unrealistic.

In February this year (14/02/2023), the European Parliament adopted new measures as part of the 'Fit for 55' package to reduce CO_2 emissions. The new measures aim to make all new passenger cars and light commercial vehicles emission-free by 2035, with CO_2 emissions to be reduced by 100 % across the EU compared to 2021. The intermediate goal of emission reduction for 2030 is 55 % for passenger cars and 50 % for vans (European Parliament, 2023).

As five years have passed since the last analysis, as already mentioned, and also due to the latest measures adopted by the European Parliament, the authors of the paper were interested in knowing what progress has been made during this period regarding the share of plug in electric passenger cars in the countries of the European Union as well as how realistic are the goals set to make all new passenger cars emission-free in 2035. Our analysis was based on the data obtained on the share of plug in electric passenger cars in each EU country in 2022, the growth of these vehicles over the last 5-year period 2017-2022, and personal calculations of the upward trends until 2035.

[1] Professional Education Centre Brežice, Higher Vocational College, Bizeljska cesta 45, 8250 Brežice, Slovenia
[2] School Center Šentjur, Higher vocational college, Cesta na kmetijsko šolo 9, 3230 Šentjur, Slovenia

2. OVERVIEW OF THE SHARE OF PASSENGER PLUG IN ELECTRIC VEHICLES IN EU COUNTRIES

The following is a presentation of the shares of passenger plug in electric vehicles in each EU country in 2022 and their growth trend in the period 2017-2022. First of all, it is first necessary to briefly clarify what is meant by plug in electric vehicles in general. Plug in electric vehicles (hereinafter referred to as PEVs) are all vehicles in which the battery to power the electric motor can be charged from an external grid, and are divided into pure battery electric vehicles (hereinafter referred to as BEVs) and plug in hybrid electric vehicles (hereinafter referred to as PHEVs) (Agencija za energijo, 2017, p. 2, 17).

At the start of the review, Figure 1 shows the total number of newly registered passenger PEVs in the EU for the period 2017–2022[3] (European Alternative Fuels Observatory (EAFO), 2023a).

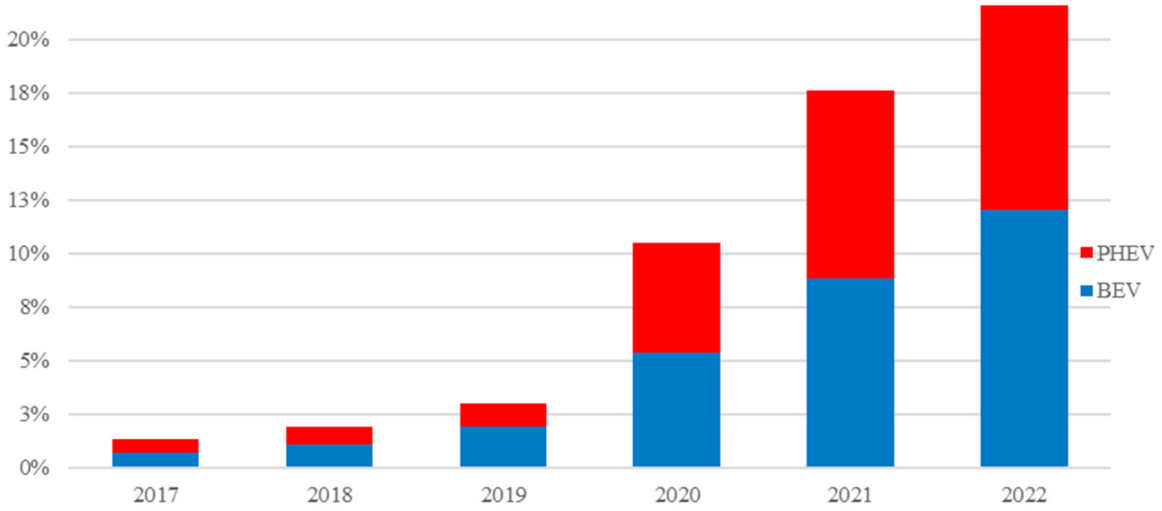

Figure 1. The share of new passenger PEVs in the years 2017 - 2022 in the EU area
Source: EAFO, 2023a

The graph itself shows that the share of the latter has increased steadily over the period, especially in the last three years, and is more than 16 times (16.21) higher in 2022 compared to 2017. The increase factor is very high, but it should be noted that the starting point itself was very low, as in 2017 the share of newly registered passenger PEVs was only 1.33 % of the total number of newly registered passenger cars in the EU area. In 2022, however, this share is well over 21 % (21.56 %), which in nominal terms would mean almost 2 million newly registered passenger PEVs. Thus, the total number of PEVs in the EU in 2022 would be about 5.8 million (EAFO, 2023a).

Of course, the shares of these newly registered vehicles in 2022 vary widely across EU Member States, as can be seen in Figure 2. By far the highest share of newly registered passenger PEVs was in Sweden, where it accounted for just over 60 % (60.87 %)[4] of all newly registered passenger vehicles. It is followed by Denmark (38.52 %) and Finland (37.59 %).

The lowest share of newly registered passenger PEVs was recorded in Slovakia (3.99 %), the Czech Republic (3.90 %) and Malta (2.99 %) (EAFO, 2023b).

[3] Data already excludes the UK (authors' note).

[4] The absolute record holder in Europe was Norway, with a share of just over 88 % in 2022 (88.58 %) (EAFO, 2023b).

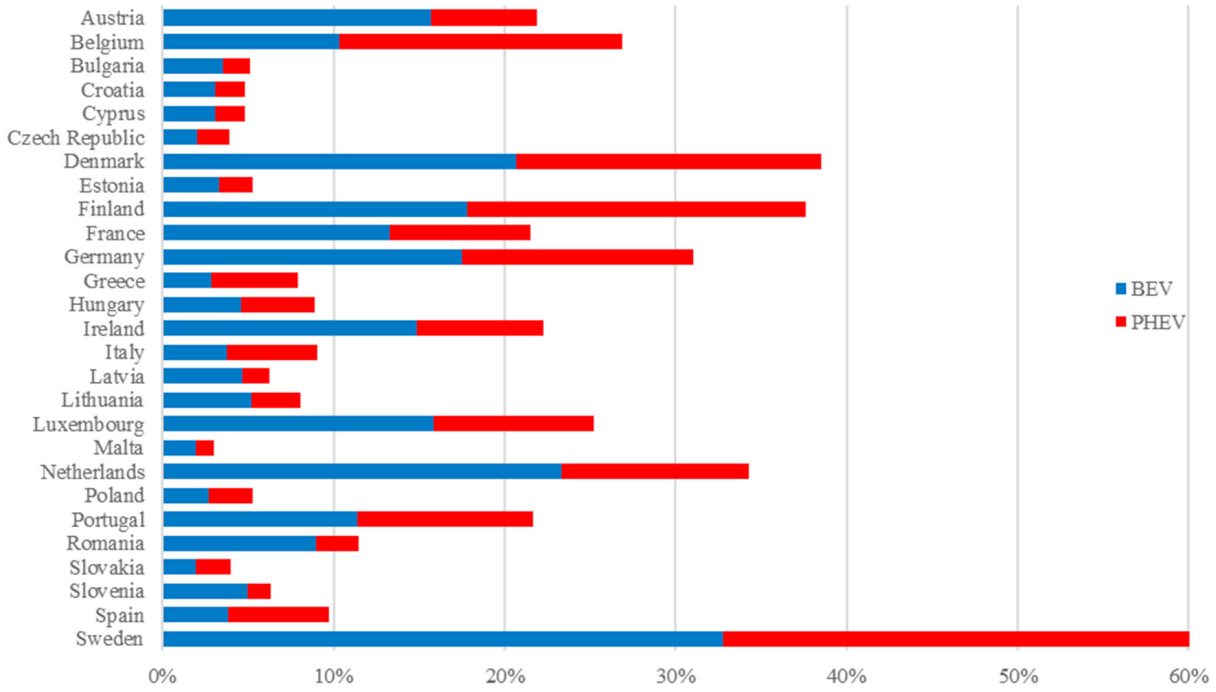

Figure 2. The share of new passenger PEVs in 2022 by individual EU countries

Source: EAFO, 2023b

The comparison of the shares of newly registered passenger PEVs in 2022 with 2017 shows that they have increased significantly in all EU countries. Croatia, for example, has an index of 9,660, which means that the share of newly registered passenger PEVs in relation to all newly registered passenger vehicles in 2022 has increased by about 96 times compared to 2017. Cyprus had the lowest index at 614 (approx. 6-fold increase). Although the calculated indices are quite high in all countries, they do not in themselves tell us much about the real state of the number of passenger PEVs in each EU country. A high index from a low starting point may not mean much, while a relatively low index from a high starting point may mean a very big leap for the better. Therefore, a much more realistic figure is the total number of all registered passenger PEVs in 2022 in individual EU countries (Figure 3), or their share per 100,000 inhabitants (Figure 4).

In nominal terms, Germany had the largest number of these vehicles, with almost 2 million (1,930,006), followed by France with just over a million of them (1,102,975) and the Netherlands, with just over half a million (515,242) in 2022. The lowest number of passenger PEVs was in Latvia (2,646) and Cyprus (1,220).

Since these data are also quite relative, they do not give us a true picture of how high the shares of passenger PEVs actually are in individual EU countries. Indeed, it is to be expected that countries with high populations will have the largest number of such vehicles, with Germany, which nominally has the largest number of passenger PEVs, also having the largest population, with a population of just over 83 million in 2022 (European Union, 2023).

This makes the data on which EU countries have the highest number of passenger PEVs in real terms much more credible. For this reason, the authors of this paper have calculated the number of passenger PEVs per 100,000 inhabitants in each country at the end of 2022, as shown in Figure 4.

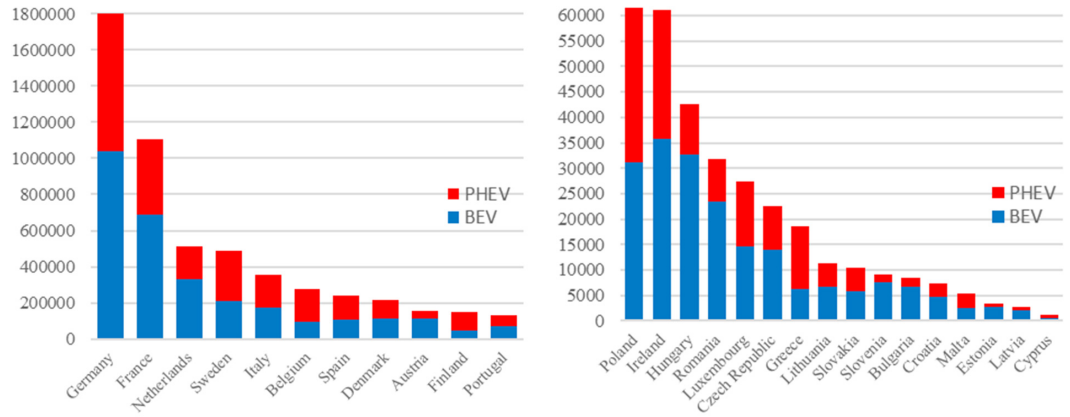

Figure 3. Total number of passenger PEVs in 2022 by individual EU countries

Source: EAFO, 2023b

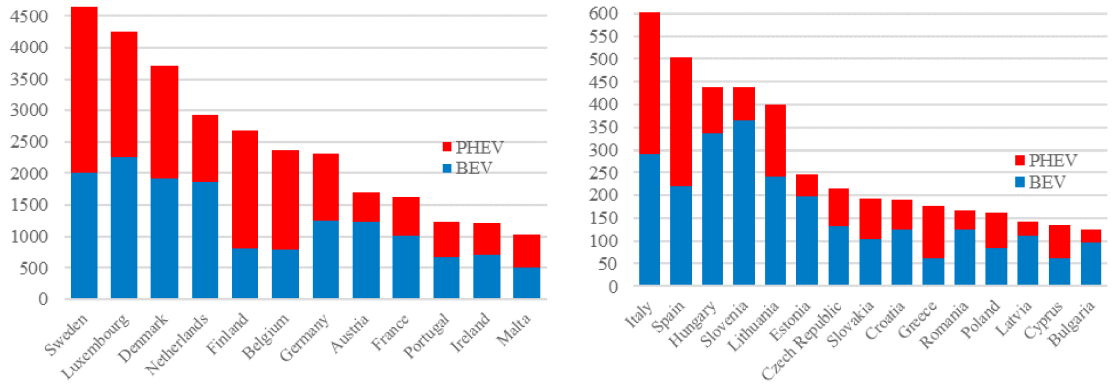

Figure 4. The number of passenger PEVs per 100.000 inhabitants in 2022 by individual EU countries

Source: EAFO, 2023b; European Union, 2023

The figure shows that Sweden has the highest number of these vehicles, with more than 4,600 (4,656)[5] per 100,000 inhabitants, followed by Luxembourg (4,254) and Denmark (3,705), with Cyprus (135) and Bulgaria (124) in the last two places. In the following, we will look at what all this data means for the European Union's strategy to reduce CO_2 emissions from new passenger vehicles by 100 % by 2035.

3. PERFORMING THE ANALYSIS OF THE OBTAINED DATA FROM THE POINT OF VIEW OF IMPLEMENTING THE STRATEGY OF THE EUROPEAN UNION

As already mentioned, the EU's strategy is to make all new passenger vehicles and light commercial vehicles zero-emission by 2035, with a 100 % reduction in CO_2 emissions across the EU compared to 2021. In the following, let's take a look at the possibilities of individual EU countries for the realization of these plans. In the analysis itself[6], the authors of the paper took as a starting point the previously presented data for 2022 in the individual EU countries. First, the number of total passenger cars (hereinafter referred to as TPCs) which are expected to be present in individual EU countries in 2035 was calculated. The calculation was based on the average growth of passenger cars over the period 2017-22 (Table 1).

[5] In Norway, there are approximately 12,770 per 100,000 inhabitants (Wikipedia, 2023).

[6] The calculations are the work of the authors.

Table 1. Calculation of average annual growth rate of TPCs and PEVs for a certain period

Country	Average growth rate of TPCs for the period 2017-22	Average growth rate of PEVs for the period 2023-35	Average growth rate of PEVs for the period 2017-22
Austria	3,00 %	36,01 %	53,97 %
Belgium	3,49 %	32,52 %	55,31 %
Bulgaria	2,68 %	61,87 %	147,21 %
Croatia	4,71 %	61,22 %	92,47 %
Cyprus	6,21%	73,33 %	48,14 %
Czech Republic	4,51 %	62,24 %	66,99 %
Denmark	4,57 %	28,47 %	87,23 %
Estonia	5,80 %	63,76 %	38,25 %
Finland	3,74 %	33,83 %	91,14 %
France	3,61 %	37,92 %	63,68 %
Germany	2,27 %	31,75 %	73,91 %
Greece	4,74 %	64,53 %	123,51 %
Hungary	5,89 %	51,86 %	90,15 %
Ireland	5,25 %	41,11 %	89,75 %
Italy	2,82 %	49,01 %	95,07%
Latvia	3,96 %	61,86 %	49,02%
Lithuania	4,97 %	54,64 %	123,75%
Luxembourg	3,96 %	29,76 %	67,54%
Malta	4,05 %	43,75 %	105,24%
Netherlands	3,51 %	29,98 %	35,11%
Poland	5,62 %	69,82 %	106,85%
Portugal	6,90 %	45,52 %	75,01%
Romania	7,73 %	65,86 %	116,34%
Slovakia	4,96 %	61,41 %	67,97%
Slovenia	3,05 %	50,77 %	55,23%
Spain	4,30 %	50,83 %	72,09%
Sweden	3,07 %	24,43 %	58,68%

Source: EAFO, 2023b; Own calculations

Thus, for example, a calculation for Sweden, which is the leader in the number of passenger PEVs per 100,000 inhabitants, shows that with the current annual average growth rate of passenger cars for the period 2017-2022, which amounts to 3.07 %, the number of TPCs in 2035 would be just over 8 million (8,349,839) (Figure 7). Since at the end of 2022, there were just under 0.5 million (486,700) total passenger PEVs in Sweden (EAFO, 2023b), this means that by 2035 the country would have to make up the entire difference, which amounts to approx. 7.9 million (7,863,139) vehicles. Based on this data, we calculated the average annual rate at which the sales of passenger PEVs must increase until 2035 in order to reach the set goal. The calculation[7] showed that the average annual growth rate for this period should be just approx. 24 % (24.43 %)[8]. The required average annual growth rates for passenger PEVs were calculated in the same way for the rest of the EU countries (Table 1). The obtained required annual growth rates were then compared with the annual growth rates experienced by EU countries in the period 2017-22 (Table 1).

From the comparisons themselves, it can be seen that the growth rates over the last 5-year period in most countries, except in three (Cyprus, Estonia and Latvia), have been higher than the calculated required growth rates until 2035. This sounds very good, however, it is necessary to draw attention once again to the fact that the differences between the starting points of the number of passenger PEVs per country in the last 5-year period under consideration are very large, as already explained in the previous section.

[7] The basis for the calculation was an interest-rate calculation.

[8] For Norway it is 14.67 % (authors' note).

Figure 5 shows the realistic ratios of the shares of passenger PEVs in individual EU countries compared to Sweden, which has the highest share of these vehicles (in real terms) at just under 10 % (9.68 %) in 2022 (EAFO, 2023b). The differences between the ratios of the individual countries compared to Sweden are very large.

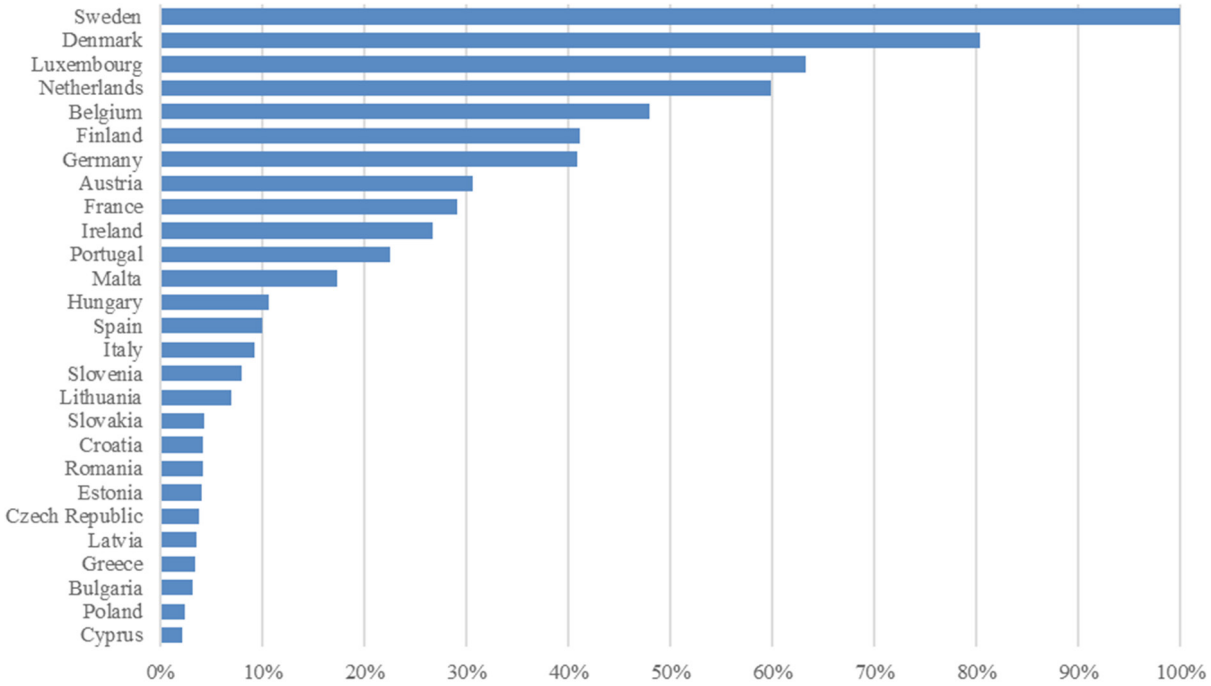

Figure 5. The ratio of the relative shares of passenger PEVs in 2022 in EU countries versus Sweden

Source: EAFO, 2023b; Own calculations

Even Denmark, which ranks second in terms of the share of passenger PEVs, already has almost 20 % (19.63 %) fewer of these compared to Sweden, while Luxembourg, in third place, has almost 37 % (36.78 %) fewer. However, if we look at the bottom part of the EU countries, Poland, in second to last place, has only (in real terms) a good 2 % (2.38 %) of Sweden's share of passenger PEVs, which is also the case, similarly, for last-placed Cyprus (2.07 %).

In our analysis below, the authors show how our calculated (required) average annual growth rates up to 2035 for individual EU countries (Table 1) would affect the actual rate of increase in the share of passenger plug-in electric ca PEVs in the EU. For this purpose, we have chosen 3 countries that differ widely in terms of their shares of passenger PEVs. From the top half of the countries in terms of share, we chose Sweden and Germany, and from the bottom half, Cyprus.

As already mentioned, Sweden is the leading country in the EU both in terms of the real share of all passenger PEVs in 2022[9], which is just under 10 % (9.68 %), and in terms of the number of passenger PEVs per 100,000 inhabitants (4,656). Figure 6 shows a graph presenting how the values of the individual items related to the number of passenger vehicles are projected to change in Sweden by 2035. We calculated them based on the obtained results of the average growth of TPCs, as well as all passenger PEVs in the period 2017-22. The main item in the graph is the cumulative share of all passenger PEVs, which shows how this needs to increase over the period 2023-2035 in order for Sweden to have a 100 % share of all newly registered passenger vehicles in passenger PEVs in 2035.

[9] In Norway, the share is 22.90 %.

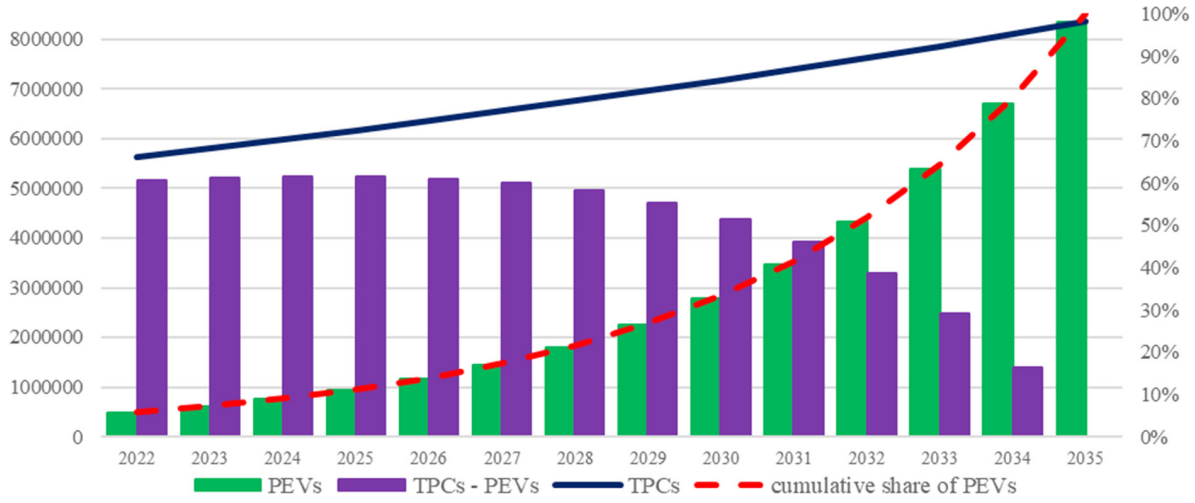

Figure 6. The change of TPCs, PEVs and cumulative share of PEVs by 2035 in Sweden
Source: EAFO, 2023b; Own calculations; Own processing

To achieve this target, we have previously calculated for Sweden that the average annual growth rate of passenger PEVs for the period 2023-2035 should be 24.43 % (Table 1). Looking at the curve of the cumulative share of these vehicles up to 2035, we see that it has been rising rather steadily, except for the last 3 years, which is also understandable, as in the last years of the period under consideration the growth rate is linked to an increasingly higher initial annual base. This in turn leads to a significant increase in the total cumulative share of passenger PEVs. At the end of 2032, Sweden would exceed the 50 % (51.86 %) share of total passenger PEVs required in 2035[10]. The remaining share would have to be covered in the next three years. This sounds like a lot, but it is also important to take into account that the baseline number of passenger PEVs at the end of 2032 is already quite high (more than 4.3 million). It is also important to note that the calculated (required) average annual growth rate for passenger PEVs until 2035 (24.43 %) is more than 50 % lower than the average annual rate for the period 2017-2022 (58.68 %), which is also due to the rather good initial share of all passenger PEVs at the end of 2022 (9.68 %), especially compared to the rest of the EU countries (Figure 5). Therefore, our opinion is that if Sweden at least approximately maintains the current rate of increase in the annual share of passenger PEVs over the next few years, it will reach the target of making all new passenger cars zero-emission in 2035.

The next country analyzed is Germany, which nominally has the largest number of passenger PEVs among EU countries (just under 2 million). The graph in Figure 7 shows how the values of the individual items related to the number of passenger cars are expected to change in Germany by 2035.

If we compare the curves of the cumulative shares of passenger PEVs of Germany and Sweden, we see that the German curve starts to climb steeply much earlier. Namely, it is not until sometime in the first half of 2033 that Germany exceeds the 50 % share of all passenger PEVs required in 2035. The difference should therefore be covered in the last two and a half years. If we compare this with Sweden, the difference is only half a year, but the problem with Germany is that it has a nominally very high number of new passenger PEVs required, which is around 30 million[11]. This is mainly because the initial share of total passenger PEVs at the end of 2022

[10] The nominal share of all passenger plug-in electric vehicles in 2032 would be 56.79 % (authors' note).

[11] By 2033, Germany would have a total of just over 40 million passenegr PEVs (authors' note).

(3.95 %) is much lower in real terms than in Sweden (by almost 60 %), and consequently, this is also reflected in the required (calculated) annual growth rate for passenger PEVs up to 2035, which is almost 32 % (31.75 %). Therefore, the authors of the paper believe that Germany will not reach the required target by 2035. This claim is further supported by the fact that in 2022 the German government adopted, as it said itself, a very ambitious plan to have 15 million passenger PEVs on the road by 2030 (Partsch, 2022), which is less than our calculation, which suggests that Germany should have over 17.5 million passenger PEVs by that year.

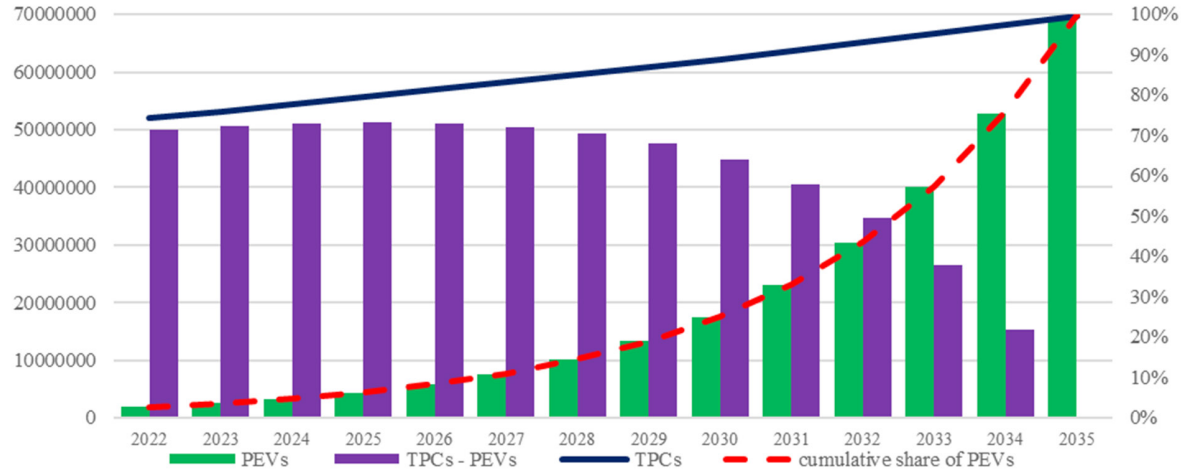

Figure 7. The change of TPCs, PEVs and cumulative share of PEVs by 2035 in Germany

Source: EAFO, 2023b; Own calculations; Own processing

The last country to be analyzed in more detail was Cyprus, which ranks last among the EU countries in terms of the real share of all passenger PEVs in relation to TPCs in 2022 (0.20 %) and is shown in Figure 8. The cumulative share curve for passenger PEVs in Cyprus is almost flat until 2030. It may be worth pointing out that the nominal number of passenger PEVs by that year, with the required (calculated) average annual growth rate for the period 2023-2035, which is already more than 73 % (73.33 %), would only amount to just over 6 % (e.g. Sweden 33, 50 %) of the total number of such vehicles in 2035.

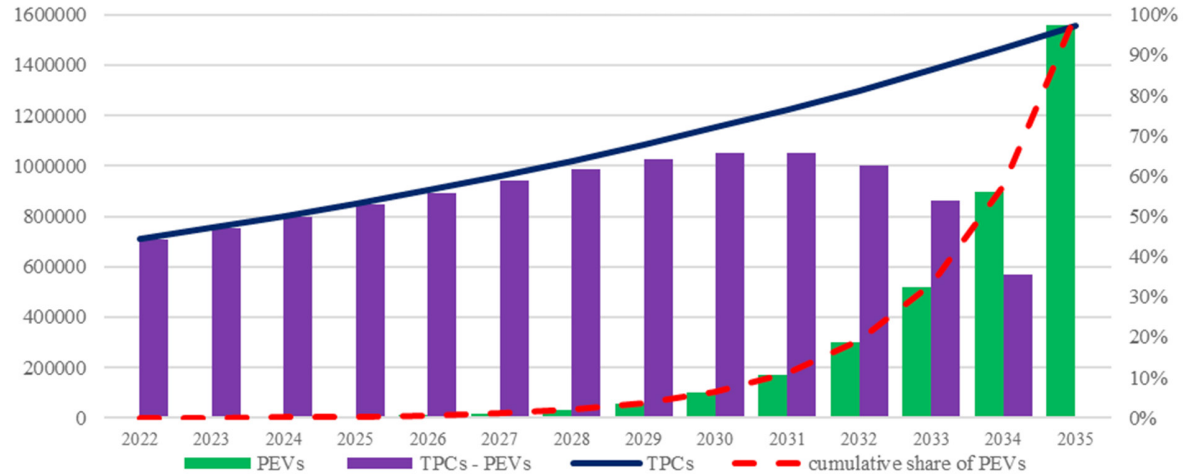

Figure 8. The change of TPCs, PEVs and cumulative share of PEVs by 2035 in Cyprus

Source: EAFO, 2023b; Own calculations; Own processing

This means that Cyprus would have to make up the difference, which would amount to just under 94 % over the last five years, which is, indeed, totally unrealistic and utopian.

The results of our analyses have shown us that we can only look for potential countries to meet the EU targets if they rank higher than Germany in terms of the real share of passenger PEVs. Among the five countries (Sweden has already been analysed), Denmark, Luxembourg, the Netherlands, Belgium and Finland, only Denmark, Luxembourg and the Netherlands (according to the authors) could still meet the targets for zero CO_2 emissions from all passenger cars by 2035, according to the results of the analysis.

Denmark would reach the 50 % share of all passenger PEVs required in 2035 in the first quarter of 2033, with a required (calculated) average annual growth rate of passenger PEVs for the period 2023-2035 of just over 28 % (28.47 %). Luxembourg and the Netherlands, on the other hand, with a required (calculated) average annual growth rate of passenger PEVs for the period 2023-2035 of just under 30 %, would reach a 50 % share of the total passenger PEVs required in 2035 in the first third of 2033. This would give all three countries, even on the basis of the baseline data, still (possibly) enough time to fulfill the set criteria in the remaining period of just over two and a half years.

It can be concluded that the European Parliament's new »Fit for 55« strategy has again too recklessly made certain commitments for the future which, with (conditionally) few exceptions, the EU countries will simply not be able to implement. And if we look at the intermediate goal, which is a 55 % reduction in CO_2 emissions from passenger cars by 2030, we see that this target is simply unachievable according to preliminary calculations, since Sweden, for example, as the EU's leading country, would reach it by the beginning of 2033. Even if we take into account the average annual growth rates of passenger PEVs for the period 2017-2022, which are very high for all EU countries (Table 1) and completely unrealistic for the future, there are still 10 EU countries[12] that would not meet the intermediate target.

Bottom line, the authors of the paper believe that, due to the goals being too high and too ambitious, it will be necessary to review the trend toward the implementation of the »Fit for 55« strategy in a few years (perhaps in 2025) and to adjust the expected targets more realistically to the situation at that time. This is also suggested by the fact that the current share of newly registered passenger PEVs in the EU in the first quarter of 2023 is down[13] by about 2 % points (10 %) compared to the previous year (EAFO, 2023c), even though the nominal number of such vehicles increased by more than 15 % in the first quarter of 2023 compared to the same period in 2022 (VIRTA, 2023). The problem is that the total number of all newly registered passenger cars has also increased significantly, rising by almost 18 % (17.9 %) in the first quarter of 2023 compared to the same period in the previous year. This is much higher than the average annual growth of all newly registered passenger cars for the five years 2017-2022, which is just under 4 % (3.78 %).

4. CONCLUSION

In this paper, the authors dealt with the ability of EU countries to achieve CO_2 zero-emission in all new passenger cars by 2035. For the analysis itself, we relied on the data obtained on the increase in the share of passenger PEVs per EU country for the last 5-year period 2017-2022, based on which we then simulated (calculated) the required annual growth rate of passenger

[12] Authors' calculation.

[13] Already in 2022, the growth in the share of these vehicles was significantly lower compared to 2021 (International Energy Agency, 2023, p. 17-18).

PEVs by 2035 for individual EU country. The calculated (required) annual growth rates of passenger PEVs were then analyzed in detail.

The results of the analysis show that the European Parliament's targets for zero CO_2 emissions in all new passenger cars by 2035 are not feasible, far too ambitious and unrealistic. According to our calculations, only 4 countries (Sweden, Denmark, Luxembourg and the Netherlands) would achieve the targets and, even for these countries, everything should be without major changes (thinking mainly downwards) in the growth rates of the share of passenger PEVs by 2035.

We therefore believe that the European Parliament will soon, within a few years, have to re-examine the dynamics of the »Fit for 55« strategy and adapt it to the situation at that time. It should also be emphasized that the authors of this paper have dealt only with the dynamics of the growth in the share of passenger PEVs, which is only one of the variables that affect the achievement of the targets. There are others, such as the number of electric vehicle recharging stations as well as the capacity of the electricity grid in individual EU countries, which will have a major impact on the growth rate of electric vehicles in general in the near future.

Although the targets of zero CO_2 emissions for all new passenger cars by 2035 will not be met, it is nevertheless important that the number of electric vehicles of all types is increasing significantly, which has a very positive impact on reducing greenhouse gas emissions now and will continue to do so in the future.

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Innovative Technologies for Bionic Transformation of Rural Areas

Sanja Tišma[1]
Andrea Ruk[2]
Anamarija Pisarović[3]

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Abstract: *This article elaborates on the current trends in rural areas in the EU related to smart rural development. It presents different models of smart villages that can increase the attractiveness of rural areas and create favorable conditions for local businesses and entrepreneurship.*

Special attention is given to bionic transformation as a new and emerging potential of rural regions to create new jobs, stabilize rural populations and strengthen the economic resilience of non-urban areas. Several examples – European successful case studies are presented.

Conclusions lead to the innovation of the smart village approach through bionic transformation, the development of a common strategic framework to support the implementation of different models based on rural areas' specifics and a common platform for the cooperation and exchange of ideas and solutions with different stakeholders.

1. EU RURAL DEVELOPMENT POLICY

Rural areas make up 83% of the territory of the European Union, where 30% of the European population lives, and this share has been decreasing for the past fifty years. These sub-areas are extremely important for the future development of the EU, as they ensure food production, renewable energy sources, climate neutrality, preservation of biodiversity, etc. Therefore, the quality of life of almost one-third of the people in the EU depends on the quality and level of rural development, which further determines the conditions for the development of rural entrepreneurship. In this respect, regardless of the country, most rural areas within Europe are still suffering from a variety of problems related to the low level of entrepreneurship and digitalization, the outflow of mostly young residents and the ageing population. Since its establishment, the European Union (EU) has been actively implementing rural development policies aimed at promoting economic, social and environmental well-being in rural areas. The primary instrument used by the EU for rural development is the Common Agricultural Policy (CAP)[4], which has undergone several reforms over the years. Today, the core objectives of CAP are as follows:

- Improving agricultural productivity: The EU supports farmers through financial assistance, research and innovation programs and measures to promote modernization and technological progress in agriculture.
- Ensuring a decent life for farmers: The CAP provides direct income support to farmers, helping to stabilize their incomes and maintain their competitiveness.

[1] Institute for Development and International Relations (IRMO), Lj. F. Vukotinovića 2, 10000 Zagreb, Croatia
[2] Institute for Development and International Relations (IRMO), Lj. F. Vukotinovića 2, 10000 Zagreb, Croatia
[3] Institute for Development and International Relations (IRMO), Lj. F. Vukotinovića 2, 10000 Zagreb, Croatia

[4] The strategic regulation that governs the CAP is Regulation (EU) 2021/2115 of the European Parliament and Council of December 2, 2021 on establishing rules on support for strategic plans drawn up by member states within the framework of the Common Agricultural Policy (strategic plans within the CAP) and which are financed from the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD) (European Union, 2021)

- Balancing territorial development: The EU recognizes the importance of maintaining balanced territorial development throughout the region. It aims to reduce disparities between rural and urban areas by supporting investments in rural infrastructure, services and other local initiatives.
- Increasing competitiveness: The EU seeks to make European agriculture more competitive in the global market by supporting market-oriented agricultural activities and encouraging value-added processing.
- Promoting sustainable management of natural resources: The CAP integrates environmental care by supporting environmentally sound practices such as organic farming, agro-forestry and sustainable land management.
- Fostering innovation and job creation: The EU promotes research, development and innovation in rural areas to foster economic diversification and create employment opportunities beyond traditional agricultural activities.
- Fostering cooperation and networking: The EU encourages rural communities to work together through various cooperation initiatives, such as LEADER (Liaison Entre Actions de Développement de l'Économie Rurale) groups, which support bottom-up local development strategies.

The EU's 2021-2027 Multiannual Financial Framework was adopted on 17 December 2020. The CAP MFF is EUR 1.21 trillion with an additional EUR 808 billion from the next-generation EU Recovery and Resilience Facility. The total amount for the common agricultural policy is EUR 386.6 billion divided between the two funds (often referred to as the "two pillars" of the CAP) (European Commission, n.d.):

The European Agricultural Guarantee Fund (EAGF) as the "first pillar" has an allocation of EUR 291.1 billion. An amount of EUR 270 billion will be provided for income support schemes and the rest will be earmarked to support agricultural markets. The European Agricultural Fund for Rural Development (EAFRD) as the "second pillar" of the CAP has a total allocation of EUR 95.5 billion. This includes EUR 8.1 billion from the EU Recovery and Resilience Facility to help address the challenges posed by the COVID-19 pandemic.

Each of the EU Member States adopts its program or programs at the national level that are consistent with the common agricultural policy and its objectives. However, in the next programming period, a joint effort is to develop smart villages and bionic transformation of economic activities related to rural development.

2. RURAL DEVELOPMENT THROUGH SMART VILLAGES

The idea of a "smart village" generally implies ensuring a high quality of life for the population through a culture of lifelong learning and acceptance of innovations while preserving cultural tradition and heritage (Maja et al., 2020, p. 152021). A smart village is defined as a village where development breakthroughs are integrated with information technology systems and innovation for the benefit of local communities (Adamowicz, 2021, p.20). This concept was introduced in 2015 by the international community through development assistance initiatives in Asia and Africa addressing issues such as energy availability, education, access to health care and water and food security. Today, smart villages are a globally recognized concept of rural development - sophisticated ecosystems involving different stakeholders, similar to smart cities. Their main goal is to raise the standard of living of rural communities, and promote development and sustainability (Maja et al., 2020. p. 152030).

Unlike well-defined definitions, the notion of a smart village depends on the context, adapting to the specific conditions and social challenges of each community. However, all smart villages share the characteristics of using technology, fostering entrepreneurship and prioritizing sustainable development, stimulating economic growth and innovation. The goal of smart villages is to improve well-being by adopting community-driven technologies and solutions that are tailored to the specific requirements and circumstances of the communities they serve (Calzada, 2023, p. 6).

The smart village concept assumes that the continuous development of technology can open up new opportunities to generate income and provide services in rural areas (Dubois & Sielker, 2022., p. 1776). This idea must be combined with other efforts under a well-thought-out and socially acceptable rural development program to significantly raise living standards in rural regions. In addition to traditional investments in infrastructure, this includes business sector development, investment in human capital, civil society development, access to public e-services, environmental protection through circular economy practices, and innovative information and communication technology (ICT). In smart villages, the implementation of locally defined smart specializations in areas such as tourism, culture, promotion of local products, including agricultural and food products, is also expected (Adamowicz, 2021, p. 9).

The development of the community into a smart village depends on a complex process of digital transformation and good governance in the local community (Satola & Milewska, 2022, p. 6) The introduction of digital technology in local government ensures the improvement of the accessibility and quality of public services, the encouragement of transparent decision-making and the active involvement of residents in the discussion and decision-making on the most important local issues. In doing so, the key challenges in this process are the limited awareness and competencies of local government and stakeholders, the need for change in organizational culture, technological and financial barriers and the imperative to create cooperation relationships among all stakeholders.

Smart village as a concept in European rural policies has come to life in the last ten years as a holistic approach to community development with an emphasis on integrating digital technologies into the process of providing services such as artificial intelligence, the Internet of Things, robotics and blockchain technology. One of the cornerstones of smart village development in the EU is fostering a creative rural economy. This implies the development of better employment opportunities, though, for example, the development of tourism, the preservation of cultural heritage and food production as the backbone of a new entrepreneurial atmosphere among the local population. Improving the spatial aspects of rural areas includes the preservation and accessibility of green areas and parks in villages and the preservation of the quality of agricultural land. The socio-cultural component of the development of smart villages in the EU includes the growth of highly educated inhabitants in villages and encouraging them to stay in the village. Instead of migration of rural population to urban centers, the strengthening of economic and social development of urban and rural areas is encouraged. In doing so, improving the information and communication infrastructure within the village ensures seamless connectivity and access to modern services serve (Wojcik et al., 2021, p. 4).

3. KEY ASPECTS OF TRANSFORMING RURAL COMMUNITIES INTO SMART VILLAGES

For a rural community to become a smart village, the digital transformation of local government is key. This process involves the use of digital technologies and platforms to improve public services, thus ensuring the acceleration of decision-making by encouraging the involvement

of the community in the reflection and planning of local development and increasing the transparency of work. Digital transformation changes the type, scope and ways of providing public services from the exclusive implementation of individual services to the planning and directing the desired development. In addition to their growth through the digital transformation process, local governments also provide access to information and communication technology skills and cybersecurity for all citizens.

Table 1. Advantages and Challenges

Advantages	Challenges
• Improving public services by using digital technologies • Increase in local government skills in working with digital technologies • Increase in knowledge of local population in the use of digital technologies • Remaining highly educated population in local communities • Involvement of local people in development decisions • Development of new economic activities (tourism) • Preservation of spatial units • Using modern technologies such as artificial intelligence, the Internet of Things, robots and blockchain	• Low level of awareness and competence among residents • Building physical infrastructures for digital transformation of local communities • Transforming organizational culture in local government • Overcoming technological barriers • Overcoming financial obstacles • Establishing effective cooperation between all local stakeholders • Connecting with urban areas

Source: Own research

One of the key challenges in the digital transformation of rural communities in smart villages is related to the inclusion of the local population in development decision-making processes. Furthermore, there is often a low level of awareness and competence among residents regarding the use of information technologies, which indicates the necessary transformation of work and organizational culture, overcoming technological and financial obstacles and establishing effective cooperation with other stakeholders, so that an increasing number of people with higher education will lead to digital transformation (Anabestani & Kalateh Meymari, 2020, p.145).

The process of transforming rural communities into smart villages is visible under the following smartness dimensions:

- Smart People – the activities implemented focus on education (organization of training on computer skills, graphic design, regular science and sports festivals), sports (organization of sports competitions), joint spending of time and integration of the local society.
- Smart Economy – the activities support starting and running a business and testing new ideas for products and activities. Some examples are the development of a Social Entrepreneurship Incubator and activities for the older generation to combat digital exclusion to abolish surtax, communal contributions, consumption taxes, taxi license fees and utility fees for hotels and camps.
- Smart Environment – the activities support the circular economy, recycling, promote awareness of environmental protection and the use of renewable energy.
- Smart Governance – the activities supporting innovative solutions for accessing information and communication with the local population via digital tools. People can access e-referendum to take part in local decisions and they can evaluate employees of municipal administration online. Also, the local population can submit their ideas (even unrealistic ones) and choose directions of development and implementation of plans.

- Smart Living – the activities support access to modern premises, communal infrastructure, health and social welfare services, schools and libraries, as well as multiple associations and institutions (sports, culture, veterans, pensioners associations).
- Smart Mobility - the activities support free local public transport and free transport connections with surrounding urban areas. Also, the road infrastructure and parking lots have been improved.
- Smart People – the activities support decision-making via e-referendum, the unemployed can engage in motivation and learning educational workshops, e-access to services, and the Internet. All activities will support young residents to return and settle in the village.

To realize the digital transformation of smart villages in its entirety, all these aspects should be included. In this way, the integrated concept of a smart village is realized, which implies a commitment to technology integration, community involvement, sustainable development, effective communication and economic empowerment (Kagungan & Rosalia, 2022, p. 174).

4. EXAMPLES OF GOOD PRACTICE: FROM URBAN INSPIRATION TO RURAL ACTION

In 2023, a survey of the European smart village concept was conducted through activities within the Interreg Central Europe project (CE100085) MTAV "Smart Village Transition, a model for more competitive and attractive villages in Central Europe / More than a Village". Five smart villages were analyzed: Babina Greda (2021) (Croatia), Sveta Nedelja (n.d.) (Croatia), Pomurje Region (Slovenia), Mniszek village (n.d.) (Poland) and Pottery Village (n.d.) (Poland). Common characteristics of these local communities are development challenges faced by a small number of residents, an aging population, the departure of young educated people to cities, poor transport connections and insufficient communal infrastructure. The smart transformation process responds to some of these challenges in order to increase the quality of life of people in rural areas. The key development steps of these rural communities are visible through the developed smart strategic development plans in which they have focused on the smart approach to development. Also, the digitalization of local government was implemented and all relevant stakeholders were actively involved in the creation of smart villages through the bottom-up development approach.

The specificities of individual approaches in the formation of smart local communities are related to the emphasis on the digital transformation components. Thus, some smart villages have a strong connection with the academic community on their way to digitization, some villages have opted for the digitization of local supply chains for selling local products (e.g. farmers to pay mobile applications), or for building modern living facilities with modern technologies as in urban areas.

The findings of the research indicate that all five smart villages analyzed have a common understanding of the need, process and implementation of digital transition. They all agree that the development of a Smart Village Strategy is an initial step that helps in identifying challenges and setting goals, enabling the allocation of resources needed to implement the right actions. In order to create and implement an effective smart village strategy, it is necessary to analyze the advantages of the area and create a resource base, as well as to describe the needs and set an end vision to be progressively achieved. It is important to stipulate in the Strategy the importance of innovation, the importance of community engagement and cooperation in the process of strategic planning. It emphasizes the importance of embracing new technologies to enhance the efficiency of the environment, create competitiveness and promote sustainable practices.

The success of the Smart Village strategy planning process as well as implementation largely depends on the active involvement and cooperation between stakeholders, including local authorities, educational institutions, and experts, and the readiness of a community to support and embrace innovations and adapt to changes. Involving and informing all local stakeholders about the possibilities and plans for smart village development in order to improve living conditions ensures a broad view of the development needs of the entire community. Involvement of local government as well as NGOs is very important, as they activate, monitor progress, encourage and support in critical situations, fatigue, or lack of spectacular successes (especially at the beginning). Active involvement and cooperation between stakeholders including local authorities, educational institutions, experts but also the villagers themselves guarantees the success of the implementation of the smart village strategy.

5. CONCLUSION AND RECOMMENDATIONS

The idea of "smart villages" is a framework for transforming rural development by providing creative responses to the specific problems that rural regions face. Inadequate transport infrastructure, limited access to digital services and negative demographic trends such as ageing population and migration to urban centers are just some of the problems that rural communities often face. These difficulties can be an obstacle to economic development and general quality of life, but they also act as incentives for creativity. Through innovative solutions, digitization, and community involvement, smart communities can be a framework to address some of these challenges. Through the implementation of the concept of smart villages, it seeks to improve the quality of life of the rural population, increase the provision of public services and promote economic growth and development with an emphasis on the use of digital technologies and digital solutions.

For the past ten years, the European Union has also committed to reducing the digital gap and improving access to networks and digitization of rural areas by encouraging projects and investments aimed at creating smart rural communities. This includes the thoughtful use of digital technology to improve public service delivery, speed up decision-making processes, increase transparency and actively involve local citizens in local government. The importance of this strategy has been underlined by the recent acceleration of digitization caused by the COVID-19 pandemic and is expected to play a significant role in the development of smart villages in the future.

Public services in rural areas cover a wide range of tasks, including local infrastructure maintenance, health care and education. The transition from conventional service delivery to new methods, such as co-production and co-creation, active citizen involvement in service delivery, are led by smart villages. With this transition, public services will become not only more efficient but also better adapted to the unique demands and ambitions of rural areas.

The path to achieving the full potential of smart villages faces many obstacles such as low involvement and awareness of the rural population, financial constraints for innovative initiatives, limited communication of infrastructure and ageing population. However, these difficulties have developed into opportunities for teamwork and new approaches to communication and the involvement of the local population in planning their development and pointing out good practices and ensuring the exchange of experience and knowledge on the digital transformation of rural areas.

The future of rural development is smart local communities. Smart villages are a development framework to improve the quality of life and foster sustainable development in rural communities by emphasizing digital transformation, the provision of new public services and the active participation of local people in planning the future development of the community. Therefore, further research in this area is needed to assess the benefits and effectiveness of smart village initiatives to date, to develop new concepts and test their adaptability to different rural contexts, and to discover more effective methods and best practices for providing public services in rural areas. In doing so, one of the priorities is to explore the possibilities of coordinating development between rural and urban areas, which should be a priority in thinking about future smart villages. This cooperation can result in improved infrastructure, economic development and joint solutions to societal challenges. Improved cooperation between urban and rural communities can also solve the accumulated problems of overcrowded urban areas, combat localism and encourage interurban cooperation. Smart villages can also, through this cooperation, develop adaptive governance structures to address specific problems caused by urbanization to adapt to the changing landscape of urban regions.

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Strategic Integration of E-commerce and Franchising

Angelo Manaresi[1]

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Abstract: *The primary objective of this article is to discern the strategy implications arising from the incorporation of e-commerce by franchisors within franchise networks. Following interviews with key informants, an experiment was conducted to investigate the franchisees' willingness to continue investing in the franchise network after the franchisor introduces an e-commerce platform that excludes them. The long-term repercussions of integrating e-commerce into franchising networks include a diminished willingness among franchisees to sustain their investments. This may differ from the short-term acceptance of the franchisor's e-commerce initiative, primarily attributable to the substantial power imbalance between franchisor and franchisee, as well as short-term inertia inherent in relation-specific investments and franchise contracts. A significant challenge faced by franchisors is the choice between establishing a profit-sharing model or, ideally, a mutually beneficial win-win arrangement with franchisees. Alternatively, the strategy may consider allocating more resources to directly operated stores.*

1. INTRODUCTION

The primary aim of this article is to discern the enduring structural ramifications stemming from the evolution of electronic commerce within franchising networks, with the overarching aim of gaining a more profound understanding of the impact of integrating digital marketing into a company's comprehensive strategy. A series of semi-structured interviews involving both franchisees and franchisors was developed in Italy. In addition to that, an experiment was run to understand the willingness of franchisees to keep investing in the franchise as a consequence of the franchisor launching its e-commerce. This research shows that the long-term consequences of integrating e-commerce with franchise networks can diverge significantly from the initial short-term acceptance. This research aims to actively contribute to this ongoing discourse, by adding a longer-term view on the development of e-commerce, by enhancing both theoretical understanding and practical knowledge in the field.

In the immediate context, franchisees predominantly embrace this integration due to one of two key factors: either (a) a pronounced power imbalance between franchisors and franchisees compels the latter to acquiesce to a centralized e-commerce model with no engagement, or (b) it results from the inherent inertia intrinsic to franchise contracts. However, in the long term, franchisees are more inclined to exhibit reluctance in reinvesting in a franchise chain that excludes them from involvement in the e-commerce system.

This paper delves into the various solutions that franchisors can employ to preserve a sense of robust partnership within a franchise. A pivotal challenge for franchisors involves choosing between establishing profit-sharing agreements or other forms of mutually beneficial win-win arrangements with franchisees. Another alternative course of action that franchisors may inevitably

[1] Department of Management, University of Bologna, Via Capo di Lucca 34, 40126, Bologna, Italy

confront is a heightened future investment in directly operated stores. In such a scenario, remaining franchisees may perceive their roles as less significant within the channel. Shifting ownership towards a greater number of stores directly managed by the franchisor has the potential to diminish the entrepreneurial value inherent in the concept and context of the franchising industry, which has been granted block exemption regulation status by the European Union.

Additionally, it is imperative to scrutinize the reactions of multi-unit franchisees, who oversee multiple stores and, in contrast to single-unit franchisees, wield greater relative power in their interactions with franchisors. Furthermore, multi-unit franchisees have a multitude of alternative business opportunities at their disposal should they choose not to renew their franchise contracts. Given that multi-unit franchising has ascended to the dominant form of franchising on an international scale, this issue holds relevance across diverse countries.

2. PROMISES AND ENCROACHMENT BETWEEN E-COMMERCE AND FRANCHISED STORES

Most franchisors, some years ago, decided to launch centralized e-commerce: when doing so, they promised not to compete against franchisees' physical stores, as they said that the main goal of that project was to promote the brand better for the benefit of all franchisees. Not necessarily they wanted to lie, as e-commerce only in the last years developed very strongly in all product categories; but the present market conditions and the context of retailing in general, and franchising in specific, will not make them easily fulfill that promise. The strong development of e-commerce of the last 10 years, mainly based on mobile internet connections of smartphones, in many cases above expectations of both franchisors and franchisees, created the conditions for which even franchised store chains that have some if not many stores in a certain region risk to be encroached by the e-commerce system. This is something that stores managers and franchisees started perceiving when they saw customers who, when inside stores, would try a product and at the same time browse an internet e-commerce site to check and search for a lower price or different ranges related to the same product. Such customers could take advantage of the service of the franchisee and then buy the product from an e-commerce, online, store.

Franchising traditionally relies on granting exclusivity within protected territories to system members (franchisees). On the contrary, e-commerce, as a business strategy, allows for a broader geographical reach across different markets without adhering to territorial boundaries. This incongruity presents challenges unique to franchising organizations when integrating e-commerce into the system, leading to encroachment, territorial overlap and conflicts not faced by other kinds of companies.

3. LITERATURE REVIEW AND GAP

Although e-commerce has the potential to enhance the operations and profitability of franchise businesses, the convergence of these two dynamic business sectors presents legal and commercial challenges, particularly regarding issues of encroachment (Terry, 2002).

Analyzing the e-commerce strategy within the realm of franchising holds crucial significance for several reasons. Firstly, in the contemporary business landscape, all businesses, including franchising, seem to need an e-commerce strategy to reach a larger number of customers and to increase efficiency and effectiveness in operations and marketing (Cliquet & Voropanova, 2016; Perrigot et al., 2017).

E-commerce has the potential to reduce the need for franchises as a means to achieve business growth and market penetration. According to this argument, if the majority of goods were purchased online, the demand for physical stores would decrease, consequently lowering the costs associated with market entry. From the perspective of resource scarcity theory, it could be argued that as the need for significant capital inputs diminishes, so too would the need for franchises (Dixon & Quinn, 2004; Watson et al., 2002).

On the other hand, adopting a dual-marketing perspective, e-commerce is seen as a platform that provides opportunities for franchises to promote their brand, products, or services to customers and to recruit franchisees (Cedrola & Memmo, 2009). Moreover, from a system perspective of the business, franchised retailers (considering together franchisees and franchisors) might derive long-term benefits from e-commerce if they can leverage the advantages of an integrated multi-channel approach, as the Internet enables companies to establish relationships with their customers (Kaushik et al., 2018).

The literature on franchising started some years ago, at the beginning of year 2000s, by analyzing the degree and the process of introduction of e-commerce systems in franchising. Kremez et al. (2019) investigated the impact of e-commerce within the realm of franchising and its impact on the dynamics between franchisees and franchisors. The primary objective was to scrutinize and pinpoint effective e-commerce strategies that franchise networks could adopt and sustain, to develop a digital business. The data collection process comprised various qualitative stages: firstly, semi-structured interviews with franchisors, and secondly, a moderated industry forum where franchisors and industry experts openly deliberated on their e-commerce strategies and concerns. The initial theme centered on the involvement of franchisees in formulating and executing e-commerce strategies, the second revolved around general franchisee sentiments and apprehensions, and the third focused on the introduction and implementation of an e-commerce strategy within an existing franchising model. The model that was devised would be useful to explain the franchisor's strategy to increase the franchisees' probability of acceptance of the e-commerce; a first important gap in that and other pieces of research is that the short-term context (mainly the adoption of e-commerce from the franchisor point of view and the short-term acceptance of e-commerce from the franchisees' point of view) was studied but not very much insight was present on the long-term effect on the franchisor-franchisee relationship.

Despite global trends indicating steady e-commerce growth and, to some extent, a decline in traditional retail sales, franchisors have grappled with identifying the most effective use of e-commerce for their systems. Not being able to rely on the relatively more solid knowledge coming from research, franchisors often solve the strategic dilemma of whether and how to jump on the e-commerce fast train by introducing an independent e-commerce system, totally centralized and independent from the activity of physical stores. For sure there has been some scarcity of empirical research in this field and there is a clear need for further investigation into e-commerce practices in franchising, as it has not been investigated enough or at all about the balance between the potentially disruptive positive effect of the launch of an e-commerce business and its other side of the coin, the potentially equally disruptive, but in a negative way, effect, on the relationship between franchisor and franchisees. Also, by analyzing the process of introduction of e-commerce in the franchising context, there has not been a strong analysis of any theoretical framework to support the analysis: for example, the basic idea behind the analysis of the process of e-commerce introduction was that if a franchisor manages to reassure a franchisee about the non-threatening impact of e-commerce on their business, then franchisees are more likely to accept it.

The expansion of both franchising and e-commerce as distinct business strategies, coupled with the inherent challenges in operations, marketing, and legal obligations that may arise when franchising firms establish their own online marketing and retail channels, underscores the critical need to address this research gap. Simplistic solutions, like as not getting franchisees involved in e-commerce and separating e-commerce from the physical store management, are very risky for the future development of a franchising store network. For that reason, scholarly contributions some years ago specifically highlighted the necessity for further investigation into the utilization of e-commerce in franchise networks, considering the growth potential of e-commerce in franchising and the associated challenges faced by both franchisors and franchisees (Perrigot & Pénard, 2013).

Some of the older research questions in the literature have already become less relevant. Some time ago research questions were on matters such as the likelihood and the speed of the adoption of e-commerce in franchising companies, as some researchers had the idea that the adoption of that innovation was slower in franchising than in other kinds of companies. Nowadays that question is no longer relevant, especially from a managerial point of view, as most franchising companies have already adopted e-commerce and digital marketing tools. Thus, now that franchising companies engaged in e-commerce that become a very important channel, the questions are about how is the adoption of e-commerce affects franchise relationships and franchisees' perception of the future business opportunity that franchising could still represent for them in the new context where digital marketing is getting more relevance in the business.

4. METHODOLOGY

From the analysis of the literature, and the evidence of the very fast development of e-commerce in most industrialized countries, we thus developed two hypotheses, regarding the long-term consequences of the introduction of centralized e-commerce in a franchise network.

H1: Franchisees perceive centralized e-commerce as decreasing the expectations for their future profitability

H2: The decrease in expectations for future profitability reduces the willingness to continue investing in the franchise business

From a methodology point of view, researchers (Cedrola & Memmo, 2009; Kremez et al., 2019) developed a positive attitude toward qualitative research for the topic of the introduction of e-commerce into franchising organizations, to go more in-depth into such a complex matter about which the main variables had not been clearly identified; on the other hand, it is clear that more quantitative research, such as surveys or experimental methods could give some ideas about the magnitude of specific issues in the franchisee-franchisor relationship. For that reason of complementarity, in this paper, we report results about both a preliminary qualitative piece of research and quantitative research.

Qualitative research. The qualitative research has been developed with interviews with both 20 franchisees and 5 franchisors in Italy. Questions about both the kind of e-commerce that was run in the franchise, if totally managed by the franchisor or not, and about franchisees' perceptions about that were key to these interviews.

Franchisors' managers were directly interviewed belonging to the five following industries:
- Apparel,
- Fast Food,
- Office products and services,
- Houseware,
- Furniture.

For each franchisor, four franchisees were randomly selected and directly interviewed among those located in the area of north and centre of Italy, which is the most developed area of Italy and accounts for 80% of the business.

Semistructured interviews, lasting approximately forty minutes each, were developed with those franchisors and franchisees, to understand three areas of the relationship between franchisors and franchisees: at the beginning of the interview, in a warm-up section, some questions were asked about the state of the franchise business performance; then, in a second part of the interview, the short term reaction of franchisees to the launch of the centralized e-commerce was the focus of a few questions; in the third and final part of the interview we investigated about the perception of franchisees (level of perceived threat on the physical retail business) and franchisors (ideas about strategies to mitigate the negative perceptions present among franchisees, involvement strategies) about the long term consequences of the overlap between centralized e-commerce and franchisees' willingness to keep investing.

Quantitative research. In addition to the qualitative research, to check and add evidence to prove/disprove the hypotheses, an experiment was run to understand the willingness of franchisees to keep investing in the franchise as a consequence of the franchisor launching its own e-commerce. We now give some reports about the way the experiment was built, starting from the respondent selection and then describing the experiment development.

a) The first stage of an experiment is the selection of respondents. A franchise network was described to some candidates, selected among university undergraduate students of management to become experiment respondents by the instructor: the instructor described many elements of a business format franchising, that is attractive for people who want to develop a small entrepreneurial activity in retailing. The format described is very similar to a few existing companies, that operate with a very good market share in the business of underwear and clothing. As it usually happens in business format franchising, the format that was described to respondents for the experiment includes:
   - A license to use a store name.
   - The provision of a certain number of elements for the store layout and product display.
   - Some information systems, software, know-how about business and accounting, and training.
   - A course about people management.

b) After describing the business format, it was asked to respondents about the likelihood with which they would engage in such a business, in case their family accepted to make available for them the sum of money required from the franchisor to set up the physical store, to set up the company, as a working capital for the business, and as an entry fee in the franchise. Those, about 40%, who said they would invest and develop the business were so selected for the real experiment.

c) The real experiment was so run on 120 respondents, with ages in the range of 20-23 years old, almost equally including men and women (48% to 52%); the experiment was run simulating three years of business. For each year we simulated a short speech from the franchise manager about the business performance of the franchise and the specific store of the respondent. So, to each of the respondents, simulating a year-by-year report, it was told, also showing some pictures of a real store, the store proved to be successful, and sales and profit grew constantly, even if the effort from each of them (the franchisee) had to be strong, something like 12 hours of work every day, including most Saturdays and Sundays. The experiment then developed as a four-group analysis, with each respondent randomly assigned to a group, respecting an equal proportion of gender in each of the four groups of 30 people.

Here are some details about the treatments of the experiments: we used in the experiment as treatments two events: the most important one for our research, that is to say, the introduction of a centralized e-commerce; and secondly, some human resource management negative events during the relationships. This latter treatment of the human resources problem was used to check if willingness to keep doing the franchise business could be influenced by other negative events.

The reason for the four groups is that we wanted to test if in a positive (all groups had been informed that the business was getting positive results) but also realistic context, the introduction of centralized e-commerce could change the perception of franchisees about the future in the business. To make the context more realistic, we introduced for all groups the information that franchisees' performance can only be obtained by working very hard. Also, in one group we introduced information about "some negative events", in specific managerial problems, such as human resource management problems, to check if that could have a relevant or even stronger impact than the centralized e-commerce on their willingness to keep on doing that business:

First group: Good performance + hard work (the control group).

To a sub-group of 30 people, randomly selected among the 120 people that participated in the experiment, it was confirmed and told again that during the period of the first 3 years, the relation with the employees had been ok and the business had gradually developed well.

Second group: Good performance + hard work + some negative events (second control group to check the impact of negative events on the future willingness to keep in the franchise business).

To a sub-group of other 30 people, randomly selected among the 120 respondents, it was told that during the period of the first 3 years some employees had created some troubles for the store: in one case one employee was caught stealing some merchandise, in another case one employee was on leave for 6 months without real reasons (but with salary) but with some protection from the trade unions, that did not allow the franchisee to lay him off. These events made business management more complex but did not significantly hurt profitability.

Third group: Good performance + hard work + new e-commerce of the franchisor.

To a sub-group of other 30 people, randomly selected among the 120 respondents, it was told that during the period of the first 3 years, the relation with the employees had been ok and the

business had gradually developed well. It was then told that towards the end of the three years the franchisor decided to launch its e-commerce site for the same brand, which was not providing any profit to the business of the franchised stores, but just to the franchisor central business.

Fourth group: Good performance + hard work + some negative events + new e-commerce of the franchisor. To a sub-group of 30 people, randomly selected among the 120 respondents, it was told that during the period of the first 3 years, some employees had created some troubles for the store: in one case one employee was caught stealing some merchandise, in another case one employee was on leave for 6 months without real reasons (but with salary) but with some protection from the trade unions, that did not allow the franchisee to lay him off. We also told them that these events made business management more complex but did not significantly affect the good level of profitability of the franchised store. It was then told that towards the end of the three years, the franchisor decided to launch its e-commerce site, which was not providing any profit to the business of the stores, but just to the franchisor central business.

d) If finally asked all 120 respondents to answer about how they felt about the opportunity to renew the franchise contract, which required an additional investment that was going to capture almost 50% of the net profit obtained in the three years. The respondents who had been told about a new e-commerce site directly managed by the franchisor, it was asked about what they felt about that e-commerce business of the franchisor.

The first item, measured with a 5-point Likert scale, about the perception of future performance, was the following: "I think that, all things considered, I have good opportunity for future performance in this franchise"

The key item for our dependent variable, measured with a 5-point Likert scale, was the following: "I think that, all things considered, I would renew the franchise contract".

5. RESULTS

Qualitative research. The preliminary interviews showed that both franchisors that have not launched e-commerce and those that have already launched it are concerned about the importance of the franchisees' reaction to that. The franchisor that has not launched the e-commerce said that the main reason for that is not to overlap with physical stores, which are mainly franchised stores; the franchisor also said that they prefer to use the internet site to create business for the franchisees, who are the real owner of the business and should keep being motivated and investing in the business.

Most franchisors that launched the e-commerce are telling the story that with a click-to-store system of delivery, franchisees will have an opportunity to increase their business, by cross-selling other products to customers coming to the store to collect the e-commerce package. The trouble is that franchisees do not buy this story very much, as they say that customers might not be easy to approach for selling other products, as they come to just collect another package, often in a hurry or with the car parked for a minute in the middle of the road.

All 20 interviewed franchisees are concerned with the fact that e-commerce is a good business opportunity and that a modern company cannot operate without it; but all of them also said that they must be involved in that growing business; they expect the physical retail business not to grow at

the same rate as the e-commerce, thus they perceive that being excluded from the e-commerce sales and profit will significantly decrease the profitability expectations of their business.

The strategies to get franchisees involved in the e-commerce business that were proposed by the franchisors were mainly related to the system of click-to-collect in the store. The strategies that franchisees proposed as possible solutions to the encroachment problem were more related to direct profitability for them coming from each e-commerce purchase, such as a percentage of e-commerce sales or direct relationship with customers in the e-commerce platform.

From all the interviews it is clear that the centralized e-commerce creates encroachment and that the franchisees' point of view is that a) there is a problem and b) the problem cannot evaporate over time but can only become stronger over time.

Quantitative research. Results of quantitative analysis can give us a more in-depth analysis of the context in which willingness to invest can be kept, as the willingness to keep on investing in the franchise after the first three-year period is here reported.

In a 5-point Likert scale of disagreement-agreement, the first control group had the largest average response (4.27). This group, by perceiving that the business had been successful, had no real reason to quit, other than just being tired of the hard work necessary to run an entrepreneurial business. Very few potential franchisees would quit such a business. The second group showed similar average responses to the 5-point Likert scale (4.3), that did not in fact significantly differ from those of the first group (significance level= .427).

This means that the profitability of the business was the main element that was considered for the contract renewal, even when considering that hard work is necessary for a franchisee in retailing. Even if some negative events can make business life more complex, potential entrepreneurs take for granted that such things can happen. Thus, a successful business is a prerequisite for motivation to keep investing, even when there are negative events when such events are both under the control of franchisees and can be solved in a relatively short period.

The third group and the fourth group were those where we introduced the treatment of the launch of the centralized e-commerce: the two groups had similar responses with each other (respectively, on average, 2.70 and 2.63), with no significant difference with each other averages (significance level=.098). This tells us that the negative human resources events had no impact on the dependent variable. But, most importantly, the average levels in the Likert scale that measured the willingness to keep on investing in the franchise, were much lower than what we found in the first two groups. This means that centralized e-commerce makes franchisees perceive a much lower future interest in the business.

If we compare the means of the willingness to keep investing in the first two groups all together (group one plus group two, an average of 4.28) with that of the two other groups (group three plus group four, on average 2.67), we find that the difference is statistically very significant (sign. level=.000).

Thus, it was clear that the willingness to invest would decrease significantly in case franchisor launched its own e-commerce, as franchisees would see the new e-commerce from franchisor as a potential threat to their business; they would also perceive a loss of focus of the franchisor that, instead of being a partner to the franchisees, would think about developing its own business, also

bypassing the franchisees. The perception of loss of control on the potential future performance of the business is another important matter that can decrease their motivation to stay in the franchise, as this was from the beginning described from franchisees during preliminary interviews.

Something very similar happens when we analyze the perception of franchisees about their future performance: groups 1 and 2 perceive a much better future performance than that of respondents in groups 3 and 4 (with no significant difference between group 1 and group 2 or between group 3 and group 4). The differences among the means that are reported in Table 1 are very clear about that. The first hypothesis (H1: Franchisees perceive centralized e-commerce as decreasing the expectations for their future profitability) is thus verified.

Table 1. Future performance perception of franchisees

	Mean (1-5 Likert scale)	Standard Deviation	Significance of the difference between groups 1 and 2 and between groups 3 and 4	Significance of the difference between groups 1 + group 2 and groups 3 + group 4
Group 1	3.77	.00	.161	.020
Group 2	3.73	.79		
Group 3	1.13	1.14	.487	
Group 4	1.53	1.31		

Source: Own research and calculation

Table 2. Willingness of franchisees to keep investing in the franchising network

	Mean (1-5 Likert scale)	Standard Deviation	Significance of the difference between groups 1 and 2 and between groups 3 and 4	Significance of the difference between groups 1 + group 2 and groups 3 + group 4
Group 1	4.27	.64	.427	.000
Group 2	4.30	.70		
Group 3	2.70	.95	.098	
Group 4	2.63	.27		

Source: Own research and calculation

Table 3. Correlation between franchisees' perception of their future performance and willingness of franchisees to keep investing in the franchising network

	Pearson correlation in each group	Significance level	Person correlation in the whole sample of 120 respondents	Significance level
Group 1	.64	.00	.85	.00
Group 2	.65	.00		
Group 3	.77	.00		
Group 4	.79	.00		

Source: Own research and calculation

The Pearson correlation (Table 3) between the perception of future performance and the willingness to invest is very significative and strong in the 120 observations (a correlation of .85 with a significance level of .00) and this happens for all groups, respectively with correlations of .64, .65, .77, and .79, always with significance levels of .00). This emerged together with what we discussed above and shown in Table 2, the much lower average levels of future performance and willingness to invest in the group 3 and 4, those where we have been treated with the event of the launch of the centralized e-commerce. Even if the association between two variables does not necessarily mean a causal relationship, the sum of Table 2 and Table 3 creates a very strong probability that the second hypothesis H2 is verified: The decrease in expectations for future profitability reduces the willingness to continue investing in the franchise business.

6. FUTURE RESEARCH DIRECTIONS

In this section, we discuss future and emerging trends related to e-commerce and digital marketing in franchise networks.

The theoretical gap has to be addressed regarding what framework can better represent and explain franchisor behavior when launching an e-commerce project without getting franchisees involved. The main hypotheses could be control theory and resource dependence theory, which could push franchisors towards some more vertical integration as digital technology allows them to disintermediate the channel, go and sell directly to customers, and to depend less on franchisees for that. According to that view, the e-commerce project would just be part of a new more vertically integrated structure and strategy for channel management.

Some more in-depth analysis should be done to understand the heterogeneous reaction of franchisees to the development of an e-commerce system managed by the franchisor; this is to say that a different active response from multi-unit franchisees, that are dominant in most franchises, could be tested as different from that coming from single-unit franchisees. This different (stronger) response of multi-unit franchisees could depend on the stronger bargaining power of multi-unit franchisees in relation to franchisors, from a larger number of investment alternatives they might have, but an opposite reaction (weaker response) could also depend on the larger scope of the territory and the business: multi-unit franchisees could be less affected by a franchisor's e-commerce as they might have more resources to keep the brick-and-mortar channel on track.

One emerging trend that should be somewhat connected to e-commerce and franchising is the unified international context for e-commerce in the European Union. EU regulation, starting from pricing and logistics, tries to make steps towards a single market even for electronic commerce. How this can be managed from franchisors and franchisees operating only in some of the EU countries, still has to be analyzed in future research, in specific with an integrated view of traditional channels and digital stores.

7. CONCLUSION

In this section, we engage in a discussion regarding the comprehensive coverage of the paper, and we present some concluding remarks. The primary objective of the paper is to contribute to the understanding of the long-term impact of e-commerce on franchise systems.

The era when independent franchisees launched their own e-commerce endeavors has come to an end, as the life cycle of e-commerce has progressed beyond its initial spontaneous stage when companies, even those of smaller scale, eagerly sought entry. E-commerce has now matured, characterized by industry consolidation and the implementation of advanced technologies and logistical systems. The landscape of competition in e-commerce and digital marketing has evolved to the point where individual stores find it challenging to compete with larger organizations. Consequently, a thorough analysis of e-commerce projects needs to focus on those developed by entire franchise systems. In such organizations, franchisors assume the roles of project and channel leaders, also determining whether franchisees should be involved in these initiatives.

In numerous instances, after attempting to comprehend the intricacies of e-commerce, franchisors choose to operate these businesses independently of franchisee contributions. The initial acceptance by

franchisees of such franchisor-independent ventures often hinges on the relative strength of franchisors in the franchisor-franchisee relationship and the relationship-specific investments made by franchisees, which introduce a level of inertia into the relationship. Examining the long-term impact of such projects on the franchise involves analyzing franchisees' willingness to continue investing in the franchise, including renewing contracts upon expiration and upgrading stores and equipment as necessary.

We approached this investigation through qualitative and quantitative research, utilizing in-depth interviews with franchisors and franchisees and conducting experiments introducing e-commerce innovations in a simulated franchise system. Both methods revealed that franchisees are significantly less inclined to maintain or renew their investments in the franchise if the e-commerce project does not involve them in a way that positions it as a growth opportunity rather than a threat.

The preferred system for franchisees might depend on the type of franchisee in question. Multi-unit franchisees managing a larger organization, typically encompassing 3-8 stores in the same area, might favor involvement in a centralized e-commerce system. In this system, once a customer connects, the business is passed to the local franchisee who then manages the online sale directly. Smaller franchisees, such as single-unit franchisees, generally prefer a click-to-store system or a percentage on a centralized sale, resembling the role of a local agent promoting the brand and receiving a share from the overall company sales with customers originating from their local territory.

This evidence holds managerial relevance. Franchisors who anticipate the continued importance of physical stores in their business must make informed decisions about e-commerce. Launching an e-commerce system that excludes franchisees will eventually necessitate significant additional investments in the store network, beyond the pilot stores. In many cases, franchisors may find themselves compelled to buy out previously franchised stores, as franchisees may decide not to renew contracts or redevelop stores, even when such actions are necessary.

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Digital Nomads: Croatian Experience

Drago Pupavac[1]
Anto Malbašić[2]
Marija Ivaniš[3]

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Abstract: *Digital nomads are entrepreneurs or employees who almost exclusively use digital technologies to perform their work. They are addicted to the Internet, work on the road and live in multiple locations around the world. The Republic of Croatia is becoming an increasingly attractive destination for digital nomads. Accordingly, the subject of research of importance for this paper is the fundamental characteristics of digital nomads in the Republic of Croatia. The results of the research are based on primary data collected by the survey method (n=40). The survey was conducted from March 13 to May 13, 2023, in a Google Forms form, which was distributed via the social networks Facebook, Twitter, and LinkedIn. The collected data are the subject of analysis using the methods of descriptive statistics. The findings in this work can be helpful to managers of numerous organizations and political decision-makers at all levels.*

1. INTRODUCTION

Digital nomads are people who are location-independent and use technology to perform their jobs, living a nomadic lifestyle (Hayes, 2021). They do their job without being physically present at a company. Digital nomads are a phenomenon of the 21st century. Digital nomads are a new fast-raising segment of the labor market. According to Schlagwein (2018) around the world lives and works with several hundred thousand digital nomads. Global digital nomads are young people between the ages of 25 and 40. They are usually highly educated and skilled in the use of technology. Many of them come from countries with a high standard of living and a strong economy, such as the USA, Canada, Australia, Great Britain, and developed EU countries. Digital nomads have different driving motives, some of the most common motives are better earnings at lower costs, flexibility, independence, and the desire to travel. Digital nomads often look for ways to balance their work life with other interests and activities they enjoy doing, such as traveling or exploring new cultures. Also, many digital nomads want to avoid traditional working conditions and environments and are looking for ways to create their own work environment that works best for them.

According to research by the Nomadic Report (2023), the largest number of digital nomads currently live and work in Germany (14%), Portugal (10%), the USA (9%), Denmark (8%), and Indonesia (5%). Other countries with lower percentages of digital nomads include Vietnam, Spain, Malaysia, Thailand, France, Romania, Mexico, Brazil, Italy, the United Kingdom, and others. The Republic of Croatia belongs to the group of twenty countries where 1% of digital nomads currently live and work. The Government of the Republic of Croatia, the Croatian Tourist Board, prominent individuals from the world of digital nomads, and the IT communities of Croatian cities are continuously working to promote the Republic of Croatia as a desirable destination for digital nomads. The Republic of Croatia created a legislative framework, clearly defined

[1] Polytechnic of Rijeka, Vukovarska, 58, 51000, Rijeka, Croatia
[2] Hrvatska elektroprivreda, Viktora cara Emina, 2, 51000, Rijeka, Croatia
[3] Faculty of Tourism and Hospitality Management, Primorska, 46, 54410, Opatija, Croatia

the conditions of residence, made it possible to obtain residence visas and, in addition to all other comparative advantages, made it relatively easy to obtain them.

The conducted research sought to investigate the fundamental characteristics of digital nomads who resided in the Republic of Croatia. Accordingly, the purpose and goal of this research is to find answers to the following four questions:

- Who are digital nomads?
- What criteria are digital nomads guided by when choosing a destination?
- How much did the Digital nomad visa contribute to the attractiveness of the Republic of Croatia as a destination for digital nomads?
- Do digital nomads who visit the Republic of Croatia show any specifics in comparison to other members of the nomadic community?

The work is divided into five parts. In the first unit, the research objective and research questions are determined. The second part presents the theoretical basis of digital nomadism and digital nomads, as well as the criteria that guide them when choosing a certain destination. The third section explains the research methodology and the sample. The fourth unit presents a summary of the results of the authors' empirical analysis. At the end of the paper, there is a conclusion in which the main findings of the paper and the importance of further study of digital nomadism and digital nomads are highlighted.

2. THEORETICAL BACKGROUND

Digital nomads are often self-employed or work in creative industries, IT, and marketing. They are an example of a new segment of the labor market in the conditions of the digital economy. They require flexibility and the ability to adapt to changes in the work environment. Digital nomads can perform various types of jobs that can be done remotely via the Internet. Their occupations are mostly based on digital skills. Some of the most common professions that are represented in the research of the association ATTA (Kelly & Arelano, 2021) in relation to the choice of locations according to the opinions of respondents and the necessary ITC infrastructure are 1) web designer, 2) programmer, 3) copywriter, 4) marketing expert, 5) virtual assistant, 6) online teacher/mentor, 7) writers, 8) travel writers/photographers, 9) editors of web portals, 10) administrators of web sites and social networks, 11) influencers.

According to research by Nomadic Report (www.nomadic.report/survey), the average digital nomad is a man, 34 years old, earns about USD 4,500, spends USD 2,000 on average, and lives in rented accommodation, where usually works forty hours a week. He often does multiple jobs for multiple different employers. The length of stay at one destination varies significantly. The earnings of digital nomads depend on the type of work they do. Computer programmers may earn higher salaries (ZipRecruiter.com, 2021).

Digital nomads are guided by different criteria when choosing a destination. Some of them choose destinations based on individual criteria that often change. Some criteria are repeated, confirming the fact that digital nomads choose destinations based more on consideration of the use of free time than employment criteria. The two most common criteria are the cost of living and the climate. Other criteria are the communicativeness of the local population, the quality of the ICT infrastructure, the possibility of working in coworking spaces, security, good traffic connections, natural beauty, and the availability of online delivery services.

Most digital nomads prefer a lower cost of living so they can enjoy a high standard of living with less work. Their choice based on the cost of living can be mathematically represented as follows:

$$FR = TR - TC \quad (1)$$

Where is:
FR – Financial result
TR – Total revenue
TC – Total costs

Unable to significantly increase their total income, when choosing a destination, they decide in options that allow them to spend less. In that case, they value their financial result as follows:

$$FR = TR - CL_{DP} + (CL_{DP} - CL_{D}) \quad (2)$$

Where is:
CL_{DP} – cost of living in domicile place
CL_{D} – cost of living in a potential destination

In this case, all options where $(CL_{DP} - CL_{D}) \geq 0$ are acceptable. The bigger this difference, the more attractive a certain destination is for digital nomads. The equation is written in a broader form to highlight the importance of comparing the cost of living in the domicile and the potential destination of digital nomads.

Accordingly, Table 1 provides an example of destination selection by digital nomads based on a comparison of the cost of living in the place of residence and the desired destination.

Table 1. Destination selection based on the cost of living

	Total revenue	CL_{MD}	CL_{D}	FR
Destination 1	4500	3200	2200	2300
Destination 2	4500	3200	2500	2000
Destination 3	4500	3200	1750	2750
Destination 4	4500	3200	1200	3300

Source: Own calculations

Based on formula (2), the potential financial result of digital nomads in the case of choosing between the four destinations was calculated. For a digital nomad who has an income of USD 4,500 and a living cost of USD 3,200, the most desirable destination seems to be destination 4, where the cost of living is the lowest (USD 1,200). By choosing this destination, he would achieve significant savings and increase his financial result from USD 1,300 (4,500-3,200) to USD 3,300. Digital nomads can further increase their financial results by increasing their total income by renting out their own properties while on the road.

However, since their decision is influenced by other criteria in addition to the cost of living, the weight factor method seems optimal for evaluating the decision of digital nomads when choosing a suitable destination. This method consists of six steps (Heizer & Render, 2011): 1. Identifying key factors relevant to the evaluation of the potential destination (as listed in Table 2); 2. Determining the importance weights for each of the key factors; 3. Determining the scale for each factor (e.g., from 1 to 10 or from 1 to 100); 4. Determining the number of points for each

potential destination and each factor based on step 3; 5. Determining the product of importance weights and the number of points associated with each factor as well as the total sum of points; and 6. Evaluating the potential destination based on the conducted quantitative analysis, i.e., the average evaluation of the project.

Table 2. Evaluation of a potential destination from the digital nomad's point of view

Critical success factor	Weight	Scores (out of 100)			Weighted Scores		
		D_I	D_II	D_III	D_I	D_II	D_III
Cost of living	0,50	80	80	85	(0,50×80)=40	(0,50×80)=40	(0,50×85)=42,5
Climate	0,15	85	70	80	(0,15×85)=12,75	(0,15×70)=10,50	(0,15 ×80)=12
Quality of ICT infrastructure	0,10	95	90	80	(0,1×95)=9,5	(0,1×90)=9	(0,1×80)=8
Communicativeness of the local population	0,05	85	75	70	(0,05×85)=4,25	(0,05×75)=3,75	(0,05×70)=3,5
Traffic connection	0,05	80	70	75	(0,05×80)=4	(0,05×70)=3,5	(0,05×75)=3,75
Security	0,05	90	65	80	(0,05×90)=4,5	(0,05×65)=3,25	(0,05×80)=4
Natural beauty	0,05	90	95	85	(0,05×90)=4,5	(0,05×95)=4,75	(0,05×85)=4,25
Coworking spaces	0,025	80	85	80	(0,025×80)=2	(0,025×85)=2,125	(0,025×80)=2
Others	0,025	80	75	85	(0,025×80)=2	(0,025×75)=1,875	(0,025×85)=2,125
Total	1				83,5	78,75	82,125

Source: Own calculations

Based on the data from Table 2, it is clear that the destination D_I is the most desirable for digital nomads. This does not mean that they will not visit other potential destinations, but destination D_I is their first choice. Furthermore, the weighting factor method enables re-analysis based on a change in the number of points of one of the critical factors. For example, if destination D_III raised the quality of ICT infrastructure to the level of destination D_I, then it would be the first choice of digital nomads with 83,625. Just as some things are taken for granted in today's society, such as access to free Internet, the weight of certain critical factors changes quickly and significantly, which can also affect the change in the attractiveness of a certain destination.

Intending to increase its attractiveness for digital nomads, the Republic of Croatia created a legislative framework, clearly defined the conditions of residence, provided visas for the residence of digital nomads, and made it relatively easy to obtain them. According to data from the Croatian Bureau of Statistics (DZS, 2023) from 01.01.2022 until 31.12.2022, 1,223 people applied for a residence visa as digital nomads and 731 or 60% of them were approved. The largest number of visa requests comes from Russia and Ukraine, 63.28%. This data leads to the conclusion that digital nomad visas from Russia and Ukraine are mainly used by those who want to escape from the war. The number of applications for digital nomad visas is followed by citizens of the USA (11.77%), Great Britain (5.56%), Canada (2.37%), Australia (1.47%), China (1.47%), Argentina (1.31 %), etc.

3. RESEARCH METHODOLOGY AND SAMPLE

The survey was carried out in the form of a Google Forms form, which was shared via the social networks Facebook, Twitter, and LinkedIn, and respondents were asked to complete the survey only if they currently reside or have previously resided as digital nomads in the Republic of Croatia. The survey consisted of 24 questions. The survey questions were taken from the Nomadic Report survey (2023), in order to establish the similarities and differences of digital nomads in the world and the Republic of Croatia. The survey was available from March 13, until May 13, 2023. The survey was completed by 40 respondents. Currently, 30 or 75% of them live and work as digital nomads. Most of them are males between the ages of 21 and 48 (see Table 3).

Table 3. Demographic characteristics of the respondents

	N	%
Sex		
Male	26	65
Female	13	32,5
Prefer not to answer	1	2,5
Age		
less than 21	1	2,5
21-27	5	12,5
28-34	14	35
35-41	11	27,5
42-48	5	12,5
49-55	1	2,5
56+	3	7,5
The year the trip started		
2017 and before	9	22,5
2018.	5	12,5
2019.	5	12,5
2020.	14	35
2021.	7	17,5
Relationship		
Solo	15	37,5
Have a partner	22	55
Another kind of relationship	3	7,5
Kind of occupation before was digital nomad		
Full-time employee	16	40
Part-time employee	3	7,5
Didn't work most of time	2	5
Run own company	5	12,5
Freelancer	10	25
Other	4	10
Citizenship		
Germany	8	20
Italy	4	10
Spain	2	5
UK	4	10
France	4	10
USA	4	10
Canada	4	10
Other	10	25
Country of current residence		
Croatia	33	82,5
USA	1	2,5
Italy	4	10
Spain	1	2,5
India	1	2,5

Source: Own research

4. RESULTS AND DISCUSSION

Digital nomads are increasingly present in today's world of work, so it is important to understand their way of life and work. The time that digital nomads spend in one city usually varies (34%), some stay longer than 15 weeks (31%), while 18% of them stay in one city for 3-4 weeks (see Figure 1).

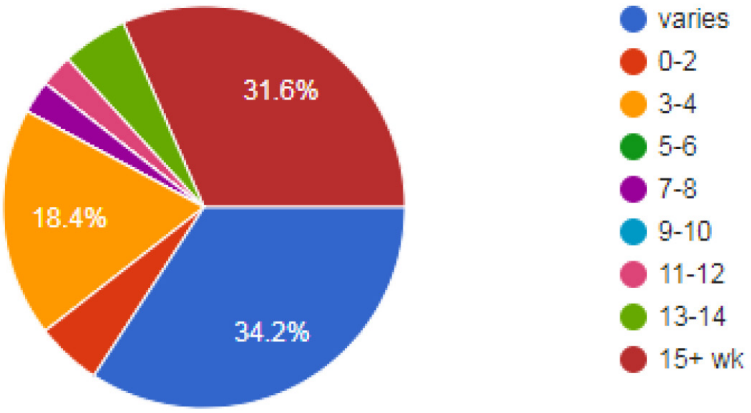

Figure 1. How many weeks do digital nomads usually stay in one city?
Source: Own research

The obtained findings are somewhat different from the findings from the Nomadic Report research. Namely, according to both types of research, the time that digital nomads spend in one city usually varies, but according to the research of Nomadic Report, digital nomads usually stay in one city for 9 to 10 weeks, in contrast to digital nomads who usually stay in the Republic of Croatia for more than 15 weeks.

Digital nomads earn different amounts. Quarterly monthly income varies. Only one earns more than $7,000. 92.5% of them earn less than USD 4,000, which is slightly less than the average from the Nomadic Report survey – USD 4,500. The amounts are expressed in USD for easier comparison with previous research (see Figure 2).

The primary motive that drives them is not only money but above all the desire for a more comfortable way of life. They often earn less than they would earn as traditional workers in their home countries, so they choose destinations with a lower cost of living to compensate for this difference in earnings.

Digital nomads spend very different amounts. 55% report spending between $1,000 and $2,000. The average spending is USD 1,805, and the median is USD 1,750 (see Figure 3).

Digital nomads who reside or have resided in the Republic of Croatia spend less on average than their colleagues who, according to the Nomadic Report's research, spend an average of USD 2,500.

For their stay in the destination, the largest percentage (57%) rent apartments or houses, while 15% use services such as Airbnb. Also, 10% stay with friends and family. A smaller percentage of respondents sleep in hostels, and own their apartments or houses (see Figure 4).

This finding is quite similar to the finding from the Nomadic Reports research, according to which 57% of digital nomads rent apartments or houses for their stay and work in a certain destination.

Digital nomads use a combination of different places to work. The largest percentage (80%) works from their own accommodation, (5%) from shared spaces, (5%) from cafes and bars (see Figure 5).

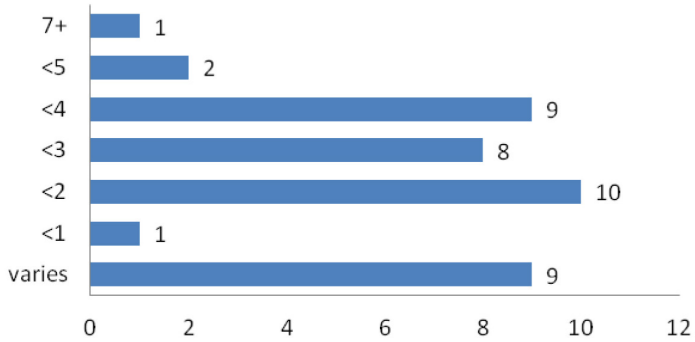

Figure 2. How much do digital nomads earn on average per month (after all taxes)?

Source: Own research

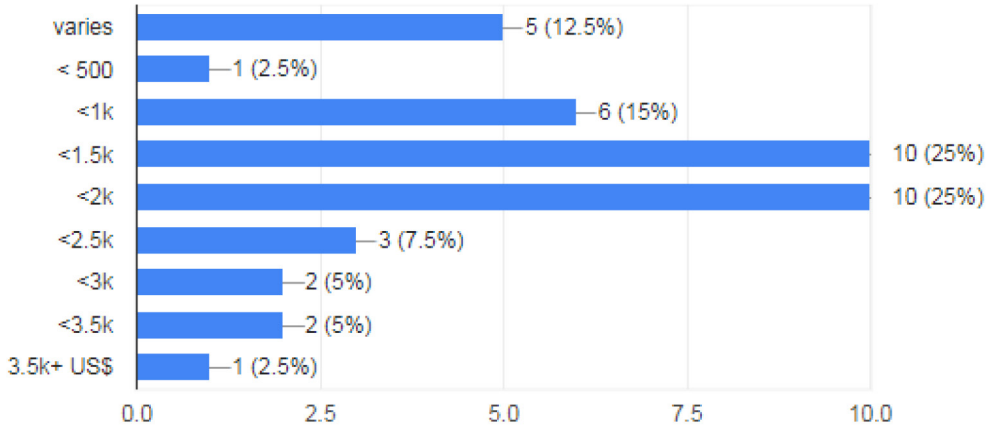

Figure 3. How much do digital nomads spend on average per month?

Source: Own research

Figure 4. Where do digital nomads stay?

Source: Own research

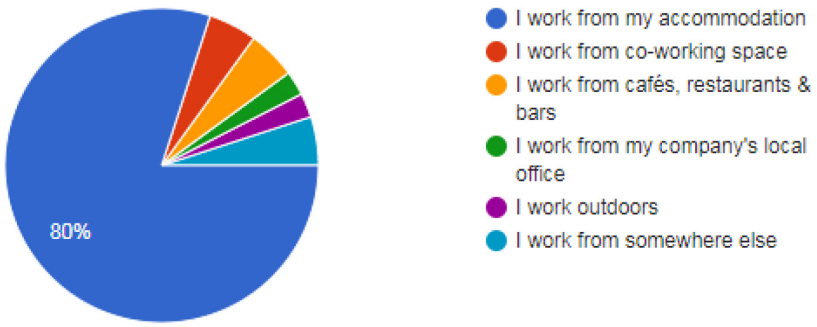

Figure 5. Where do digital nomads work from?

Source: Own research

This finding is almost identical to the finding from Nomadic Reports, according to which 77% of digital nomads work from their accommodation.

The average weekly working hours of digital nomads vary. Most often they work between 20-29 hours a week (27.5%). The same percentage of them work longer than 40 hours a week, while only three of them (7.5%) work less than twenty hours a week (see Figure 6).

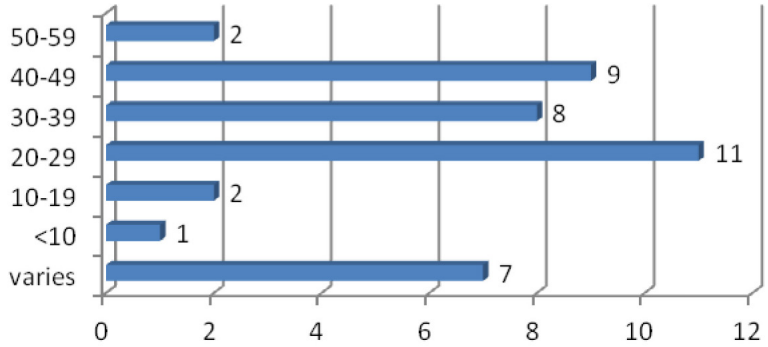

Figure 6. How many hours do digital nomads work on average per week?

Source: Own research

This finding points to the conclusion that digital nomads residing in the Republic of Croatia work fewer hours per week compared to their colleagues from the community who work an average of 40 hours per week. According to research by Nomadic Reports, as many as one-fifth of digital nomads work between 40 and 49 hours a week. It is important to note that digital nomads do very different jobs, from different places, so their working hours may vary depending on their location and the type of work they do.

Only 16% of respondents stated that the introduction of the nomadic visa had an impact on their arrival in the Republic of Croatia, while 50% had no impact on them (see Figure 7).

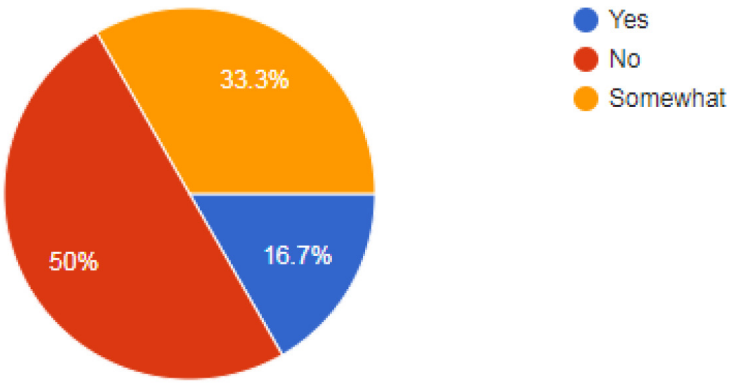

Figure 7. Did the introduction of the nomadic visa have an impact on your arrival in Croatia?

Source: Own research

The digital nomad lifestyle is an increasingly popular way of living and working, with many individuals opting for this type of flexibility and freedom. Numerous companies and countries can take advantage of this opportunity by attracting digital nomads and creating a stimulating environment for them to stay and work. Therefore, it is essential to continuously study and understand this community in order to adapt to changes and take advantage of all the benefits that a digital nomad way of living and working can provide to individuals and organizations.

Accordingly, there is a need for further research and monitoring of the phenomenon of digital nomadism for a deeper understanding of its implications for society, the economy, organizations and individuals themselves. The digital nomad lifestyle is a complex phenomenon with many dimensions. Understanding its implications for society, economy, organizations and individuals requires an interdisciplinary approach that includes economic, sociological, psychological and technological perspectives. Only through comprehensive interdisciplinary, multidisciplinary research can one get a complete insight into this increasingly widespread way of life and work and contribute to the development of adapted strategies and policies.

5. CONCLUSION

Digital nomadism brings certain challenges and problems, such as a lack of stability in life without a permanent address, difficulty in maintaining a balance between work and free time, and lack of social interaction. Also, the status of digital nomads in some countries is still not clearly defined, so there are problems related to tax systems, security, and other aspects of life to which they must adapt. The advantages of this way of living and working include freedom and flexibility in work, the possibility of traveling and getting to know new cultures and increasing productivity, creativity, and job satisfaction.

Digital nomads in the Republic of Croatia are mostly men, in a relationship, aged between 21 and 48. They come from economically developed countries. 40% of them worked full-time before becoming digital nomads. The time they spend in one city most often varies (34%), while one-third of them stay longer than 15 weeks in one city. They earn less than $4,000 and spend about $1,800 on average. For their stay, they usually rent apartments or houses, where most of them work. On average, they work more than 20 hours a week, while 27.5% of them work more than 40 hours a week. The number of digital nomads who used a digital nomad visa to stay in the Republic of Croatia is negligible. It is obvious that the digital nomad visa did not increase the attractiveness of the Republic of Croatia as a destination for digital nomads. The fundamental specificity of digital nomads who stayed in the Republic of Croatia is that they work fewer hours per week than their colleagues from the nomadic community, but also that they earn less on average. This finding leads to the conclusion that earnings are not the primary motive for the arrival of digital nomads in the Republic of Croatia, but other criteria such as the climate, communicativeness of the local population, the quality of the ICT infrastructure, natural beauty, etc.

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Competencies Related to the Web and Digital Accessibility

Valentina Kirinić[1]

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Digital accessibility;
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Abstract: *An important aspect of information technology (and digital information/content) should be and is its inclusiveness and openness to people with disabilities (PwD) as well as to all other people with special needs. Web and digital accessibility are the basics of digital inclusion, needed to assure equality in the digital world. Each profession should implement, support and promote accessibility in domains that it is responsible for. Accessibility is an important priority today for all. In this paper, the competencies related to the web and digital accessibility are analyzed and discussed. The goal of the study presented is to investigate, using in-depth content analysis, how accessibility is defined and described in information technology standards, recommendations, models and frameworks of (digital) competencies.*

1. INTRODUCTION

In the UN Convention on the Rights of Persons with Disabilities (United Nations, 2006, p. 9), Article 9 – Accessibility, emphasizes the need for taking appropriate measures to ensure that persons with disabilities access, among others, information and communications, including belonging technologies and systems.

In the digital world, equal rights and opportunities are unthinkable without web and digital accessibility implemented.

Web accessibility is fostered by Web Content Accessibility Guidelines (WCAG), in the form of the international standard ISO/IEC 40500:2012 Information Technology - W3C Web Content Accessibility Guidelines (WCAG) 2.0 (International Organization for Standardization, 2012). Following the WCAG we can make content accessible to people with disabilities, as well as to those whose abilities decrease due to aging, as well as those who have a temporary disability or some other difficulty (slower Internet connection, for example).

Web accessibility as well as the accessibility of the content (PDF and some other documents/formats) is the focus of Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies (European Parliament, 2016).

Web and digital accessibility are defined and fostered by many international standards, directives, legal documents and recommendations and guidelines such as:

- EN 301 549 - Accessibility requirements for ICT products and services) (ETSI, 2021) as well as other related standards, guidelines and legislation (such as (European Parliament, 2016))
- ISO/IEC 29138-1:2018, Information technology, User interface accessibility, Part 1: User accessibility needs (International Organization for Standardization, 2018)

[1] University of Zagreb Faculty of Organization and Informatics, Pavlinska 2, 42000, Varaždin, Croatia

- ISO/IEC TR 29138-2:2009, Information technology, Accessibility considerations for people with disabilities, Part 2: Standards inventory (International Organization for Standardization, 2009)

It is professional (of all professions) and also a moral duty to assure and foster accessibility and to do that we all have to be equipped with the corresponding competencies. This is the reason to explore if the competencies related to digital accessibility are referenced and how in the digital competence frameworks of both ICT professionals and all other citizens.

2. METHODS

The main method used to explore it is analysis of the content of the selected documents relevant to the area of web and digital competencies of

- ICT professions - web and digital competencies as "professional" competencies and
- other professions, wider audience, citizens – "general" web and digital competencies.

Only two main, relevant documents recognized and used across Europe to define digital skills in general per each group of intended users were selected to be analyzed.

For ICT professions they are:

- the European e-Competence Framework (e-CF) - European Standard EN 16234-1:2019 (CEN, 2019), defining 40 competencies of the ICT professionals in five (ICT business) areas, and
- the Skills Framework for the Information Age (SFIA) (SFIA Foundation, 2021), describing the skills required by professionals responsible for "designing, developing, managing and protecting both the data and the technology that power the digital world".

For other professions selected documents relevant to the web and digital accessibility are:

- the DigComp 2.2: The Digital Competence Framework for Citizens (Vuorikari et al., 2022), is intended for all citizens, no matter the profession, in the context of employment, education and training, and lifelong learning, it provides a common understanding of what digital competence is, serves as a basis for framing digital skills policy as well as it enables evaluating own digital competence,
- the European Framework for the Digital Competence of Educators: DigCompEdu (Redecker, 2017), is "directed towards educators at all levels of education, from early childhood to higher and adult education, including general and vocational education and training, special needs education, and non-formal learning contexts" (p. 9), it promotes the digital competence and boost innovation in education.

Content of those documents was analyzed to check whether or not and how web and/or digital accessibility, as a term, have been directly addressed in the definition of competencies or their description or elements.

3. RESULTS

In the following tables (Tables 1, 2, 3 and 4) show in which parts of the frameworks (documents) and how digital accessibility has been directly referenced in the text.

In **the European e-Competence Framework (e-CF)**, shortly e-CF Framework, accessibility is one (T1) of the seven transversal aspects being relevant to all competencies defined by the standard. The transversal aspects could be incorporated by using the phrase, 'Being aware of and if applicable, behaving proactively in' (CEN, 2019, p. 15).

Accessibility, as stated in (CEN, 2019, p. 15):

- "is applicable to the design of products, devices, services or environments to ensure that they are usable by all, irrespective of their personal capacities"
- "is relevant to the extent to which products, systems, services, environments and facilities can be used by people from a population with the widest range of characteristics and capabilities to achieve a specified goal
- "is also relevant, for example, when working in adverse conditions (such as noisy or badly illuminated environments) or stressful situations".

Accessibility is also connected to usability as it is one of its characteristics (CEN, 2019, p. 16). The e-CF Framework outlines the minimum requirements of ICT professional competence (with the typical knowledge and skills to support orientation and understanding), clearly defining which elements are mandatory (shall) and which are merely examples (should/may/can…).

In the e-CF Framework (CEN, 2019), competencies are organized and described through the four dimensions as follows:

- Dimension 1: Five e-Competence areas "expressing the abilities of planning (conceiving, designing, deciding, etc.), building (developing and implementing), running (delivering, supporting, maintaining, etc.), enabling (creating the proper conditions), and managing (conducting, ensuring, etc)" (CEN, 2019, p. 10),
- Dimension 2: e-Competences (a title and a generic description of the competence) for each e-Competence area (41 in total),
- Dimension 3: Five work proficiency levels (e-1 to e-5) for each competence which defines proficiency criteria and describe the degree of mastery required by an ICT professional to meet different levels of performance in each competence" and are characterized by a combination of levels of influence within a community, context complexity, autonomy, and typical behaviour expressed by examples of action verbs" (CEN, 2019, p. 11),
- Dimension 4: Knowledge and skills examples "provided to add value to the competence descriptor and are not intended to be exhaustive" offering "inspiration and orientation for the identification of further context-specific knowledge and skills assignment" (CEN, 2019, p. 11), and
- Transversal Aspects that apply across the entire framework, recognizing "the relevance of many crosscutting aspects that are important in the ICT workplace", complementing competence descriptions and providing "additional descriptors that vary in their relevance to each competence ranging from the need for awareness to proactive engagement" (CEN, 2019, p. 11).

Table 1 shows the dimensions of the e-CF framework in which, in their text, digital accessibility is directly referenced. From Table 1, the dimensions of the framework Dimension 3 (e-Competence proficiency levels e-1 to e-5, related to EQF levels 3 to 8; SHALL APPLY) and the part of Skills examples (Is able to MAY APPLY) in Dimension 4 are omitted, because in their text digital accessibility is not mentioned.

Table 1. Digital accessibility competencies addressed in European e-Competence Framework (e-CF)

Dimension 1 **e-Comp. area**	**Dimension 2** **e-competence:** **Title + generic description** **SHALL APPLY**	**Dimension 4** **Knowledge examples** **Knows/ aware of/ familiar with** **MAY APPLY**
A. PLAN	A.5. Architecture Design Takes into account interoperability, reversibility, scalability, usability, accessibility and security, including the need to account for the development and management of vulnerability within existing and emerging technologies.	K2 systems architecture requirements: performance, maintainability, extendibility, scalability, availability, security and accessibility
A. PLAN	A.6. Application Design Ensures that all aspects take into account interoperability, usability, accessibility and security.	K10 accessibility-related requirements, standards and frameworks
A. PLAN	A.10. User Experience	K5 principles, standards, methods and frameworks related to ergonomics and accessibility
B. BUILD	B.1. Application Development	K8 usability and accessibility requirements
B. BUILD	B.3. Testing	K3 the different sorts of tests (functional, integration, performance, usability, accessibility, security, stress, etc.)

Source: Own processing based on CEN, 2019

In Annex B (informative) Positioning this standard to other structures and frameworks, there are related ISO (and IEEE) standards and standardization initiatives emphasized. Regarding accessibility, ISO/IEC DIS 29138-1: Information technology - User interface accessibility (ISO/IEC 29138-1:2018 Information technology - User interface accessibility - Part 1: User accessibility needs) has been mentioned as an example, as well as ISO/IEC TR 29138-2:2009 Information technology - Accessibility considerations for people with disabilities - Part 2: Standards inventory, and EN 301 549 Accessibility requirements suitable for public procurement of ICT products and services in Europe.

Skills Framework for the Information Age (SFIA) "has become the global common reference for skills and competency for the digital world" (SFIA Foundation, 2021, p.3). Documents that complement the SFIA framework, which can be downloaded from the website https://sfia-online.org/, enable skills and competence development in the ICT area.

Within the SFIA Framework document (SFIA Foundation, 2021) one hundred and two skills are arranged into six categories and nineteen subcategories in total. Each skill has a unique name and unique code for simple reference as well as an associated range of levels of responsibility (and accountability). There are seven levels of responsibility (1 – Follow, 2 – Assist, 3 – Apply, 4 – Enable, 5 - Ensure, advise, 6 - Initiate, influence and 7 - Set strategy, inspire, mobilize) defined in SFIA but there is not such a skill having all seven levels used. Each level of responsibility is defined through the elements of Autonomy, Influence, Complexity, Business skills and Knowledge.

In the SFIA Framework, skills are constructed with the elements of Skill name, Skill code, Skill description, Guidance notes (a broader description and examples), and Level description (definitions of the skill for each of the levels at which it is practiced) (SFIA Foundation, 2021, p. 23).

Table 2 shows the SFIA Framework skills elements in which digital accessibility is directly referenced.

Table 2. Digital accessibility competencies addressed in the Skills Framework for the Information Age (SFIA)

Category/ Subcategory	**Skill name Skill code Skill description**	**Guidance note (Activities):**	**Level (The skill range of levels) Level description**
Development and implementation/ User experience	User Experience Analysis UNAN Understanding the context of use for systems, products and services and specifying user experience requirements and design goals.	• understanding and specifying user experience and user accessibility requirements for all potential users.	Level 4 (3-5) Specifies measurable criteria for the required usability and accessibility of systems, products, services and devices. Level 5 (3-5) Plans and manages user experience and accessibility analysis activities.
	User experience design HCEV Producing design concepts and prototypes for user interactions with and experiences of a product, system or service.	• understanding and addressing design goals, usability and accessibility requirements • using an iterative design process to enhance user satisfaction by improving usability and accessibility	Level 3 (3-6) Review design goals and agreed security, usability and accessibility requirements. Level 4 (3-6) Evaluate alternative design options and recommend designs taking into account performance, security, usability and accessibility requirements. Level 6 (3-6) Obtains organizational commitment to strategies to deliver required user experience, usability, accessibility and security.
	User experience evaluation USEV Validating systems, products or services against user experience goals, metrics and targets.		Level 4 (2-6) Validates that security, usability and accessibility requirements have been met. Checks operational systems, products, services, or devices for changes in usability and accessibility needs. Level 5 (2-6) Assures that the security, usability and accessibility requirements have been met and that required practices have been followed. Advises on the achievement of required usability and accessibility levels of specific designs or prototypes. Prioritises input for future user research. Level 6 (2-6) Specifies standards and methods for security, usability and accessibility and ensure that this is addressed in future designs.
Development and implementation/ Content management	Content authoring INCA Planning, designing and creating textual information, supported where necessary by graphical content.		Level 4 (1-6) Controls, monitors, and evaluates content to ensure quality, consistency and accessibility of messages and optimal use of chosen media.
	Content publishing ICPM Managing and continually improving the processes that collect, assemble and publish content.		Level 2 (1-6) Applies principles of usability and accessibility to published information.

Source: Own processing based on SFIA Foundation, 2021

The DigComp 2.2: The Digital Competence Framework for Citizens (Vuorikari et al., 2022) contains five dimensions of Competence area, (Dimension 1), Competence (Dimension 2), Proficiencies level (Dimension 3), Examples of knowledge, skills and attitudes (Dimension 4), and Use cases (Dimension 5) with Employment and Learning scenarios. In five Competence

areas (Information and data literacy, Communication and collaboration, Digital content creation, Safety, and Problem-solving) there are 21 competencies in total defined and described.

The biggest changes in version 2.2 compared to previous versions of DigComp from the aspect of accessibility are the emphasis on the importance of accessibility, the introduction of digital accessibility (highlighted with (DA)) in the examples of knowledge, skills and attitudes (Dimension 4), as well as Annex 4, which presents a version of the framework accessible for a screen reader.

In the Glossary of the DigComp 2.2 Framework (Vuorikari et al., 2022) the definition of Digital accessibility (DA) is also given as "extent to which people from a population with the widest range of characteristics and capabilities can use digital products, systems, services, environments and facilities to achieve a specified goal in a specified context of use (direct use or use supported by assistive technologies). (Modified from EN 301547)." (p. 63).

Table 3 presents Dimensions 1, 2, and 4 of the DigComp 2.2 in which, digital accessibility is directly referenced. From Table 3, the dimensions Dimension 3 and 5 are omitted, because in them accessibility is not mentioned/referenced.

Table 3. Digital accessibility competencies addressed in the DigComp 2.2: The Digital Competence Framework for Citizens

Competence area (Dimension 1)	Competence (Dimension 2)	Examples of knowledge (K), skills (S) and attitudes (A) (Dimension 4)	
1. Information and data literacy	1.1 Browsing, searching and filtering data, information and digital content	15. Concerned with inaccessibility of information for all users	A
2. Communication and collaboration	2.1 Interacting through digital technologies	45. Aware of which communication tools and services are appropriate - inclusive and accessible for all users	K
	2.4 Collaborating through digital technologies	91. Inclined to use digital tools for fostering collaboration ensuring digital accessibility	A
	2.5 Netiquette	96. Aware of accessibility requirements when communicating	K
3. Digital content creation	3.1 Developing digital content	120. Aware of what "digital accessibility" means and how important is for all users	K
		122. Can use tools and techniques to create accessible digital content following relevant standards and guidelines	S
		129. Inclined to follow relevant standards and guidelines to test the accessibility of web/digital content	A
	3.2 Integrating and re-elaborating digital content	132. Knows how to use tools and to enhance digital accessibility of digital content	S
5. Problem-solving dimension	5.2 Identifying needs and technological responses	230. Knows technical approaches for improvement of inclusiveness and accessibility of digital content and services	K
		231. Aware that AI-driven speech-based technology can enhance the accessibility of digital tools and devices	K
		234. Knows how to choose assistive tools to foster accessibility	S

Source: Own processing based on Vuorikari et al., 2022

The European Framework for the Digital Competence of Educators: DigCompEdu (Redecker, 2017), defines digital competence (competencies) concerning educator's professional competencies, educator's pedagogical competencies, and learner's competencies.

Table 4. Digital accessibility competencies addressed in the European Framework for the Digital Competence of Educators: DigCompEdu

Competence Area	**05 Empowering Learners**
Competence	**Accessibility and inclusion** • To ensure accessibility to learning resources and activities, for all learners, including those with special needs. • To consider and respond to learners' (digital) expectations, abilities, uses and misconceptions, as well as contextual, physical or cognitive constraints to their use of digital technologies.
Activities	• To provide equitable access to appropriate digital technologies and resources, e.g. ensuring that all students have access to the digital technologies used. • To select and employ digital pedagogical strategies which respond to learners' digital context, e.g. contextual constraints to their technology use (e.g. availability), competences, expectations, attitudes, misconceptions and misuses. • To employ digital technologies and strategies, e.g. assistive technologies, designed for learners in need of special support (e.g. learners with physical or mental constraints; learners with learning disorders). • To consider and respond to potential accessibility issues when selecting, modifying or creating digital resources and to provide alternative or compensatory tools or approaches for learners with special needs. • To employ design principles for increasing accessibility of the resources and digital environments used in teaching. • To continuously monitor and reflect on the suitability of the measures implemented to improve accessibility and adapt strategies accordingly.
Progression & Statements	• Newcomer (A1) Being concerned about accessibility and inclusion. I am afraid that the use of digital technologies in teaching will make it even more difficult for already disadvantaged students to participate and keep up with the others. • Explorer (A2) Being aware of accessibility and inclusion issues. I understand the importance of ensuring equal access to the digital technologies used for all students. I am aware that digital technologies can hinder or improve accessibility. • Integrator (B1) Addressing accessibility and inclusion. I understand how access to digital technology creates divides and how students' social and economic conditions have an impact on the way technology is used. I ensure that all students have access to the digital technologies I use. I am aware that compensatory digital technologies can be used for learners' in need of special support (e.g. learners with physical or mental constraints; and learners with learning disorders). • Expert (B2) Enabling accessibility and inclusion. I select digital pedagogical strategies that adapt to learners' digital contexts, e.g. limited usage time, and type of device available. I consider and respond to potential accessibility issues when selecting, modifying or creating digital resources and provide alternative or compensatory tools or approaches for learners with special needs. I employ digital technologies and strategies, e.g. assistive technologies, to remediate individual leaners' accessibility problems, e.g. visual or hearing impairments. • Leader (C1) Enhancing accessibility and inclusion. I select and employ digital pedagogical strategies fitted to learners' digital technology uses, competences, expectations, attitudes, misconceptions and misuses. I employ design principles for increasing accessibility for the resources and digital environments used in teaching, e.g. as concerns font, size, colours, language, layout, structure. I continuously monitor and reflect on the suitability of the measures implemented to improve accessibility and adapt my strategies accordingly. • Pioneer (C2) Innovating strategies for accessibility and inclusion. I reflect on, discuss, re-design and innovate strategies for equal access to and inclusion in digital education.

Source: Own processing based on Redecker, 2017

4. DISCUSSION AND FUTURE RESEARCH

In both IT and education professions related relevant documents there are references to the term and concept of digital accessibility.

In IT-selected relevant documents "digital accessibility" is either:

- defined as transversal skill, mentioned just in two e-competences - Dimension 2 (Title + generic descriptions) and in a few examples of Knowledge - Dimension 4 of the e-CF Framework (CEN, 2019), or
- mentioned in very few Guidance notes (Activities) and Level description elements of the Skills Framework for the Information Age (SFIA) (SFIA Foundation, 2021).

It is far away of to be expected to promote and foster digital accessibility.

In selected relevant documents for other professions "digital accessibility" is either:

- just lightly referenced and emphasized in a few (in 7) Competences – Dimension 2 and Examples of knowledge (K) (in 5 out of 259 K, S and A in total), skills (S) (in 3 out of 259 K, S and A in total) and attitudes (A) (in 3 out of 259 K, S and A in total) – Dimension 4 of the DigComp 2.2: The Digital Competence Framework for Citizens (Vuorikari et al., 2022), or
- strongly defined, referenced and emphasized in the European Framework for the Digital Competence of Educators: DigCompEdu (Redecker, 2017, p. 70) as a separate Competence "Accessibility and inclusion" with all Activities, Progression & Statements (of the level of competence) described.

No matter the missing strong references in all analyzed documents, especially those related to the IT profession, the documents are very valuable as a starting point for promoting and assuring digital accessibility.

In this sense, competencies needed to support web and digital accessibility for/expected from IT professionals should be (at least):

- awareness and compliance/application of guidelines from international (IT) standards (ISO/IEC 40500:2012 Information technology W3C Web Content Accessibility Guidelines (WCAG) 2.0 (International Organization for Standardization, 2012) and EN 301 549 - Accessibility requirements for ICT products and services) (ETSI, 2021) as well as other related standards, guidelines and legislative (such as (European Parliament, 2016)),
- awareness of expected (few) competencies related to accessibility defined in model(s) of IT profession: European e-Competence Framework (e-CF) (CEN, 2019) and Skills Framework for the Information Age (SFIA) (SFIA Foundation, 2021).

Competencies needed to support web and digital accessibility for/expected from all other professionals (citizens) should be (at least):

- awareness and ensuring digital accessibility in the sense of DigComp 2.2 - The Digital Competence Framework for Citizens,
- awareness and empowering others (learners) to promote, provide and benefit from accessible digital technologies/content in the sense of DigCompEdu - European Framework for the Digital Competence of Educators, as well as other standards, guidelines and legislation.

Further research is directed to the exploration of the current state and levels of competencies related to digital accessibility, IT and educational professionals, as well as citizens in general.

5. CONCLUSION

Digital technologies are powerful tools in each area and aspect of our lives. It could (and should be) be used to make us more empowered and successful in mastering all (life, private and business) challenges and tasks, but at the same time so that none of us is neglected and pushed into a (even more) worse position and deeper digital divide. Digital accessibility should be strongly recognized and emphasized in all aspects of digital technologies, in related knowledge, skills and attitudes as well as usage/practice. To assure it two professions play crucial role: IT and educational professions.

Both IT and educational professionals have tasks of being actively engaged in

- assuring (higher level of) digital accessibility of digital products and services (software, hardware, orgware,…) as well as (digital) content and environment, and in
- spreading awareness, knowledge and best practice examples of digital accessibility.

Digital accessibility naturally belongs to the IT profession, in general as well as to some specializations (Web Accessibility Specialist and/or Accessible Document Specialist for which the certification offers International Association of Accessibility Professionals (IAAP) (Certification, n.d.) for example).

Considering that digital technologies are represented in all aspects of human activity, digital accessibility also strongly belongs to educational professions, because all other future professionals (and citizens) who will use digital technologies as expected responsibly, taking into account and caring about accessibility, are formed through education.

Results of the analysis presented in this paper show that for both (IT and educational) professions digital accessibility has been referenced more or less (but still not enough) in relevant frameworks and models of digital competencies.

For both professions, there is a strong need for digital accessibility and related concepts and prerequisites to be embedded, defined and emphasized in respective profession/digital competency frameworks and models. Profession/digital competency frameworks and models are the broadest and most effective platforms to support digital accessibility and accessibility and inclusion in general.

It should and will turn today's modern, digital societies into inclusive ones.

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Analysis of Labor and the Workforce in the National Economy of the Republic of Bulgaria

Krassimira Zagorova[1]

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Keywords:
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Working population;
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Abstract: *Human resources are carriers of the working force and reflect directly the invested "live" labor in the activity of economic entities. The subject of analysis in the present study are the economic categories «labor» and «workforce», including their meaning, characteristics, and specifics of their functions. Labor is a specific production factor and as such it is inherent in man as an indivisible part of him. Like a specific human activity, labor fulfills two main functions, namely economic and social. Another issue put under discussion is the state of the labor market and the dynamics of the employed workforce in the economy of the Republic of Bulgaria within the period 2018 - March 2023. The analysis focuses on the changes in the growth of employment and the coefficient of economic activity of the population of the Republic of Bulgaria, the structure of the workforce by age groups regarding the national economy, its geographic distribution within the country, etc. At the end, conclusions and recommendations are summarized.*

1. INTRODUCTION

Human resources ensure the unification of the means and products of labour. Human resources are what the labour force is made up of and reflect the work directly put into the activity of an economic entity.

In a broad sense, "...the term human resources refers to the individuals who, at a certain point or period, are employed in the production of goods and services, i.e. the population that can engage in labour.

In the strict sense, the concept of human resources is identified with the concept of an economically active population (Labour Economics course, 2017).

In the quantitative aspect, human resources are determined by the natural growth and migration processes of the population. In the qualitative aspect, human resources are, among others, characterized by the educational and qualification level of individuals, their professional experience and skills, work activity, and personal and business skills.

For the purposes of statistical analyses, the labour force comprises both the employed and unemployed, i.e. the labour force category also includes the unemployed, but not the economically inactive such as pupils, students and pensioners, housewives or men, provided that they are not working or looking for a job, although some of them may be of working age (Eurostat, 2020).

The coefficient of economic activity represents the relative share of economically active individuals out of the total population of the country in the respective group (National Statistical Institute, 2023, p. 36).

[1] Technical University of Varna, 1 Studentska str., 9000 Varna, Bulgaria

From an individual point of view, labour force is defined as an ensemble of physical and spiritual (intellectual) skills possessed by an individual, through the use of which, he or she is able to perform an activity with a certain degree of complexity, to produce products, perform services, etc.

In the context of the above definition, it has to be clarified that "the specific manifestation of the labour force has its own peculiarities. Above all is its individuality that stands out - for an individual, the set of physical and spiritual powers is too different and specific. Secondly, it is a dynamic category because it changes over time - physical and spiritual powers can increase or decrease. Thirdly, it is characteristic of the labour force that it has a certain professional focus" (Donchev et al., 2003, p. 122).

The quality of the labour force and the work performed are of decisive importance for the successful functioning and development of an organization. Higher-skilled labour is associated with a labour force of higher quality, able to produce products with certain properties demanded by customers and to perform more complex functions and activities.

The quality of the labour force is formed under the influence of two groups of factors: (1) *inherent* - such as talent, inherited abilities, specific skills and aptitudes, and natural endowments of an individual, and (2), *acquired* - formed in the process of education, qualification, specialization and professional self-fulfilment. In general, the labour force quality is determined by the ensemble of the mentioned characteristics complemented by the individual's personal and business qualities, including self-organization, discipline, self-consciousness, creative initiative, sense of responsibility, efficiency, adaptability, etc.

2. BASIC APPROACHES FOR DEFINING LABOUR

The term labour does not have a simple definition. As a multi-aspect phenomenon, labour is defined in different ways depending on the approach taken, as follows:

a. *The economic approach* considers labour as the purposeful activity of people to produce goods and services they use to satisfy their own needs. Seen from this perspective, labour is only and solely inherent in human beings (Labour Economics course, 2017).
b. *The physiological approach* considers labour as a process of spending a certain amount of physical and neuro-psychic energy, which should be brought in line with the mission of ensuring and maintaining the necessary working capacity of the labour force throughout its work life.
c. *The sociological approach* considers labour as a system of relationships that arise between an individual and an organization (group) in the process of joint activity in a labour microenvironment. The organization coordinates this activity and integrates its members, who are jointly engaged in the implementation of specifically set goals.

Labour is a specific factor of production. It is inherent in human beings and is an indivisible part of them. Labour is an essential and primary source of subsistence income for the majority of the population. In the process of production, labour is repeatedly used in the realization of the potential professional abilities of those who perform it, which are in turn compensated with the income generated from labour.

3. FUNCTIONS OF LABOUR

As a specific human activity, labour fulfills two main functions, namely economic and social, finding expression in the following directions (Kalchev & Valkanova, 2001, p.7):

a. *The economic function* of labour is expressed in the fact that:
   i. labour is the creator of the material and spiritual goods necessary for people to exist and develop.
   ii. labour is the source of the means necessary to satisfy human needs.
   iii. labour is a factor in the development of the national economy.
b. *The social function* of labour is expressed in the fact that it represents:
   i. a means of social communication.
   ii. a means of self-probation and self-realization of people.
   iii. a factor and prerequisite for the implementation of various social policies.

4. ANALYZING EMPLOYMENT FLUCTUATIONS: THE BULGARIAN LABOUR MARKET FROM 2018 TO MARCH 2023

The subject of analysis in this section is the state of the labour market and the employment fluctuations in the Bulgarian economy for the period 2018 - March 2023. According to the data provided by the National Statistical Institute (NSI) of the Republic of Bulgaria, the lowest employment rate for the period under consideration is reported in 2021, with the total economically active population numbering 3 147,5 thousand or 72.0% of the country's economically active population (aged between 15 and 64 years). This is a direct reflection of the changes in the working and employment conditions in the context of the global COVID-19 pandemic and the impossibility of exercising many activities and professions. For the mentioned year of 2021, the number of people employed in the country is 7% lower compared to the pre-pandemic year of 2019.

An increase in the country's economic activity is reported in 2022, which is reflected in the increase in the number of people employed in the national economy, reaching as high as 3 290,9 thousand people.

Again, based on data provided by the National Statistical Institute of the Republic of Bulgaria, the first quarter of 2023 saw a sharp decline in the number of people employed in the economy, dropping below 3 million and reaching 2 928 thousand people (Figure 1). Part of the main causes of this unfavourable change for the first quarter of 2023 is the increasing external migration owing to the recovery of the world economy after the Covid-19 pandemic, the drastic political and economic instability in Bulgaria in the period 2021 - 2023, the high inflation rate in the country in 2022, exceeding the average Eurozone inflation rate, geopolitical factors, the intensifying demographic crisis, etc.

Notwithstanding given data, the highest employment rate of the active population in the Republic of Bulgaria was reported in 2022, as for the same year the coefficient of economic activity of the employed exceeds that of the pre-pandemic year of 2019 by 0.4 percentage points, reaching as high as 73.6%. The above increase is an indicator of the recovery of Bulgaria's national economy after the COVID-19 pandemic despite the slow economic growth in times of energy, raw material and price crisis, which is typical for the rest of the Eurozone countries and the global economy as a whole.

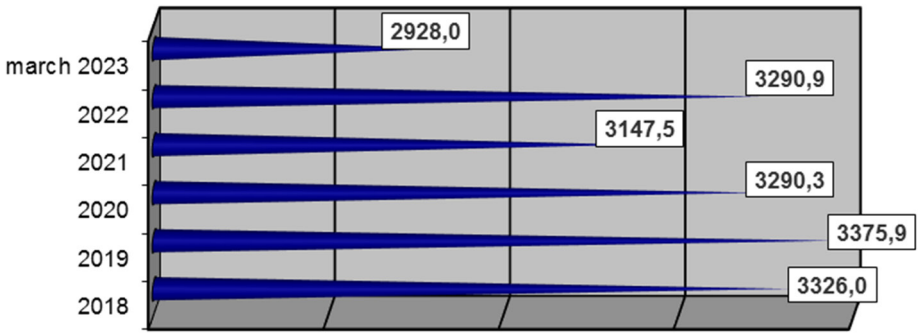

Figure 1. Number of people employed in the Republic of Bulgaria for the period 2018 - March 2023

Source: National Statistical Institute, 2023, p. 37; Investor Finance Forum, 2023

The dynamics in the structure of the coefficient of economic activity (relative share of economically active individuals compared to the total population of the country) in the age range from 15 to 64 years for the period 2018 - 2022 is presented in Figure 2.

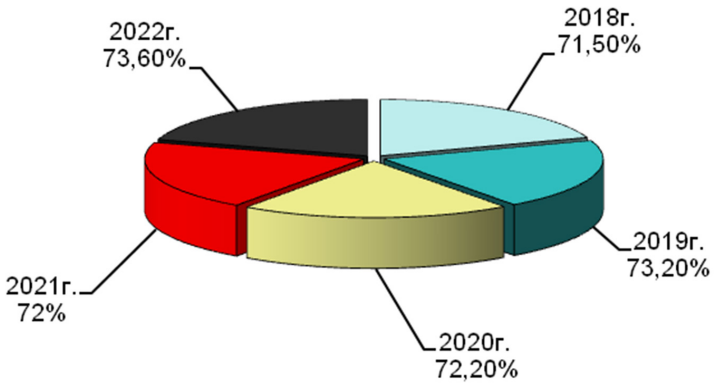

Figure 2. Structure of the coefficient of economic activity of the population of the Republic of Bulgaria for the period 2018-2022

Source: National Statistical Institute, 2023, p. 37

The distribution of the active working population of the Republic of Bulgaria by age group for the period 2018-2022 is presented in Table 1.

Table 1. Age structure of the labour force in the Republic of Bulgaria for the period 2018 -2022

	Age	**15-24**		**25-34**		**35-44**		**45-54**		**55-64**	
Year	**Total number**	Number, thous.	%	Number, thous.	%	Number, thous.	%	Number, thous.	%	Number, thous.	%
2018	3239,6	149,3	4,61	719,9	22,20	908,1	28,03	847,8	26,17	614,6	18,97
2019	3276,4	147,8	4,51	718,9	21,94	902,6	27,54	868,5	26,51	638,5	19,48
2020	3190,4	134,1	4,20	675,9	21,19	871,3	27,31	877,1	27,49	632,1	19,81
2021	3155,3	123,6	3,91	658,5	20,87	855,4	27,11	890,6	28,23	627,3	19,88
2022	3191,2	138,7	4,35	641,4	20,10	856,9	26,85	911,7	28,57	642,4	20,13

Source: National Statistical Institute, 2023, p. 37; Own calculations

The data presented in Table 1 show a stable trend in the distribution of the employed population by age category, as for all five years of the period under consideration, the highest relative share of employment (27% on average) belongs to the employed within the age range 35-44, followed by those aged 45-54 and 55-64. With the lowest share- an average of 4.3% of the total number

of people employed is the age group 15-24 years, which proves to be at risk in the labour market in the long run. The data also show a trend of a gradual increase in the share of employed people between the ages of 45 and 54. The relative share of those employed over 65 years of age remains relatively constant (approximately 0.5% of the total number of the employed population).

The structure of the employed population in the Republic of Bulgaria by age group for 2022 is presented in Figure 3.

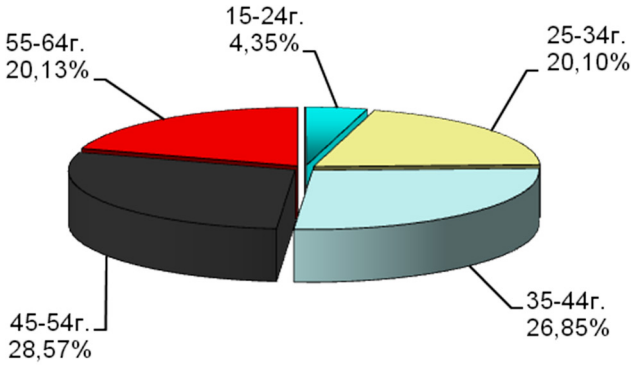

Figure 3. Structure of the employed population in the Republic of Bulgaria by age groups, the year 2022

Source: National Statistical Institute, 2023, p. 37; Own calculations

The age structure of people in employment in the economy of the Republic of Bulgaria follows the trends of the labour market in the Eurozone, which are a result of unfavorable demographic processes, mainly related to a decrease in the population of working age.

Traditionally, the labour force in the Republic of Bulgaria is concentrated in urban areas as well as in the agglomerations[2] around the larger cities, whereas the employed in rural areas are approximately 30% of those employed in cities. Details on the distribution of the population employed in the country by types of settlements for the period under consideration are presented in Table 2.

Table 2. Number of employed by place of residence, thousands of people

By region:	**2018**		**2019**		**2020**		**2021**		**2022**	
By city	2595,2		2623,5		2532,1		2503,4		2534,3	
By village, including share of those employed in cities %	730,8	28,2	752,5	28,7	758,2	29,9	744.1	29,7	756,7	29,9

Source: National Statistical Institute, 2023, p. 37; Own calculations

Given that the active population in rural areas is mainly employed in the country's agricultural sector, characterized by a long-term stagnation in earnings compared to other economic sectors (services, industry, etc.), the data pertaining to the employment rate and economic activity of the labour force in the rural areas of Bulgaria reflect these objective interdependencies (Figure 4). According to the national statistics for the period 2018-2022, the average annual salary of those employed in Bulgaria's agricultural sector does not exceed 75% of the average annual salary for the country as a whole.

[2] Aglomerations in urban planning are settlements that arose as a result of uniting large cities and smaller settlements located around them into a common urbanized territory

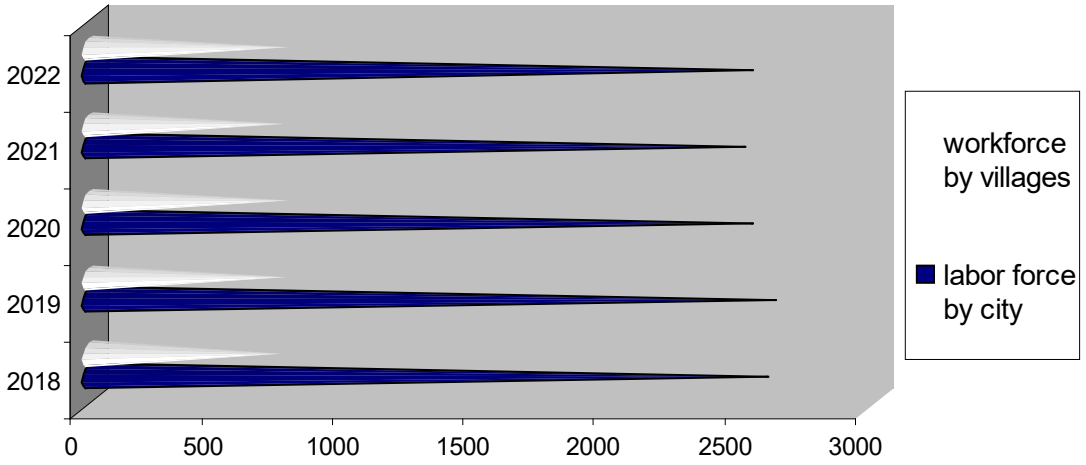

Figure 4. Distribution of the employed workforce in the Republic of Bulgaria by populated area types

Source: National Statistical Institute, 2023

5. FUTURE RESEARCH DIRECTIONS

Future research in the field of the labour market and the structure of the labour force in employment would be directed towards analyzing the regional distribution of labour resources in the Republic of Bulgaria, taking into consideration the labour force composition, qualification, education, professional orientation, etc., having a key importance for both the development of individual economic sectors at the regional level and the organization of the respective industry enterprises locally.

The personnel planning and selection methods at the enterprise level would be of interest too. However, of particular interest would be the application of contemporary methods and approaches in the selection of personnel in view of the new challenges, including the application of the positive aspects of artificial intelligence in certain activities and professions.

6. CONCLUSION

Summarizing the results of the analysis related to the employment rate, economic activity and structure of the labour force in the national economy of the Republic of Bulgaria for the period 2018-2022 (2023), it can be concluded that:

a. The lowest labour force employment rate in the country's economy is reported in 2021, which is a direct reflection of the Covid-19 pandemic that affected the labour and employment conditions for the majority of economic sectors;
b. A recovery of the labour force's economic activity is reported in 2022, after which a steep decline in the number of people employed in the Bulgarian economy is registered for the first quarter of 2023, whose number falls below 3 million people, being the lowest for the period 2018 - 2022/ 23;
c. The highest coefficient of economic activity of the labour force in the Republic of Bulgaria is reported in 2022, as for the same year the participation of the country's active population in the national economy reaches 73.6%;
d. The maximum relative share of the employed is reported in the age range 35-44, followed by those employed within the age range 45-54, as for the latter group the employment rate sees a smooth increase;

e. With the lowest share - an average of 4.3% of the total number of people employed in the national economy of Bulgaria is the age group 15 - 24 years, indicative of the fact that the high youth unemployment rate has become a long-term phenomenon in the country.
f. Traditionally, the labour force in the Republic of Bulgaria is concentrated in urban areas, while the share of people employed in rural ones is approximately 29% of all employed in cities.

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Civil Servant Status and Labor Relations

Lirime Çukaj (Papa)[1]
Iris Pekmezi[2]
Elsa Miha[3]

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Public official

Abstract: *Albania, as a signatory of the Stabilization and Association Agreement, is legally obligated to meet European standards, even for public administration. This modest work attempts to provide a regulatory overview of the status of public administration employees, the impact of political forces on sustainability, and the continuity of employment relationships of civilian servants.*

The primary goal of the entire regulatory system governing the status of civil servants is to establish uniform regulation for all positions related to the exercise of public authority and responsibility for safeguarding the overall interests of the state. Simultaneously, it aims to strengthen legal protection, impartiality of civil servants, political independence, job stability, professionalism, efficiency, and the optimal protection of individual rights and legitimate expectations of citizens from public administration.

This work seeks to highlight these elements as reflected in Law No. 152/2013, as amended, also bringing to light the shortcomings or issues related to the implementation of this law.

In the paper, an evolution of public administration has been reflected up to the present day, highlighting the issues related to recruitment, and movements within and outside public institutions. Efforts to establish sustainability in administrative positions through career progression, and staff motivation based on job performance, which should be objective and serve the purpose for which such a system has been established, are discussed. We have also endeavored to address these elements related to the status of civil servants in this work.

1. INTRODUCTION

This study aims to give an analytical and descriptive state of the civil servant according to Albanian law.

More specifically the objectives are: To analyze the improvements brought to Albanian legislation on civil servant employees and efforts taken by Albanian institutions in reaching the EU standards in this field.

Despite the crisis that happened in the last years in Albania and all over the world, it seems that Albanian has continued to remain the overall focus on reaching out the reforms and standards according to the agenda prescribed by EU bodies.

Per each year one of the indicators of the EU monitoring on the field of reaching the EU standards towards integration is also the improvements in the public administration of Albania.

[1] University of Tirana, Faculty of Law, Criminal Department, Road "Milto Tutulani", Tirana, Albania
[2] Legal Department, One Communication Company, Tirana, Albania
[3] Tirana Prosecutor Office, General Jurisdiction, Road "Haxhi Hysen Dalliu", Tirana, Albania

Even though there has been limited progress in the field there is still work to do, on many aspects of public administration and civil servant status. Full decentralization is needed in a way to create a sustainable administration independent from the political impact in public administration, the latter has as its function to realize its duty in compliance and protection of the public interest.

With the opening of the negotiations for integration on 19 July 2022, the reform in the public administration seems to be one of the fundamental elements to be discussed during these meetings. As long as the configuration of the civil service system and rules of governing public employees are a reflection of the state sovereignty.

Methods: Sorting and analyzing the data received from different yearly reports of DoPA and EC reports and analyzing the legal framework of the civil servant and its evolution.

2. CIVIL SERVICE NOTION

Civil service often is misconfused with public service as a synonym concepts but public service is a broader concept, which includes, the exercise of all public activities legislative, executive, or judicial. On the other hand, civil servant is just a part of public service which includes employees employed by the executive power in the government. Taking into this aspect is difficult to achieve the de-politization of civil servants, at a time when they are directly related to the governing power.

A "civil servant" is a person who performs the functions for the exercise of administrative public authority, on a merit and professional basis, who participates in the drafting and implementation of policies, monitors the implementation of administrative rules and procedures, ensuring their execution, and providing general administrative support for their implementation (Law on Civil Servant).

Public administration has been one of the focal areas for EU integration, and improvements are made one achieving the standards and requirements of the EU, obligations falling under the respective chapter for integration.

Mainly the improvements were focused on achieving the following objectives:
- Transforming the recruitment process, on a wider scale.
- Digitalizing the application procedure;
- Making the competition exams more transparent;
- Making career management for civil service more accessible;
- Stimulating performance;
- Improving the tools needed for effective work.

Following this paper, we can identify the pros and cons of this system and also weaknesses that need to be improved.

The first years of the establishment of democratic institutions, showed a week of public administration and mostly this happened because in the post-communism the resources were focused on raising the private sector, meanwhile, the state was focused more on building the fundamental central democratic institutions and leaving in one side the public administration. In the last

decade, improvements have been made, starting with the legal framework regulating the status of civil servants. Albania like other post-communist countries is trying to develop a civil servant system independent from politics. This challenge is hard in a reality where Albania for approximately 50 years period of communism, there was no apparent distinction between political party apparatuses, public administration, and the idea of the State as an independent reality both from public administration and political party.

Following the EU integration, Albania is walking in similar steps on the frame governing the job relations in the civil servant system. In a way to achieve and guarantee the legal independence of officials, the ties between officials and administration are regulated by law.

Albania must achieve a full separation and independence of the civil servants from the government. Taking in consideration that we aim to be part of an EU organization, where challenges related to civil servants consist of achieving the independence of humans working in communitarian institutions from their state of origin. One solution found by the EU administration is regulating the status of these positions through regulations of the EU, which would guarantee legal independence from the states and secure a real career prospect for the staff. (European Parlament, n.d.)

3. ORGANIZATION OF THE PUBLIC ADMINISTRATION IN ALBANIA

Just like in other countries, also in Albania, the public administration is organized hierarchically, at the top of which is put the prime minister, and after him comes the other bodies.

If we would present the organization in a figure way, it would look like the following:

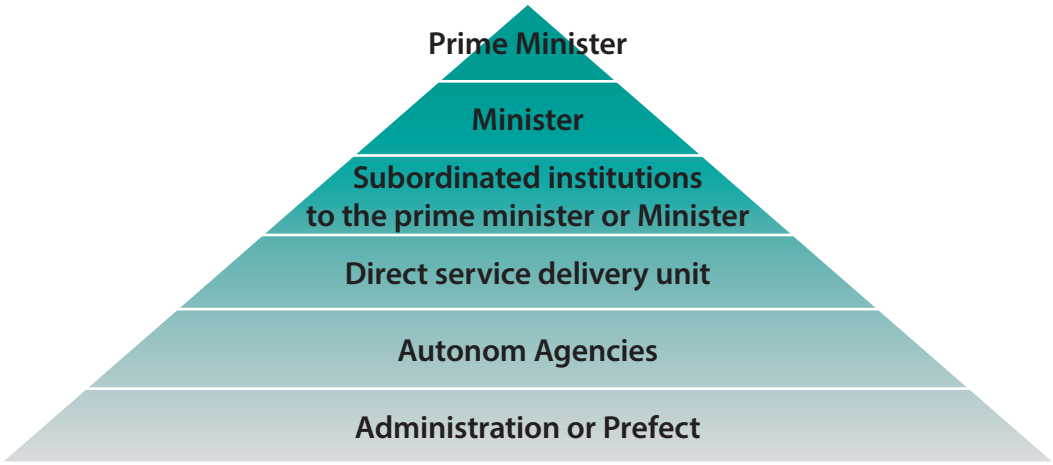

Figure 1. Organization of the public administration
Source: Authors

The civil Servant is split into four main levels:

- First, the Top Management level includes General Secretaries, Director of departments, and General Directors.
- Second, are Mid-level management, including Director of Directorates.
- Third, Low-level management included the head of Sectors.
- Finally, Executive Level which are specialist.

Based on Law for Civil Servant article 2, it's stated that the scope of this law applies to any civil servant (hereinafter referred to as "civil servant"), exercising a public function in a state administration institution, independent institution, or in a local government unit, except for some employees on state institutions that have specific positions (Law on Civil Servant).[4]

From the beginning of the Civil Servant with first law on 1999, we can notice that the scope of the application is extended in public administration, and many positions that were regulated by the Labor Code now are under the scope of law for Civil Servants. This fact can be seen also in the yearly reports published by the Department of Public Administration, on their official website. (Administration, n.d.)

4. IMPROVEMENTS IN THE PUBLIC SERVICE

As prescribed in the above sections the reform of the civil servants started with the approval of the law on civil servants in 2013 and is still an ongoing process towards EU standards according to the Stabilization Association Agreement signed by Albania.

Law on civil Servant foresees a few new bodies aiming to establish a civil servant system, that grants fulfillment of public functions in respect of law on one side, quality in offering the services and same time assures and protects the civil servants on their rights, by establishing a system based in transparency, equality and merits.

One of these bodies is also the Albanian School of Public Administration (ASPA), which is a central public institution, with administrative and academic autonomy, with the mission of training the civil servants of central government, local government, and independent institutions (Law on Civil Servant). Based on the reports and data published by ASPA the results of training are as follows (ASPA, n.d.):

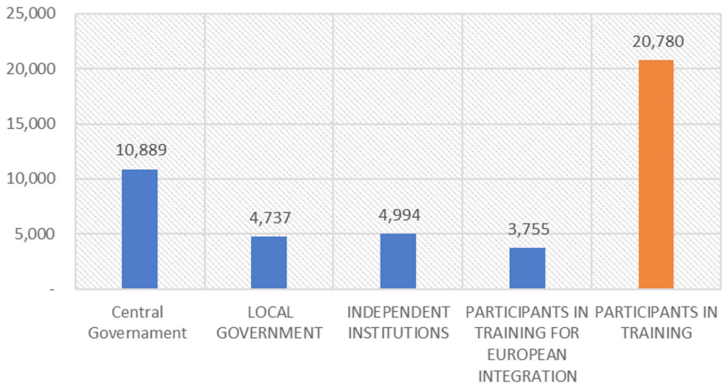

Figure 2. Training during 2022 according to the typology of the institutions
Source: ASPA, n.d.

[4] Law no 152/2013 Article 2 "This law applies to any civil servant (hereinafter referred to as "civil servant"), exercising a public function in a state administration institution, independent institution, or in a local government unit, with the exception of: a) elected persons, b) ministers and deputy ministers; c) officials appointed by the Assembly, the President of the Republic or Council of Ministers; ç) judges and prosecutors; d) judicial administration employees; dh) militaries of the Armed Forces; e) personnel of the state intelligence service; ë) personnel of the direct service delivery units; f) members and chairmen of the steering collegial bodies of the committees or institutions under the authority of the Prime Minister or a Minister; g) administrative employees; gj) cabinet functionaries; "h) the employees assuming the powers of the Judicial Police agent/officer and those permitted to carry weapons under the law; i) civil employees of the Armed Forces structures; j) employees of the Financial Surveillance Authority; k) employees of the drainage boards; l) advocates at the State Advocacy".

Another body foreseen by the law is also the Commissioner for Civil Service Monitoring (COCM). The Commissioner for Civil Service Monitoring is an independent, legal public entity, which is responsible for monitoring the legality in the management of the civil service. He reports directly to the Parliament at the end of each year. The commissioner ex officio or upon a request monitors the enforcement of civil law in all institutions under the scope of this law. During 2021 there have been investigated and closed 118 cases (Servant, n.d.).

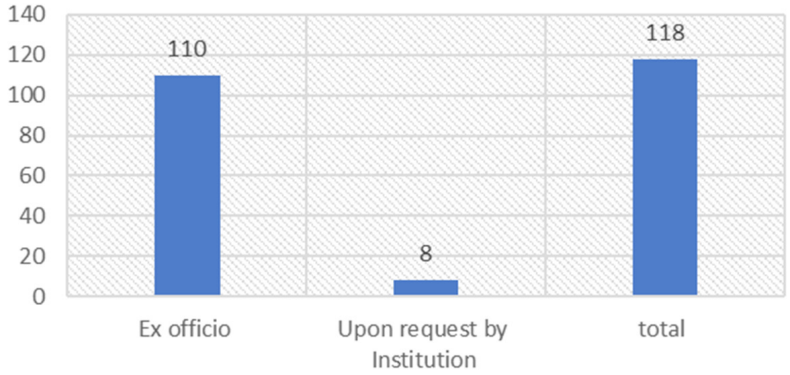

Figure 3. Investigations on infringement of law during 2021

Source: Servant, n.d.

If during the inspection, the Commissioner finds a violation of law in the management of the civil service, he shall, by a written decision, warn the institution, leaving tasks to improve the situation and set a reasonable deadline for their implementation. In case of non-execution of the decisions issued following paragraph 1 of this Article, the Commissioner can fine the person responsible for the non-fulfillment of the measures. The fine amount shall range from 20 to 30% of the monthly salary of the responsible person. In case of further failure to implement the decision, the Commissioner can impose a higher fine of up to 50 % of the monthly salary of the liable person (Law on Civil Servant).

From the yearly reports of DoPA there we can notice some positive steps in some aspects of the civil servant up to date.

It's increased the number of employees with civil status. In 2015 there was a distribution of the staff as in the graphic below:

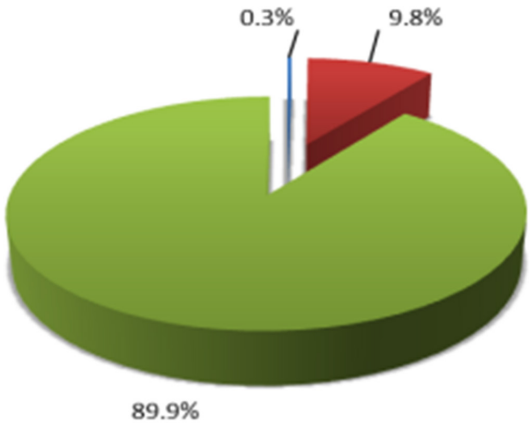

Figure 4. Staff distribution - status

Source: Administration, n.d.

It resulted that 89.9 % were employees with a different status than civil servant like staff regulated by the Labor code, teachers, armed forces personnel, state police employees, doctors, and nurses, etc. 0.3 % were staff with political functions and only 9.8 % were civil servants (Administration, n.d.).

With the extension of the scope of the application of law for civil servants according to Article 2, the number of staff with the status of civil Servant has increased significantly. Based on data published by INSTAT, in the Public Sector, there has been a progressive increase in the staff in these positions (INSTAT, n.d.).

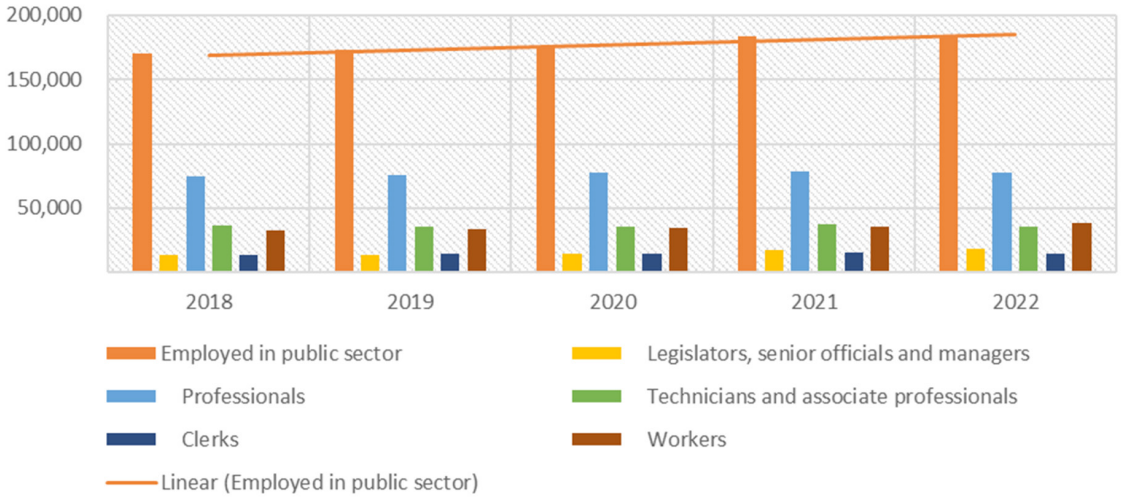

Figure 5. Employment in the Public sector from 2018-2022

Source: INSTAT, n.d.

Based on data analysis from INSTAT, we can notice that even for 2023 the highest number of employees are localized in the private sector, 75 % of the employees during the II-quarter of 2023 are working in the private sector and only 25 % are working in the public sector (INSTAT, n.d.).

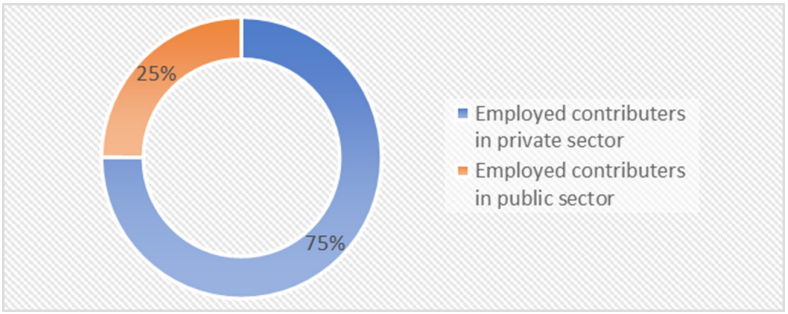

Figure 6. Employed contributors in the private sector account for the majority of 'II quarter - 23'.

Source: INSTAT, n.d.

This ratio between the two sectors is influenced by different reasons such as salaries, and requests for employees, which is higher in the private sector rather than in the public one, also the possibility of accessing the public sector in Albania seems to be more difficult than in the private sector, this because de-politicization isn't still achieved in the highest scale and also nepotism that in a small country like Albania is present.

4.1. Recruitment Procedure for Civil Service

The procedure to access the Civil Service in Albania has been improved through the years regarding transparency and facilities for publication and application, but there is no fundamental change regarding the selection Procedure. The only substantial change is related to the final phase of choosing the winning candidate. According to law no. 8549 /1999 the ad hoc commission proposed three winning candidates and the direct superior of the hiring institution would select the most suitable one (servant, n.d.). Meanwhile, nowadays the winning candidate is the one with the highest score at the end of the recruitment procedure (Law on Civil Servant).[5]

Other facilities are related to the application. Digitization in the field of civil servants has also been significantly improved, and the publication of vacancies on the DoPA website and the receipt of candidacies online through the system are full proof of the application of the principle of transparency in this process.

Despite this, we cannot overcome the fact that in the test phase, there are a lot of problems related to the written test and interview. No matter what the positions and backgrounds are, the formulation of the test is focused on testing the legal knowledge of the candidates rather than professional ones. This may come out due to a lack of professional knowledge in the DoPA personnel, responsible for developing the test questions. The same approach is followed also in the interview phase where most of the questions are related to technical legal knowledge, even though for the position the legal background is not requested.

4.2. Human Resource Management System

HRMS is a system for management of the personal files and automatization for the calculation of salaries. Up to date in Albania, there is an HRMS, which fulfills the criteria of saving the staff file, but yet automatization of salaries isn't reached. With the approval of DCM No. 833, dated October 28, 2020, which relates to rules regarding the content, procedures, and administration of personnel files and the Central Personnel Register, and the approval of Guidance No. 1, dated May 21, 2021, which pertains to the format, elements, and completion of the monthly payroll and expenditure order for salaries in general government units were important steps towards the automatization of the salaries.

Obstacles in this process may be considered the lack of knowledge for the staff dealing with the calculation of the salaries, and missing infrastructure in achieving this development in all of Albania.

So first, the administrative capacities must be well established by developing training in this field and also ensuring the infrastructure for reaching the scope.

Even though digitalization is a focal point for the state, nowadays a considerable number of services are being offered through the state system (e-Albania). This has had a good impact on reducing the risk of corruption among public employees by avoiding physical contact. On the other hand, problems may also related to the process of appraisal of performance for the civil

[5] Law No. 152/2013 On civil Servant, Article 23 "1. The successful candidates, determined in accordance with Article 21/5 of this law, starting from the best ranked, have the right to chose to be appointed in any position of the group for which the competition was organized, and to any other vacant position of the same group made vacant within the period of the validity of the list, in accordance with the point 3 of this Article"

servants, which should be based on objective indicators and well-formulated templates by DoPA in collaboration with the institution. The performance is done twice per year and this appraisal system helps in growing the career of civil servant. This system must serve to establish the motivation policy in a way to creates a sustainability of professional and well-formed staff in the civil service.

During the 2022 monitoring that the EC has done to the Albanian progress regarding public reform, it is stated that limited progress is made but further steps are needed mostly in this points (European Commission, n.d.):

- Increase the capacities for policy planning and monitoring and ensure that the central administration's supervisory and subordinated bodies are well-structured and assigned clear roles;
- prepare new public administration and public financial management strategies in line with relevant sectoral strategies, while at the same time reviewing the effectiveness of the current monitoring structures;
- effectively implement the provisions on merit-based recruitment in the civil service law at all levels, especially at senior level; reform the salary system for civil servants and further expand the automation of the payroll system.

However, the implementation of the public administration reforms requires a continued political steer. Financial sustainability needs to be improved through better reviewing of overall financial resources, as currently, the reform implementation depends heavily on funding from external donors.

5. CONCLUSION

Public administration remains attractive in the job market. The salary scale is regulated for managerial positions. Seniority pay has been increased to reward experience for positions in public administration. Even though better work needs to be done in all units of Human Resources, that should be more effective in preparing motivational policies and facilities for the civil servants in performing their jobs.

Recruitment in public administration institutions is based on open competition, following the principle of merit, ensuring the selection of the best candidates. ASPA has extended the training program to increase the administrative capacities of civil servants in new fields such as digitalization and EU integration. Even though further steps must be taken in this area to increase staff knowledge in better performing their duties.

As analyzed above the recruitment procedures despite the improvements in the legal framework, need to be better organized, specifically in the test phase, in a way to achieve to take well-professionalized people in the right positions.

The Civil Servant System is a system where the status and career of the employee are strictly regulated by law, this way ensures better job stabilities and security and opens the door for a clear career path for the people. So it is a good incentive that should be taken into consideration in the labor market.

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Innovative Approaches and Practices for Managing People in a Dynamic Environment

Pavlina Ivanova[1]
Katya Antonova[2]

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Abstract: *Dynamics of changes, uncertainty and inability to predict emerging problems, events, situations, complexity of interrelationships, emergence of new problems, situations and knowledge are only part of the modern conditions in which companies work. This requires them to adapt to changes in the environment in a short time, looking for new and innovative approaches, not only in terms of the production process but also in terms of human resource management. The purpose of the authors is to present some of the opportunities for organizations to create and use innovative approaches to human resource management in a dynamic environment, as well as to make quick decisions related to them in company-specific situations.*

1. INTRODUCTION

The rapidly changing business environment is challenging organizations to remain competitive in the marketplace and evolve at the speed of change. This requires them to manage flexibly and innovatively in response to both rapid technological change and innovation, globalization and new levels of awareness, and unexpectedly emerging circumstances related to global epidemics and crises. Thomas et al. (2020) describe the contemporary conditions in which organizations operate through the acronym VUCA, which represents the four unique characteristics of the modern world:

- *volatility* - speed, dynamics and importance of changes;
- *uncertainty* - inability to predict emerging problems, events, and situations;
- *complexity* - the complexity of the environment and interrelationships;
- *ambiguity* - the emergence of new problems, situations and interrelations, making it impossible to use previous experience and knowledge.

The emergence of unforeseen circumstances (crises, epidemics, regulatory changes, governmental decisions, etc.) that affect mobility and the requirements for new skills imply making quick decisions related to the management of people in organizations. Examples of such contingencies include the war in Ukraine and the COVID-19 epidemic, where organizations are forced to respond quickly to travel bans, quarantines, large-scale workforce restructuring, layoffs, physical distancing, and an overall shift to a work-from-home mode (McCulloch, 2020; Thomas et al., 2020; Wei & Wong, 2020).

Continuous changes in the external environment require every organization and its people to change in order to survive, adapt and thrive, which in turn gives innovation a special role in organizational development (Peicheva, 2020). Scholars have described how the human resource

[1] University of Economics – Varna, 77 Knyaz Boris I blvd, 9002 Varna, Bulgaria
[2] University of Economics – Varna, 77 Knyaz Boris I blvd, 9002 Varna, Bulgaria

management function, through adapted HR strategy and practices, through organizational culture and leadership, and by shaping employees' innovative behavior, can improve organizational response to rapidly changing external competitive conditions (Cappelli & Tavis, 2018; Shafer et al., 2001; Shipton et al., 2017).

Increasingly, HRM researchers (Cappelli & Tavis, 2018; Larsson, 2019) have emphasized the important role of an agile workforce, of creative employees who need to be free to develop ideas and make decisions without being hampered by bureaucratic barriers. In this context, the authors explore under the current environmental conditions what innovative approaches to managing people in the organization can be used, and how innovative work behavior of employees can be stimulated. The paper aims to present some of the opportunities for organizations to create and use innovative approaches to human resource management in a dynamic environment, as well as to make quick decisions related to them in company-specific situations.

For the purpose of this paper, the research problem of creating and using innovative approaches to human resource management in organizations is limited to the consideration of organizational culture management and team management.

2. MANAGEMENT OF ORGANIZATIONAL CULTURE AS AN INNOVATIVE APPROACH FOR HRM

A key element for strategic development and organizational change is company culture. Some authors (Kaplan & Norton, 2006) define it as a "culture of creativity and innovation", while others (Minkov, 2009) point out that it should be dominated by values such as creativity, innovation, flexibility, and risk-taking. Managers must stimulate creativity, accept employees' ideas, take care of staff development, and involve collaborators in organizational decision-making (Antonova & Ivanova, 2023). Namely, one of the main functions of organizational culture is to ensure the organization's adaptation to the changing characteristics of the external environment (Minkov, 2009).

Today, companies increasingly rely on diverse, multidisciplinary teams that combine the collective abilities of employees with different competencies (Antonova & Ivanova, 2023). For these teams to be effective and to ensure the required productivity, the development of an adhocratic, clan-based and/or inclusive organizational culture (inclusive leadership) is necessary.

In recent years, in the context of globalization and rapid change, there has been a shift in the key success factors for firms in the market, with a focus on innovation. This causes a change in the value system and organizational culture of companies, precisely in the conditions of dynamic development of the environment, an innovative and entrepreneurial approach by management is necessary.

In particular, the application of an adhocratic organizational culture as an innovative approach can stimulate the development of companies in the face of rapid change and unpredictable circumstances because it implies flexible solutions, avoiding the use of bureaucratic procedures and policies, and placing emphasis on continuous innovation and the pursuit of improvement, as the pace of work is usually extremely fast, and this is critical for success in a market that is constantly changing and highly competitive (Cameron & Quinn, 2012) (Figure 1). Of course, in large organizations with many staff, an adhocracy culture is less applicable across

the organization, but it can be useful at the business unit level or applied to specific functions, i.e. the adhocracy culture can be transferred to specific units, which will ensure that the organization as a whole remains innovative and competitive in the marketplace.

A clan organizational culture, in turn, aims to get employees working together in teams, ensuring equality, relevance, empathy and commitment, leading to a job well done and high performance. Team members feel free to give ideas and honest and open feedback. Implementing their ideas makes them find meaning in what they do and motivates them to be creative. Companies that are able to balance the demand for performance and the sharing of employee values become desirable places for talented employees to thrive (Figure 1).

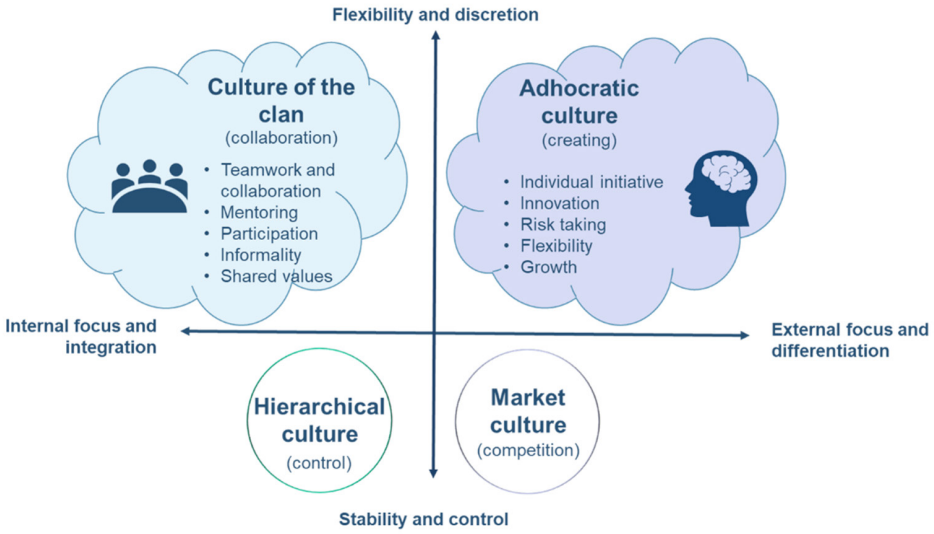

Figure 1. Adhocratic and Clan organizational culture

Source: Adapted from Cameron & Quinn, 2012

A "clan" is a group of close-knit and interrelated families or a group of people with a strong common interest. Clan cultures are common in small or family businesses that are not hierarchical. Employees are valued regardless of their level and the environment is supportive.

Another innovative approach is the implementation of an inclusive organizational culture through inclusive leadership. Inclusive leadership ensures that all team members will feel significant, empathetic, engaged and treated with respect and fairness. Peace of mind and a sense of significance motivate employees to be creative and share ideas freely. In a study by NLP Bulgaria (2022) among more than 4,100 employees, the traits or behaviors that distinguish inclusive leaders from others were highlighted:

- "Visible commitment" - embracing diversity and making diversity a personal priority. These leaders hold team members accountable, challenge the status quo and bureaucracy, and show their concern for employees daily.
- "Humility and modesty" - behaviors where the leader shows modesty about his or her own abilities to create space and opportunities for others to express themselves, admits mistakes, shares personal weaknesses, demonstrates a humble manner, and asks if unsure.
- Is "aware of his biases", knows his weaknesses and shortcomings, and works to create equal opportunities.
- "Curiosity about others" - leaders who listen without judgment, and are empathetic and accepting of ideas.

- "Cultural intelligence" - an inclusive leader learns and accepts different cultures and adapts according to their needs.
- "Effective collaboration" - the leader's ability to bring the team together, recognize members as individuals, delegate rights and empower team members. An inclusive leader embraces divergent thinking, cares about psychological safety, knows the work process and people, and addresses each team member by name.

An ineffective and unproductive organization would be one working with a direct and overbearing leader, one that limits the ability of team members to contribute to development through creativity and free expression of ideas, one that assigns duties to the same top performers, creating an imbalance in duties, one that does not allow for the sharing of alternative solutions, etc.

3. TEAM MANAGEMENT, AS AN INNOVATIVE APPROACH FOR HRM

The second aspect in terms of exploring innovative approaches to human resource management in organizations is through team management. For the purpose of this paper, the nature of virtual teams and agile groups are considered.

In recent years, with the dynamic development of information technology and communications, organizations are transforming their operations through experimentation and the introduction of innovative ways of working. Emphasis is increasingly placed on the need for teamwork on a consultative basis as a key factor in achieving competitive advantage in today's highly uncertain environment.

Teams are small groups of people with different knowledge and skills, linked directly in achieving specific common goals and unique outcomes through an approach for which they hold each other accountable. The key characteristics of teamwork are simultaneity, task parallelism, alignment among individual team members, and mutual accountability.

Working in a virtual team is becoming a daily activity, and virtual communication is the norm for many organizations. Much of the managerial functions related to planning, organizing, leading and controlling are the responsibility of the team, with the primary goal being to minimize the status quo and bureaucracy and increase speed and efficiency in getting tasks done. The work of virtual teams is done partially or entirely outside the boundaries of the organization, with team members interacting with each other in the process of completing assigned tasks and realizing common goals.

Duarte and Snyder (2006, 2011) and Marinov (2023) distinguish the following types of virtual teams according to the nature of the tasks and goals (Table 1):

In contrast to standard (traditional) teams, virtual teams have advantages such as: 'unprecedented levels of flexibility; reducing time and cost through the use of ITC; providing equal opportunities in the workplace by reducing age and race discrimination; eliminating the impact of non-verbal cues and status differences; and overcoming time and geographical barriers; minimizing the costs associated with conducting a physical meeting; high levels of productivity with the ability to engage team members 24/7" (Hadzhiev, 2017, 2021).

Some of the drawbacks of virtual teams are related to the lack of physical interaction between team members, the possibility of non-technical problems, complex (for some team members) technological applications to implement the meeting, etc.

Table 1. Types of virtual teams

Virtual teams	Typical features
 **Parallel teams**	Parallel to the organization, perform specific tasks or functions that the organisation does not want or does not have the capacity to implement. They are built to carry out short-term tasks (projects) related to optimizing processes or solving specific problems.
 **Networking teams**	Consist of people interacting to achieve a common goal. People work together, but at different times, from a distance and outside the organization. It is possible that in some situations members of may not know about all the participants in the network.
 **Project teams**	They are created to achieve a specific result and cease to exist after the project activities have been implemented. They are characterized by the fact that participants can enter or exit from the team when their expertise is needed. Key difference is that members of project teams generally belong to other teams in the organization, but for a certain point are integrated within the project team and become part of both structures.
 **Working teams**	Perform continuous over time and regular activity, being within a single function of the organization (finance, marketing, recruitment, training, etc.). Have defined boundaries and membership that make them distinguishes them from other structures in the organization. They can function virtually, separated in time and space.
 **Management teams**	Perform regular management functions. May exist outside national but within organizational teams. They are a typical model for transnational and international corporations, with their members being part of a single organizational structure but being geographically separated.
 **Operating teams**	They are applied in critical situations by functioning virtually, separated in time and space.

Source: adapted from Duarte and Snyder, 2006, 2011; Marinov, 2023

In theory, there is no universally accepted model for the management and effectiveness of virtual teams. The basis for the various modifications of virtual team management models is the model of Heckman and Morris (1978), according to which the main factors of influence are: input, process, and outcome. With the development of theoretical knowledge in the field of HRM, it has been pointed out that the effectiveness of the team can also be analyzed in terms of the results achieved and the personal satisfaction of its members, as well as according to the specific functions of the team, namely: adaptability; shared situational perception; interpersonal relationships; coordination; communication; decision-making; monitoring and feedback (Antonova & Ivanova, 2023).

Another tool for innovative HRM is the use of informal structures - flexible groups empowered to work with minimal managerial constraints to deal quickly with technological challenges, the idea being to be free from bureaucratic constraints, to be both creative and effective in generating new ideas, i.e., to be free in developing the idea that can generate innovation (Larsson, 2019).

The use of agile groups (teams) could complement formal organizational HR practices by providing non-traditional solutions to specific people management situations in organizations. According to Larsson (2019), it is typical that an agile team should:

- be physically isolated;
- critically analyse the needs of a potential customer/user;
- focus only on the task (mission) at hand;
- plan all activities in advance;
- appoint an experienced project manager to properly allocate functions among team members;

- is multifunctional, formed by talents in areas specifically related to the challenge (task);
- the skills and knowledge of the team members can be used optimally for subsequent projects.

In this HRM approach, the team organization, high degree of autonomy, creativity, and flexibility (Oltra et al., 2022) imply more particular attention to the design and development of jobs and work tasks in the agile group. The high autonomy of agile teams coupled with the need for their members to be highly skilled, creative, and experts in the field (Larsson, 2019) suggests that these employees should be significantly empowered and, as highly skilled professionals, have input into decision-making processes, i.e., employee voice and power should be given (Oltra et al., 2022).

4. FUTURE RESEARCH DIRECTIONS

Future research on the topic may provide clearer insights into the application of the approaches considered in addressing current HRM challenges, such as the risks to employees' work and health arising from emergencies, or in improving aspects of HRM such as employee learning and development, well-being, creativity, engagement, etc. From a research perspective, it is also interesting to study and analyze the impact of innovative HRM approaches on work processes. In this context, the authors develop a toolkit based on the theoretical propositions and findings presented to explore and evaluate the applicability and impact of the approaches in HRM practice.

5. CONCLUSION

In conclusion, it can be summarized that in a context of dynamic change, organizations are facing more and more challenges that affect the management of people and, in this sense, rapid and adequate measures are needed to deal with the unpredictable circumstances that have been common in recent years.

By adapting HR strategy and practices and by shaping innovative employee and manager behavior, organizational responses to rapidly changing conditions can be improved.

To cope with the new unexpected and dynamic changes in the business environment, companies can successfully implement an innovative organizational culture that allows for flexible solutions, avoiding the use of bureaucratic procedures and policies, and focusing on continuous innovation and the pursuit of improvement.

Virtual teams and agile groups are dynamic systems in which the influence of different factors changes over time, as technology evolves, as team members improve, etc. In practical terms, their use adds another option to the toolbox of innovative people management in organizations.

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What Defines Modern Leadership? An Analysis Based on Literature from 2021-2023

Anton Vorina[1]
Vuk Bevanda[2]
Nikolina Vrcelj[3]

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Keywords:
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Abstract: *This research paper presents an original exploration into the central question: "What defines modern leadership?" It is imperative to emphasize that this study highlights the imperative for modern leaders to harness the capabilities of Artificial Intelligence (AI) without allowing biases to taint their decision-making process. In the past, the role of a manager was often characterized by authority and command, where people followed directions unquestioningly. In the modern business landscape, marked by rapid changes, the impact of COVID-19, and evolving workplace dynamics, the nature of leadership has transformed. This study aims to explore modern management practices by investigating scholarly papers and online resources from Google Scholar and Google Search, focusing on the period from 2021 to 2023.*

What we found is that modern leaders need to possess different skills. They should focus on building trust, persuading, and influencing people instead of merely giving orders, as was done in the past. Our research indicates that the ability to adapt, understand others, engage in lifelong learning, and demonstrate care are truly essential for leaders in today's ever-changing business world. This research paper presents a novel perspective on modern leadership. It underscores that future leaders will leverage Artificial Intelligence (AI) to aid in problem-solving and boost productivity.

1. INTRODUCTION

In earlier times, being a manager typically involved giving orders, which were followed without question. However, times have evolved considerably. Nowadays, work environments are in a constant state of change, and leadership has adjusted accordingly.

Recent literature has explored various facets of modern leadership, often with a focus on women's perspectives. For instance, Brzezińska (2023) investigates whether women, driven by strong internal religious motivations like Catholicism, exhibit greater determination to engage in public activities, particularly in politics. They tend to favor a relational style of political leadership combined with goal-oriented strategies, showcasing adaptability. In another study Yuan et al. (2023) delve into ethical issues in leadership, emphasizing that Western philosophical traditions may not be universally applicable, especially in cultural contexts like China, where Confucian virtue ethics shape leadership ideals. Coats (2022) highlights Frances Perkins' significant contributions as a servant leader, impacting social justice and labor policies in the United States. Perkins' commitment to marginalized groups, women's rights, and creating a social safety net exemplifies the qualities of a servant leader, such as empathy, vision, persuasion, and a commitment to others' growth.

[1] Celje School of Economics, Higher Vocational College, Mariborska 2, 3000 Celje, Slovenia
[2] Faculty of Social Sciences, Bulevar umetnosti 2a, 11070 Belgrade, Serbia
[3] Association of Economists and Managers of the Balkans - Udekom Balkan, Ustanička 179, Belgrade, Serbia

This research paper examines modern leadership characteristics, with a specific focus on the relationship between leaders and employees, without delving into the question of whether women or men are superior leaders in general.

We conducted a thorough examination of academic papers and online resources available on Google Scholar and Google Search, focusing on the years from 2021 to 2023.

Within this paper, we explore modern leadership and the qualities required to excel as a contemporary leader. We endeavor to provide a holistic understanding of modern leadership, shedding light on the qualities, challenges, and opportunities that define leadership in today's dynamic world.

2. THE TRAITS OF MODERN LEADERSHIP

Jameslopresti (2022) provides an overview of three types of management theories: classical management theory, behavioral management theory, and modern management theory. It discusses the origins, key concepts, strengths, and shortcomings of each approach. The paper covers various theories within each management approach, including scientific management theory, bureaucratic management theory, administrative management theory, human relations theory, and contingency management theory. It emphasizes the importance of adapting different management theories to handle new situations and highlights the complex nature of the modern business world.

Dasmadi's (2023) research paper delves into transformational leadership and its impact on organizations. It explains how this leadership style translates an organization's vision into action by transforming individuals. The paper highlights key factors in transformational leadership, such as idealized influence, inspiration, individual consideration, and intellectual stimulation. It also underscores the importance of vision, motivation, creativity, innovation, a learning culture, and effective communication.

Workhuman (2022) discusses two key trends in the workplace: humanizing the workplace and revitalizing the community. The first trend focuses on creating a human-centric work environment where employees can thrive. It emphasizes the need to unlearn traditional ways of doing business and reimagine work in a way that leverages the power of human connection. The paper suggests promoting work-life unity by recognizing that work is a part of life and showcasing the human moments employees experience both inside and outside the office. It also highlights the importance of creating a culture of caring and supporting employees' well-being, especially in the context of remote or hybrid work arrangements. The second trend highlights the growing expectation for organizations to address social and environmental issues and make a positive impact on the community. It discusses the risks that climate change poses to businesses and the need for collective action to mitigate them. The paper recommends involving employees through sustainability employee resource groups and internal campaigns to promote energy-saving practices. It also suggests providing volunteer opportunities and donations to support causes employees are passionate about. Furthermore, it emphasizes the significance of making even small changes to reduce the organization's carbon footprint and celebrating wins to foster positive habits.

Center for Creative Leadership (2022) highlights twelve challenges that new managers often encounter. These challenges include:

1. Shifting Mindset: Adapting from a task-focused mindset to a leadership mindset.
2. Building Relationships: Establishing effective relationships with team members and colleagues.
3. Asserting Authority: Finding the right balance between being approachable and asserting authority.
4. Delegating Effectively: Learning to delegate tasks and responsibilities to team members.
5. Providing Feedback: Delivering constructive feedback and performance evaluations.
6. Managing Conflict: Addressing and resolving conflicts that arise within the team.
7. Time Management: Prioritizing tasks and managing time effectively.
8. Making Decisions: Developing decision-making skills and making informed choices.
9. Developing Others: Mentoring and developing the skills of team members.
10. Managing Upwards: Building a positive relationship with superiors and managing expectations.
11. Handling Stress: Coping with the pressures and demands of the managerial role.
12. Continuous Learning: Embracing a mindset of ongoing learning and professional development.

CMOE (2023) blog discusses influential business leaders who have made a significant impact on the business world. It highlights the qualities that make these leaders successful, such as being informative and innovative, goal-oriented, possessing solid communication skills, and being risk-takers. The article provides a list of 20 influential business leaders, including:

1. Reshma Saujani: Founder of Girls Who Code, empowering women in the workplace.
2. Tim Cook: CEO of Apple, leading the company through innovation and expansion.
3. Sheryl Sandberg: Former COO of Facebook and advocate for women in business.
4. Bob Iger: Executive Chairman of Disney, responsible for major acquisitions and park expansions.
5. Reed Hastings: Co-founder and CEO of Netflix, transforming digital entertainment.
6. Mary Barra: Chairman and CEO of General Motors, driving innovation in the electric automobile market.
7. Huateng "Pony" Ma: Founder and president of Tencent, one of the largest internet companies in China.
8. Jack Ma: Founder of Alibaba Group, leading the company to become a global e-commerce giant.
9. Jan Koum: Co-founder of WhatsApp, revolutionizing communication through the popular messaging app.
10. Bill Gates: Co-founder of Microsoft, philanthropist, and advocate for global health and education.
11. Elon Musk: Founder of SpaceX, Tesla Motors, and advocate for renewable energy and space exploration.
12. Warren Buffett: CEO of Berkshire Hathaway, renowned investor, and philanthropist.

The article also discusses other influential leaders such as Jeff Bezos, Ursula Burns, Arianna Huffington, Indra Nooyi, Meg Whitman, and Rosalind Brewer (CMOE, 2023).

As highlighted in the article "The Top 15 Management Challenges Facing Managers Today" by Growth Engineering (2023), some of the key challenges include managing remote teams, ensuring employee well-being, addressing skill shortages, promoting diversity and inclusion, and navigating data compliance and cybersecurity issues. To overcome these challenges, managers

need to prioritize effective communication, foster a supportive and inclusive work culture, and provide resources and support for remote employees. It is crucial to invest in upskilling and reskilling initiatives to bridge the skills gap and ensure the organization remains competitive. Attracting a diverse talent pool and implementing a comprehensive onboarding process are vital for successful talent acquisition.

The article explains the benefits of incorporating modern management theories, such as boosting productivity, aiding decision-making, improving employee engagement, promoting objectivity, and enabling adaptability. It also explores three approaches to modern management: the quantitative approach, the contingency approach, and the systems approach. The quantitative approach uses statistics and mathematical techniques to solve complex problems and make objective decisions. The contingency approach states that the optimal management style depends on the situation and requires leaders to be flexible and adaptable. The systems approach views organizations as complex collections of various components that work together towards a common goal. Overall, the article emphasizes the importance of understanding and implementing modern management theories to effectively lead organizations in today's rapidly changing business environment (Indeed Editorial Team, 2023).

Managers used to be selected and promoted based on their ability to evaluate performance and manage tasks. However, three disruptive trends - normalization of remote work, automation, and changing employee expectations - are challenging traditional definitions of the manager role. In this new era of management, it is more important for managers to understand how employees feel rather than just what they are doing. Leading with empathy is crucial for success in this environment. Organizations and HR functions need to develop managers' skills, shift mindsets, and create the capacity for this new approach (Kropp et al., 2021).

The YouTube video titled "Why this is the moment to change" discusses how the COVID-19 pandemic could serve as a positive catalyst for substantial management changes. In the video, Jo Owen CMgr CCMI explores the notion that the pandemic has opened up an opportunity for transformative shifts in management practices. In the past, simply being the manager that people had to follow was sufficient, but nowadays, rather than relying on command and control, managers need to acquire the skills of trust-building, influencing, and persuasion (Chartered Management Institute, 2022).

The author (From Day One, 2022) underscores the imperative for businesses to prioritize diversity, equity, and inclusion, particularly in championing marginalized communities. It also delves into the evolving landscape of caregiving and its influence on employee well-being. Additionally, the article underscores the significance of managers in cultivating meaningful connections with their team members and the role of empathy in effective leadership.

According to Schwantes (2022), Google conducted a year-long research project called Project Oxygen to identify the traits of great managers. The project involved gathering over 10,000 observations about managers across more than 100 variables. The researchers also conducted interviews with managers to gather additional data. The results of the research identified five key traits that successful managers consistently exhibited:

1. Being good coaches: Successful managers engage with their team members, care about their development, and help them perform at their best.
2. Not micromanaging: Empowering employees and trusting them to perform their work leads to a more positive employee experience.

3. Showing interest in employees' well-being: Leaders need to prioritize employees' holistic well-being, including their mental, emotional, and physical health.
4. Listening to the team: Active listening is a crucial skill for effective communication and building trust with employees.
5. Helping employees with career development: Managers play a vital role in supporting and fostering the growth and development of their team members.

Watson (2023) emphasizes the importance of strong leadership and management skills for success in today's business landscape. The article highlights that effective leadership and management are crucial for navigating the ever-changing business environment and competing in the global economy. It distinguishes between leadership and management, stating that while management focuses on getting things done, leadership involves inspiring and influencing others to achieve a common goal. The article emphasizes the role of leadership in setting the vision for a company, making tough decisions, communicating effectively, and building strong teams. On the other hand, it discusses the importance of management in ensuring smooth day-to-day operations, handling various tasks, motivating employees, and fostering collaboration. To be successful leaders or managers in a competitive environment, the article provides several tips. It suggests staying updated with the latest trends and changes in the business world, being a good communicator, and being proactive in taking control and making decisions. It also recommends developing leadership and management skills through studying principles, practical application, taking courses or workshops, and learning from others.

Vorina et al. (2023) emphasize the challenge of developing smart individuals due to a combination of natural abilities, education, and training. Limited access to education worldwide contributes to a scarcity of smart people. Hence, investing in education is vital for nurturing intelligence and fostering a smart world. This requires a blend of smart people and compassionate love. The paper's thesis, supported by a literature review, underscores the need for more intelligent individuals and the promotion of compassionate love to achieve a smarter world.

Recent research (Računalniške novice, 2023) suggests that advancements in artificial intelligence (AI) may lead to the automation of a quarter of human work. Generative AI, such as ChatGPT, is expected to increase productivity and raise the global gross domestic product by seven percent over a decade. The article highlights the potential impact of AI on various professions, including lawyers, administrative workers, and even company directors. Dictador, a Polish beverage company, is the first in the world to "employ" an AI named Mika as its director. Mika assists the company in finding new customers, selecting designers for packaging, and organizing events. The decisions made by Mika are unbiased and rational, as it does not rely on emotions. However, Mika's decision-making is still subject to human approval, and it cannot terminate employees or implement radical company reorganizations without the consent of other directors.

The paper "Do You Have What It Takes To Be A Modern Leader?" explores the qualities of modern leaders. It highlights that modern leaders embrace different perspectives and approaches to problem-solving, rather than considering themselves the smartest individuals in the room (Forbes, 2021).

"What Does it Mean to Be a Modern Leader?" discusses modern leadership as a combination of intellectual and emotional intelligence. Modern leaders lead with curiosity, wisdom, and perspective (head) as well as empathy and compassion (heart) (The Growth Faculty, 2023).

Fleximize (2023) emphasizes the importance of connecting employees to purpose, accomplishment, and each other. Modern leaders demonstrate how their employees' work contributes to a greater impact.

CoachHub (2022) examines different leadership styles and their impact on employee well-being. The following modern leadership styles are discussed:

1. Transformational leadership: This style focuses on the positive development of followers and encourages collaboration, independent thinking, and job satisfaction. Transformational leaders inspire their teams through their passion for a shared vision or cause.
2. Agile leadership: Agile leaders create an environment that fosters team growth and success, regardless of circumstances. They provide support, clear expectations, regular feedback, and resources to empower their team members.
3. Servant leadership: Servant leaders focus on serving their team and company. They mentor and guide their team members, promote an inclusive environment, and prioritize the needs and growth of their employees.
4. Authentic leadership: Authentic leaders lead by example and value integrity in everything they do. They are honest, trustworthy, and make decisions based on principles rather than personal gain.
5. Positive leadership: Positive leaders create an optimistic and community-oriented environment. They focus on a shared vision of success, encourage their teams, and foster a positive mindset among team members.

It explores the positive effects of transformational leadership and agile leadership on well-being.

3. DISCUSSION

Our objective is to address the question: What defines modern leadership?

Multiple authors present varying viewpoints and conclusions regarding the definition of modern leadership. Here, we will discuss a few of them. Several papers delve into modern leadership:

"Do You Have What It Takes To Be A Modern Leader?" (Forbes, 2021) emphasizes diverse problem-solving approaches.

"What Does it Mean to Be a Modern Leader?" (The Growth Faculty, 2023) highlights emotional and intellectual intelligence in leadership.

"Modern Leadership in Today's Workplace" (Fleximize, 2023) underscores connecting employees to purpose.

Jameslopresti (2022) gives us a good look at three types of management theories: classical, behavioral, and modern. It tells us where these ideas came from, what they're about, where they work well, and where they have limitations. The paper also mentions different theories within these groups, showing that there are many ways to think about how to manage people and organizations. It reminds us that in today's complex business world, it's important to be flexible and use different theories as needed.

Workhuman (2022) talks about two important trends in the workplace. The first trend is all about making the workplace more people-friendly. It's about creating an environment where

employees can be their best selves. It says we should rethink how we do business and remember that work is part of life. We should value the moments that make us human, both at work and outside of it. The paper also tells us to care for our employees' well-being, especially when they work from home or in a mix of in-office and remote settings.

The article discusses the benefits of modern management theories, such as productivity enhancement, better decision-making, improved employee engagement, objectivity, and adaptability. It explores three modern management approaches: quantitative, contingency, and systems. The quantitative approach uses math for objective decisions, the contingency approach stresses adaptability, and the systems approach sees organizations as complex systems. In summary, the article emphasizes the importance of understanding and applying these theories to lead effectively in today's fast-changing business world (Indeed Editorial Team, 2023).

The way managers used to be chosen and promoted was based on their ability to evaluate work and handle tasks, but now, things have changed because of remote work, automation, and how employees expect to be treated. In this new way of managing, it's more important for managers to understand how their employees feel, not just what they're doing. Being understanding and caring as a leader is really important for success in this new situation. So, organizations and HR departments need to help managers learn and think differently to be good at this new way of leading (Kropp et al., 2021).

In the past, simply being the manager that people had to follow was sufficient, but nowadays, rather than relying on command and control, managers need to acquire the skills of trust-building, influencing, and persuasion (Chartered Management Institute, 2022).

Watson (2023) spotlights the significance of leadership and management skills in today's business landscape, differentiating their roles and advocating for continuous learning and adaptability.

Recent research suggests that AI advancements may automate a significant portion of human work, potentially impacting various professions. Polish company Dictador employs an AI named Mika as a director, aiding in customer acquisition and decision-making. Mika's decisions are rational and unbiased but require human approval for major actions (Računalniške novice, 2023).

CoachHub (2022) explores transformational, agile, servant, authentic, and positive leadership styles' impact on well-being.

To sum up, modern leadership involves building trust and signifies a fundamental shift in leadership paradigms, emphasizing the necessity for adaptability, empathy, and trust-building. Leadership and management should recognize the importance of continuous learning, growth, and the practical application of leadership and management skills. Also, the role of AI in business operations is expected to become increasingly crucial.

4. CONCLUSION

Modern leadership requires agility, adaptability, and a proactive approach to address the complex challenges faced by managers today. By embracing innovative solutions, nurturing a supportive work environment, and prioritizing the well-being and development of employees, leaders can navigate the modern landscape successfully and drive organizational growth.

The article concludes by summarizing the key points of modern leadership: striving for improvement, holding back to let others shine, working at eye level, serving the system, and responsibly managing resources. Furthermore, managers should focus on enhancing team productivity through effective tracking and collaboration tools. Building a strong organizational culture that fosters employee engagement and a sense of purpose is key to driving performance and motivation. Leaders must continuously adapt their leadership styles and strategies to meet the evolving needs of their teams and the business landscape.

We can conclude, based on Kropp et al. (2021), that managers should pay attention to how employees feel, not just what they do. This means being caring and understanding leaders, so companies and HR teams should help managers learn these new skills. In the past, just being the manager that people had to follow was enough, but now, instead of commanding and controlling, managers need to learn how to build trust, influence, and persuade, as noted by the Chartered Management Institute (2022).

Study limitations include contextual variability, where leadership effectiveness varies with organizational factors, and a temporal scope limited to data up to 2023, potentially missing evolving leadership trends. Additionally, the paper primarily focuses on leaders' responsibilities towards employees, neglecting the examination of social and environmental responsibilities, which are not addressed in the research."

Practical applications encompass fostering innovation, prioritizing employee well-being, advancing leadership development, integrating technology, and entrusting AI to aid leadership.

Future explorations in modern leadership should encompass a range of domains. These domains include Ethical Leadership, which explores ethical decision-making in our rapidly evolving world. Cultural Intelligence is another vital area that entails studying cultural sensitivity to promote inclusivity in global workplaces. Additionally, Cross-Generational Leadership is of utmost importance, as it focuses on effectively bridging generational gaps and addressing the unique challenges of leading Generation Z.

"The modern world requires smart leaders who are highly empathetic and compassionate. These leaders will need to engage in continuous learning and utilize AI as assistants."

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What is the Impact of Technological Turbulence on Business Model Novelty and Efficiency?

Brunilda Kosta[1]

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Abstract: *In today's rapidly evolving business landscape, technological turbulence has become a defining factor that reshapes traditional business models. This paper explores the relationship between technological turbulence and the transformation of business models. To do so, a survey involving 201 businesses operating in Albania was conducted. The survey results show that technological turbulence has a significant positive impact on the development of novel business models and efficient business models. This paper concludes with theoretical and practical implications.*

1. INTRODUCTION

The crucial role that technology plays in the economic development of a nation is widely recognized. Research conducted in both developed and developing countries consistently demonstrates the lasting impact of technology on a nation's competitiveness and its overall growth potential (Haque et al., 1996). According to industrial organization theorists such as Mason (1939), Bain (1968), and Porter (1985), technological change not only stimulates competition but also shapes the structure and rules of industries. In this context, technological turbulence (TT) is defined as the rate of change in product and process technologies used to convert inputs into outputs (Kohli & Jaworski, 1990), representing a critical factor in environmental turbulence (Mason, 1939).

At the firm level, the consequences of a dynamically changing technological landscape can be detrimental if companies do not respond promptly (Ali et al., 2016; Zott & Amit, 2017). Falling behind the technology frontier, as emphasized by Schilling (1998, p. 263), can pose serious risks to firms in certain industries, and catching up becomes a challenging and costly endeavor. Interestingly, despite investments in technology, firms relying solely on technological innovation may not achieve success (Christensen, 1997; Chesbrough & Rosenbloom, 2002; Chesbrough, 2007; Teece, 1988). The failure to extract value from new technologies is a recurring theme in the literature (Chesbrough, 2007; Teece, 1988, 2006). Some scholars argue that it is the business model (BM) that serves as the key to unlocking the potential value of technology (Chesbrough & Rosenbloom, 2002; Johnson et al., 2008; Teece, 2006). Despite its significance, the relationship between technology as a driver of business model innovation (BMI) and its outcomes remains inadequately explored (Foss & Saebi, 2017).

Existing empirical research on this topic is fragmented, with studies showing mixed results. While some indicate that technological turbulence is a crucial driver of Business Model Innovation (BMI) (Bouwman et al., 2018; Guo et al., 2017), others find no direct relationship between technological turbulence and BMI (Pucihar et al., 2019). Notably, the exploration of the

[1] Faculty of Economy, University of Tirana, Arben Broci Street, 1001, Tirana, Albania

quantitative impact of technological turbulence on BM design, despite being a key precursor to dynamic capabilities (Teece, 2018, p. 49), has been limited. This article seeks to fill this gap by evaluating the influence of technological turbulence on business model novelty and efficiency. Empirical and conceptual studies indicate that when faced with high levels of TT, companies strive to adapt by engaging in Business Model (BM) experimentation, particularly through the incorporation of new Information and Communication Technologies (ICT) (Bouwman et al., 2018). While there is consensus regarding the impact of TT on the BMI, there remains uncertainty in the evidence regarding its effect on specific BM design themes. To investigate this relationship more comprehensively, it is essential to grasp the core concept of BM design themes. These themes are described as "the primary drivers of value creation within a system. Design themes represent configurations of design elements or the extent to which they are coordinated and connected by distinct themes" (Amit & Zott, 2010, p. 221). Novelty is identified as the primary value creation driver for Novel Business Models (NBM), while transaction efficiency takes precedence for Efficient Business Models (EBM) (Amit & Zott, 2010).

Based on this definition, this paper contends that the external environment plays a pivotal role in influencing the selection of the BM design adopted by a firm. On one hand, TT has been shown to elevate employee creativity (Deegahawature, 2014) and, consequently, spur organizational innovation (Amabile, 1996). Hence, it is reasonable to expect that TT enhances the NBM design theme since creativity is intimately linked to NBM, as suggested by Amit and Zott (2010, 2015). On the other hand, TT introduces uncertainty regarding the optimal BM design to adopt. Consequently, new entrant firms may opt to emulate incumbent firms by adopting the dominant design, which is more inclined towards cost reduction and efficiency (Amit & Zott, 2015), thereby suggesting the adoption of a BME design theme.

Building on this rationale, this paper presents the following hypotheses:

H1. TT positively affects NBM.

H2. TT positively affects EBM.

The research is based on a 2019 survey of a diverse sample of 201 Albanian firms located in Tirana and Durres, the capital and main port of the country, respectively. The structure of this paper unfolds as follows: Section 2 outlines the research design used to assess the hypothesis, Section 3 presents the study's results, and the final section discusses the main conclusions and implications of the research.

2. DATA, VARIABLES AND METHODS

2.1. Data

The sample for this study was extracted from a comprehensive database encompassing all limited liability companies operating in the most economically significant regions of Albania. These regions, namely the capital city Tirana and Durres, account for 41% of all businesses in the country (National Statistical Business Register, 2019). Data collection primarily relied on a questionnaire protocol, with 62% of respondents participating in face-to-face interviews, while the remaining responses were gathered through email survey protocols. Face-to-face interviews were favored due to their effectiveness in establishing trust, boosting response rates, and ensuring the reliability and validity of the information obtained. To uphold ethical standards, all respondents were explicitly informed

that survey data would be treated as confidential and solely used for academic purposes. The survey was conducted by four trained researchers who adhered to written guidelines outlining the appropriate methods for conducting interviews and addressing survey items. The final sample encompasses 201 cases out of 505 active companies, resulting in a response rate of 39.8%. It is noteworthy that despite repeated attempts to reach them, a considerable number of companies (52 cases) proved unreachable. Therefore, the active response rate, accounting for reachable companies, stands at 44.37%.

2.2. Variables

All variables in the study were quantified through multi-item self-assessed indicators, employing a seven-point Likert-type scale. Appendix A (refer to Table 2) provides a comprehensive overview of all items, adapted from existing literature. To measure the NBM and EBM design themes, the original scales developed by Zott and Amit (2008) were utilized as dependent variables. TT was measured using four items, with respondents indicating the perceived extent of technological turbulence. An EFA with promax rotation was conducted to validate the self-assessed, multi-item variables, with maximum likelihood factor extraction used for normally distributed data. Factors including TT, NBM and EBM that showed high loadings were kept, while items with low loadings and cross-loadings were removed based on reliability analysis. Additionally, firm size and age were introduced as firm-level controls, and these variables were transformed as specified earlier. This incorporation aims to account for potential influences stemming from the size and age of the firms in the analysis.

2.3. Modelling Framework

To evaluate the influence of TT on NBM and EBM design themes, a linear regression model was employed. Before conducting the regression analysis, preliminary checks were carried out to ensure that the assumptions of linearity, independence, homoscedasticity, and normality of errors were met. The ultimate econometric model is articulated as follows:

$$pi^* = \beta 0 + \beta 1 X1 + \ldots \beta nXn + \beta jCj + \varepsilon i$$

where pi* represents business model design themes, Cj represents TT, Xn encompasses other determinants of business model design themes, and εi represents the error term.

3. FINDINGS

The final dataset for analysis comprises predominantly smaller entities, with 62.1% representing micro and small organizations, while medium and large firms make up the remaining 37.9%, as illustrated in Table 1. In terms of age distribution, approximately 46% of the sampled firms are less than ten years old, about 35% fall within the 11-20 years age bracket, and the remaining entities are older than 20 years.

Moving on to the results of the linear regression analysis, presented in Table 1, it is evident that TT has a statistically significant and positive impact on both NBM and EBM. This implies that as the perceived level of technological turbulence increases, there is a corresponding positive effect on the adoption and development of both innovative and efficient business models. The outcomes of the regression analysis provide empirical support for the notion that technological turbulence plays a noteworthy role in shaping the design themes of business models within the sampled firms.

However, it is noteworthy that the adjusted R-squared for business model efficiency is reported to be very low. The adjusted R-squared is a measure of how well the independent variable (Technological Turbulence) explains the variability in business model efficiency. A low adjusted R-squared indicates that the model, as currently specified, explains only a small proportion of the observed variation in business model efficiency. This may suggest that factors beyond technological turbulence, which were not considered in the analysis, could be influencing business model efficiency. It is essential to recognize the complexity of the relationship between technological turbulence and business model efficiency, and future research may benefit from exploring additional variables to enhance the explanatory power of the model.

The regression analysis also examined the influence of firm age and firm size on both NBM and EBM. The results, as depicted in Table 1, indicate that neither firm age nor firm size has a statistically significant impact on NBM and EBM. In other words, the age of the sampled firms and their size, whether micro/small, medium, or large, do not seem to be significant predictors of the adoption and efficiency of business models.

This suggests that, within the scope of this study, factors related to firm age and size are not key determinants in explaining the variations observed in the development of new and efficient business models. It is important to note that while technological turbulence emerged as a significant factor influencing both NBM and EBM, other contextual or industry-specific variables not considered in this analysis might contribute more substantially to the observed outcomes. These findings underscore the nuanced nature of the relationship between organizational characteristics such as age and size and the evolution of business models. Future research endeavors may explore additional dimensions or firm industry-specific variables to gain a more comprehensive understanding of the factors influencing business model dynamics.

Table 1. Linear regression results

	Model 1: Novel Business Model		**Model 2: Efficient Business Model**	
Variables	B	Std. Error	B	Std. Error
Constant	3,489	,359	5,179	,329
Technology Turbulence	,337***	,051	,112**	,046
Firm size (log)	-,013	,052	-,009	,047
Firm age (log)	,110	,113	,080	,104
Adjusted R Square	,183		,018	
N	201		201	

*Note: ***p < 0,01, **p < 0,05, *p < 0,1.*

Source: Own research

4. CONCLUSION

This article sought to explore the correlation between TT and Business Model design by analyzing a diverse sample of 201 firms situated in Albania, a post-communist developing country. The research uncovered a significant influence of TT on businesses, manifesting in both the inclination to innovate and the enhancement of operational efficiency within their business models.

These findings hold particular significance from an entrepreneurial perspective, as they underscore the importance of adapting to technological changes. The observed impact of TT on both innovation and operational efficiency suggests that businesses in the sampled context need to navigate and harness technological turbulence to stay competitive and thrive in a dynamic

market environment. The implications extend beyond the individual firms studied, providing valuable insights for entrepreneurs and decision-makers navigating the challenges posed by technological disruptions in the evolving business landscape.

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Appendix A

Table 2. Measurement items

Novel Business model design theme (NBM)	Zott & Amit (2008)
Our business model offers new combinations of products, services, and information (NBM1). The business model brings together new participants (NBM2). Incentives offered to participants in transactions are novel (NBM3). Our business model gives access to a wide variety and number of participants and/or goods/services (NBM4). The richness (i.e., quality and depth) of some of the enabled links between participants is novel (NBM5). In our industry, we are a pioneer in exploiting our business (NBM6). We have continuously introduced innovations to make our business more effective (NBM7). There are no competing businesses in our industry that are threatening ours (NBM8). There are other important aspects of the business model that make it novel (NBM9). Our business model, overall, is novel (NBM10).	
Efficient Business model design theme (EBM)	Zott & Amit (2008)
Inventory costs for participants in the business model are reduced (EBM1). Transactions with our firm are simple from the customer's/user's point of view (EBM2). Our business model enables a low number of errors in the execution of transactions (EBM3). Costs for participants in our business are reduced (i.e., marketing and sales costs, transaction-processing costs, communication costs, etc.) (EBM4). Our business model can handle small as well as large transaction volumes (EBM5). Our business model enables participants to make informed decisions (EBM6). Our business model enables benefits through demand aggregation (e.g., bundling of smaller volumes) (EBM7). Transactions are transparent: flows and use of information, services, goods can be verified (EBM8). Our business model enables fast execution of transactions (EBM9). Our business model, overall, offers high transaction efficiency (EBM10).	
Technology turbulence (TT)	Slater & Narver (1994)
The technology in our industry is changing rapidly (TT1). Technological changes provide significant opportunities in our industry (TT1). It is very difficult to forecast where the technology in our industry will be in 3 to 5 years (TT1). A large number of new product ideas have been made possible through technological breakthroughs in our industry (TT1).	

Source: Own research

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Project Management, Functional and Business Analysis in Fin-Prisma

Vítor Martins[1]
Leonilde Reis[2]
Marco Santos[3]

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Tests;
Software

Abstract: *Organizations rely heavily on Information Systems and Information and Communications Technologies to support business strategies and offer unique services to their clients. In project management, the focus is on the role of functional analysts and their skills in enhancing client relationships. This approach involves exchanging information and knowledge among specialists and researching internal and external documents related to each business's specific context. The key outcomes highlight the functional analyst's importance in the organizational setting, serving as a differentiator in client relations and facilitating interactions to ensure the final solution meets the client's expectations and needs.*

1. INTRODUCTION

According to Marchewka (2015), it is determined that the business analyst has been called by other names as "(…) business system analysts, systems analysts, business technology analysts, or requirements analysts (…)". "Anyone who has ever worked on a complex and lengthy software development project knows that the involvement of a business analyst can mean the difference between success and failure. And that involvement starts at the very beginning of the project." (Marchewka, 2015, p. 145).

Marchewka (2015, p. 145) refers to Wailgum's outline of eight key duties of a business analyst:

- Understand the scope of the system (working closely with the business stakeholders to communicate and determine their vision for the project).
- Interpret the business needs ("translation" of the stakeholder's requirements linked to the business to the programmers and, all the matters regarding the programmers back to the business stakeholders).
- Translation of the technical matters (transmit the technical specifics in a way that can be understood by the business).
- Determine the details of the project and requirements.
- Link that keeps the programmers in contact with the right people (intermediary with good contacts able to help the project members contact people of the organization).
- Political guide (avoid problems and political conflicts).
- Tests and validation (working in proximity with the Quality team in a way that can check if the requirements of the business stakeholders are met).
- Represent the project stakeholders along with all the process.

[1] ESCE - Polytechnic Institute of Setúbal, Setúbal, Portugal
[2] ESCE - Polytechnic Institute of Setúbal, Setúbal, Portugal
[3] Fin-Prisma Lda, Lisboa – Portugal

Furthermore, it is possible to see an overlapping of the concepts, being very similar. The importance consists of serving as an intermediary between the project team and the business stakeholders, possessing the ability to be the bridge between the parts, translating and replicating the needs and communication in a way that both can understand each other and execute, with success the projects, providing solutions for business problems (Marchewka, 2015).

The paper is structured into six chapters. The first chapter, which is the current one, is titled Introduction. The second chapter is named Further Responsibilities, while the third chapter is called In Loco Developments. The fourth chapter covers Validation and Documenting. The fifth chapter discusses Future Research Directions, and the sixth and final chapter is the Conclusion.

2. FURTHER RESPONSABILITIES

The main aspects of a functional analysis that is done by business analysts, regarding Marchewka (2015), are that is a broader and global denomination and, to be able to encapsulate all its roles, responsibilities, and necessities, and be able to deliver a solution (it can be a product/service) interesting and useful to the client. It is needed to have the structure and project follow-up necessary for that same solution, being necessary to undertake a project.

Managing a project requires the ability to identify requirements, establish clear and attainable objectives, equilibrium regarding the quality, scope, time, and cost (the last three impact the quality of the project), and adapt to the specifications, plans, and approach to the stakeholder's expectation. Furthermore, the manager (regarding the dimension and necessity of the company, could be the business analyst) needs to be able to manage and respond to the uncertainty, mainly when calculating the risk of affecting (negative or positive) the project objective (Fahrenkrog et al., 2004).

The planning and preparing of a project for developing a solution that potentiates the success of that same project, even if it is simple and direct, short, or long and complex. Only with a holistic understanding of the enterprise in hand and follow-up by one of the stakeholders that connects the parts is the key that permits that correct guidance (Martins, 2023).

In the final stage and, possibly, the most important to find if the intended value by the client of the existent solution is necessary tests to exist to ensure that the new, or changed, functionalities comply with the defined requirements. Considers that a test strategy, in addition to defining a general approach able to apply to an environment, platform, or service, should extend to the developed solutions by the organization, or by others developed externally and that that strategy should be based on acceptance criteria aligned with the stakeholder requirements. Various tests could be performed (Utilitarian/Functional; Regression that is composed of performance and capacity, compliance, operational, and the guarantee that achieves what the users want) (AXELOS, 2019).

However, the main function of the test, according to Jindal (2016) is to detect bugs and, according to AXELOS (2019), tests should include executing the code in various environments and examining various aspects of the same, checking if the solution does what is supposed to and works accordingly with the specified requirements. According to Jindal (2016) is an activity that exists to test the quality of the software and upgrade, mentioning that the objective of testing is to detect errors, with minimal effort and time, having as a base purpose verify and validate in a way to detect various problems, being able to solve them. However, tests should be done in controlled situations.

The necessity of tests during the Software Development Life Cycle is rooted in the identification of errors, ambiguity removal, improvement of the company's reputation, improvement of the solutions quality, removal of danger, verification and validation, improvement of reliability, improvement of the cost and increase the usability (Jindal, 2016). The purpose of tests is to meet some of the business analyst's necessities and enable him to inspect, in the final moments, if the assumptions made by the clients are achieved.

3. IN LOCO DEVELOPMENTS

A business analyst can take on any or all roles at any stage of a project, depending on the project's needs. However, certain duties are constant, such as acting as a bridge between the client, commercial team, and development team. This involves interpreting and facilitating communication across different languages and perspectives. The business analyst also plays a crucial role in mediating between the client's specific needs and what the commercial team aims to sell. They must balance satisfying the client's needs without overloading the technical team responsible for implementing the solution. The goal is to manage expectations and bring a realistic approach to meeting everyone's objectives.

In their work, a business analyst should prioritize neutrality and focus on the client's needs without fostering unrealistic expectations. Their role is to be a useful and realistic guide, offering their full attention and expertise to assess whether the client's requests are feasible and whether they involve significant or even insurmountable effort. The importance of this assessment is that if the development team is unable to realize the sale due to the analyst's unrealistic promises, then the earlier negotiations and identified needs would ultimately be in vain. The goal is to ensure all parties are aligned and maintain a balanced approach throughout the process.

A business analyst should possess professional qualities such as curiosity and a love for learning. In the context of software, the analyst needs to explore its capabilities to meet the client's requirements. This involves understanding the potential of different technologies and finding ways to align what can be developed with the client's specific business needs.

In that regard, exemplifies the behavior of a client regarding the needs of the development of a solution. In this way, it becomes fundamental to:

- Being familiar with the company's solutions allows the business analyst to know whether they can be used or adapted for a new project. By assessing the aesthetic and functional aspects of a current solution, the client may suggest a new approach that mirrors the existing one. This approach offers the benefit of reusing frontend and backend code for the new solution, as well as drawing on the experience gained from implementing similar projects.
- Listening carefully to the client's needs and being familiar with existing internal solutions allows one to identify already-developed options that can address the client's requirements. Additionally, this knowledge can lead to discovering other needs the client may not have considered but are logical extensions of their initial needs.

4. VALIDATING AND DOCUMENTING

Documentation is essential. In the case that the client wants to visualize the solution, but it is not yet a Proof of Concept, it is important to reunite the needs and expectations, know the capabilities of the product and services, own the capabilities of the company, and then start producing physical documentation that can be used as a factual confirmation of this what the solution can be.

The client wants documentation for reference and the solution provider needs a clear starting point to develop the solution. Therefore, it is important to produce a document that encapsulates both the client's needs and the provider's capabilities, facilitating understanding, interpretation, translation, and planning. This document should detail the component's functions, and adjustments to existing solutions, and provide a written visualization of how the result will look, offering the client a realistic view of what can be achieved.

Figure 1 outlines a document flow that can be used for any solution's documentation needs. It was created using Fin-Prisma's software, Read, Write, and Share (RWS), which is a vital tool for creating workflows, archiving documents, and managing tasks.

Figure 1. Steps for Documenting
Source: Own research

Figure 1 presents the relevant phases regarding documenting:

- "Proposal Documentation", serves as a basis for development and project, for the provider and client, reuniting the client's needs in the first phase, has expectations, conditions, and interests.
- "Client Requisites Documentation", is the final phase of the requirements and sketches that shall support the development.
- "Developing Documentation", documents about the development, either be code, project, or meeting minutes.
- "Tests Documentation", test documents to support the solution regarding the client and its requests.
- "Application Support Documentation", is documents that can be reunited knowhow from previous phases and that shall be useful to generate manuals and development closure.

The following figure, Figure 2, was made to show, in terms of finalizing, the global aspect of some roles the Business Analyst should have, based on Marchewka (2015).

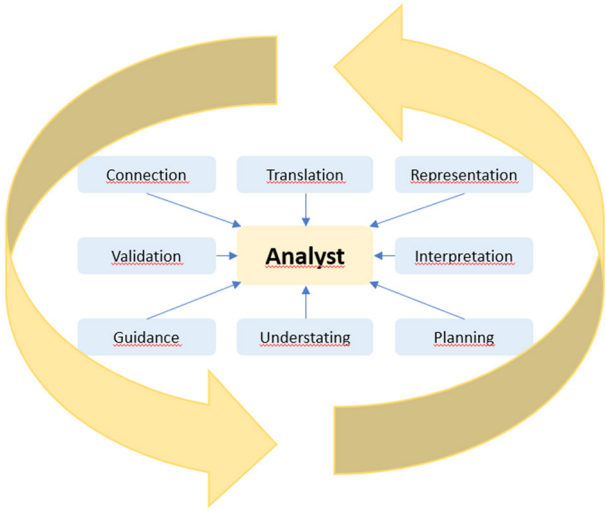

Figure 2. Holistic involvement expected from a Business Analyst
Source: Marchewka, 2015

Figure 2 presents the elements that permit a business analyst to fulfill his role. However, returning to documentation, this is an important activity end in pouring to the NP ISO/IEC 27001:2013 (2013) and ISO/IEC 27002:2022 (2022) norms that, in many of their instances, mention and indicate the need to generate evidence (pieces of evidence that can be in document format).

5. FUTURE RESEARCH DIRECTIONS

Regarding the theme in the study, it considers that the business analyst work should include the vision of the global management facing the specifics of the organization's business.

6. CONCLUSION

The broader discussion on functional and non-functional requirements is particularly relevant, emphasizing the importance of functional tests and documentation for the client. Conducting these tests and providing thorough documentation is invaluable and essential. Testing ensures the quality of the solution within the agreed requirements, while documentation allows for future analysis, maintaining purpose, and disseminating information to both current and future users. This process aids in optimizing use and fostering continuous improvement, contributing to the generation and sharing of knowledge.

Recalling Walsh's (2008) words, the role of the business analyst remains a highly sought-after asset due to the dependence on technology and the gap between IT and business. More than a decade later, this statement still holds true.

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Management of the Care of the Injured and Sick in Emergencies

Katarina Štrbac[1]
Brankica Pažun[2]

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Abstract: *Managing the care of the injured and sick in emergencies is critical to disaster and emergency preparedness. Effective management is essential to saving lives and minimizing suffering, whether it's a natural disaster, a public health crisis, a mass casualty event, armed conflicts, or any other emergency. For every possible emergency, it is necessary to follow fundamental principles and steps: preparedness, assessment and triage, resource allocation, communication, evacuation and transportation, and coordination with other institutions. Effective management of the injured and sick care in emergencies requires careful planning, coordination, and adapting to rapidly changing situations. Collaboration among healthcare organizations, government agencies, and the community is crucial to ensure the best possible outcomes for those affected by emergencies. Coordinated activities in a society are vital to be prepared for emergencies, including developing emergency response plans on all levels. Management plays a crucial role in strengthening the resilience of communities and effective response to emergencies. The involvement of civil society, cooperation with the government and local self-governments, partnership with the private sector, identification of challenges and obstacles, and recommendations for improving the management system are critical factors for successful risk management. Due to the necessary time caring for sick and injured people, one possible solution could be modern information technology. This paper is trying to raise the importance of this issue.*

1. INTRODUCTION

There has been a noticeable rise in the frequency of major emergencies, crises, and disasters. This pattern is not confined to any particular geographical area but mainly affects middle and low-income countries. These events significantly impact people's lives, disrupt essential services such as healthcare, and hinder sustainable human development. Such incidents can lead to fatalities, injuries, displacement, and infrastructure damage. "Most vivid in the public imagination are natural disasters – events of a scale that endanger both populations and environments, such as floods, windstorms, and earthquakes. According to historical data, the number of recorded natural disasters since 1900 has increased, as has the number of people affected. At the same time, man-made events are growing in frequency and impact. In the 1970s, man-made events accounted for 16.5% of disasters and 4.3% of related deaths; in the 1990s, they had risen to 42% and 9.5%, respectively (these figures do not include "complex emergencies" involving armed conflict and a total breakdown of authority)'' (World Health Organization, 2007).

The biggest problem arises when an emergency suddenly occurs, including armed conflicts, when there is no immediate response nor adequate care for the injured and sick. The reasons for this are multiple. One of the main reasons lies in the sudden events and the fact that very few countries can

[1] Faculty of Engineering Management, Bulevar Vojvode Mišića 43, 11000 Belgrade, Serbia
[2] Faculty of Engineering Management, Bulevar Vojvode Mišića 43, 11000 Belgrade, Serbia

care for all the injured and sick in urgent need. In addition to sudden natural and technological accidents, we have witnessed a large number of wounded and sick people in recent armed conflicts, as well as inadequate management of care for the sick at the beginning of the COVID-19 pandemic.

Being prepared for such incidents is crucial. Governments, local communities, and health organizations must have organized and scalable response systems to minimize the damage and save lives. Health authorities, particularly at the national level, play a crucial role in both preparing for and responding to emergencies. Their involvement is essential for effective preparedness and response efforts. Proper preparedness can help prevent or mitigate these issues. This interdisciplinary approach ensures a more comprehensive and effective response. Addressing emergency requests requires increased coordination efforts and investment in preparedness planning and infrastructure. "In particular, many countries have not yet developed Mass Casualty Management Plans, and communities are too often left alone to develop preparedness and response plans without higher-level guidance" (World Health Organization, 2007). In his brief to the Committee, High Commissioner for Refugees Filippo Grandi, in his report 2023, said the number of forcibly displaced worldwide has soared to a record 114 million people, a jump of 4 million since May (UN News, 2023).

Persons who have been forcibly displaced and who otherwise come from areas where health care is poor do not have adequate access to health services. "According to the Centre for Research on the Epidemiology of Disasters, a disaster is defined as a situation or event that surpasses local capacity, requiring a request for external assistance at the national or international level. It is an occurrence that is typically unforeseen and abrupt, resulting in extensive damage, destruction, and human suffering" (Harms & Alston, 2018).

The World Health Organization describes mass casualty incidents as disasters and major incidents distinguished by the quantity, severity, and diversity of patients, which can quickly surpass the capacity of local medical resources to provide comprehensive and definitive medical care. Occurrences of these events have become more frequent in recent decades, impacting countries across various socioeconomic backgrounds. Preparedness and planning are crucial, as these events can occur in any community at any given time. "Defined pre-hospital triage systems are essential in saving lives and optimizing the initiation of resource allocation when these disasters strike" (Clarkson & Williams, 2023).

Given the possibility of sudden emergencies caused by natural phenomena or, for example, terrorist attacks or armed conflict in which mass injuries can occur quickly, states should also define the rules of action and behaviour in such cases. For the care of the vulnerable civilian population to be adequate, it is necessary to engage healthcare systems in caring for the population. The competent state authorities should regulate the possibility of free distribution of medicines to injured and sick persons or with minimum participation. Given the complexity of the disaster management process, various actors are involved in multiple phases and different capacities. "In general, the actors that are involved in disaster management can fall into any of the following groups or types: government, multilateral organizations (including financial institutions), private sector and civil society, including long-term and short-term NGOs, academia and media" (Macapayag & Misic, 2015).

Managing the process of caring for the injured is a complex process, especially in demanding circumstances. Although countries have systems for the operation of medical teams in such circumstances, the fact is that it is not always possible to provide an emergency response. Therefore, most victims are in the triage process until they arrive at an adequate medical facility. In

those moments, there is a need to act to assess the condition of the injured and sick adequately. The cooperation of all relevant actors, especially the establishment of mobile medical teams, is essential in preparing for and responding to emergencies.

With the advent of modern information technology, we can streamline and assist the existing emergency management processes. Emergencies provide a difficult environment for keeping track of injured people and their needs with regular means. Applying information technology in digitalized databases and distributed communication devices allows more manageable and more durable tracking of injured and sick people in emergencies.

The ability of emergency response teams to communicate with each other during an emergency is crucial for the care of the injured and sick, especially for mobile medical teams. On-field information technology systems such as edge computing devices and remote telemetry solutions allow the field teams to perform rapid triage and constant automated monitoring of injured and sick, allowing the field teams to focus on more critical patients. Another benefit is the remote distribution of information between emergency teams using distributed database technologies like blockchain. This allows them to share resources via information technology protocols like HTTPS.

2. OBJECTIVES

"Considering that there are dilemmas regarding the triage of patients according to the duration of the first examination and that, according to research, it is considered that the intuitive way is faster than the algorithmic one, it would be useful to investigate a method of a simple algorithm that would not prolong the arrival time of the injured and sick in an adequate medical institution" (Hart et al., 2018). The research objective of this paper is to relate the international efforts and strategies for finding solutions for a quick and adequate measure of caring for the injured and sick in emergencies. Also, provide recommendations on procedures for short management of emergencies in part related to treatment. The use of technology in such cases can be of great help. Indeed, further research in this area is necessary to reduce the time of caring for people in emergencies.

The objectives can be summarised in the below:

- To determine the effects of caring for the injured and sick in emergencies,
- Analysis of the current international policies on management in emergencies and part related to the care of endangered,
- Determine the effective use of technology in such cases.

3. PREVIOUS RESEARCH

According to the available literature, several emergency care methods exist for the population in emergencies. However, most authors emphasize that it has been observed that mortality is high by the time of arrival at the hospital. Practically, it would be necessary to reduce the time from the moment of the emergency to the admission of the injured and sick to a health facility. Therefore, it is necessary to establish adequate management at the level of the state, local community, and medical teams. Regardless of the proper engagement of medical teams, it is necessary to increase efficiency and establish the organisation of the teams' work for the urgent treatment of the injured and sick.

"Mortality increased with the increasing scale of MCIs, medical rescue capability of hospitals was relatively good, but the efficiency of organisation and command was poor, and the pre-hospital

time was too long. Mortality declined when increasing ambulances and improved the efficiency of organisation and command; triage and on-site first-aid time were shortened if the availability of emergency medical staff. The effect was the most evident when 2,000 people were involved in MCIs; however, the influence was very small under the scale of 5,000 people" (Yu et al., 2018). The problems of managing emergencies in part related to the injured and sick were the most visible compendium of the COVID-19 epidemic. Recognizing the importance of adequate care for the injured and sick in accidents with many victims, the World Health Organization (WHO) published "Mass Casualty Management Systems: strategies and guidelines for building health sector capacity" in 2007 to point out the need for better preparation and the need to develop care plans.

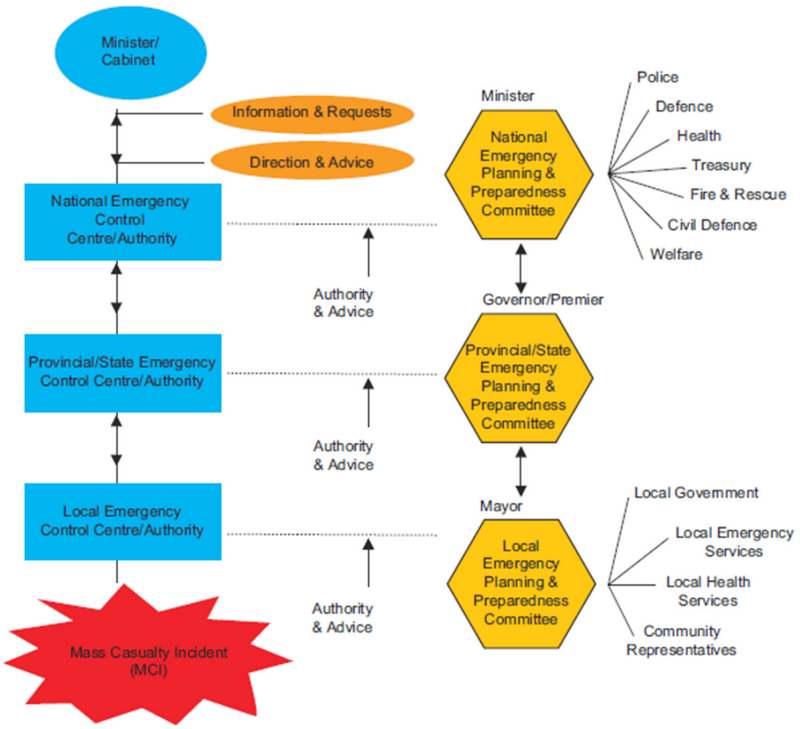

Figure 1. National Emergency Operational and Preparedness Structure
Source: World Health Organization, 2007

Even though the WHO wrote strategies and guidelines from the previously mentioned sources, it can be stated that the situation has not improved much until today. Many authors emphasize the importance of an adequate medical care system in emergencies.

"A comprehensive approach to strengthening health systems and care is therefore shown to be indispensable for disaster preparedness and response" (BündnisEntwicklungHilft, 2023). "Since the publication of the first mass casualty triage protocol approximately 30 years ago, numerous adaptations and alternatives have been introduced and are currently in use worldwide. This variety may represent a challenge for the cooperation between emergency medical providers and the interoperability of emergency medical services often required during mass casualty incidents. To enhance cooperation and interoperability, a standardization of triage protocols is required" (Streckbein et al., 2016). Adequate management was not established even during the COVID-19 pandemic, which would call for change in management during emergencies.

Regarding local communities, in many cases, there is no interest in establishing better management for emergencies. As Cvetković et al. (2021) stated "In the realm of establishing expert

operational teams and standing commissions for damage assessment, there has been little to no significant advancement. Particularly in domains demanding substantial political, professional, and public dedication, along with significant resource allocations, such as the establishment, training, and equipping of general-purpose civil protection units, situation centers, acoustic studies, the development of an alert system, personal and collective protection, and simulation exercises, the overall status is generally unsatisfactory. There is notable inadequacy in the operational and tactical competencies of local self-government in these areas".

It would be expected that the states were prepared for such an emergency. "Thousands of healthcare workers have been infected amid the ongoing coronavirus outbreak, a sign of the challenging working conditions for doctors, nurses, and healthcare workers. They should be instead among those best protected. The infections, along with the deaths of several doctors in China, underscore the deeply challenging, chaotic environment that healthcare workers face when toiling on the front lines of an epidemic outbreak. They face long hours, changing protocols, potential medical supply shortages, and risks to their health and loved ones. In every mass casualty event, the healthcare workers who go to the forefront are the main actors. The lack of national and international action plans forced health workers to work in a situation of extreme unsafety" (Coccolini et al., 2020).

During the Java earthquake in 2006, Japan provided medical help, but due to poor management, it faced problems that could have been solved if the Government of Indonesia had an appropriate management system. "The JDR Medical Team opened a temporary clinic on the street in front of Muhammadiyah Hospital, one of the largest hospitals in the city of Bantul, to support its medical operations. Initially, the JDR Medical Team started diagnosing patients who could not be treated at the hospital due to overcapacity. However, the team and the hospital soon started working complementarily by, for example, requesting that the hospital receive patients for whom the team could not provide adequate treatment due to lack of equipment. Because the hospital was well prepared for the potential eruption of Mt. Merapi, it was able to recover its medical service by the time the JDR MedicalTeam completed its activities and smoothly took over the activities of the JDR team" (Japan International Cooperation Agency, 2008).

"Lack of a predefined disaster management plan including need to prevent infected people from entering emergency departments and to place the triage systems outside the emergency departments from the beginning of the infection outbreak" (Coccolini et al., 2020).

"Abandoning the reactive way of preparing for disasters and increasingly implementing proactive measures, societies are desperately trying to improve their resilience in resource-scarce situations and mitigate future consequences of disasters" (Cvetković & Šišović, 2023).

"It is necessary to establish joint emergency response mechanisms. However, meeting this precondition requires political will, predominantly, both in the region and Europe" (Strbac, 2009).

"Whether it be drought, cyclone, earthquake, or floods when an extreme natural event hits a village or a town, the vulnerability of the society crucially depends on the population's health status as well as the health care, and it is functioning in crisis and disaster situations. But in times of the global financial crisis, the health systems worldwide are subjected even more strongly to economic principles. Often, humans facing an unacceptable vulnerability suffer the most from these austerity and privatisation measures" (World Risk Report, 2023).

4. FUTURE RESEARCH DIRECTION

Effective management of the injured and sick care in emergencies requires careful planning, coordination, and adapting to rapidly changing situations. Collaboration among healthcare organisations, government agencies, and the community is crucial to ensure the best possible outcomes for those affected by emergencies.

As mentioned before, applying information technology can increase efficiency in managing injured and sick people in emergencies. The design of specialised software that can quickly be deployed in emergencies for communication and tracking is one of the more promising approaches. This would allow easier tracking of injured and sick people and increase information sharing during emergencies. Information technology infrastructure processes are also an important research area since this would enable a standardised approach to deploying information technology to manage injured and sick.

Due to the number of different protocols and implementations of information technology solutions, a review of the common communication protocols such as HTTP or MQTT applied to emergencies for different scenarios would give future improvement to the organisation of information technology in aid to the injured and sick.

5. CONCLUSION

We have identified the following principles as crucial points for managing injured and sick people in emergencies: preparedness, triage, resource allocation, communication, patient care, coordination with other agencies, reporting, and review.

Developing emergency response plans is essential and training for preparedness. Clear protocols and rapid assessments should cover the triage process, while resource allocation should depend on the strategic situation of emergencies.

If possible, communication methods should be predefined and established before emergencies appear. To keep them operative, it is necessary to implement information technology solutions such as software and digitalised databases to maintain stability.

Similar to communication, patient care principles should be defined beforehand, and emergency resources should be available to emergency personnel to maintain the status of injured and sick.

Multiple agencies are often involved in the processes surrounding an emergency involving the sick and injured. Orchestration between different agencies and collaboration is of prime importance in sharing necessary resources and information regarding emergencies.

After the emergency passes, documentation and reports must be generated to gauge the effectiveness of measures taken during the emergency and the current status of the sick and injured. This becomes trivial when necessary information technology solutions have been deployed before and used during emergencies. An additional advantage is the capability to execute or perform more accessible reviews, improve processes and protocols, and potentially simulate new emergencies based on existing ones.

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A Systematic Literature Review of Malcolm Baldrige National Quality Award (MBNQA)

Thaleia Dima[1]
Michael Glykas[2]

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TQM;
Quality performance

Abstract: *Many organizations measure and assess organizational performance as a business excellence strategy and make quality a key element of their overall business philosophy, as quality leads to improved business performance. In an increasingly turbulent and competitive business environment, numerous organizations have adopted business excellence frameworks to obtain and monitor progress toward business excellence. Developed in the USA, the Malcolm Baldrige Award is a prominent award concerning quality management. This paper reviews approximately 90 journals from different countries, and most of the researchers use the criteria of the Malcolm Baldrige National Quality Award (MBNQA) to gauge organizational performance. The paper aims to present the Malcolm Baldrige National Quality Award (MBNQA) and compare it with even two well-known business excellence models in the world: the Deming Prize and the European Foundation for Quality Management (EFQM) to show what criteria the authors can apply to enhance Business Excellence Models (BEMs).*

1. INTRODUCTION

The common asset of the modern world in the face of global competition is quality management. Quality-related concepts and examples are developed by many scientists and professionals. The first worldwide quality model was the Deming Prize. The Malcolm Baldrige National Quality Award (MBNQA) is a prestigious prize in the field of quality management, and the EFQM was created in Europe since firms there frequently utilize it as a guideline for implementing Total Quality Management (TQM) (Haktanir & Kahraman, 2020). Aydin and Kahraman (2019) claim that in international business rivalry, Total Quality Management (TQM) is the most widely used strategy for enhancing customer satisfaction and process quality within enterprises. A key principle of the quality reward model's continuous improvement (CI) is TQM (Lazaros et al., 2017). Access to a large variety of goods and services encourages countries to implement quality management systems globally (Sawaluddin et al., 2013).

The MBNQA was instituted in 1987 by the U.S. Congress to increase awareness of quality management. The Baldrige framework aims to reward and encourage quality organizations. The Malcolm Baldrige Award is developed to identify organizations that establish and display high-quality standards. The assessment is based on seven critical areas: leadership, strategic planning, customer and market focus, information and analysis, human resource focus, operations, and the organization's results. The evaluation points for these seven sets of criteria are divided into eighteen, with a maximum score of 1.000 (Haktanir & Kahraman, 2020).

[1] Department of Financial and Management Engineering, University of the Aegean, Kountouriotou, 41, 82100, Chios, Greece
[2] Department of Financial and Management Engineering, University of the Aegean, Kountouriotou, 41, 82100, Chios, Greece

The Baldrige Award is not only designed to achieve goals but also to increase output and competitiveness. Focus on continuous improvement, innovation management, social responsibility, strategy development, and delivery of value to customers helps organizations increase organizational sustainability and competence (Lee, 2018).

The newest version of the Malcolm Baldrige Criteria for Performance Excellence (MBCfPE) published the Baldrige Excellence Framework, which includes fundamental principles and concepts for measuring high-performance organizations. MBNQA is also known as an "integrated management framework", which is appropriate for identifying, understanding, and managing organizational performance.

Since its appearance in 1987, the MBNQA Award has had a crucial impact on US organizations for their achievements in quality and performance, regardless of organization, size, or sector, and their awareness about the significance of quality as a competitive advantage. The development of Business Excellence Models (BEM) and Quality Awards (QA) has played a crucial role in initiatives to enhance the organization's performance standards for quality worldwide. The development of MBNQA in the USA gave a spur to other countries to develop, apply, and manage their business excellence models.

2. RESEARCH METHOD

The present paper demonstrates the significance of the MBNQA award in developing organizational performance, regardless of the organization's type. This paper begins with a study framework, including business areas that measure quality performance the most and, consequently, different MBNQA application strategies from multiple geographic areas that are concerned about organizational effectiveness. There isn't much information in the existing literature about the MBNQA award so far.

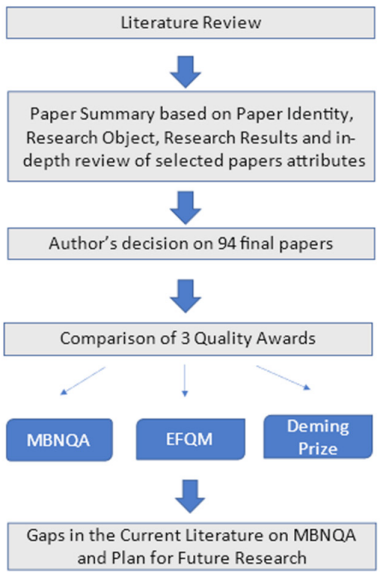

Figure 1. The framework of the study
Source: Own research

The authors selected 94 samples from journals out of 5.150 articles that cover the MBNQA Award for further analysis. Using the keywords MBNQA, award, application, and analysis, Google Scholar gave us 5.150 results related to these keywords. Then, we further analyzed the results, and we

selected the most relevant for this literature review. This paper assesses and offers an overview of the MBNQA Award procedures used by different types of organizations around the world. A comparison of the existing types of excellence awards that are widely used around the world is included in the paper, giving information on what criteria are assessed for each type of award, which is the practical application of the awards, and which award is commonly used by multiple scholars to ascertain the maximum level of success in organizational performance.

3. RESULTS AND DISCUSSION

3.1. Paper Summary

For the review, 94 articles demonstrating the MBNQA Award from different geographic areas were selected. The MBNQA methodology aspect and the MBNQA criteria for developing organizational performance are investigated. To evaluate the development of the MBNQA award in organizations, we selected a sample of various journals and publishers spanning 22 years, from 2000 to 2022.

The authors provide an overview of the implementation of the MBNQA Award in different organizations from multiple industries around the world. Furthermore, the connection between the MBNQA award and other quality organizational performance award practices may be recognized. By documenting the contents of the 94-article sample, we can identify what criteria are mostly and effectively applied to our company and determine the methods that will give results later. Different work culture environments may differ in the way employees perceive the need for the MBNQA assessment. This literature will offer an in-depth analysis of the factors that many countries utilize.

Below, we attempt to classify the studies based on journal, publisher, year of publication, geographic area, industry sector, and CiteScore to explain the profile of the MBNQA articles examined.

Journal Publisher. The articles studied come from respected journals and publishers from different universities around the world. From the selection of publishers discussing MBNQA, it was found that a total of 22 articles were published by Emerald Group Publishing Limited, which tops the list. Taylor & Francis is following with 17 articles. Wiley-Blackwell comes in third with 9 articles, followed by Springer with 4 articles and Elsevier with 4 articles. In IEEEE, Wolters Kluwer Health, the American Society of Health-System Pharmacists, and the Multidisciplinary Digital Publishing Institute (MDPI), there were 2 articles published accordingly. In UiTM Press, BMJ Publishing Group, MCB University Press, and Cogent OA 1, an article was found. The list also includes 1 article from the publishers: Kerman University of Medical Sciences, WSEAS Press, International Network for Scientific Information Publication (INSI), and Inderscience Publishers. Two articles were found in conference proceedings, and one article was found in a book. All the information presented above is summarized in Figur 2.

Geographic area. If we take into consideration the countries in which the studies were conducted, we conclude that there have also been lots of multinational studies. More specifically, most of the research on the MBNQA was conducted in the U.S.A. (20 articles), where the quality assessment criteria were developed, and in Indonesia, with a total of 10 articles. Korea and Malaysia have four articles. China, Greece, and Palestine have a total of 3 articles, followed by the rest of the countries.

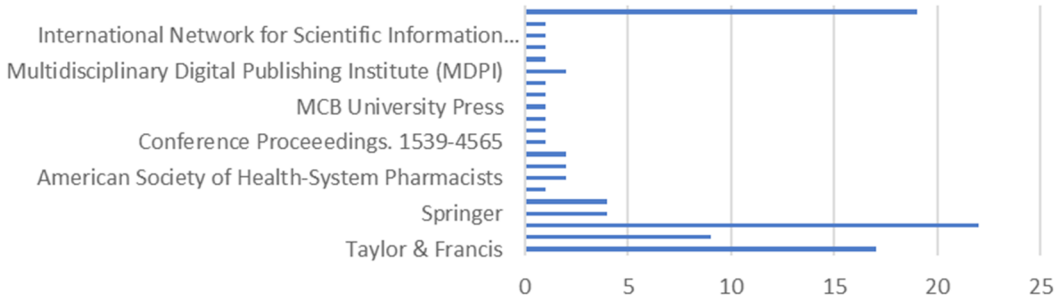

Figure 2. Journal Publisher

Source: Own research

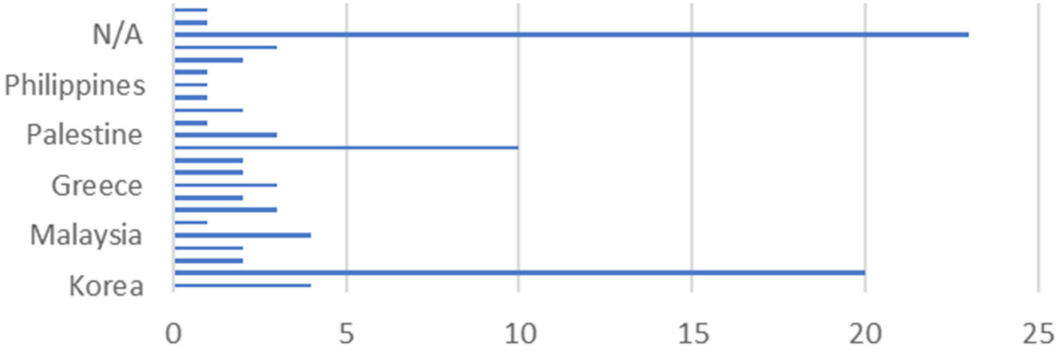

Figure 3. Geographic area

Source: Own research

Industry sector. The following figure presents the most widely used sectors of the selected articles. As seen in Figure 4, the most widely used sectors of this study are general studies, with a total of 24 articles, followed by healthcare with 20 articles and education with 19 articles. The manufacturing sector has 4 articles, the stock market has 3 articles, and the municipal government/government sector, Food and Manufacturing, and Services have 2 articles accordingly.

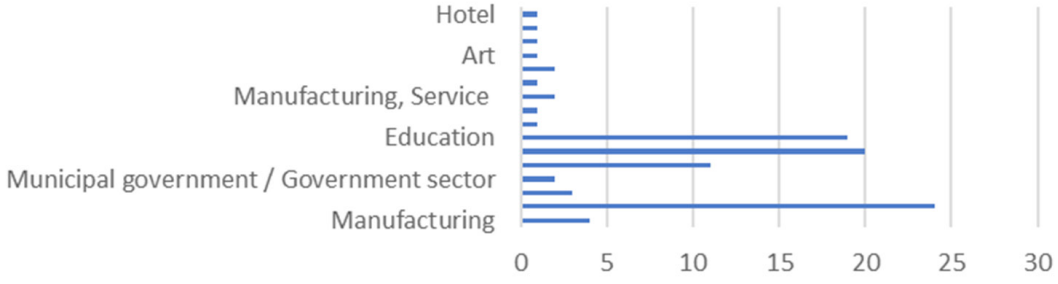

Figure 4. Industry Sector

Source: Own research

Cite Score. The CiteScore metric is used to measure the journal impact in Scopus. The number of citations a journal received in the four most recent years (including the calculation year) divided by the total number of papers published in the journal during that time is used to calculate the CiteScore for the current year. Specifically, Cite Score for 2021 measures the reports received in the last four years in reviews, articles, book chapters, conferences, and data papers published in 2018–2021 and divides it by the number of those reports published in the given period. The pie chart below shows the Cite Scores from the journals examined in this study, most of which show measurements taken in 2021.

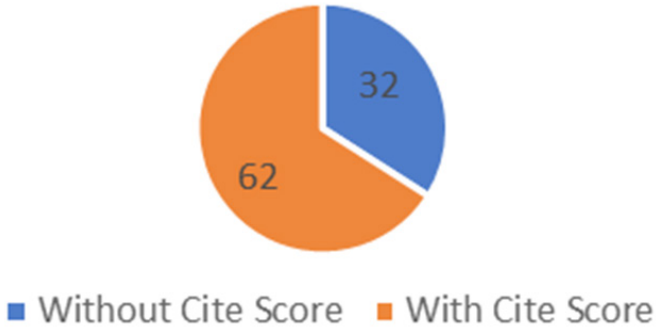

Figure 5. Cite Scores from the Journals examined in this literature study.
Source: Own research

Looking at the pie chart, it is easy to see that 32 articles were not found to have Cite Scores, while 62 were found to have Cite Scores. The Cite Score of most journals (5 journals) is 14.6. Only one journal was observed to have a high score, more specifically, a 15.2 citation score. 41 journals range between 0.7 and 7, followed by scores between 7 and 14.6 (10 journals).

3.2. Quality Award Comparison

In this paper, the research is not limited to assessing the organizational performance in different sectors. This study has also compared the criteria of MBNQA with those of other awards, including the European Foundation for Quality Management (EFQM) Award and the Deming Prize. The comparison of the three quality awards provides further information on quality performance and business excellence.

Table 1 presents the purpose, the establishment, the basic premises, the applicability, the quality principles, and the output of each quality model.

The two business excellence models, EFQM and MBNQA, share many similarities. Similar definitions and business excellence constructs are found in both. MBNQA and EFQM focus on continuous improvement, while the Deming Prize stresses the need for organizational quality management. The MBNQA award focuses on human resources and customer factors; the EFQM model concentrates on stakeholder satisfaction; and the Deming Prize focuses on effective operations and planning. Customer, employee, and society satisfaction is the focus of the criteria of the models. The customer has the greatest weight for the European Quality Award and Business Results for MBNQA. Instead, the Deming Prize includes 10 equally weighted points.

The three business excellence models, MBNQA, Deming Prize, and EFQM Award, have common areas of excellence, which are: leadership factor, customer and market focus, human resource focus, strategic planning, process management, and business results. The consensus view of the three Business Excellence models (MBNQA, EFQM, and Deming) is that the criteria are used as a guide for applying Total Quality Management (TQM) by worldwide organizations.

Table 1. Quality Award Comparison

	EFQM	MBNQA	Deming Prize
Purpose	To promote sustainable excellence in European organizations and to stimulate and support European manager's efforts to initiate Total Quaity Management. To increase awareness of the importance of quality to achieve competitive advantage across the European community. To support European businesses in their efforts to enhance consumer and employee satisfaction as it relates to Business Results and Society.	To recognize US organizations for theirs achievements inquality. To improve and raise awareness about the importance of performance excellence and quality as a competitive advantage for US companies. To use it, in particular as a working tool for understanding and managing organization's performance, planning and assessment.	To evaluate and recognize methods of Company- Wide Quality Control (CWQC) for Japanese businesses based on Statistical Quality Control (SQC).
When established	In 1992 created by the EFQM.	In 1988 established by the US Congress. However, National Institute of Standards and Technology (NIST) is responsible for designing and managing the award program.	In 1951 established to commemorate W. Edwards Deming who contributed greatly to Japa's profiteration of statistical quality control after World War II.
Applicability	Any kind of organization regardless of size, sector or location within a European perspective in the public as well as the private sector. (European-based national accredited award)	Any organization located in the U.S. that is in the manufacturing, education, service or health care sector. (U.S.-based national accredited award)	All organizations, large or small, public or private, can apply for the Deming Prize within specific guidelines, regardless of the kind of business they operate. (Japanese-based national accredited award)
Basic Premise	Leadership, Partnerships and Resources, Processes, Policy and Strategy, and People are the keys to achieving excellent results in terms of Performance, Customers, People, and Society.	An organization can improve overall performance by focusing on the Baldrige performance excellence criteria.	Deming Prize focuses on the concept of TQM at the operation site and companies can be successful if they embrace TQM as the management philosophy.
Key Evaluation Criteria	Leadership People Strategy Partnership and Resources Processes and Products Customer Results People Results Society Results Key Results	Leadership Customer Focus Measurement, Analysis and Knowledge Management Strategic Planning Human Resource/Workforce focus Business Results Process Management	Organization Policies Information Standardization Human Resources Development and Exploitation Activities for Quality Assurance Activities for Maintenance and Control Impacts/Results Future plans
Quality Principles	1. Customer Focus	Companies should be customer-focused and have a clear direction.	Create a vision and demostrate commitment.
	2. Supplier partnerships	Company's customers evaluate the performance and quality.	Recognize the inspection process.
	3. People Development and involvement	Both organizational and personal learning are necessary.	Learn the new philosophy.
	4. Processes and facts	Partners and employees are crucial to company's success.	Stop making decisions founded on costs.
	5. Continuous Impovement (C.I.) and Innovation	Flexibility and change management are necessary for success.	Enhance
	6. Leadership and consistency of purpose	Future orientation is necessary for market leadership.	Establish Training
	7. Public Responsibility	A meaningful change requires Innovation.	Institute Leadership
	8. Results Orientation	Management requires processes and facts.	Drive out fear
		Public/ Social Responsibility is crucial to company success.	Optimize the efforts of teams.
		Performance Measurement should focus on results.	Eliminate call to action.
		System Thinking is required (a systems perspective).	Eliminate numerical quotas and maagement by objectives
			Remove barriers and take action
			Encourage educations and self-improvement
Output	The feedback report identifies strengths and opportunities for Improvement and presents scoring ranges in each criterion. In particular, results about objective achievement, stakeholder satisfaction, financial achievement and impact on society.	The feedback report makes out strengths and opportunities for Improvement and presents scoring ranges in each criterion. In particular, results about customer, financial, human resource, supplier, operational and competitive.	The feedback report includes the company's practices regarding TQM. In particular, the end results are about the quality, safety, delivery,profit and cost, and environmental effects of quality control.

Source: Own research

The models' criteria are listed in Table 2. The table demonstrates the comparison of three business excellence models based on their criteria.

Table 2. Quality Awards Comparison, based on its criteria

Criteria	MBNQA	EFQM	Deming Prize
Leadership	X	X	X
Policy and Strategy	X	X	
People Management	X	X	X
Resources		X	
Processes	X	X	X
Customer Satisfaction	X	X	
People Satisfaction		X	
Impact on Society		X	
Business Results	X	X	X
Standardization			X
Information and Analysis	X		X
Quality Assurance			X
Maintenance/Control			X
Improvement			X
Future Plans			X

Source: Garza-Reyes et al., 2015

3.3. Gaps in the Current Literature on MBNQA

Nowadays, most organizations endeavor to be more and more competitive to survive. The TQM philosophy is commonly recognized as a motivating idea that supports effort. Bou-Llusar et al. (2009) support the idea that TQM is a management strategy that incorporates both social and technical dimensions and is used to achieve adequate quality performance by participating employees. Business Excellence Models (BEMs) emerged as effective tools in the field of competitive edge more than 20 years ago.

According to the literature, countries strive to measure and assess the organizational performance of their organizations using the MBNQA criteria approach. MBNQA is widely used in the USA, especially in the industrial sector. In Europe, the EFQM Award is the most known and implemented Business Excellence Model (BEM) to measure the performance of organizations. However, some countries in Europe have developed their own standards for quality awards, such as the Australian Business Excellence Model (ABEM) and the UAE Government Excellence Model (GEM), which are used mainly internally in the country. The Deming Prize criteria are used by many Japanese manufacturing businesses. Organizations around the world use the criteria model from the Deming Prize, MBNQA, and EFQM awards as a guide for applying the TQM philosophy.

It is an undeniable fact that we are traversing the era of the fourth industrial revolution. Industry 4.0 is an era that we cannot avoid. It relies heavily on applying smart systems, the internet, and future-oriented technologies. Industry 4.0 connects the virtual and physical worlds, supported by the application of key technologies such as simulations, big data and analytics, cloud computing and the Internet of Things (IoT), augmented reality (AR), additive manufacturing (3D printing), vertical and horizontal system integration, and cybersecurity (CS). Companies must have an innovative and transformational strategy to face the fourth industrial revolution.

In the era of the Fourth Industrial Revolution, the application of criteria (from excellence models such as MBNQA, Deming Prize, and EFQM) to Total Quality Management (TQM) has a crucial

and influential influence on the company's competitive advantage. Though the business excellence models for Industry 4.0 are a field that is deemed important, researchers' interest is scarce. Industry 4.0 (I4.0) is increasing rapidly each year and, consequently, quality, and organizational excellence. Academics should get involved more in this research field and make innovative contributions to Industry 4.0 and its alignment with excellence models if they want to maximize organizational performance by combining the technology dimension. As highlighted by the academician Asif (2020), quality models are not in compliance with Industry 4.0. Moreover, the findings of the same research show that advances in Industry 4.0 have outpaced Models of Quality (QM). Quality models and Industry 4.0 should be operationally and strategically integrated to maximize a company's organizational performance. The improved digital-based processes, the installation of sensors on companies' equipment, and the automation of processes can prevent any aberrations in the production process, as companies will address them in real-time and fix them immediately. All these above-mentioned actions will create a better-quality management strategy.

4. CONCLUSION

This paper presents a literature review of 94 studies about MBNQA in different sectors. Based on the literature review results, it was found that most of the organizations guided their organizational assessment using the MBNQA criteria. The examined studies are either using exclusively the MBNQA model or in comparison with other awards.

The literature highlights that the Malcolm Baldridge National Quality Award (MBNQA) was developed as a tool for performance measurement and assessment, for determining what constitutes quality excellence, for disseminating knowledge about successful quality benefits and strategies, and finally for formulating an organization's approach to competing in the global market. The comparison of the Deming Prize (DP), MBNQA, and EFQM provides an overview of the range of criteria available for assessing an organization's quality performance.

The articles studied have been categorized based on the journal in which they were published. It was found that most studies were published in the International Journal of Production Research and the Quality Management Journal, followed by Total Quality Management & Business Excellence, the Journal of Operations Management, and the International Journal of Quality and Reliability. Also, attempting to classify the studies based on the year in which they were published, we found a gradual upward trend, which indicates the increasing number of publications over time. Regarding the geographic area in which the articles were published, it is evident that the U.S.A. is leading, followed by Indonesia. Lastly, we classified the articles examined by their respective Cite Score. These results can be found in the Paper Summary section.

This research has several consequences for academicians and practitioners. It displays the MBNQA criteria and provides support to organizations that want to measure and assess organizational performance using the MBNQA methodology. From a theoretical point of view, it contributes to the limited knowledge addressing the MBNQA model and its possible synergies with Industry 4.0 in future research. According to Gunasekaran et al., the Business Excellence Model paradigms need to consider digital transformation and Industry 4.0. Given the exploratory nature of this research, future studies, with the practical support of the MBNQA model implementation, are recommended to additionally expand on this area of study. Further investigation is required by Industry 4.0 to address the application of Business Excellence Models (BEMs) within the I4.0 paradigm.

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Traditional vs Digital Supply Chains

Andrijana Čolaković[1]
Anđela Đorđević[2]
Biljana Cvetić[3]
Miloš Danilović[4]
Dragan Vasiljević[5]

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Abstract: *This paper thoroughly describes traditional and digital supply chains and their key characteristics. Since digitization has had an impact on every single aspect of human life across the world, it is also transforming traditional into digital supply chains. The research domain is the explanation of traditional and digital supply chains and their comparison based on their stated differences. The methodological approach involves a comparative analysis of traditional and digital supply chains based on a literature review. The result of the paper is the identification of the specifics of digital supply chains and their importance for the company's business. The originality of the paper is ensured by a comparative analysis of the characteristics of traditional and digital supply chains, which are presented in the form of a table and described in the text. Possible limitations of the paper refer to the availability of relevant literature.*

1. INTRODUCTION

In the context of the global economy, demand fluctuates regularly, consumers are becoming increasingly discerning, and products and markets are growing more intricate. This complexity extends to supply chains (SCs) as well. As SCs become more complex, involving a larger number of participants and intricate business relationships, managing them becomes more challenging. Visibility and monitoring of product movements become difficult, leading to increased costs and other related issues. The existing business solutions, concepts, and supporting software are inadequate in addressing these challenges. The requirements set forth by the Industry 4.0 concept make it essential to transform conventional SCs into digital SCs.

The structure of this paper is as follows: following the introduction, the second section defines traditional SCs, outlining their objectives and the common challenges associated with them. The third section delves into the detailed explanation of digital SCs. The fourth section presents a comparative analysis of traditional and digital SCs based on predefined criteria. The paper concludes with final thoughts.

2. TRADITIONAL SUPPLY CHAINS

Traditional SCs involve turning raw materials into finished goods and products, as well as delivering products on time to end customers. They also represent the combination of key business processes thanks to which products and services are delivered from suppliers to end customers.

[1] University of Belgrade, Faculty of Organizational Sciences, Jove Ilića 154, 11000, Belgrade Serbia
[2] University of Belgrade, Faculty of Organizational Sciences, Jove Ilića 154, 11000, Belgrade Serbia
[3] University of Belgrade, Faculty of Organizational Sciences, Jove Ilića 154, 11000, Belgrade Serbia
[4] University of Belgrade, Faculty of Organizational Sciences, Jove Ilića 154, 11000, Belgrade Serbia
[5] University of Belgrade, Faculty of Organizational Sciences, Jove Ilića 154, 11000, Belgrade Serbia

The goal of traditional SCs is to maximize profits, maximize operational performance, and develop better relationships between employees within companies. In a traditional SC, products move linearly and each link in the chain depends on the previous one. If an error occurs in a traditional SC, it can take days or even weeks to detect it, and a single error can lead to missed deadlines and customer dissatisfaction claim Ayesh et al. (2020). The phases of traditional SCs are (DIGGIPACKS, 2023):

1. Collection of raw materials - In this phase, all the raw materials needed in the production process are collected and the raw materials can be composed of one element or a group of elements;
2. Obtaining raw materials from suppliers - In this phase, raw materials are collected from suppliers, which cannot be obtained without them;
3. Production - In this phase, the production of products is carried out, after collecting raw materials and obtaining them from suppliers;
4. Distribution- In this phase, finished products are distributed to retailers or customers;
5. Consumption- This is the final stage where finished products are bought and consumed by retailers or customers.

Characteristics of traditional SCs according to Ayesh et al. (2020) are:

- Long delivery time;
- High transportation costs;
- Complex distribution networks;
- Dependence on economies of scale;
- Non-immediate consumer response;
- Managing demand uncertainty can be a complex task;
- Elevated inventory levels;
- Production is carried out far away from the places of product consumption;
- Generally not strict product quality control;
- Each participant in the SC works on demand forecasting;
- Employees at lower levels are not given enough importance.

A traditional SC is defined as an integrated production process in which suppliers deliver raw materials or semi-finished products to manufacturers, and then manufacture or assemble the semi-finished products into final products, and then the finished products are sent to distributors and retailers, and finally delivered to customers. In traditional SCs, the physical flow of products takes place from suppliers to customers, and the flow of information takes place from customers to suppliers claim Deshmukh and Vasudevan (2014). Figure 1 shows the structure of a traditional SC.

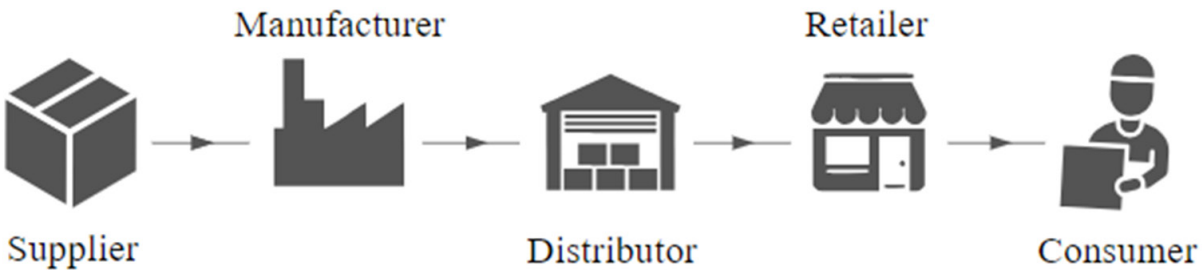

Figure 1. Traditional SC structure
Source: SourceTrace, 2023

The advantages of traditional SCs according to Kadam et al. (2017) are:
1. Striving to achieve profit maximization;
2. The focus is on the production and distribution of products;
3. Striving to achieve better relations between employees in the company.

Disadvantages of traditional SCs are (LinkedIn, 2023):
1. Weaker data updating in real-time;
2. Higher number of expected delays;
3. Difficulties in adapting to changing market conditions;
4. Increased inventory levels;
5. Detecting possible problems can be time-consuming, laborious, and unreliable.

3. DIGITAL SUPPLY CHAINS

A digital SC is characterized as a smart, value-oriented network that leverages cutting-edge technologies and analytical tools to generate business benefits. According to Büyüközkan and Göçer (2018), it can be defined as a customer-focused platform that efficiently harnesses real-time data from diverse sources. Utilizing digital technologies and data analysis, a digital SC makes informed decisions, optimizes performance, and swiftly adapts to evolving circumstances. It encompasses a series of processes that employ advanced digital technologies, enabling companies to enhance their decision-making regarding inventory requirements, product demand, and the interconnections between these factors. Digital SCs function more like networks. The configuration of digital SC is a network, rather than traditional linear SC. According to Ageron et al. (2020), it is a dynamic system that leverages information technology to integrate the SC activities for smooth material flows. The configuration for the digital SC depends upon the company's objectives and strategies. Digital SCs can provide real-time insight into the performance of each step in the chain. This visibility into supplier performance and customer needs allows the company to develop more relationships with more suppliers and better protects the company from disruptions when they occur states (RECIPROCITY, 2023). According to Ye et al.(2022) SC transparency and SC agility are two key factors that have helped companies achieve astonishing SC performance in the COVID-19 crisis. Gupta et al. (2020) stated that Industry 4.0 and digitalizing the SC offer executives the means to effectively manage complex environments and achieve mass customization with heightened speed, efficiency, and productivity. Within the SC, various points can contribute to wastage and inefficiencies. However, when companies collaborate closely and integrate their operations, it results in enhanced transparency and system safety. Rasool et al. (2021) proposed a set of metrics including operational efficiency, operational speed, error rate, system reliability, system flexibility, operational cost, on-time delivery, supplier relation, information availability, inventory level, return on investment, etc. for digital SC' performance measurement.

Figure 2 shows the structure of digital SCs.

The advantages of digital SCs according to (RECIPROCITY, 2023) are:
1. Improved visibility into SC performance - companies have real-time visibility into supplier performance, enabling them to pinpoint and address issues that could potentially lead to disruptions.;
2. Process automation - A digital SC eliminates the need for manual data entry and the reliance on phone calls to request updates; all required information is readily accessible, streamlining business processes, enhancing efficiency, boosting worker productivity, and

ultimately improving profitability; digital tools like sensors enable live inventory tracking throughout the SC;

3. Lower costs and faster innovation - a digital SC provides up-to-date information that helps manage and optimize processes such as raw material flows, forecasting, and resource planning, leading to lower costs; enhanced information sharing and collaboration lead to the identification of process bottlenecks, shortening the time to market for a new product and accelerating innovation;
4. Advanced Analytics - a digital SC can provide advanced analytics tools that visualize data, making it easier for users to learn from errors, predict outcomes, and enhance decision-making;
5. Enhanced planning - In a digital SC, shared and current data on quality and control empower companies to anticipate and proactively address issues before they escalate. Digital SC management simplifies the planning and management of all SC activities;
6. Reduced delivery times - digital SCs significantly minimize waiting times, enabling quicker and more efficient deliveries;
7. Improved financial management - With shorter lead times, digital SCs reduce financial requirements and enhance cash flow by reducing the capital tied up in excess inventory stored in warehouses;
8. Forward-looking Approach - Instead of merely reacting to events, digital SCs empower companies to anticipate future demands by collecting, analyzing, and sharing a wealth of data, enabling a more proactive approach to SC management.

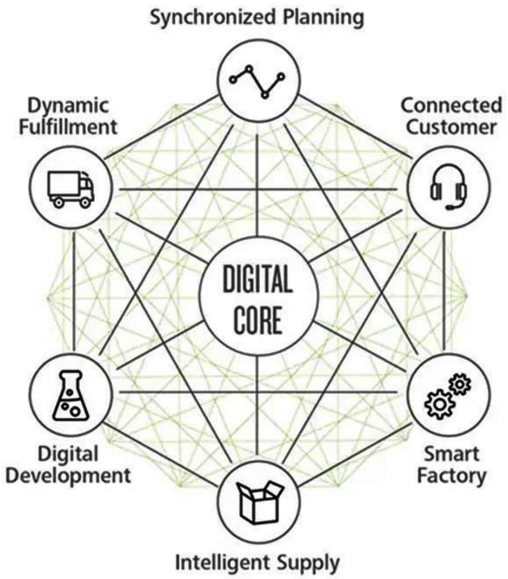

Figure 2. Digital SC structure
Source: RECIPROCITY, 2023

Disadvantages of digital SCs according to (CHRON, 2023) are:

1. It takes time to implement digital technologies, as well as to train employees to learn to use them;
2. There is a risk of cyber attacks due to the exchange of large amounts of data in real-time;
3. If there is a power outage or network interruption, it can lead to serious disruptions in the entire SC, because information will be unavailable;
4. Implementation costs are high, as significant initial investments in digital technology are required.

The steps for transforming a traditional SC into a digital SC are (RECIPROCITY, 2023):

1. Evaluation of the traditional SC - the journey toward digitization should always commence with an assessment of the existing SC; this assessment entails examining the strengths, weaknesses, opportunities, and threats within the SC, identifying and analyzing current issues, risks, and potential complications;
2. Defining a digital strategy - collaboration and communication between companies and their SC partners are essential in defining the objectives of a digital SC; it's crucial to grasp the anticipated benefits to ensure that the new digital system aligns with the requirements of all stakeholders. Transitioning from a traditional SC to a modern, fully integrated digital one can be a complex endeavor, underscoring the importance of developing a well-defined strategy and implementation roadmap;
3. Conduction of a supplier analysis - an integral step in establishing a digital SC involves evaluating the maturity and readiness of suppliers, including their awareness of potential risks, to ensure alignment with digital initiatives;
4. Investing in digital opportunities - once goals, risks, expectations, and potential benefits are clearly defined, then investment in relevant digital opportunities follows; the right opportunities are critical to the success of companies;
5. Employee training - the successful adoption of digitization hinges on well-informed personnel who have received comprehensive training, ensuring their capability to effectively and efficiently manage new technologies.;
6. Performance analysis for continuous improvement - after the implementation of digitized systems and processes, it is imperative to regularly assess the performance of the digital SC; this assessment encompasses productivity, efficiency, return on investment, delivery times, and inventory; such analysis can help assess whether new systems are performing as expected and uncover opportunities for digitally driven optimization and growth.

Integration of Industry 4.0' concept trends and enablers, such as Internet of Things/Internet of Services, click and collect delivery, pick-up points, product-lifecycle management, radio-frequency identification, simulation tools, smart factories, etc. is generating an essential dimension in the transition of traditional SCs into digital SCs confirm Garay-Rondero et al. (2019).

According to Queiroz et al. (2019), transitioning from traditional to digital SCs, that is, SC digitalization necessitates a substantial integration of an organization's internal capabilities with those of its SC partners. Additionally, the resistance of employees to embracing these changes may manifest at different phases of the transformation, prompting managers to carefully weigh the expenses and potential risks linked to digitalization initiatives.

Digital SC facilitates strategic SC improvements by optimizing design processes, enhancing product quality, improving planning and inventory management, managing risks, fostering collaboration with suppliers, increasing operational efficiency, optimizing logistics, maximizing sales performance, and enhancing after-sales services stated Ageron et al. (2020).

4. COMPARATIVE ANALYSIS OF TRADITIONAL AND DIGITAL SCS

The differences between traditional and digital SCs are shown in Table 1 (LinkedIn, 2023; Oracle, 2023; RECIPROCITY, 2023):

1. Traditional SCs are rigid, following predefined rules and historical data, whereas digital SCs operate in real-time, exhibit dynamic behavior, and can adjust to evolving situations.;

2. Traditional SCs follow a linear model, whereas digital SCs function as interconnected networks;
3. In contrast to traditional SCs that frequently use isolated systems, digital SCs seamlessly integrate data from both information technology systems and operational technology;
4. In a traditional SC, detecting potential problems and predicting potential effects can take a lot of effort. Most companies should conduct regular assessments of the SC resilience of their most critical suppliers. In a digital SC, on the other hand, the sharing of quality and control data with suppliers allows companies to predict issues and take proactive measures without the need for extensive upfront planning.
5. In traditional SCs, employees make decisions based on input from machines, while in digital SCs, machines make decisions, with employees supervision;
6. Traditional SC primarily concentrate on production and logistics, whereas digital SCs have a broader focus, addressing overall customer requirements and striving to enhance the overall value of the product delivered to customers, rather than solely emphasizing distribution aspects;
7. Traditional SC has no strategy to improve the value of the finished product. In contrast, companies operating within a digital SC create value for the end customer's product;
8. Traditional SCs allow companies to progress more slowly than digital SCs;
9. Traditional SC does not use any logistics management tool, while digital SC uses logistics management tools to ensure safe delivery of goods;
10. Unlike traditional SCs, where delivery times are significantly slower, digital SCs are much faster. New approaches to product distribution in the digital SC can reduce the delivery time for many products to just a few hours;
11. Digital SCs are more flexible than traditional. Real-time SC planning means that companies can respond more flexibly to changing demands or supply situations. Through the reduction of planning cycles, digital SCs facilitate a more continuous and agile planning process, enabling quicker responses to changing demands or constraints;
12. Unlike traditional SCs, digital SCs allow customers to choose offers that exactly match their needs;
13. Digital SCs are more accurate because they provide real-time transparency throughout the SC;
14. Unlike traditional SCs, digital SCs are more efficient. Automating physical tasks and planning means increasing efficiency along the SC. For example, in a digital SC, robots handle materials throughout the warehousing process, from receiving and unloading, to putting away materials, to picking, packing, and shipping;
15. Unlike traditional SCs, digital SCs are more environmentally conscious;
16. Different from traditional SC, digital SC enables more efficient management of the storage of goods and continuous monitoring of inventory levels with the help of sensors or other advanced technologies;
17. Compared to traditional SCs, a key characteristic of digital SCs is innovation, so they are always open to change.

Table 1. Traditional and digital SC – a comparison

	Traditional SC	**Digital SC**
1.	Static	Dynamic
2.	Linear	Networks
3.	Reliance on standalone systems	Non-reliance on standalone systems
4.	Detecting a problem requires a lot of effort	Problem anticipation without complex planning
5.	Employees make decisions based on input from machines	Machines make decisions with employees' supervision

6.	Focus on production and supply only	Focus is also on customer needs
7.	Non-defined improvement strategy for value of the finished product	Defined improvement strategy for value of the finished product
8.	Slow progress of the company	Fast progress of the company
9.	Logistics management tools are not used	Logistics management tools are used
10.	Slower delivery time	Faster delivery time
11.	Less flexibility	Greater flexibility
12.	Standard product range	Personalized products (offers)
13.	Lower accuracy	Higher accuracy
14.	Lower efficiency	Higher efficiency
15.	Environmental negligence	Environmentally conscious
16.	Lower efficiency in goods storage management	Greater efficiency in goods storage management
17.	No innovation	Innovation

Source: Own research

5. CONCLUSION

Traditional and digital SCs are presented and explained in detail in this paper. Although traditional SCs are much simpler than digital SCs, they have their advantages. The focus is on maximizing profits and establishing better relations between employees. Contrary to the linear structure of traditional SCs, digital SCs have a network structure. Real-time data providing and visibility are the digital SC's best features.

A conducted comparative analysis of traditional and digital SCs is the result of this paper. In comparison to traditional SCs, digital SCs are more flexible, accurate and efficient. Digital SCs welcome innovations, while traditional SCs hold on to familiar things. While traditional SCs focus only on production and supply, the main focus of digital SCs is customers. Thus, digital SCs offer more personalized and customized products to their customers. A big advantage of digital SCs is their environmental awareness.

In the end, it can be concluded that digital SCs are a better choice for companies' business because they are faster, more flexible, innovative, proactive, environmentally friendly, and if companies have the opportunity, they should implement digital SCs.

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The Role of Social Media in Marketing for Albanian Small Meat Processing Farms: A Comparative Study

Belisa Korriku[1]
Elena Horska[2]

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Abstract: *Social media has become an important tool for Albanian farmers in the field of marketing, helping them grow their small businesses in various ways. Social media is key to providing transparency and showing consumers how their food is grown and raised.*

This study aims to investigate the social media and online marketing strategies of selected small meat processing farms in Albania. A comparative analysis was carried out on two farms: "Istrefi meat shop" and "Vellezerit Allgjata" Farm. The study used information from the farms' Instagram page and conducted a benchmarking analysis.

The results showed that both farms were successful in reaching their target audience and keeping them engaged. Still, it is suggested that companies should engage more with their followers and share more post information that resonates with customers

1. INTRODUCTION

Natural eating is a practice that has become less common in households due to the globalized and processed food market of today's world. Communities have become disconnected from their food, and are often unable to fully appreciate it. As noted by Holden (2017), "Today, many Americans only experience food as an industrial product that doesn't look much like the original animal or plant". However, in recent years, social media has made it possible for companies to be more transparent with their customers, allowing them to see where their food is coming from.

The coronavirus outbreak has caused a new type of farming lifestyle content to become increasingly popular, encouraging people to live simpler lives and stay home more often. Social media, particularly Instagram, has become an outlet for buyers to see where their food is sourced and raised. Kim and Kim (2021) found that there is a strong correlation between an influencer's expertise, authenticity, and homophily, leading to trust, loyalty to the influencer, positive product attitude, and purchase intention. Personal relationships and genuine connections have become crucial in building trust and influence, with social media platforms providing a solid base for companies to build their brand.

Social media plays a significant role in the food industry, as it provides clarity and honesty to the consumers of a business. Exposure to the private side of a business allows for a deeper understanding of what goes into the farming and raising of plants and animals, as well as the

[1] Faculty of Economics and Management; Slovak University of Agriculture in Nitra, Trieda Andreja Hlinku 2, 949 76 Nitra, Slovakia
[2] Faculty of Economics and Management; Slovak University of Agriculture in Nitra, Trieda Andreja Hlinku 2, 949 76 Nitra, Slovakia

building of relationships with consumers. It is critical for small businesses, such as farms, to have a presence on social media to increase their customer base.

The purpose of this study is to examine the social media and online marketing strategies of two selected meat processing small businesses in Albania: "Istrefi Meet shop" Farm and "Vellezerit Allgjata" Farm. A comparative analysis was conducted on their Instagram pages. The results showed that both farms are successful in reaching their target audience and keeping them engaged. It is advised that both companies should communicate more with their followers and post content that resonates with customers.

The study will try to answer the following question regarding the online marketing and social media strategies employed by "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm in Albania:

- Which social media channels are currently utilized by both farms?
- What type of content is shared on their respective social media channels?
- What is the nature of the digital interaction between the farms and their customer base?
- To what extent are the current social media channels used by the farms effective?
- To what extent is the content shared on the social media channels of both farms effective?
- To what extent is the digital relationship between the farms and their customer base effective?

2. LITERATURE REVIEW

Marketing through social media is a cost-effective and powerful approach that businesses of all sizes should use. According to Son and Niehm (2021), social media marketing differs from traditional practices as it relies heavily on local and regional markets, making businesses vulnerable to economic instability. However, social media enables businesses to overcome geographical limitations and reach more consumers, building trust and transparency in the company through relationships with clients. Social media is a strategy that can enhance retention and attract new business, allowing for a completely new connection with consumers (Black, 2019).

In addition, social media allows for two-way communication to respond to customers, better addressing their interests and inquiries about products and services (Son & Niehm, 2021). Furthermore, social media has a significant impact on consumer purchase trends, with consumers making purchases based on influence from social media, rather than traditional marketing techniques and campaigns (Kumar & Greene, 2017). Brands become more "humanized" by humanizing their brands, which creates more favorable attitudes among consumers and improves brand performance (Gensler et al., 2013).

Small businesses have an opportunity to establish long-lasting relationships with consumers, and social media marketing provides a platform that exposes small businesses to potential customers and nurtures their existing customer base cost-effectively and efficiently (Schaupp & Bélanger, 2014). Allowing customers to feel more involved in the company builds brand loyalty and increases sales. Consumer engagement through social media is highly collaborative and experiential, and it stems from a sense of belonging to the group, highlighting the importance of the social aspect of consumer engagement (Brodie et al., 2013). The consumer engagement process is initiated primarily by consumers seeking information, which is highly interactive and experiential, including learning, sharing, advocating, socializing, and co-developing (Brodie et al., 2013).

Social media marketing can be highly advantageous to small businesses in terms of brand awareness, generating exposure and increasing traffic at a lower cost compared to traditional marketing

approaches (Schaupp & Bélanger, 2014; He et al., 2017). Social media can also create online groups that give individuals a purpose within the company and lead to positive brand outcomes such as stronger engagement, loyalty, and purchase intentions (Kumar & Greene, 2017).

Effective agricultural marketing through social media not only attracts more customers and boosts sales, but also provides transparency and traceability for consumers to connect with producers (Aaditi, 2020; Morris & Penri, 2017). Consumers are becoming more conscious of where and how their food is produced, and social media allows producers to be part of the conversation surrounding controversial and emotional issues regarding farming practices, thus improving social capital and financial returns indirectly (Stanley, 2013).

Moreover, social media is not limited to two-way communication with consumers, but it can also connect people within the industry, allowing for problem-solving, creativity, and overall improvement of the food distributed to the public (Stanley, 2013). As the demand for transparency and morality behind food production increases, social media enables the agricultural industry to be more in touch with customer needs and viewpoints.

3. METHODS

The tool employed in this investigation was a set of best practices guidelines (refer to Appendix A). The objective of the tool was to examine the social media marketing methods used by two family-owned small businesses in Albania: "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm. The tool comprises six main categories, including the number of followers, the average number of posts per month, the average engagement on posts, the time of day when posts are made, and company interaction through posts.

To ensure the tool's efficacy, a pilot study was carried out on a comparable small business, "Ferma ime" Farm. After the pilot, the language was refined to suit the research questions. Additionally, the tool was adapted to gather an appropriate amount of both qualitative and quantitative data. Conducting this pilot allowed to gain a deeper understanding of the content creation process for these businesses.

A comparative analysis was performed on "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm in Albania, utilizing the previously mentioned best practices guide developed for the "Ferma Ime" Farm. For this study, the data was collected from various social media sites run by both small business farms.

The procedure commenced with an analysis of the homepage of both "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm's Instagram pages. Next, further analyzed the data analytics of the posts. This is evident in questions two and three of the tool, which inquire specifically about the average number of posts per month and the average engagement on posts.

Next, it was investigated what time of day both companies typically posted their content and whether that impacted engagement. The final step of the process was to examine if and how both companies interacted and responded to customers through Instagram posts. Finally, both farms' Instagram pages were analyzed to determine if they mirrored one another.

Throughout this process, analysis was predominantly conducted via the Instagram pages of both companies.

4. FUTURE RESEARCH DIRECTIONS

"Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm are small agricultural businesses located in Albania that have adopted social media platforms such as Facebook, TikTok, and Instagram to reach out to their audience. Despite their similarities in using social media as a marketing tool, both farms differ in their social media approach, follower count, and content style.

"Istrefi meat shop" Farm has a relatively lower follower count of 29,700 on Instagram as compared to "Vellezerit Allgjata" Farm, which has 32,100 followers. While "Istrefi meat shop" Farm shares an average of 3.5 Instagram posts per month, "Vellezerit Allgjata" Farm posts about 32.3 Instagram posts monthly. The two farms are equally active on Instagram stories, where they engage with their followers by frequently going live. However, "Istrefi meat shop" Farm's content is more casual and less consistent in terms of aesthetics, while "Vellezerit Allgjata" Farm adopts a more branded approach and uses the same marketing tactics across all social media platforms.

Both farms share content about their daily farm activities, family life, and the process of farming and raising food. They also engage their followers actively by sharing an average of 8 and 17 Instagram stories daily for "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm, respectively. Additionally, both farms sell their products through their shops and share the process of baking bread and the shops that sell their products through their Instagram stories.

When it comes to engagement, "Istrefi meat shop" Farm received a total of 572 comments on their ten most recent Instagram posts, which averages to 57 comments per post. On the other hand, "Vellezerit Allgjata" Farm received 601 comments with their last ten Instagram posts, averaging 60 comments per post. Both farms respond to comments and communicate with their followers, with "Istrefi meat shop" Farm having an average of 1.3 responses per post, and "Vellezerit Allgjata" Farm having an average of 2.8 responses per post.

To increase engagement, both farms use Instagram polls to interact with their audience and hold giveaways and contests. Instagram polls also provide real-time data that can help them better understand their customers' wants and needs, leading to more informed decision-making. By utilizing social media as a marketing tool, these small agricultural businesses in Albania can increase their reach and engage with their audience, leading to increased sales and brand awareness.

Instagram is proving to be a successful marketing tool for small farms in Albania, such as "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm. Both have built strong and loyal customer followings by using this platform, as Kumar and Greene (2017) found in their research that digital media is increasingly influential in purchasing decisions. People are motivated by personal information rather than traditional marketing tactics. Both farms frequently post on Instagram to keep their followers updated on their activities, and effective posting strategies allow them to connect with existing customers and attract new ones. Posting also brings transparency to the food production process, which is becoming more important to consumers. To keep their audiences engaged, both farms could consider involving buyers more through online polls and giveaways, which can also help to gain new followers.

The content posted on the Instagram accounts of "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm has a homely feel, reflecting their commitment to living off the minimum and

incorporating homestead practices into their daily lives. Aaditi (2020) found that buyers look for transparency and honesty when purchasing food, making social media an excellent outlet to showcase the work that goes into producing it. The "Vellezerit Allgjata" Farms is successful in creating aesthetically pleasing content, while "Istrefi meat shop" Farm could enhance the creativity of their page by using more consistent filters throughout their feed. Both farms post cooking tutorials using their own meat products, but "Vellezerit Allgjata" Farm could share more of their products and less of their children's lives, while "Istrefi meat shop" Farm could post more cooking videos using their cuts of meat. It's essential to share personal aspects with followers, but not to overshare.

The relationship between farmers and consumers has developed from the latter's desire to know the source of their food. Social media, as (Stanley, 2013) found, brings the farmer, consumer, and industry closer together, allowing for more authenticity, transparency, and engagement in business logistics. Two-way communication helps the consumer make purchasing decisions and helps farmers be more in touch with customers' needs. While both farms acknowledge all comments, they could improve their response rates by answering questions from their followers.

The study had some limitations due to the time frame and scope, as only the latest ten posts were analyzed, and only seven days of Instagram stories were considered. All the sources used were online, which may limit access to new information not yet available online. Nevertheless, the comparative analysis offers valuable insight into social media marketing strategies for agricultural small businesses.

Overall, social media is an effective marketing tool, allowing consumers to experience the company and see what goes on behind the scenes in a personal manner. In the agricultural industry, it allows consumers to see how their food is raised and processed, enhancing the customer experience. Additionally, social media allows farmers to learn and support one another, contributing to the success of the industry. Small businesses, in particular, should embrace social media as a trend that is increasingly useful in the marketing industry.

5. CONCLUSION

Based on the findings of this study on "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm in Albania, the following conclusions can be drawn:

- Both "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm use Instagram as their primary platform to communicate with consumers.
- Both "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm post diverse content on their Instagram pages including daily Farm life, tutorials, and animal farming techniques.
- Both "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm have established strong digital relationships with their consumers.
- While both farms effectively use Instagram as their main social media platform, they do not utilize other social media platforms.
- "Istrefi meat shop" Farm strikes a good balance between personal life and business, while "Vellezerit Allgjata" Farm focuses too much on personal activities and not enough on meat processing.
- Both "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm excel at engaging their followers through their posts.

Based on these conclusions, the following recommendations are suggested:

- Small agricultural businesses in Albania should explore and utilize social media platforms as a marketing tool.
- "Vellezerit Allgjata" Farm should focus more on posting content about animal farming techniques and less about personal activities.
- Both "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm should be more consistent in replying to comments on their posts.
- Both "Istrefi meat shop" Farm and "Vellezerit Allgjata" Farm should engage consumers by conducting online polls and hosting giveaways.
- "Istrefi meat shop" Farm should post more cooking tutorials using their cuts of meat.
- "Istrefi meat shop" Farm should improve the aesthetic quality of their photos and videos on their Instagram page.

Future research should study the engagement rates for a more extended period and examine a higher number of posts to obtain more precise data

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How the Use of the Internet Affects the Attitudes of Serbian Citizens about Public Institutions

Alma Dobardžić[1]

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Abstract: *There is no doubt that digital literacy and the increasing use of the Internet are making economies more productive. The free flow of information and the ease with which it can be accessed means that information sources such as the Internet have a great influence on the formation of public opinion and the making of individual decisions. The article investigates how the use of the Internet and the trust Serbian citizens show towards state institutions are connected. For this purpose, data from The European Social Survey (ESS) were used, in which more than 3,500 residents of Serbia were surveyed and the attitudes of Internet users towards the state of the economy, democracy, the work of the national government, the education and health system, as well as trust in the legal system and the police were examined. Respondents were categorized according to the frequency of Internet use, age and gender. The results of the descriptive statistical analysis showed that the more often they use the Internet, the less trust residents have in the state. If we consider that young people spend the most time on the Internet, it is easy to assume that losing trust in institutions and responsible people can have very negative long-term consequences for the entire society.*

1. INTRODUCTION

Today's media is a multi-layered phenomenon that significantly affects the individual, his personal attitudes and social relations as a whole. With the use of Internet sources, more and more residents show a growing mistrust towards relevant social actors such as the government, politicians and political parties, showing at the same time a completely changed nature of communication and social engagement. What is most often criticized by the creators of macroeconomic policy is propaganda, that is, an attempt to advocate certain ideas of a political and economic nature, to gain personal benefit - either materially or in the form of an increase in popularity. (Stanley, 2015). The unequal distribution of power and the influence on the masses thanks to propaganda and demagoguery in the mass media are, as Chomsky says, an integral part of modern societies - democratic or not (MacLeod & Chomsky, 2019). This is supported by many examples from recent history, such as the presidential campaign of Donald Trump, during which, with the help of certain data collection and processing agencies, he used a large amount of information about voters to subtly deliver hidden messages of his political idea to them (Pomeranstev, 2019; Singer & Brooking, 2018). Zhuravskaya et al. (2020) talk about the obvious connection between the Internet and social media on the one hand and voting, protests, polarization in society, autocratic regimes and the behavior of politicians on the other.

In extreme situations, internet access can be the population's only connection to the outside world and a way to send the true picture of the situation that the authorities are concealing. In recent history, there were more than enough examples – such as the overthrow of authoritarian regimes during the Arab Spring, or the current Israeli-Palestinian conflict and the way the

[1] State University of Novi Pazar, Vuka Karadžića bb, 36300, Novi Pazar, Serbia

major media reported on that bloody war, which undoubtedly changed the perception and attitudes of people around the world towards America and the European Union.

In this regard, this paper aims to examine how the use of the Internet affects public attitudes on topics of general importance, or more specifically, how the use of the Internet affects the level of satisfaction with the work of state institutions.

2. SURVEY METHODOLOGY

For this purpose, descriptive statistics methods were used to analyze the data obtained by surveying the residents of the Republic of Serbia, within the mentioned European Social Survey, which included 3548 participants, 1768 men and 1715 women, aged 15 to 90 years.

When asked whether and how often they use the Internet, respondents could choose one of the following options: Never, Only occasionally, Several times a week, Most days a week or Every day. Each of the aforementioned groups of respondents declared their willingness to participate in a political group, their willingness to participate in public demonstrations, their satisfaction with the way democracy functions in the country, the current state of the economy, the work of the national government, trust in the legal system and the police, as well as the state of the educational and health system. The relationship between the mentioned variables is given in the following tables:

Table 1. Internet use, how often; Able to take active role in political group – crosstabulation

	20 Able to take active role in political group					
	Not at all able	**A little able**	**Quite able**	**Very able**	**Completely able**	**Total**
Never	608	150	64	17	16	855
	71.1%	**17.5%**	**7.5%**	**2.0%**	**1.9%**	100.0%
Only occasionally	185	106	53	9	13	366
	50.5%	**29.0%**	**14.5%**	**2.5%**	**3.6%**	100.0%
A few times a week	39	56	25	10	5	135
	28.9%	**41.5%**	**18.5%**	**7.4%**	**3.7%**	100.0%
Most days	158	161	70	22	21	432
	36.6%	**37.3%**	**16.2%**	**5.1%**	**4.9%**	100.0%
Every day	592	518	332	107	113	1662
	35.6%	**31.2%**	**20.0%**	**6.4%**	**6.8%**	100.0%

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	351.310[a]	16	**.000**
Likelihood Ratio	358.039	16	.000
Linear-by-Linear Association	232.367	1	.000
N of Valid Cases	3450		

Source: Own calculations

Internet use and the possibility of taking an active role in a political group are related ($p < 0.0005$). For example, 71.1.5% of people who never use the Internet are unable to take an active role in a political group, while the percentage of people who use the Internet every day is only 35.6%. Only 1.9% of people who never use the Internet are fully capable of taking an active role in a political group, while among people who use the Internet daily, that number is higher and amounts to 6.8%.

More frequent use of the Internet increases the willingness to take an active role in a political group.

Table 2. Internet use, how often;
Taken part in public demonstration last 12 months - crosstabulation

			33 Taken part in public demonstrations last 12 months		Total
			Yes	No	
14 Internet use, how often	Never	Count	3	164	167
		% within 14 Internet use, how often	**1.8%**	98.2%	100.0%
	Only occasionally	Count	1	142	143
		% within 14 Internet use, how often	**.7%**	99.3%	100.0%
	A few times a week	Count	3	45	48
		% within 14 Internet use, how often	**6.3%**	93.8%	100.0%
	Most days	Count	21	205	226
		% within 14 Internet use, how often	**9.3%**	90.7%	100.0%
	Every day	Count	111	777	888
		% within 14 Internet use, how often	**12.5%**	87.5%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	34.487[a]	4	.000
Likelihood Ratio	47.147	4	.000
Linear-by-Linear Association	32.868	1	.000
N of Valid Cases	1472		

Source: Own calculations

Internet use and participation in demonstrations in the past 12 months were associated with ($p < 0.0005$). For example, 1.8% of people who never use the Internet participated in demonstrations in the last 12 months, while this percentage of people who use the Internet only occasionally is 0.7%, and among people who use the Internet several times a week, 6.3%, among people who use the Internet most days 9.3% and among people who use the Internet daily 12.5%. More frequent use of the Internet has increased participation in demonstrations over the past 12 months.

Table 3. How satisfied with the way democracy works in the country

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Never	777	**4.54**	3.307	.119	4.31	4.78	0	10
Only occasionally	355	**4.27**	3.208	.170	3.94	4.61	0	10
A few times a week	138	**4.24**	2.995	.255	3.73	4.74	0	10
Most days	426	**3.84**	3.165	.153	3.54	4.14	0	10
Every day	1631	**3.22**	2.856	.071	3.08	3.35	0	10
Total	3327	3.76	3.102	.054	3.66	3.87	0	10

ANOVA					
How satisfied with the way democracy works in country					
	Sum of Squares	df	Mean Square	F	Sig.
3,21Between Groups	1086.583	4	271.646	29.187	.000
Within Groups	30918.448	3322	9.307		
Total	32005.032	3326			

Source: Own calculations

In addition, the differences in satisfaction with the way democracy works in the country between categories of Internet use are statistically significant ($p < 0.0005$).

The mean value of that satisfaction of people who never use the Internet is 4.54 ± 3.31, for people who only occasionally use the Internet is 4.27 ± 3.21, for people who use the Internet several times a week is 4.24 ± 2.99, persons who use the Internet most days is 3.84 ± 3.16 and persons who use the Internet daily is 3.22 ± 2.86. If the Internet is used more often, the opinion about the way democracy works in the country is worse.

Table 4. How satisfied with present state of economy in country

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Never	755	**4.36**	3.168	.115	4.13	4.59	0	10
Only occasionally	351	**4.38**	2.902	.155	4.07	4.68	0	10
A few times a week	138	**4.21**	2.941	.250	3.72	4.71	0	10
Most days	421	**4.07**	3.003	.146	3.78	4.35	0	10
Every day	1623	**3.56**	2.695	.067	3.43	3.69	0	10
Total	3288	3.92	2.904	.051	3.82	4.02	0	10

ANOVA

How satisfied with present state of economy in country

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	453.719	4	113.430	13.658	**.000**
Within Groups	27265.721	3283	8.305		
Total	27719.440	3287			

Source: Own calculations

Furthermore, differences in satisfaction with the current state of the economy in the country between categories of Internet use are statistically significant ($p < 0.0005$).

See mean values. If the Internet is used more often, the opinion about the state of the economy in the country is worse.

Table 5. State of education in country nowadays

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Never	744	**5.33**	3.036	.111	5.11	5.54	0	10
Only occasionally	348	**4.51**	2.907	.156	4.21	4.82	0	10
A few times a week	136	**4.63**	2.938	.252	4.13	5.13	0	10
Most days	422	**4.09**	2.951	.144	3.81	4.37	0	10
Every day	1622	**3.85**	2.758	.068	3.71	3.98	0	10
Total	3272	4.32	2.931	.051	4.22	4.42	0	10

ANOVA

State of education in country nowadays

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1160.488	4	290.122	35.180	.000
Within Groups	26942.402	3267	8.247		
Total	28102.890	3271			

Source: Own calculations

Differences in satisfaction with the current state of education in the country between categories of Internet use are statistically significant ($p < 0.0005$).

See mean values. If the Internet is used more often, the opinion about the state of education in the country is worse.

Table 6. How satisfied with the national government

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Never	834	**5.40**	3.381	.117	5.17	5.63	0	10
Only occasionally	366	**4.78**	3.158	.165	4.45	5.10	0	10
A few times a week	137	**4.53**	3.176	.271	4.00	5.07	0	10
Most days	423	**4.35**	3.309	.161	4.03	4.66	0	10
Every day	1634	**3.56**	3.039	.075	3.41	3.71	0	10
Total	3394	4.28	3.268	.056	4.17	4.39	0	10

ANOVA

How satisfied with the national government

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1997.488	4	499.372	49.438	**.000**
Within Groups	34232.104	3389	10.101		
Total	36229.592	3393			

Source: Own calculations

Differences in satisfaction with the national government between Internet use categories are statistically significant ($p < 0.0005$).

See mean values. The more frequently the Internet is used, the worse the opinion of the national government.

Table 7. State of health services in country nowadays

	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
Never	864	**4.70**	3.341	4.48	4.92	0	10
Only occasionally	377	**4.18**	3.148	3.86	4.50	0	10
A few times a week	139	**4.15**	2.859	3.67	4.63	0	10
Most days	434	**3.96**	3.053	3.68	4.25	0	10
Every day	1681	**3.62**	2.723	3.49	3.75	0	10
Total	3495	4.01	3.010	3.91	4.11	0	10

ANOVA

State of health services in country nowadays

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	679.791	4	169.948	19.144	**.000**
Within Groups	30981.704	3490	8.877		
Total	31661.495	3494			

Source: Own calculations

Differences in opinion about the current state of health services in the country between categories of Internet use are statistically significant ($p < 0.0005$).

See mean values. If the Internet is used more often, the opinion about the current state of health services in the country is worse.

Table 8. Trust in the legal system

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Never	832	**4.07**	3.387	.117	3.84	4.30	0	10
Only occasionally	373	**3.63**	3.047	.158	3.32	3.94	0	10
A few times a week	136	**4.05**	2.816	.241	3.57	4.53	0	10
Most days	431	**3.49**	3.061	.147	3.20	3.78	0	10
Every day	1677	**3.38**	2.835	.069	3.24	3.51	0	10
Total	3449	3.61	3.039	.052	3.51	3.71	0	10

ANOVA					
Trust in the legal system					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	297.589	4	74.397	8.119	**.000**
Within Groups	31556.674	3444	9.163		
Total	31854.263	3448			

Source: Own calculations

Differences in trust in the legal system between Internet use categories are statistically significant ($p < 0.0005$).

See mean values. If the Internet is used more often, the opinion about the legal system is worse.

Table 9. Trust in the police

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Never	850	**5.42**	3.413	.117	5.19	5.65	0	10
Only occasionally	373	**4.71**	3.173	.164	4.38	5.03	0	10
A few times a week	138	**4.93**	2.980	.254	4.43	5.44	0	10
Most days	431	**4.78**	3.167	.153	4.48	5.08	0	10
Every day	1684	**4.40**	3.038	.074	4.25	4.54	0	10
Total	3476	4.75	3.187	.054	4.64	4.86	0	10

ANOVA					
Trust in the police					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	592.634	4	148.158	14.822	**.000**
Within Groups	34695.116	3471	9.996		
Total	35287.750	3475			

Source: Own calculations

Differences in trust in the police between Internet use categories are statistically significant ($p < 0.0005$).

See mean values. If the Internet is used more often, the level of trust in the police is lower.

Table 10. Age of the respondents, calculated

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Never	871	**68.93**	10.915	.370	68.20	69.65	16	90
Only occasionally	364	**59.14**	13.660	.716	57.73	60.55	16	88
A few times a week	136	**58.40**	13.273	1.138	56.15	60.65	17	88
Most days	418	**53.12**	15.086	.738	51.67	54.57	15	87
Every day	1632	**43.65**	16.039	.397	42.87	44.43	15	90
Total	3421	53.48	17.853	.305	52.88	54.08	15	90

ANOVA

Age of respondents, calculated

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	380495.487	4	95123.872	457.913	.000
Within Groups	709618.007	3416	207.734		
Total	1090113.494	3420			

Source: Own calculations

The differences in age between Internet use categories are statistically significant ($p < 0.0005$).

See mean values. The older people are, the less they use the Internet.

3. CONCLUSION

The goal of the work was to point out the fact that the use of the Internet significantly affects the attitudes of citizens toward the state and its institutions. Unfortunately, in the example of the Republic of Serbia, it has been confirmed that regular internet users, in most cases young people, show doubt and skepticism towards the efficiency of the state's work.

To the question of whether they would be able to engage politically, a relatively larger part of those who get information on the Internet answered positively than those who use it less. Also, as many as 12.5% of those who use the Internet daily have participated in some form of demonstration and protest in the previous year, while this percentage among those who do not use the Internet is below 2%. This confirms the fact that in Serbia, a large part of the population shows dissatisfaction with the way social actors lead political life, so accustomed to misleading and inaccurate information, that they look for the truth in alternative sources. On the other hand, overall, there is a small number of citizens involved in activist initiatives, which confirms their apathy and the opinion that "systemic regression" can no longer be cured.

The more often they use the Internet, the respondents show an increasingly negative opinion about the state of democracy, the economy, and the work of the national government, but also less trust in the legal system and the police, which, although they should be independent, are considered an extended arm of the executive power. Also, they are less satisfied with the state of the education and health system in the country.

The reasons for such an attitude can be found in insufficient transparency and lack of accountability for the government's actions, as well as the feeling that the concerns and needs of individuals are not adequately addressed. Considering that public services and official media have taken sides in a polarized society, citizens are increasingly turning to alternative sources of information, such as the Internet, where they can get objective data and hear the opinions of people they respect. Macroeconomic policymakers must in the future take into account the needs

and attitudes of their citizens if they want to raise the level of general satisfaction and efficiency in the country. For this purpose, they must learn as best as possible how to use social media to reach disaffected groups.

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Innovative Teaching and Learning Method Using Information and Communications Technologies

Delia Rosu[1]
Mariana Fratu[2]

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Abstract: *The paper provides an overview of digital technology integration in education, from computers to other more advanced forms of Information Technology, through which teachers and students use innovative methods in the educational process The schools and universities use a diverse set of Information and Communications Technologies (ICTs) solutions to communicate, create, store, and manage information in any contexts. ICTs have also become intrinsic to the teaching-learning interaction. In this digital era, ICTs are essential for giving students opportunities to learn and apply the required 21st-century skills. ICTs are essential for teachers in performing their role of maker of pedagogical environments. The advantage of ICTs in education is that students can learn from extracurricular materials. ICTs develop higher-order thinking and reasoning skills.*

By integrating ICTs into education, students become more interested in learning, thanks to new technologies that make learning amusing and creative, improving learning in many ways. ICTs encourage collaboration when students work as a team and improve communication skills when students discuss and study together.

In this paper, one proposes a new teaching-learning methodology based on ICTs. This methodology consists of the transmission in advance to the students of the course support to inform them about the topics to be addressed. At the time provided for the respective lecture, one will present to the students the course support using the video projector, and one will comment/analyze the content of the course, bringing clarifications and additions. This educational approach combines digital components on-line with face-to-face learning instruction. With the proposed methodology one can plan such courses to increase motivation, provide more feedback and help students learn on their own. ICTs help the teacher to present his teaching attractively.

1. INTRODUCTION

Information and Communications Technologies (ICTs) can assist students when teachers are digitally literate and understand how to incorporate them into the curriculum. Teachers demand specific professional development opportunities, to increase their ability to use ICTs and to encourage student interaction and collaboration.

Without this support, teachers are inclined to use ICTs for skill-based applications, limiting student academic thinking.

Schools use a diverse set of ICT tools to communicate, create and manage information. ICTs have become integral to the teaching-learning interaction, using students' own devices for

[1] West University of Timisoara , B-dul Vasile Pârvan 4, 300223, Timisoara, Romania
[2] Transilvania University of Brasov, B-dul Eroilor 29, 500036, Brasov, Romania

learning during class time. At home, the students can watch lectures on the computer and they use classroom time for more interactive exercises.

ICTs can have positive effects on student learning when used appropriately and effectively. There is a need to assess the potential of ICTs to enhance it and empower students with the knowledge and skills they need to understand the course. When students are trained to use ICTs, these techniques can lead to higher-order thinking skills and can furnish students with creative and personalized options for their understanding of various course topics (Ghory & Ghafory, 2021).

2. COMMON EDUCATIONAL APPLICATIONS OF ICT

Common educational applications of ICTs include:

- One laptop with Bluetooth and WiFi connectivity, per student. Laptops combine numerous of the input/output components and capabilities of a desktop computer into a single unit. A laptop includes a display screen, small speakers, a keyboard, and a pointing stick. Most ultramodern laptops include a built-in webcam and microphone, and a touchscreen.
- Tablets: Tablets are small personal computers with a touch screen, permitting input without a keyboard or mouse. Cheap learning software ("apps") can be downloaded onto tablets, making them versatile for learning. The effective apps develop advanced order thinking skills and furnish creative and personalized options for students
- Smart Boards: Interactive whiteboards permit projected computer images to be displayed, manipulated, or copied. At the same time, handwritten notes can be interpreted on the board and saved for future use. Interactive whiteboards are connected with whole-class instruction instead of student-centered activities. Student engagement is in general higher when ICTs are accessible for students throughout the classroom.
- E-readers: E-readers are electronic devices that can hold numerous books in digital form, and they are more and more utilized in the delivery of material support as tutorials. Students use e-readers for independent reading.
- Flipped Classrooms: The flipped classroom model, refers to lecture and practice at home via computer-guided instruction and interactive-cooperative learning activities in class.

3. THE INFRASTRUCTURE FOR ICTS

ICT infrastructure refers to the accessibility of computers, access to the Internet, and all other correspondent facilities that are associated with the use of ICTs. Digital learning materials include all the digital educational content and tools that teachers use in their educational practice. The fundamental elements to support teachers' pedagogical use of ICTs are infrastructure, digital learning materials, expertise, and imagination.

These elements are given from the "technology-driven" innovation approach:

- ICT infrastructure - the availability of computers, interactive whiteboards, and Internet connection;
- Digital learning materials - their use of computer programs in teaching and their use of digital learning materials from various sources;
- Expertise - their familiarity with ICTs, level of skills for utilization, and pedagogical ICT skills;
- Vision - their pedagogical vision of using ICTs for knowledge creation and transfer of knowledge.

School policies need to provide schools with acceptable infrastructure for ICTs, including stable and inexpensive internet connectivity and filters and site blockers such as security measures.

Teacher policies demand to target basic ICT literacy skills, their use in pedagogical settings, and discipline-specific. Successful implementation of ICTs requires their integration in the curriculum. Technical, human and organizational support are needed to ensure effective use of ICTs.

Numerous digital learning programs and platforms have been developed and made independently available to teachers and students. The availability of Internet, hardware, and software is initially necessary but needs to be complemented by empowered schools.

The use of ICT equipment implies into professional development of teaching staff, school goals, teachers' views on ICT outcomes, and their self-efficacy with ICTs. ICT infrastructure is a necessary condition for teachers' ICT use.

Teachers need to have prompt access to the necessary technology, and they need to have the time and possibility to use this infrastructure in their practice. When delivering ICTs into classrooms, policies should establish infrastructure and bring in sustainable and easily upgraded ICTs. Some schools allow students to bring their mobile technology, such as laptops, tablets, or smartphones into class rather than providing such tools to all students. This practice is called Bring Your Own Device.

It allows students to use their own devices at school for educational purposes with the permission of the classroom teacher. This practice increases the amount of technology available in the classroom, giving the students more access to technology devices for learning. This allows students to manage their time to access the online learning environment during class (Moşteanu, 2021).

Using ICTs is understood as technological development in pedagogical methods for education (Limniou, 2021). ICTs use tools such as telephone, fax, computer, data projector, and smart board based on various software such as word processor program (MS Word), calculation and table program (MS Excel), presentation preparing program (MS PowerPoint), website designing programs. Mobile devices can also offer programs ("apps") that provide extra support to students.

4. COMBINED LEARNING AS PEDAGOGICAL METHOD

Teaching-learning methods are the methods that are put into practice in the teaching and learning processes. The teachers need to be well aware in terms of the teaching methods. These are regarded as the key factors in the transmission of knowledge and understanding to the students in terms of academic concepts and lesson plans.

Combined learning is used to make higher education more accessible to students. The online activities allow students accessibility to the learning materials, when and wherever they want. In addition to this increased accessibility, combined learning offers opportunities to provide students' individual needs and attain real personalized subject matter.

For example, the popular flipped classroom approach proposes a combined learning method to reserve the necessary time for student questions, in-depth discussion, and personal feedback. Students will prepare in advance for learning activities online, according to their levels of understanding.

The implementation of combined learning in higher education is increasing, with the aim to offer flexibility for study, in terms of time and place, for varied student populations. Student populations in higher education are becoming more and more diverse. However, specific attention to the diversity of this group, and how to provide individual needs, is still necessary (Rugube & Govender, 2022).

The combined learning methodology presented in this paper consists of the transmission in advance to the students of the course support to inform them about the topics to be addressed. At the time provided for the respective lecture, we will present to the students the course support using the video projector, and we will comment/analyze the content of the course, bringing clarifications and additions. This educational approach combines digital components online with face-to-face learning instruction.

This approach helps students learn on their own and be better able to integrate new information. The teacher designs such courses to increase student motivation, and to receive more feedback from students. ICTs help a teacher to present his teaching attractively, for the learners at any level of educational programs.

Combining face-to-face activities with online activities thus holds great potential for organizing differentiated instruction in higher education. Such learning methods typically involve differentiated instruction, which provides different paths to learning concerning students' individual needs.

5. INNOVATIVE METHOD IN LEARNING-TEACHING PROCESS FOR PRACTICAL PROJECTS

The innovative combined learning methodology proposed, suppose also the use of ICTs in practical projects that accompany the theoretical courses. In this article, one analyzes an example of the architectural design. A building is a perfect example of such a project. In architectural design, modeling is a process of translating conceptual ideas into visual forms. From its origins, the idea of modeling has been the same, but it has taken on many forms of expression. These expressions are principally the result of technological advances in producing imagery, using ICTs in the thinking process of the project (Drossel et al., 2020).

Design thinking is an iterative process that design teams use to understand the needs of beneficiaries. The design thinking process is a collaborative process by which the designer's sensibilities and methods are employed to answer people's needs by redefining the project data. Design thinking converts needs into demands which helps designers become more innovative and more creative.

Currently, the technical development of a product begins with the numerical analysis and simulation of the product, carried out in a virtual scenario using ICTs (Chu & Kao, 2020). An intelligent design needs to start with a complete virtual model. Three-dimensional modeling and visualization in motion introduce a new dimension to the architectural representation of an intelligent building Jiang (2021), used to make optimization decisions.

The main distinctive feature of Virtual prototyping is its capacity to create realistic scenarios, and its "openness", to perform experimental research regarding intelligent buildings (Brocca, 2023). It is important to note the contribution of Virtual prototyping for the activities related to the new architectural model development for intelligent buildings.

The virtual prototype of a building starts with the virtual model of basic structures and lead to more complicated cases for an intelligent building, which must include the components for automation (Tai, 2023).

In our example, from rendering in numerous scenarios of building, a frame is shown in Figure 1, which presents a virtual model of an intelligent building.

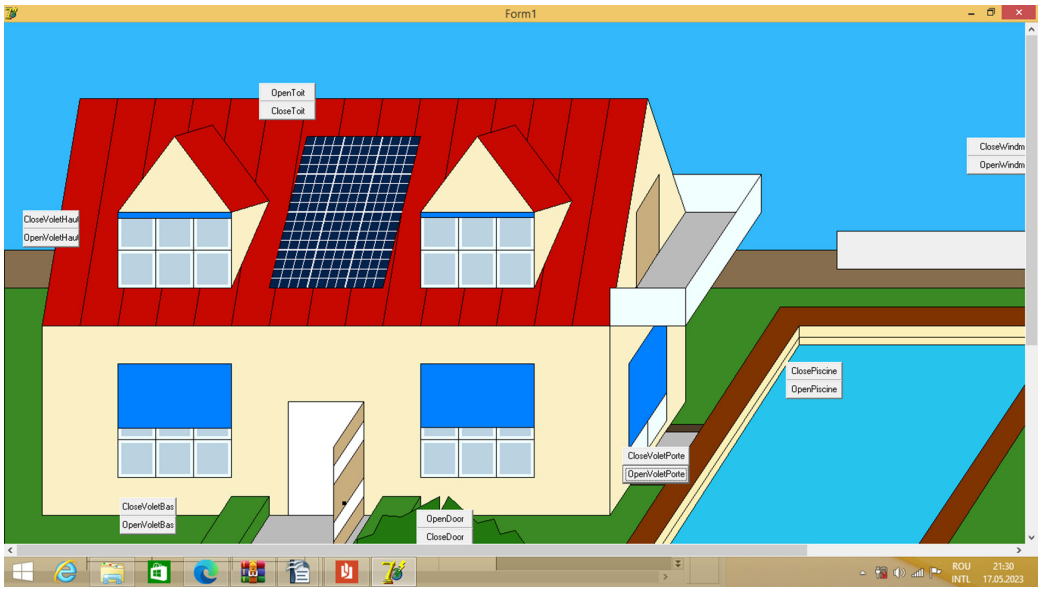

Figure 1. Using of virtual prototype for evaluation design in an intelligent building – virtual model with control systems

Source: Own elaboration

The virtual system makes it possible to design different housing plans and to adapt these plans to changing needs. Any construction modifications can be made in the design stage. The users (buyers) can become involved just before the project's completion to declare their preferences. Inevitably, traditional ways of thinking and working had to make way for more innovative approaches such as virtual prototyping.

6. CONCLUSION

In the teaching and learning process, using ICTs are capable of supporting the process of sharing experience and information with others. Computer access, internet access, technology competences and preferences of students, regarding online learning, are the major factors that have been predicting the intention of teachers regarding the use of " ICTs in the teaching and learning process".

Using ICT equipment efficiently is a challenge for teachers as it requires knowledge at a high level of technology but it improves the teaching process and that has a positive influence on the learning process.

Implementation of ICTs makes the teachers capable of motivating students and developing an interest in the learning process that can serve a better result at the end of the entire educational system. In addition to that, ICTs are engaged in promoting technology literacy and supporting the distance learning process. Digital technology integration in education is one of the helpful teaching-learning techniques, able to prepare the learner for the competitive real world.

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Students' Privacy vs. Improved Learning Experience

Marija Kuštelega[1]
Renata Mekovec[2]

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Students' privacy

Abstract: *Data-driven technologies have had a significant impact on every sector of the economy. The increased use of these technologies has boosted the volume and potential value of data for individuals, corporations, and society. Many universities also gather and analyze data about their students in order to improve the learning experience. In this study, the authors examine how well universities in Croatia uphold fundamental privacy principles. An attempt was made to link ISO/IEC 29100, the GDPR and the Data Act Proposal. Six major Croatian universities' privacy compliance was examined using the multiple case study methodology. The major finding demonstrates that not all universities adhere to privacy standards to the same level, with non-compliance with the data reduction principle being particularly alarming. Because more personal information is released than is required, there is a greater chance that it may be linked to other personal information, endangering the student's privacy.*

1. INTRODUCTION

E-learning platforms have revolutionized education, enabling students to access diverse materials, start discussions, and think critically about certain topics (Pardo & Siemens, 2014). The improved learning experience with the help of information and communication technologies (ICT) has simplified tasks for educators, enabling effective and preventive monitoring (Jones & Hinchliffe, 2023). Higher education institutions are deploying learning analytics (LA) with the aim that teachers would be able to extract meaningful insights about student learning and make decisions to improve their teaching (Kaliisa et al., 2023).

Based on a national survey, learning engagement analytics is favored by 80% of 496 undergraduate students polled across the United Kingdom (Open Access Government, 2023). Nearly three-quarters of students (71%) concur that institutions should use this data to figure out what kind of additional academic support students might need. Research on the application of learning analytics shows that since 2011, when the field's awareness was brought to light, the amount of available research on the subject has grown rapidly (Ferguson et al., 2016). Learning analytics is increasingly being used to understand and improve the learning process (Ouhaichi et al., 2023) because it has a wide range of possible applications. A study that used learning analytics to analyze students' pattern recognition skills identified learning gaps that traditional assessments could not (Henkel & Belfi, 2023).

Learning analytics may be utilized to uncover learning strategies in the flipped classroom (Jovanovic et al., 2017), improve learning design activities (Rienties & Toetenel, 2016) and make interventions based on students' online learning behavior (Akçapınar & Hasnine, 2022). In a quasi-experimental study including 348 students, Ameloot et al. (2024) explored the impact of using learning analytics to boost students' autonomy and competency. The findings show that

[1] University of Zagreb, Faculty of Organization and Informatics, Pavlinska 2, 42000 Varaždin, Croatia
[2] University of Zagreb, Faculty of Organization and Informatics, Pavlinska 2, 42000 Varaždin, Croatia

adjusting teaching methods based on learning analytics reports has a beneficial impact on student satisfaction in a blended learning environment. In today's society, Zamecnik et al. (2022) emphasizes the value of a learning analytics dashboard in fostering collaborative learning. It may be used to monitor team interactions, support self-regulation, and provide teachers better insight into collaborative learning processes. As a result, by utilizing technology, we can acquire valuable insights about the students' real ability to cope with the given tasks.

The objective of learning analytics is to evaluate data from students and learning environments in order to support learning at various levels. However, the increased availability and use of sensitive and personal student data raises new privacy concerns (Jones, 2019). Understanding students' privacy concerns is the first step toward adopting effective privacy-enhancing measures in learning analytics (Mutimukwe et al., 2022). This paper aims to explore how higher education institutions manage the personal data they obtain on students. The authors present the methods of the research design as well as the examination criteria.

2. METHODOLOGY

The research utilized a case study methodology to collect concrete evidence on how universities handle student data protection. The methodology, as defined by Yin (2009), involved six key phases in order to correctly plan, design and analyze the data obtained from the case study. Figure 1 provides an overview of the methodology used to conduct the case study, outlining the key components of each executed phase.

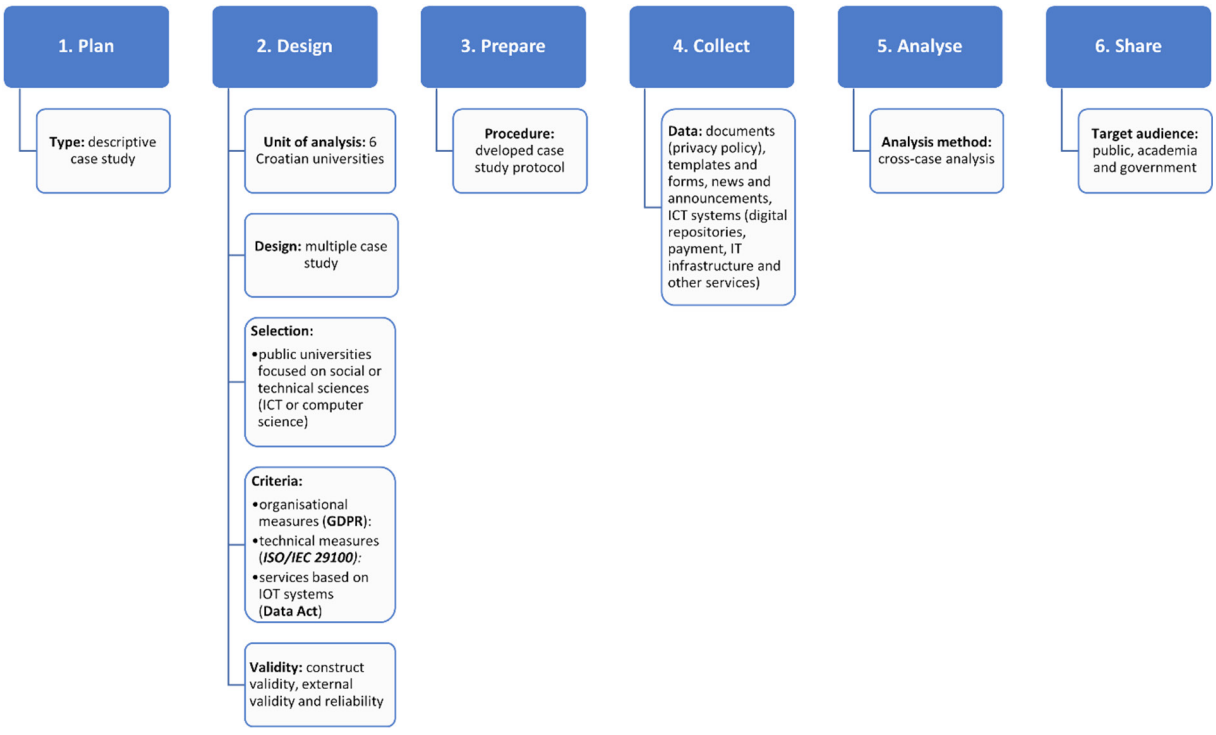

Figure 1. Methodology of the conducted case study process

Source: Own processing

Given the nature of the problem, we used a descriptive multiple case study with a sample of six major public universities in Croatia associated with ICT and related. For this purpose, a protocol was developed for implementation and data collection. The quality of the selected empirical

case study was checked depending on construct validity, external validity and reliability. Construct validity requires correct operationalization, defining attributes and criteria to measure the concept to be investigated (Saith, 2001). To satisfy the construct validity, the following activities were undertaken:

1. An operationalization was carried out in which the verification criteria were defined based on theoretically valid and generally known privacy principles.
2. Use of multiple sources of evidence (documents, templates, forms, news, announcements and ICT systems) to measure the criteria
3. The author's internal agreement on the conduct of the research (fulfilment of the requirement that the individual case meet the level of a certain criterion: no, partially, or yes).

To enhance external validity, multiple case studies were analyzed to assess predictability and similarity of results. The verification of the reliability of the study is made possible by detailed descriptions of the methodology, which enables the repetition of the data collection procedure following the criteria and theoretical construct defined by the author, which would have yielded the same results. As far as the case study studies are concerned, a theoretical framework of three criteria is being prepared consisting of criteria describing:

a. organizational measures
b. technical measures and
c. the application of modern technologies such as services based on IOT systems.

For data analysis, cross-case analysis was applied, to develop an explanation about similarities and differences in the observed unit of analysis.

3. CRITERIA

The study assesses Croatian higher education institutions' commitment to student privacy using principles from the General Data Protection Regulation (GDPR), Data Act, and ISO/IEC 29100:2011. The primary concepts and ideas that best capture the attitude toward privacy protection were extracted from each of these three important documents. Based on this, three criteria were created focusing on organizational, technical and IoT service-related measures.

The General Data Protection Regulation outlines regulations for natural persons' protection in personal data processing and free data flow, emphasizing trust building for the digital economy and ensuring easy access and control of personal data (Official Journal of the European Union, 2016). Personal data handling should be fair and legal, with clear notice of data collection, use, and clear justifications for processing. To ensure security and confidentiality, proper handling procedures for personal data must be followed, including the designation of individuals in charge of data processing and preventive measures against unauthorized access to personal data.

Criteria for organizational measures (from GDPR):

1. lawfulness, fairness and transparency,
2. purpose limitation,
3. data minimization,
4. accuracy,
5. storage limitation,
6. integrity and confidentiality.

For technical measures, ISO/IEC 29100:2011 was chosen as a privacy framework that identifies actors, roles, challenges, and references established privacy principles for information technology processing of personally identifiable data (International Organization for Standardization, 2011).

Criteria for technical measures (from ISO/IEC 29100):

1. **Consent and choice:** Participants should be informed about data processing, purpose, and rights before giving consent. Processing without consent is illegal, especially for sensitive data.
2. **Purpose legitimacy and specification:** Before data collection begins, the aim of data collection should be clearly defined, and participants should be informed of it.
3. **Collection limitation:** Data collection should be limited to only what is required for a specified purpose and is required by law.
4. **Data minimization:** Unlike the collection limitation principle, it refers to the limitation of personal data processing. This includes measures such as restricting data access, using pseudonymization or other solutions to limit the connectivity of personal data with the rightful owner, and regularly deleting data that is no longer required for a specific purpose.
5. **Use, retention and disclosure limitation**: Limiting data to only those that have a justified legitimate purpose. This principle emphasizes the importance of limiting data usage and implementing practices like storing data only for a certain period and later destroying or anonymizing them to ensure secure archiving and data protection.
6. **Accuracy and quality**: States that the data's accuracy, completeness, and up-to-date, as well as the source's dependability, should be ensured. It refers to facilitating procedures and control mechanisms for data collection, and storage, as well as checks of their quality and accuracy. This principle is especially important in cases where inaccurate and low-quality data could result in the denial of an individual's rights or benefits.
7. **Openness, transparency, and notice:** Refers to the provision of clear and easily accessible information related to the processing of personal data, including the purpose of the data collection, who processes it and how to contact them.
8. **Individual participation and access**: Refers to the right to access, review, correct, or delete data, including mechanisms that allow individuals to access only their data promptly and effectively.
9. **Accountability:** Provide privacy policies, organize training, and inform individuals about privacy attacks to mitigate potential harm and mitigate the damage caused to those who have experienced privacy violations.
10. **Information security:** Protecting personal data against security risks like unauthorized data access, use, and modification. It is necessary to perform careful selection of data processing employees and implement appropriate control systems.
11. **Privacy compliance:** Implement safeguards and systems to ensure privacy compliance, using privacy risk assessments to evaluate program and service compliance with privacy regulations.

The Data Act aims to strengthen the EU's data economy by releasing industrial data, promoting a competitive cloud market, and enabling users to access data generated by connected devices. It promotes innovation and aftermarket services while protecting trade secrets (European Parliament and Council, 2022). This criterion aimed to find out to what extent Croatian universities take advantage of the opportunities brought by the new flow of digital data.

Criteria for services based on IOT systems (from Data Act):

1. Utilization of associated goods or services,
2. Ability to gather data from related products or services.

One of the important steps for conducting a case study is the selection of documents and other materials that could be used to sufficiently address the stated research questions. Some examples of these measures include privacy policies, documents/forms for exercising rights, news published by universities, and information systems they use. Table 1 shows a more detailed description of the documents searched from the faculty's website.

Table 1. Documents, news and ICT systems for conducting case studies

Privacy policy
Information on the principles of personal data processing
Data processed (types of personal data collected)
Purpose of personal data processing and legal basis
Making personal data available (to third parties)
Information about personal data protection officers, manager and processor
Amendments to the privacy policy
Documents/forms
Templates for exercising the right to access information (request for access to information, supplement/correction of information, reuse of information)
Forms (consent, deletion of data, limitation of data collection)
News (principle of minimality)
Rector's awards
Ranking list of university scholarship winners
Information systems
Digital repository
Security of personal data (where personal data is processed, personal data retention period, etc.)
Other services and IT infrastructure (payments, instructions for using distance learning tools and digital services, etc.)

Source: Own processing

4. RESULTS

Preliminary research was conducted on the sample of three universities to determine whether the criteria and accompanying metrics were well defined. The preliminary research aimed to define the evidence available on the university's websites that can be related to established criteria in the case study. This study contributed to the development of a procedure for implementing the case study approach, ensuring that all researchers examined the same criteria in the same way.

Even on a small sample, it was assessed that there are significant differences between universities in terms of compliance with privacy principles. For example, not all universities had their privacy policies or they didn't have clearly described principles, purposes, and individuals responsible for handling data. Also, it was observed that the problem arises with the amount of data that is published, where some universities reveal more personal data about their students than they should.

5. CONCLUSION

The criteria and measures outlined in this document can be utilized for more comprehensive research on universities and faculties. The primary conclusion demonstrates that not all faculties follow the same set of privacy regulations, with alarming non-compliance with data reduction guidelines. Student privacy is compromised when more personal information is disclosed than is necessary since it is more likely to be connected to other personal information.

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The Cultural Identity of the Region as a Sign of Social Development

Lyubov Kirilova Ivanova[1]

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Abstract: *The concept of culture is developed based on many customs, values, traditions, religious characteristics, language and linguistic differences, artifacts, and laws, through the preservation and practice of which the knowledge is transmitted to the population of a given territory, which helps in their rapid adaptation to the local environment and preservation of the local heritage. Cultural heritage is a part of the history of a given territory or region and is a source of social cohesion for the people who inhabit it. In this way, it is a prerequisite for determining the sense of identity of the people, as well as a vitally important factor for the sustainable development of a given territory and its positioning as competitive with other regions. Cultural heritage is specific to each region and is a set of features related to the language, customs, manners, traditions, folklore diversity, natural features, and architectural-historical wealth, typical for a given community or group of people, which build their cultural identity. The preservation of cultural identity is an important mark for distinguishing and understanding the other, the foreign culture. On one hand, through the knowledge of the foreign identity, a collective image of the region is created, and on the other, it emphasizes its characteristics, according to which a given community can define itself and which emphasizes the differences in communication with other cultures and communities.*

1. INTRODUCTION

Cultural identity is part of a person‘s identity or his concept of development and is a way of perceiving his surroundings. It is related to an individual‘s nationality, ethnicity, religion, social class, generation or locality, or a distinct type of social group that has its own distinct culture. Thus, cultural identity characterizes an individual or an identical group of members sharing the same cultural identity or upbringing. Cultural identity is a continuous process that is been changed, based on different social, cultural and historical experiences**.** *The more people change, the faster their cultural identity develops and the more stable it is.* This means that people have a dynamic but stable integration of their culture (Usborne & Sablonnière, 2014).

The purpose of this report is to highlight the essence of the concept of cultural identity in the context of cultural heritage, based on territorial identity, traditions and mentality, and its role and factors that influence identity as a system to support the social development of the region in the era of globalization.

2. CULTURAL IDENTITY AND HERITAGE IN THE AGE OF GLOBALIZATION

The question of cultural identity is relevant more than ever, given the political and economic situation in the age of globalization, as a result of which there have been many changes affecting genders, religions, language, ethnic characteristics, regional specifics in traditions and, above

[1] South West University Neophit Rilski, 66 Ivan Mihaylov, Str. 2700M Blagoevgrad, Bulgaria

all, the value system of the population, which build the system of cultural identity. There are quite a few negative effects on culture as a result of globalization, which has given rise to popular culture, posing a threat to traditions, beliefs and values, which would lead to a loss of cultural richness and identity. The future of cultural identities under the influence of globalization is uncertain, as it depends on how global interactions proceed and how cultures interact with each other (Tuncer, 2023).

Another main purpose of this work is to conceptualize the phenomenon of cultural identity as a resource for social development and to reveal the features of the role of the cultural identity of the region based on cultural heritage and its role in the attitude of the local population for its preservation as a factor in the development of the sphere of culture and art in the region. This can be realized by formulating the following tasks:

- An analysis of the state of cultural heritage and its influence on the cultural characteristics of the population in the region is necessary;
- Analyzes the current state of studying the problems of IT of the population, its formation and its impact on people‘s livelihood;
- The cultural diversity of the region as a driving factor for its socioeconomic development;
- Maximum use of the population‘s potential for the preservation and development of cultural wealth by creating different approaches/models, and projects in the field of art and culture;
- Analysis of the geospatial characteristics of the region and their impact on the lifestyle of the population;
- Study the influence of all spheres related to the preservation of the cultural identity of the region;
- determine the leading guidelines for the further use of IT by the population for various purposes of the development of the territorial communities of people.

The tasks thus set are relevant to the role of resources and the overall potential of the region in the context of traditions in culture and art known as cultural heritage.

Identities, whether they are based on class, gender, religion, nationality or some other social/cultural marker – play a role in building social movements and ‘framing contention’ (Tarrow, 1998).

Identity itself develops under the influence of one main factor, and that factor is culture. Culture is constructed in the process of social and material existence within which individuals construct their way of life. As a result, people also construct their way of self-expression by giving their meaning to themselves within the region they inhabit and identifying with its cultural characteristics. The creation of cultural characteristics that distinguish one region from another is a continuous process that is influenced by many factors - territory, nature, language, religion, history, traditions, and monuments that make up the cultural heritage.

Cultural heritage is a part of the history of a given territory or region and is a source of social cohesion for the people who inhabit it. In this way, it is a prerequisite for determining the sense of identity of the people, as well as a vitally important factor for the sustainable development of a given territory and its positioning as competitive with other regions. Cultural heritage is specific to each region and is a set of features related to the language, customs, manners, traditions, folklore diversity, natural features, and architectural-historical wealth, typical for a given community or group of people, which build their cultural identity.

Based on the above, it is worth noting the role of resources and potential in the field of culture and art, which are a means of improving the investment climate in the region and creating a positive financial and economic effect. A special role in this matter should be given to the consideration of geospatial components, which are of primary importance in the development and adoption of constructive and rational management decisions.

In this scientific study, under the sphere of culture and art of the region, we understand a system of interconnected enterprises, institutions, organizations and establishments of various forms of ownership, creative unions and public organizations, operating in the relevant regional geo-cultural space and directly involved in production, distribution, storage, the distribution and organization of consumption of goods and services for cultural, informational, artistic and decorative purposes. Therefore, the geospatial organization of the sphere of culture and art is the relative location of its elements, spatial connections (management, organizational, transport, informational, educational, scientific, creative, commercial) and territorial public entities (formations, combinations, systems, structures) and their functioning (Shablii, 2003).

Some authors define cultural heritage as an important factor in shaping identity, calling it a „historical reservoir" (Ahmedova, 2023). Since one of the primary characteristics of a culture is its „historical reservoir," many, if not all, groups make revisions, consciously or unconsciously, to their historical records in order to strengthen the strength of their cultural identity or to forge one, which provides they are a precedent for actual reform or change.

Some critics of cultural identity argue that the preservation of cultural identity based on difference is a divisive force in society and that cosmopolitanism gives individuals a greater sense of shared citizenship (Chaim, 2003).

An element of the structure of any state is its constitution, which, apart from allowing it to be included in the international society to which it presents its culture, also provides it with a basis and opportunities for identification with other states. Each nation is characterized by its cultural identity, built on its internal culture, which identifies it with other nations and is thus influenced by external cultural realities. Nations provide the framework for cultural identities, called external cultural reality, which influences the unique internal cultural realities of individuals within the nation.

It is also noted that an individual's „cultural arena" (Aristova, 2016), or the place where one lives, impacts the culture that person abides by. The surroundings, environment, and people in these places play a role in how one feels about the culture they wish to adopt.

A number of events such as many Western and Eastern influences, and the destruction of ethnocultural boundaries, in the last century, known as the era of globalization, are a threat to the erasure of the cultural identity of society, as they affect changes in views, thinking, values, which, from in turn lead to changes in the way of life of the population. The high levels of technology have led to many transformations that give rise to crises and threats to the loss of authenticity, the results of which can lead to „cultural trauma" (Danailova, 2004).

Cultural identity is the equivalent of authenticity. Different social groups are faced with the dilemma of whether to give up their traditional cultural values or to come to terms with the new changes (Ginder, 2010), which in many cases affect their civil liberties. It is the civil and

political liberties of the population that are necessary to create a favorable climate for maintaining unity between the population and security in the region, respectively the nation.

Historically, cultural heritage expresses the millennial cooperation between nature and the way of life of human society. At a time of constant new challenges, society must be responsible for its conservation and take advantage of the opportunities to realize its potential arising from its diversity and dynamism. At the core of the concept of preservation of cultural identity is the idea of preservation and respect for the land of the ancestors who inhabited a given region, the local language, cultural heritage, social ideals and values transmitted through generations to the inhabitants of the region. This causes cultural identity to become a large-scale direction that affects the preservation and change of the multicultural characteristics of the region and the population that lives in it.

Culture is the shared characteristics of a group of people, which encompasses, place of birth, religion, language, cuisine, social behaviors, art, literature, and music. What constitutes cultural identity is culture, which is a shared characteristic of a group of people, such as place of birth, religion, language, cuisine, social behavior, art, literature, and music. Preserving cultural identity means preserving cultural heritage, tradition and race. Culture and its heritage reflect and shape values, beliefs and aspirations, thus defining the national identity of people. It is important to preserve our cultural heritage because it preserves our integrity as a people. Cultural identities are influenced by several different factors such as one`s religion, ancestry, skin color, language, class, education, profession, skill, family and political attitudes. They are directly related to the cultural identity of the society because they also determine the perception of the main characteristics of its culture (Esquivel & Tafoya, n.d.).

Cultural identity refers to a person‘s sense of belonging to a particular culture or group. This process involves learning and accepting the traditions, heritage, language, religion, origins, aesthetics, thought patterns and social structures of a culture (Lustig, 2013).

There are three pieces that make up a person‘s cultural identity: *cultural knowledge, category label, and social connections.* Cultural knowledge refers to a person‘s connection to their identity through understanding their culture‘s core characteristics (Wan & Chew, 2013).

The preservation of the cultural identity of a territory or a place can be done by researching and studying languages, restoring historic artifacts found that are significant to its culture or heritage and encouraging the preservation and use of languages or rituals symbolic to them. It is only possible through keeping close relations between the individuals and their own culture, developed by the origin, experience, the origin and protecting the family traditions, spread out among the population in the region.

Research in connection with the development of the sphere of culture and art in the region, through its cultural-historical potential, became the reason for N. Abalmasov and A. Pine to identify three models for constructing the cultural identity of the region or territory, through impact on culture and art. The primary means of construction is the so-called *token management*. Museums, monuments, manufactured goods, historical facts, heroes and real figures, local natural, geographical objects, buildings specially built for these purposes, etc. become symbols. The best model for the continuous influence of culture and art is various initiatives related to these symbols every year, annually. This model is characterized by good planning by the

stakeholders and becomes a focus on bringing the community together. It is characterized by a wide range of areas, consistency, duration and high enthusiasm for performance (Abalmasova & Pain, 2012).

For the development and offering of socio-cultural services to the population, it is necessary to thoroughly analyze the main factors for their formation and development in the region. Globalization has moved and strengthened the processes of regionalization, one of which is the process of building and preserving the territorial identity (TI) of the population - a factor that determines the foundations and specificity of the main trends in the development of territorial communities of people. This makes the question of researching this factor extremely relevant from the point of view of social sciences, especially social geography.

There are not a few definitions defining the concept of „territorial identity". Some of the Ukrainian and Russian researchers identify this concept with regional identity. According to Krilov (2005), it is a systematic set of cultural relations related to the concept of „small homeland". Turovski (1999) believes that this phenomenon is not so much cultural as cultural-political; it is directly related to the political organization (and self-organization) of the territory, where the cultural landscape can be counted as its primary basis.

According to the Anglo-Irish political scientist Anderson (2006), this is the individual's perception of himself as a representative of a certain „imagined community", based on the unity of the territory of residence, as well as history and traditions, socio-cultural experience, value orientations and way of life inherent in the territorial community.

The Estonian scientist Raagmaa (2002) argues that it is identification with the social system of a particular region, with its people, culture, traditions, landscape, etc.

Oikonomopoulou et al. (2023) consider territorial identity in the context of the cultural landscape as a complex and integrating concept with both material–physical and immaterial substance. They also state that the protection of the natural and cultural wealth of the region will bring the achievement of balanced economic development and *social cohesion*, which ultimately leads to sustainable social development.

According to Zadvornii (2014), the main reasons and conditions for the formation of the cultural identity of the population are:
- natural geographical conditions and resources of the territory;
- features of historical development;
- historical and cultural heritage and local traditions;
- ethnic, linguistic and religious characteristics;
- the economic specialization of the region and the quality of life of the population;
- political and administrative structure.

According to Ivanova (2002), the development of culture and art in the region is influenced by the mentality of the population, the basis of which is its individual identity. She defines mentality as an expression of group consciousness in different historical periods and geographical spaces, which means that culture is also mentality and has its components: group consciousness (creation of cultural values), historical time (culture is inseparable from history), and geographical space (cultural traditions are tied to a certain territory). Art is also linked to mentality

through the concept of culture. Just as culture is the most important and best thing that has evolved in mentality, so art is the main and best thing that defines a particular culture.

Based on this, it can be argued that the identity of the region is one of the initial prerequisites for the process of production of mentality, culture, and art, as well as their joint influence on the characteristics of the very sphere of culture and art in the region, which is represented as a circle of 4 levels, as it is shown on Figure 1.

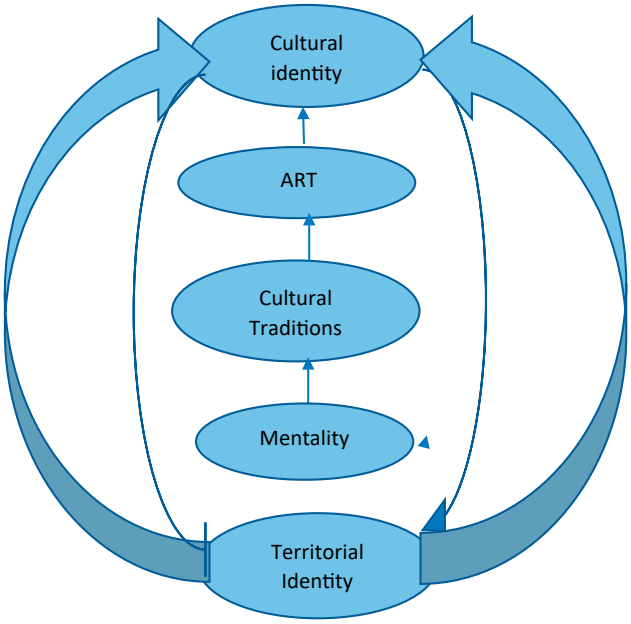

Figure 1. The levels that form the identity of a region
Source: Author based on Zadvornii, 2014

Depending on the degree of integration of tradition in social structures, the image of the society and its future are determined in a certain sense.

On the other hand, tradition is one of the ways of ordering and structuring culture, which consolidates both the phenomena of the cultural space and the various spheres of the social system into a completely integrated complex. The invariance, stability and sustainability of sociodynamics, as well as the continuity of translation of sociocultural codes, which ensure the reproduction of meanings in historically changing conditions, largely depend on the status and role of cultural tradition in society.

Frequent economic instability in the first two decades of the 21st century caused the emergence of a new type of society with a new type of cultural behavior and cultural potential in terms of traditions. The idea of tradition, in terms of values, which is a source of social order, in an era of global cultural changes, already has other characteristics, dictates new socio-cultural conditions and norms, but continues to be a prerequisite for sustainable development. The strategy of sustainable development as a priority of civilizational dynamics in the conditions of global instability can only be realized if tradition, realizing its bifunctionality, acts as a measure of identity and development orientation. At the same time, it is important to remember that cultural tradition is not so much a specific mechanism for stabilizing development, but rather „an integral feature of sociocultural dynamics, the nature of which is the establishment of value-semantic relations between social states of time divisions public life" (Anochina, n.d.).

3. CONCLUSION

Cultural heritage is a mixture of natural, material and spiritual development and is the property of society and as such helps to define cultural identity. It is a conscious memory and respect for society's past and a connection to the present. The maintenance of cultural identity can be accomplished by strengthening the individual's ties to the local culture and his identification with it. This identification is a process that develops based on learning and experience, interest and knowledge of the individual's background, getting to know and continuing the family traditions and sharing them with the community in the region.

Cultural heritage is specific to each region and is a set of features related to the language, customs, manners, traditions, folklore diversity, natural features, and architectural-historical wealth, typical for a given community or group of people, which build their cultural identity. Cultural identity is the main driving force of the socio-economic development of any region in the conditions of modern dynamic transformational changes in society. Considerable efforts are needed in all branches of the economy, especially in the sphere of culture and art, to motivate society to implement creative and economic activities for the preservation of cultural identity. The results of these efforts can be seen based on continuous analyses and studies of cultural identity, which will inform the development of strategies for the development of the regions.

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Unlocking Potential: A Deep Dive into the Funding Landscape of Agtech Start-Ups

Junada Sulillari[1]

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Abstract: *This research aimed to identify some critical developments related to the funding landscape in agtech start-ups. It is exploratory and interpretative research based on secondary information. We collected information from the venture capital industry, agricultural organizations, industry reports, and other relevant research.*

The research found that investments in the agtech sector have increased significantly in the last decade and venture capital plays a vital role in this. Some critical reasons for this are shifting consumer habits and needs, high capital requirements, the rise of impact investors, and having a greater variety of exit options for agtech start-ups. The Covid-19 pandemic transformed the fundraising environment for these start-ups. However, the nature of these start-ups renders them more stable in terms of access to funding, because of the existence of impact investors who are ready to balance between earning higher returns and investing in enterprises with social impact.

1. INTRODUCTION

Agriculture is the greatest and fundamentally the most important of our industries. The cities are but the branches of the tree of national life, the roots of which go deeply into the land. We all flourish or decline with the farmer. (Bernard Baruch)

This quote reflects the importance of agriculture. Agriculture has a significant impact not only on the farmers who have dedicated their lives to work on the land but on the entire society. For farmers, it is a way to make a living, but the impact of agriculture is much wider. Agriculture is the basis of many other industries, so its impact is not only present for those who directly work in the field or are involved with a farming activity. Many products that we produce derive from these farmers' worldwide produce. As this quote says, we all flourish or decline with the farmer, because many other activities and industries depend on the farmer and his success. If they have a successful year, this will bring positive changes in the other parts of the chain, including organizations and final customers.

A comparative analysis between today's agriculture and the way things in this sector used to operate decades ago helps to see the notable contrast and the radical changes that this sector has experienced. A key factor that has catalyzed these changes is technology. Many things that were made manually decades ago are being made by using the amazing solutions that technology is offering now. Start-ups are contributing by offering solutions to farmers that none would have ever imagined could exist. Farmers are now enjoying the benefits that technology is giving them. Examples of innovation in agriculture include smart irrigation systems, drones, targeted weed control, robotic harvesters, and autonomous tractors (Bear Flag Robotics, 2022). Agtech stands for the technology that is being used in agriculture (Senior, 2020). Many start-ups contribute positively to society by introducing innovative solutions like these, driving transformative changes in the agriculture sector. Even though many start-ups have the potential to

[1] Economic Faculty, Fan S. Noli University, Korce, Albania

transform the agriculture sector, many of them fail for several reasons. Limited access to funding is a key reason for agtech start-up failure. This represents a missed opportunity to benefit from their potential to transform the sector.

The production of advanced machinery has led to the production of farm equipment that contributes to a more efficient cultivation of land. (Goedde et al., 2020) Improved seeds, fertilizers, and irrigation systems have contributed to increased yields for farmers. A key role in transforming this sector is playing artificial intelligence, analytics and connected sensors, which help in improving the efficiency of water and other inputs, increasing yields, and promoting sustainable agriculture. The role of regenerative agriculture is getting more and more important and its practices are being used widely. Considering the increasing global demand for food (United Nations, 2021), these solutions and practices that help improve the yield for farmers, protect the environment and do not damage the land, are critical.

As previously mentioned, funding can be a critical factor in determining the degree of impact that start-ups in this sector may have on society. The number of start-ups and agtech start-ups that are established every year is high, and also high is the rate of start-ups that fail. As the numbers from Statista show limited access to funding is a major reason for start-up failure (Statista, 2023). These numbers include all the start-ups, despite the sector in which they operate. The question that this research raises is "Is limited access to funding a key challenge for agtech start-ups too?". What is happening with the investments in start-ups in this sector? How are these start-ups positioned compared to start-ups of other sectors related to their ease of difficulty in securing funding? What are some key drivers of the funding landscape of start-ups in this sector? How can agtech start-ups deal with the changes in the funding environment that the Covid-19 pandemic brought? This is what the research will focus on.

2. AIM OF THE PAPER AND METHODS

This research aimed to identify key developments related to funds invested in start-ups in the agtech sector. It helped identify the key drivers underlying the changes experienced within this sector. Analyzing key developments related to agtech start-up funding helped to understand the changes that the funding environment of these start-ups has faced. This could serve as a basis to see what are the funding opportunities and challenges for agtech start-ups. It can make it easier for start-ups to deal with the challenges and how to take advantage of the opportunities. These funding challenges add to challenges that are faced by all start-ups and not only agtech start-ups. It is exploratory and interpretative research based on secondary information. We collected information from the venture capital industry, agricultural organizations, industry reports, and other relevant research. We filtered the information collected to keep only the one that was relevant to the research. This information was the basis for doing the qualitative analysis. The aim of the research was realised by achieving some objectives. These objectives were:

- Analysing some key developments related to the funding landscape of start-ups in the agtech sector.
- Finding some key drivers of the funding landscape for start-ups in this sector.
- Analysing the impact that the Covid-19 pandemic had on the process of funding agtech start-ups.
- Finding some key ways for agtech start-ups to succeed in securing funding despite the challenges that they face.
- Creating a guideline that can help other start-ups in the sector manage better similar challenges.

3. LITERATURE REVIEW

Agriculture is an important sector, and technology is showing that it has an enormous potential to transform it. Agriculture, technology used in agriculture and agtech start-ups have attracted the attention of different stakeholders, like investors, governments and researchers. This section aims to make a summary of some key research that is related to this research. The following section includes some key findings of existing research made by other academics.

According to (Dutia, 2014) government policies, incentives and regulations will play a key role in determining the future of agtech start-ups. He also emphasizes the increase in the number of investors that have a more diverse set of motivations, where they still care about the economic returns, but also about setting goals related to the social impact or the environmental impact of the start-ups where they invest. Other sources of capital that seek environmental and social returns are emerging. This includes angel investors, venture capital funds, philanthropists, and crowdfunding.

Sippel and Dolinga (2023) emphasize that potential investors see agtech start-ups as a profitable investment opportunity and also as a moral obligation that enables the continuity of food production in the presence of environmental threats.

Kumar (2023) focused on the funding issue of agtech start-ups in India. The research found a growing interest in the investors' community to invest in agtech start-ups. This reflects the significance of agriculture and its potential. The research found a high interest in investing in supply chain optimization, which reflects the urgency to improve supply chain efficiency in this sector. Something significant that the research highlights is being more supportive of start-ups in agri-financing, farm management systems and land transactions. This would enable them to unlock their potential and would contribute to promoting sustainable agriculture.

4. THE IMPACT OF AGTECH ON THE ECONOMIC DEVELOPMENT

As previously mentioned, agriculture plays a key role in the economic development of many countries. When agriculture meets technology, the potential to promote higher economic growth is higher. What is the potential of agtech to contribute to the economic development of countries around the globe? What are the ways through which start-ups in this sector can do this? Some key ways through which agtech start-ups can enable this are (FasterCapital, 2023):

- *Increasing efficiency in farm operations*. Agtech start-ups are offering solutions and are introducing technologies that are increasing efficiency significantly compared to traditional farming practices. This is empowering farmers by enabling resource utilization, streamlining production processes, and reducing waste. Some examples of this include satellite imaging and drones that allow monitoring of crop health, identifying problems early, and applying targeted treatments. They lead to lowered costs and higher yields.
- *Enhancing crop yield and quality.* Agtech start-ups are providing farmers with technologies that improve the yield and quality of their crops. Examples of this include sensors and data analytics platforms that allow farmers to have access in real-time to data about soil moisture, nutrient levels and temperature. This improves their decision-making process regarding fertilization, irrigation and other activities which leads to increased productivity.
- *Enabling sustainable agriculture.* Agtech start-ups have become key players in promoting sustainable agriculture practices. Their solutions are promoting the minimization of the

environmental impact on farming operations. This goes parallel with the creation of long-term viability. Some well-known examples of this include hydroponic and vertical farming, which enables crop cultivation all year round and also reduces the need for land and water. Other technologies like biological pest control help minimize the use of pesticides, which helps protect the ecosystem and increases food security.

- *Improved supply chain efficiency.* The technological innovations in agriculture are transforming the entire supply chain, from farmers to final customers. Agtech start-ups are developing platforms that enable farmers a direct connection with their final customers. Blockchain technology is becoming widely used to increase traceability and transparency in the supply chain.
- *Creating new economic opportunities.* Creating new economic opportunities. Agtech start-ups have a high potential for creating new economic opportunities. They do this by creating jobs, attracting investment and promoting entrepreneurship in rural areas. The creation of agtech hubs, for example, supports agtech start-ups by helping them attract capital and talent to local communities. Adopting innovations that agtech start-ups offer can also promote the development of ancillary industries that can contribute further to economic growth.

All these reasons reflect the importance of the agtech sector and its potential to foster economic development. The contribution that agriculture has to the GDP (Gross Domestic Product) varies from one country to the other, but in some of them, it goes up to 37% of the GDP (The Global Economy, n.d.). This shows how significant agriculture and the development of this sector are for these countries.

5. AN OVERVIEW OF THE MOST INNOVATIVE AGTECH START-UPS WORLDWIDE

This section aims to make a summary of some information about the most innovative start-ups that operate in the agtech sector. There is a wide range of solutions that start-ups in this sector may offer, but this section will focus on some of the most innovative agtech start-ups in the world (Startup Savant, 2023). It helps to create an idea about what agtech includes and to bring some examples of how the technology is contributing to transforming agriculture.

- *Farmspeak Technology.* This company is based in Nigeria and helps Sub-Saharan agricultural businesses with its IoT (Internet of Things) technology. Their technology offers African poultry farmers the opportunity to grow their profit by using data-driven decisions. They aim to fight extreme poverty among farmers and ensure food security.
- *Biome Makers.* This company is based in California and produces bio-computing applications that enable sustainable and productive farming techniques. It aims to optimize farming practices, improve soil health and promote sustainability.
- *Oishii.* This company is based in New Jersey and is leading the vertical farming revolution. It produces high-quality strawberries indoors in every season by using its proprietary technology. They are setting new standards for sustainable agriculture, by using hydroponic farming and by delivering pesticide-free strawberries.
- *Mootral.* The company is based in the United Kingdom and offers a solution that reduces greenhouse gas emissions and the use of antibiotics, by fighting antimicrobial resistance. Their technology, which includes a natural feed supplement, reduces the methane emissions from cattle.
- *Augumenta.* This company is based in Greece and it enables yield increase, quality improvement, and the reduction of inputs used by using an automated precision application

for farm inputs. Their solution which is based on deep learning is a way to promote profitable sustainability.

- *Agriledger.* This company is based in the United Kingdom and helps in developing traceability, transparency, and accountability in the supply chain. They do this by using digital identity, information and financial services.
- *Big Wheelbarrow.* The company is based in Texas and focuses on helping small local producers. They do it by creating a SaaS company that enables wholesale food buyers to work with smaller companies. Through this, they empower local buying to help wholesale food buyers increase the portion of the local produce they buy.
- *Trace Genomics.* This company is based in California and offers a solution that focuses on the soil that is being used and leveraging it to bring sustainable change. They provide the customers with insights into the quality of their soil and what type are the best management practices that they can use.
- *RootWave.* The company is based in the United Kingdom and develops innovative products that use electricity to kill weeds. They do not use chemical herbicides, and the way they kill weeds does not harm the soil and does not generate additional costs. This makes that a sustainable and regenerative technology.
- *Apeel Sciences.* The company is based in California and solves the global waste problem by developing plant-derived shelf-life extensions for fresh produce. The way they do it enables keeping moisture inside the produce and prevents the oxygen from getting inside. This reduces the spoilage during the process.

6. AN OVERVIEW OF SOME KEY DEVELOPMENTS OF FUNDING AGTECH START-UPS

The previous sections discussed the importance of agtech start-ups and the start-ups in this sector and the crucial role that funding plays in their success or failure. It is interesting to see how the funding landscape of agtech start-ups has changed with the rapid changes that this sector is experiencing. This section aims to make a summary of some key developments related to the funding landscape of agtech start-ups. Besides this, the focus will be on the critical drivers of the funding landscape for these start-ups.

The agtech sector has experienced significant growth in the last decade to attract funding. Among the different sources of financing that are being provided for start-ups in this sector, venture capital is one of the biggest investors in these start-ups. Considering the limitations of getting access to funding information on a database on the investments made in agtech start-ups we could access only information from the venture capital industry. Figure 1 shows the number of venture capital deals in agtech start-ups, between 2013 and 2022. As the figure shows, the number of agtech start-ups that have secured funding from venture capital funds has experienced significant growth in 10 years. The figure shows a steady increase in agtech start-ups that have secured financing from venture capital funds.

Different from figure number 1, which shows the number of agtech start-ups that have secured funding from venture capital funds, figure number two represents the value of the venture capital deals in the agtech sector. The tendency that this figure shows is the same as the one in the first figure, a significant increase in the money that is invested in agtech start-ups. What is interesting is that even though in 2022 the number of start-ups where venture capital funds have invested has increased, the amount of money that is being invested is lower compared to 2021.

This partly relates to the impact of the Covid-19 pandemic on transforming the funding environment for agtech start-ups, by making it more difficult for start-ups to secure funding. Securing funding become more challenging because of the increased interest rates. In 2022, there were fewer funds available for start-ups in the later stages (Asthana et al., 2022). Compared to other start-ups, funding for agtech start-ups has been more stable, for several reasons. This will be the focus of the coming section.

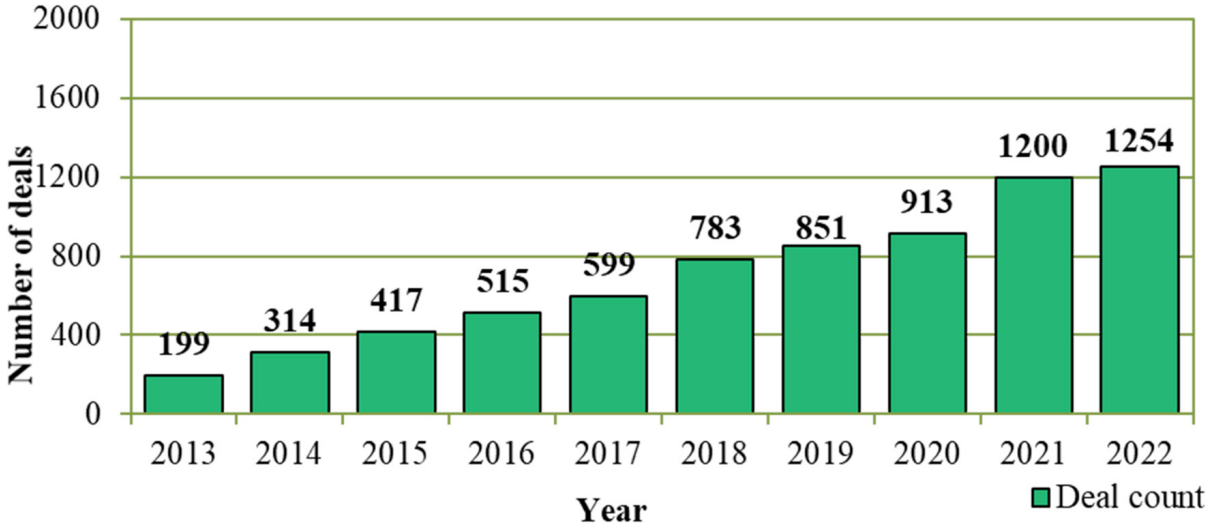

Figure 1. Agtech venture capital deal activity (deal count) during the period of 2013-2022
Source: PitchBook, 2023

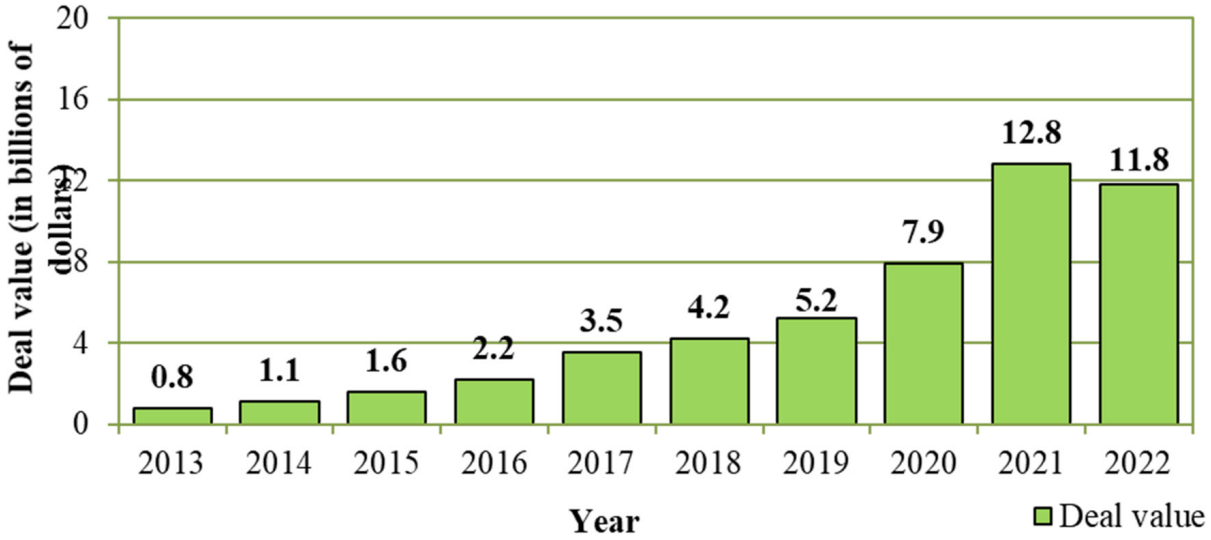

Figure 2. Agtech venture capital deal activity (deal count) during the period of 2013-2022
Source: PitchBook, 2023

The above figures show a significant increase in the money that is being invested in agtech start-ups. What lies behind his numbers? What is driving the funding landscape of agtech start-ups? The following section analyses some key drivers of the funding landscape of agtech start-ups.

- *Rise of impact investors in agtech.* Impact investing, which seeks to generate both financial returns and positive social or environmental impact, has seen a surge in the agtech sector (Asthana et al., 2022). These investors prioritize sustainability and are often willing to balance profit with purpose. Unlike traditional investors, impact investors often adopt a

long-term perspective, understanding that transformative solutions in agriculture may require extended timelines to realize both their financial and societal benefits. More impact investors are aware of the importance of the reduction of the carbon imprint and the environmental impact that agriculture has. This is made through the promotion of sustainable agriculture. (White, 2019).

- *Collaborative funding models.* The agtech sector is witnessing a shift towards collaborative funding models. Co-investment strategies, where multiple investors pool resources, are becoming common. Public-private partnerships are also on the rise, leveraging the strengths of both sectors to drive innovation in agriculture. Public-private partnerships can enable the creation of a start-up ecosystem that drives emerging tech innovations and agile business models. Universities and research institutions can help validate the business solutions by bringing in their expertise in the sector (World Economic Forum, 2022). Also, crowdfunding platforms are emerging as a viable funding source, democratizing investment opportunities and allowing a broader audience to support agtech innovations.
- *High capital requirements in agtech.* Agtech start-ups often face high capital requirements, especially those focused on hardware or biotech solutions. The research and development (R&D) processes in these areas can be expensive. Also, the product development cycles can be long, requiring sustained funding over extended periods. As these start-ups aim for scalability, the initial capital requirements can pose significant challenges, especially for those without substantial backing. Venture capitalists and angel investors often hesitate to invest in these start-ups because of these reasons. Securing financing and building a strong and experienced team becomes critical to overcoming the challenges. Some options to secure funding besides angel investors and venture capitalists are seeking government grants, loans, incubators and accelerators, crowdfunding, or partnering with established companies in the industry. These established companies can support them with funding and expertise (AdvisoryCloud, 2023).
- *Geographical disparities in agtech funding.* While agtech innovations are global, funding often concentrates on developed markets. Start-ups in emerging economies, despite their potential to offer localized solutions for unique agricultural challenges, often face limited access to capital. In small countries, start-ups may not access angel investors or venture capital funds, or may not even be aware of the existence of these funding options (Petković et al., 2012). Sometimes start-ups lack information about potential investors, angel investors, or venture capitalists who can reach out. This leads to missed opportunities for them to secure funding. Bridging this geographical funding gap is essential to harness the full potential of agtech innovations worldwide.
- *Changing exit strategies for agtech start-ups.* The exit strategies for agtech start-ups are evolving. While the IPO market has slowed down, there's a noticeable rise in strategic acquisitions by larger agricultural corporations seeking to integrate innovative technologies. This shift underscores a broader trend in the sector: a focus on long-term value creation over short-term gains. These changes partly resulted from the Covid-19 pandemic, which was a key factor in transforming the funding environment of agtech start-ups. General partners take more time to evaluate the deal and for due diligence, which leads to longer times for closing deals. They mainly invest in the following rounds in existing portfolio companies or start-ups with lower risk (PitchBook, 2023).
- *Changes in consumer behaviour.* The behaviour of today's consumers differs from decades ago. Customers now are more concerned about what they are consuming or eating. They are not as indifferent as in the past. Besides being interested in what the food taste is consumers are interested in the nutritional qualities and sustainability. Consumers are now

more interested in knowing about how the food is being produced, which motivates companies to find innovative ways to produce their products. (Thioller, 2022). The demand of customers to have different products all year round has led to an increasing demand for vertical farming and other agtech solutions. People now do not care only about agriculture-related emissions but also about the amount of land and water that is needed to support the supply chain (Weber & Bigalke, 2022).

Agtech start-ups indeed face several challenges regarding funding, but this shall not discourage them. Besides the challenges that shall take advantage of the opportunities that come up and learn not to give up when difficult situations arise. They shall try to avoid playing safe during downturns and be more strategic. It is also important to set ambitious but achievable goals. Start-ups shall also move quickly to achieve their milestones so they can increase their growth rate and become more attractive to investors in the later rounds (Asthana et al., 2022). Staying focused is also critical to eliminate distractions and better manage the burn rate. Considering all the possibilities and challenges, it is up to start-ups themselves the final result: succeeding or failing.

7. FUTURE RESEARCH DIRECTIONS

Considering the crucial role that agriculture plays in the economy and in economic development, it shall get more attention from different stakeholders. Agtech start-ups have a high potential to transform agriculture. This research was an explorative one and the author could not access the full information about the investments made in agtech start-ups. The information accessed included only venture capital investments, which is a limitation of this research. Considering the fact that the research was a more exploratory and descriptive one, this suggests that there is space for future research to focus on a deeper analysis of this topic. Future research can focus on a more detailed analysis of the factors that impact the way venture capitalists, angel investors, or other investors make their decisions when investing in agtech start-ups. To make the research more complete, a deeper analysis that considers the perspective of start-ups in this sector would help to better understand what is driving the funding landscape of agtech start-ups.

8. CONCLUSION

Technology is playing a crucial role in transforming agriculture. Many technological innovations are offered by start-ups. Considering the many challenges that start-ups face, funding is crucial. This is also true for agtech start-ups. This research aimed to analyse some key developments in the funding landscape of agtech start-ups and to find some factors that have transformed the funding environment of agtech start-ups. The research was an exploratory and descriptive one. What the information collected from the venture capital industry was that agtech start-ups have experienced significant growth in terms of the investments that they have attracted. The change is significantly different compared to a decade ago. Some key factors that explain the changes in the funding landscape of these start-ups are the rise of impact investors in agtech, geographical disparities in agtech funding, changing consumer behaviour, changing exit strategies for agtech start-ups, collaborative funding models, and high capital requirements for agtech start-ups.

The research found that even though the COVID-19 pandemic had an impact in slowing down investments in this sector, the nature of these start-ups makes them more stable in securing

funding compared to other start-ups. What the results suggest would be for start-ups not to give up, but to keep going, and for different stakeholders like the governments to be more active in supporting them. Creating solutions that would enable start-ups to access funds more easily would make a difference in determining their success or failure.

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