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on Economics and Management

EMAN 2023

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7TH INTERNATIONAL SCIENTIFIC CONFERENCE
EMAN 2023

EMAN 2023 – Economics & Management: How to Cope with Disrupted Times

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Contents

Index of Authors

Index

Preface

The purpose of the annual EMAN 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 economics and management through encouraging advancement via excellence, and interaction.

EMAN 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 EMAN conference is committed to the highest standards of publishing integrity and academic honesty 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 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, editors highly recommend that the author address any issues, explaining why their research process or conclusions are correct.

Association of Economists and Managers of the Balkans headquartered in Belgrade – Serbia along with the partner institutions, namely the Faculty of Management Koper, University of Primorska, Slovenia; Faculty of Economics, Administration and Business, "Stefan cel Mare" University of Suceava – Romania; Faculty of Economics in Osijek, Josip Juraj Strossmayer University of Osijek - Croatia and the School of Economics and Business, University of Sarajevo (SEBS) - Bosnia and Herzegovina organized Seventh International Scientific Conference on Economics and Management: How to Cope with Disrupted Times - EMAN 2023. Conference was held in Ljubljana, Slovenia (online/virtually/in-person) at the Faculty of Public Administration, University of Ljubljana, Slovenia, Gosarjeva ulica 5, Ljubljana, Slovenia.

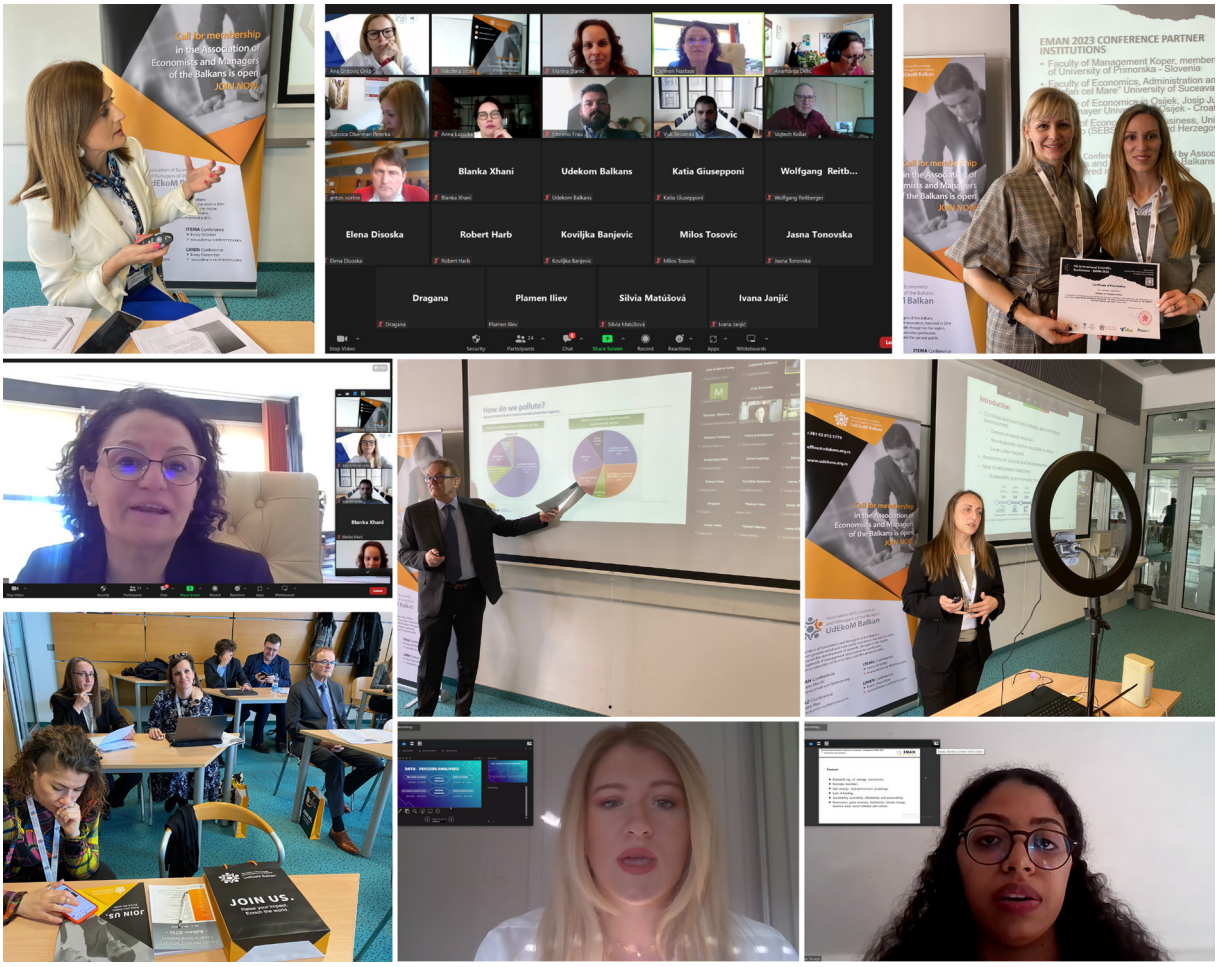
EMAN 2023 keynote speaker was Moreno Frau from the Corvinus University of Budapest, Marie Curie Research Fellow, Institute of Marketing and Communication Sciences, Department of Marketing Management, Hungary with the topic "*Digital Transformation, Agility, and Environmental Sustainability in the Agri-Food Industry*".

Within publications from the EMAN 2023 conference:

- **20 double peer-reviewed papers** have been published in the *EMAN 2023 – Economics & Management: How to Cope with Disrupted Times – Selected Papers* (in English),
- **50 double peer-reviewed papers** have been published in the *EMAN 2023 – Economics & Management: How to Cope with Disrupted Times – Conference Proceedings* (in English, Croatian, Bosnian, Serbian and Slovenian), and
- **110 abstracts** have been published in the *EMAN 2023 – Book of Abstracts* (in English).

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

Participation in the conference took nearly **200 researchers** representing **26 different countries** from different universities, eminent faculties, scientific institutes, colleges, various ministries, local governments, public and private enterprises, multinational companies, associations, etc.



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Identifying Barriers Hindering the Application of Blockchain in the Energy Sector: Pestle and SWOT Analyses

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Abstract: *The global energy market is in a period of radical change. Decentralized energy production, energy storage and consumer-producers of electricity constitute the future shape of the electricity system. Distributed Ledger Technology, known as blockchain, is an emerging technology that can play an important role in green energy transition. Although blockchain can be applied to a wide range of applications in the energy sector, there is a lack of sound understanding. This paper aims to provide a market analysis with the use of PESTLE and SWOT, resulting in a list of barriers that affect the successful application of blockchain technology in the energy sector. The findings could assist related stakeholders, such as energy market actors and policymakers to acquire a clearer view of blockchain use in the energy sector and draw strategies that will overcome the barriers leading to the establishment of this technology in the energy sector.*

1. INTRODUCTION

In the last years, radical changes have occurred in the energy sector due to decarbonisation targets. The introduction of blockchain technology has provided a new set of opportunities in the energy sector and it could help meet goals, like energy efficiency and energy transition since applications such as emission trading systems, and P2P energy trading in smart grids (Ruan et al., 2023) energy management in systems with high contribution of renewable sources in energy production can be supported by blockchain-based models (Ping et al., 2023). A more obvious use case in the energy sector is the use of cryptocurrencies for monetary transactions (Bürer et al., 2019).

The decentralized nature of blockchain, combined with the security, transparency and safety it provides, make it a very promising technology for energy management and trading implementations, among others. Application fields of blockchain in energy include smart grids, microgrids, energy trading, storage, energy management, electric vehicles, carbon mitigation, and smart meters (EU Blockchain Observatory & Forum, 2023). However, technical constraints, such as the scalability problem, security threats, as well as sociopolitical and regulatory barriers should not be neglected (Andoni et al., 2019).

The scope of the paper is to identify the main barriers that hinder the adoption of blockchain technology in the energy sector through a proposed approach. A market analysis is carried out by using the analytical tool of Political, Economic, Social, Technological, Legal and Environmental (PESTLE) (Summut-Bonnici & Galea, 2015; Zahari & Romli, 2019) while following the

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reclassification of the results of the PESTLE analysis into four groups that corresponded to each factor of the strength, weakness, opportunity and threat category in the SWOT analysis (Teoli et al., 2022). At the end of the process, the main barriers preventing the application of blockchain technology in the energy sector are identified, while important conclusions are drawn.

Apart from this introductory section, the paper is structured as follows: Section 2 gives an overview of the methodological approach that is proposed in order to identify the main barriers that affect the adoption of blockchain technology in the energy sector. Section 3 presents the application of the approach through the PESTLE and SWOT analyses. Section 4 presents the results which are the main barriers identified and, finally, Section 5 sums up the main conclusions and presents some ideas for further research.

2. METHODOLOGICAL APPROACH

The methodological approach followed with the scope of identifying the main barriers that affect the adoption of blockchain technology in the energy sector is depicted in the following figure (Fig. 1), while the main steps are described below.

Figure 1. Methodological approach
Source: Authors

Step 1: In this step, the background details of the problem and the current state of blockchain technology in the energy sector are presented. Although blockchain can be applied to a wide range of applications in the energy sector, there is a lack of sound understanding. This topic of research was identified and studied within the framework of the European Union Innovative Energy (Efficiency) Service Models for Sector Integration via Blockchain (InEExS) project. InEExS improves the implementation of Energy Efficiency Directive (EED) Article 7 and supports Obligated Parties to provide integrated service offers that enable energy savings. A crucial element of the project is the Energy Web blockchain platform, which is specifically designed for energy applications (Zahoor et al., 2023). Within the framework of InEExS, a market analysis of the application of the blockchain in the energy sector was the first basic step in order for the business models of the InEExS real-world business cases to be implemented through the adoption of blockchain technology.

Step 2: A Market analysis is being conducted by using the analytical tools of Political, Economic, Social, Technological, Legal and Environmental (PESTLE). PESTLE analytical tool is a variation of the PEST analysis and helps the identification of the factors that might influence the integration of blockchain platforms and models in energy systems (Summut-Bonnici & Galea, 2015; Zahari & Romli, 2019). Then, the reclassification of the PESTLE analysis is implemented into four groups which corresponded to each category in the SWOT analysis. SWOT stands for Strengths, Weaknesses, Opportunities and Threats. The strengths and weaknesses regard the present situation, whereas the opportunities and threats aim to analyze possible future aspects of blockchain adoption in the energy field (Leigh, 2009; Teoli et al., 2022).

Step 3: In this final step the main barriers that hinder the application of blockchain technology in the energy sector are identified and presented based on the results of the SWOT analysis.

3. PESTLE AND SWOT ANALYSES

The three steps have been applied and the results are presented in this chapter. Through our PESTLE analysis (Figure 2) various factors that might influence the integration of blockchain platforms and models in energy systems have been identified.

***Political*:** Due to the climate crisis, energy transition targets have become an irremovable part of the political agenda (Bürer et al., 2019). Blockchain applications can help manage complicated energy systems, even when a high percentage of the produced energy is generated by renewable sources. It must be noted that there might be a knowledge inadequacy surrounding blockchain, due to the novelty of the technology. Because of this ignorance, political institutions may not be fully aware of the prospects of blockchain applications, the benefits that might ensue, as well as the feasibility of certain use cases (Sadhya & Sadhya, 2018). Therefore, a lack of sound understanding of blockchain technology makes its adoption uncertain. Since politicians tend to avoid risk, this uncertainty must be considered a notable impediment to widespread blockchain adoption (Ahl et al., 2022; Morstyn et al., 2018).

Economic: The effectiveness and success of blockchain in terms of monetary transactions have already been proven, so its extension to other types of transactions is promising (Egelund-Müller et al., 2017). Blockchain enables smart contracts to promise to change payments as well (Teufel et al., 2019). Energy blockchain could create investment opportunities, however, it has been observed that executives are still skeptical (Bürer et al., 2019). The investment might not be applicable for many businesses due to the computational requirements of blockchain (Sadhya & Sadhya, 2018). Also, since the initial cost of implementation is generally high, potential investors are concerned that the profit margin generated by their investment may be too low (Borges et al., 2022).

Social: The first finding concerns the social acceptance of decentralized P2P energy trading. Decentralization of the trading system and integration of new technologies are seen as too risky by a considerable number of potential prosumers (Borges et al., 2022). The functionality of smart homes in smart grids depends largely on data sharing, but many prosumers will likely be too nervous and unwilling to share energy data. Furthermore, whether the algorithm will favor certain network participants in the early stages of its development is still uncertain. Other concerns include security and reliability issues, policy uncertainties and possible errors that won't be easily reversible (Ahl et al., 2022; Egelund-Müller et al., 2017). The irreversibility of blockchain is a notable issue. For example, it is questionable whether a mistake in a smart contract could be fixed. Also, decentralization is not necessarily socially acceptable. A non-negligible number of participants feel safer if the system is managed by an external authority (Borges et al., 2022). In addition, society views bitcoin and blockchain as two undistinguished technological breakthroughs, which causes misconceptions, since bitcoin has been connected with illegal actions, such as money laundering, hacks and frauds, so there is a lack of trust in DLT (Monrat et al., 2019).

Technological: The decentralized nature of blockchain technology makes it ideal for P2P energy trading applications (Diestelmeier, 2019). Data stored in a blockchain are generally immutable,

which is crucial in a variety of energy applications, while data is always accessible after it is logged into the chain (Erturk et al., 2020). Blockchain-based systems are generally considered highly secure and reliable since all network participants can create blocks and keep a replica of the data. Consequently, the network cannot be easily damaged (Teufel et al., 2019). In addition, blockchain can offer the flexibility that modern energy systems and distribution grids require. Efficient management can be achieved using blockchain services combined with sensors and smart meters (Bürer et al., 2019). But although security, cryptographic algorithms, data privacy, identity protection and anonymity are key advantages of blockchain, the potential vulnerabilities, such as Irreversibility and possible data deletion, must not be neglected (Abramova & Böhme, 2016; Risius & Spohrer, 2017).

Legal: The DLT is a relatively new technology, thus blockchain regulation has not yet been formulated (Sadhya & Sadhya, 2018). The legal vacancy is a critical barrier because in certain use cases, an intervention by a legislator might be required to resolve a conflict, which might ensue. However, there is a lack of concrete guidelines for the legislator to follow (Chiarini & Compagnucci, 2022; Zhou et al., 2021). Once the regulation is formulated, which is expected to be quite complex, it could discourage political institutions, business executives as well and members of society, so blockchain may not be used to its full potential (Ahl et al., 2022; Bürer et al., 2019). In addition, there are no specific legally enforceable standards, so the interoperability between different technologies and physical facilities is inhibited (Brilliantova & Thurner, 2019). Lastly, compliance of activities in blockchain platforms with the General Data Protection Regulation (GDPR) framework of the European Union (EU) must be considered. Whether the personal information of EU residents could be included and available within smart contracts is questionable and has not yet been clarified (Borges et al., 2022; Teufel et al., 2019).

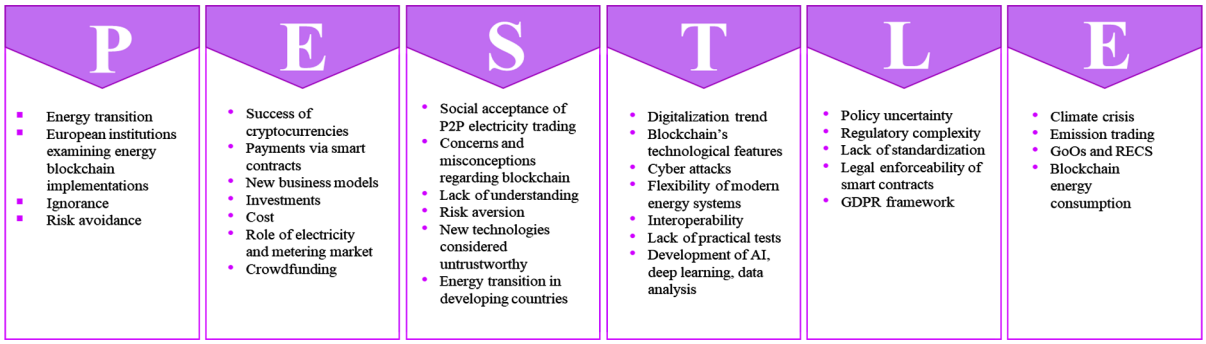

Figure 2. PESTLE Analysis

Source: Authors

Environmental: Digitalization of energy systems using blockchain and other disruptive technologies could improve the management of the systems and help reach energy transition goals, which aim to alleviate the consequences of climate change (Bürer et al., 2019; Diestelmeier, 2019). Blockchain can be utilized not only in energy trading but also in emission trading. This technology guarantees transparency and could therefore prevent fraud or other issues that frequently occur in emission trading applications (Ahl et al., 2022; Khaqqi et al., 2018). Blockchain-based platforms can be a useful tool when it comes to tracking the source of electricity used (Ahl et al., 2022). Encouraging consumers' knowledge and control over their energy mix could have a positive environmental impact (Borges et al., 2022). However, the computational intensity resulting in high energy consumption of blockchain algorithms is a crucial barrier (Sadhya & Sadhya, 2018).

In the continuation of our research, with the advantages and disadvantages resulting from the PESTLE analysis, a SWOT analysis was carried out. While PESTLE analysis only concentrates on the external factors, SWOT analysis looks at the internal and external strengths and weaknesses factors that are affecting the implementation of blockchain in the energy sector. The SWOT analysis that derived is presented in the following figure (Figure 3).

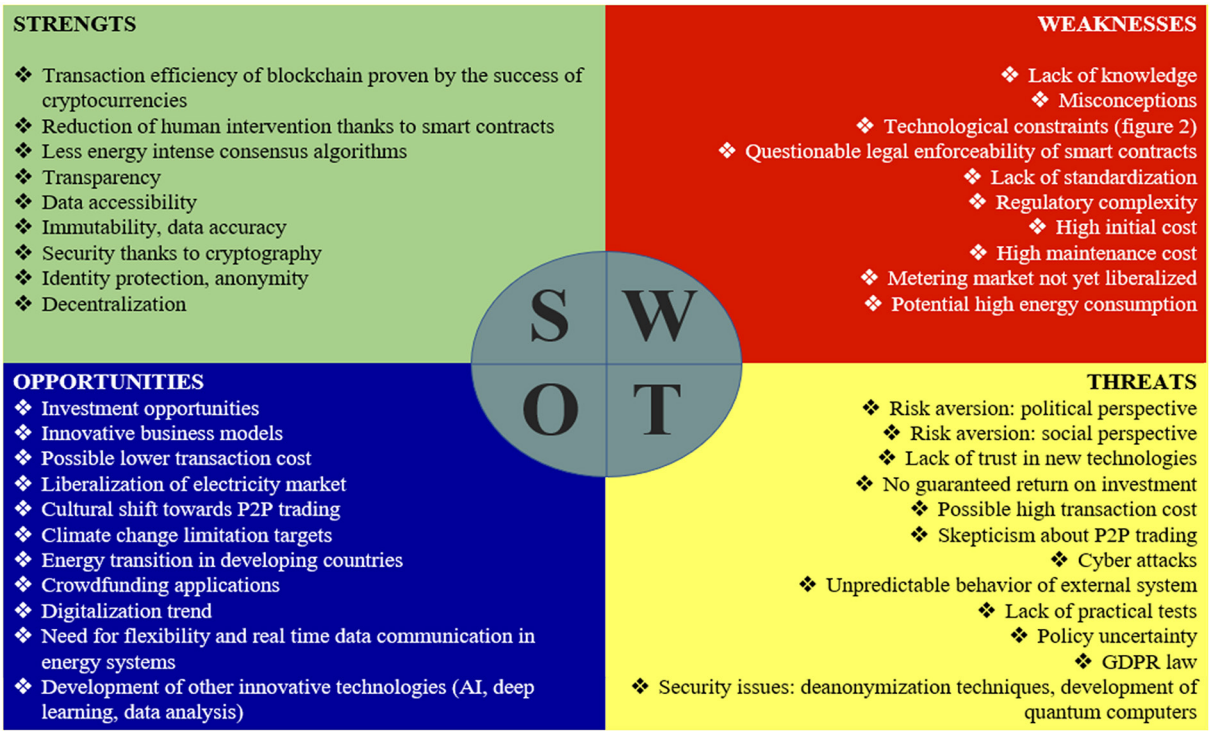

Figure 3. SWOT Analysis
Source: Authors

4. RESULTS: THE IDENTIFIED BARRIERS

By focusing on the "Weaknesses" and "Threats" sections of our SWOT analysis, the barriers to blockchain implementation in the energy sector were identified and categorized. 29 barriers were identified, which were divided into 4 categories, Technological, Legal, Social and Political, and Economic (figure 4).

First of all, it is clear that most of the barriers that arise regarding the implementation of blockchain technology come from the technological side. The main problem is the limitations of the existing network, such as the performance and data storage, as well as the energy required to implement this technology, especially in a wider application. Also, the reversibility as well as the issues of security and authenticity of the data that are stored creates additional obstacles to making the technology more accessible. As far as the social and political side is concerned, the main factor that negatively affects the application of the blockchain is ignorance towards this technology. From the legal side, the barriers are more related to the uncertainty and complexity that entails this technology with regards to the policy aspects, while several aspects such as the data protection regulations and standardization procedures are missing or not clarified yet. Finally, from the economic perspective, the factor from which many of the barriers stem is its novelty. Because of this, the initial cost is high, as well as the maintenance cost of the network, and at the same time due to the high risk involved, the return on investment is not certain.

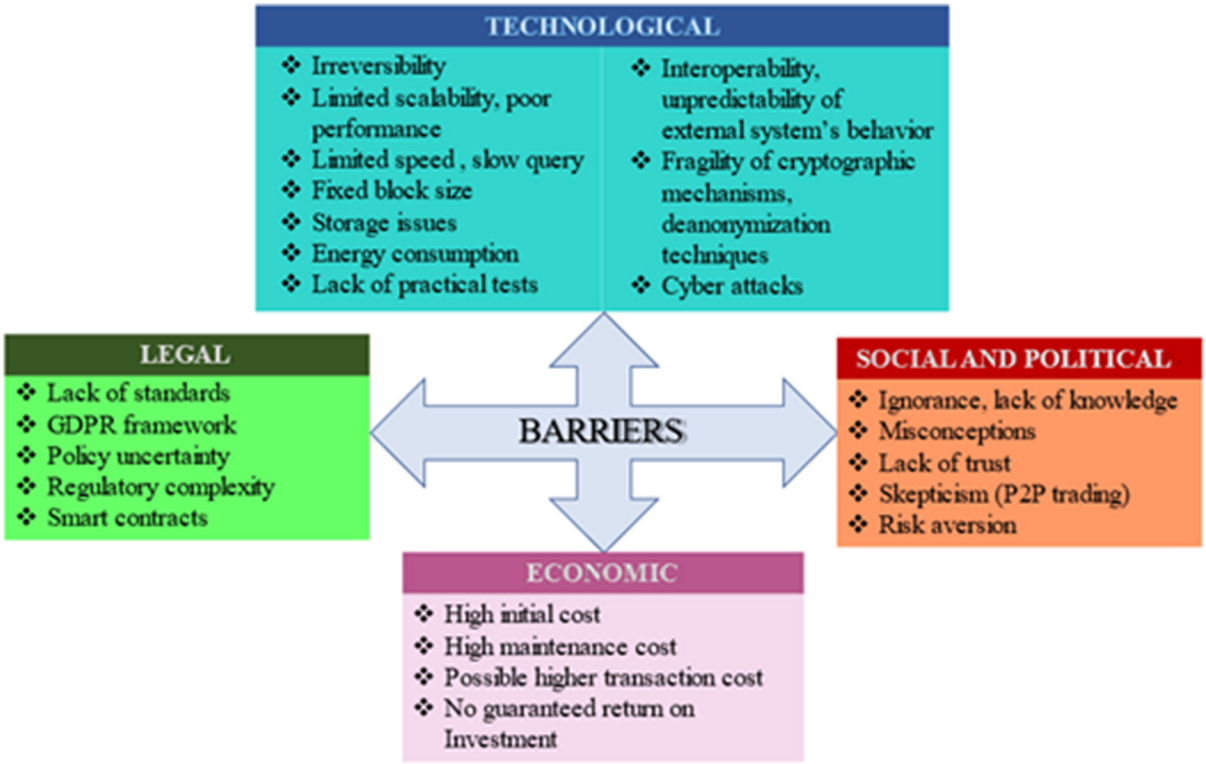

Figure 4. Barriers to blockchain adoption
Source: Authors

5. CONCLUSION

Blockchain is an innovative technology that could contribute to the energy transition and the digitalization of energy systems. Its technical features make it a very promising technology in energy services applications, however, several issues and constraints make potential users skeptical when it comes to its adoption. This paper provided a market analysis with the use of PESTLE and SWOT analyses resulting in a list of barriers that affect the successful application of blockchain technology in the energy sector. The findings of this study could assist related stakeholders, such as energy market actors and policymakers to acquire a clearer view of the blockchain use in the energy sector and draw strategies that will overcome the barriers that arisen leading to the establishment of this technology in the energy sector. As further research, a stakeholder engagement process could follow in the form of a survey or bilateral/multilateral meetings to externalize the views and perspectives of the involved key actors with regard to their perception of the identified barriers. An assessment and ranking of the barriers with the use of a multicriteria method for group decision-making is proposed with the aim of prioritizing and identifying the most important ones in each sector. The results could entail recommendations and assist market actors in designing their policies and strategies towards the effective adoption of the blockchain in the energy sector and guide the widespread application of the technology that can have a key role in the global energy transition.

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Bridging the Broadband Divide through 5G Solutions Based on Community-Based Broadband Solutions for Balancing Competition

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Abstract: *This paper addresses the issue of insufficient broadband and wireless technology access in rural areas and proposes the use of 5G technology to bridge the digital divide. The paper analyzes a possible cost model for community implementation of 5G, with a focus on Chicago's South and West Sides, where internet access is an issue for citizens. The methodology is based on qualitative research through narrative analysis and a focus group discussion with economists and consultants specializing in the digital divide. The paper proposes a cost model based on average revenue per machine (ARPM) instead of the traditional average revenue per user (ARPU) model, which provides a fairer cost model for rural areas. Participants of the focus group evaluated the model and concluded that it would provide a fair and competitive ground between local and nationwide providers, with potential government support.*

1. INTRODUCTION

The issue of the "broadband divide" - the lack of access to high-speed internet and wireless technologies, particularly in rural areas - has been a global issue that has been recognized by various stakeholders. While the global divide is decreasing, the issue of not having access to critical "last-mile" connections, which would have enabled higher speeds, remains a problem (Rivera-Illingworth et al., 2020). According to a report by The Executive Office of the President (2022), in the US, 94% of urban Americans can purchase a 25 Mbps connection, but only 51% of the rural population has access to that speed. In Latin America, while 44% of the population will have access to fixed broadband services by 2026, only 5.3% will have access to 500 Mbps or more and only 1% to over 1 Gbps. Wired internet, which can deliver the highest speeds, remains highly concentrated, with most Americans having only three or fewer providers to choose from.

5G has the potential to revolutionize the internet in locations where it is available and to bridge the broadband divide. It can provide both mobile and fixed broadband needs, but the providers of 5G infrastructure are currently major companies that are already market leaders, and this limits competition. This paper will explore the potential of 5G for community-based broadband solutions, using successful case studies and initiatives such as Open Radio Access Network Architecture (Open RAN) (Plantin, 2021) to balance competition in the market and contribute towards the future of the internet.

2. LITERATURE REVIEW

Previous research informs us about 5G's opportunities, both in rural areas and in general, as evidenced by research by Kearney (2018), American Enterprise Institute (2012), Taylor and Cervera-Jackson (2020), Wallace et al. (2015) speaking about its potential for increasing competition

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and with opportunities and challenges for its usage in rural areas discussed by Fernández (2021), Oughton et al. (2022), Schmidt (2021), and Skouby (2021). Warf (2003) shows how competition from major networks has traditionally led to monopolies, motivating the need for increases in community-based providers. Honker (2022), Pressgrove (2019), and UN Broadband Commission (2022) discuss initiatives and solutions that have been implemented so far within rural areas, which this paper intends to build on with the opportunities that 5G provides and from the knowledge derived from the related opportunities proposed by the relevant 5G research. As research by Prieger (2013) and Williams (2018) mentions, many economic benefits can be reaped from bridging the broadband divide in these communities, which Suryanegara (2018) and Yaghoubi et al. (2018) also discuss by proposing a pricing model that is meant for general communities but can be built upon and applied to rural communities, which will be done in this paper. Dangi et al. (2021) and Global Platform for Sustainable Cities (2022) provide more information about 5G technology systematically and globally, which will be used to complement the economic benefits that are to be obtained.

In 2018, the United Nations (UN) Broadband Commission called for the international community to work towards achieving an interim milestone of 75% global broadband coverage by 2025, while hoping to achieve full coverage by 2030 (UN Broadband Commission, 2022). However, with the failure of many community-based broadband solutions to provide that last-mile connectivity that communities need to be able to have sufficient access to the internet, achieving the milestone will not mean much. In 2015, the FCC recommended that the minimum broadband speed should be 25 Mbps for downloading files and 3 Mbps for uploading, though even this was said to be too low according to the Government Accountability Office.

There have been successful initiatives done in the past that have worked well to take the first steps in addressing this issue over the long term. A couple of successful cases, as detailed by Wallace et al. (2015), tapped into funding at local, regional, national, and European Union levels as well as utilized charitable foundations and donations alongside charging through subscription fees to set up small private enterprise, non-profit organizations, occasionally contracting outside companies to assist in the process. Peninsula Village was one such community in Scotland that was able to have such a service started from a family business through that method, making use of telephone exchanges that were nearby and eventually replacing the infrastructure with a fiber optic line. Such self-started community models should be the norm in most areas, and as seen from the report by The Executive Office of the President (2022), the executive branch of the government has already identified the need and the challenges but has yet to implement modern approaches through the latest technology advancements, namely 5G, on a more practical basis. Three factors utilizing 5G can change to address this issue: the pricing model, spectrum accessibility and regulatory issues.

With broadband, communities have seen significant economic benefits and savings. In the study by Prieger (2013), broadband was associated with population and employment growth. There are also explorations for a link between broadband penetration and economic growth at a national level using international data, showing that a 10-percentage point increase within the broadband penetration of a household consequently boosts a country's GDP within the range of 0.1% to 1.4%. Townsend et al. noted that the cost of wired broadband deployment has traditionally depended on three parameters: distance, remoteness, and sparseness of the population, making up costs in terms of network and administration fees (Townsend et al., 2013) and within rural areas, it is no surprise that remoteness and sparseness of the community would be the major concern with the cost accumulated. With community-based broadband networks, sparseness is still often an issue as well, given that the distance that the network must travel already slows the speed

of the internet of the recipient. The pricing model of how customers are charged through community-based networks certainly must consider this and get funding from a regional or national level to support those that are more scattered from the area where the network is based and expand the network towards them as well. With 5G, transmission speeds will be faster over the same distance, achieving better speeds more efficiently.

3. METHODOLOGY

The first avenue is through narrative analysis as part of understanding and extracting trends from stories of stakeholders as part of gaining qualitative data into how conditions of the global divide warrant the use of the cost model based on internet research. In the second avenue of research, results are obtained from a focus group where the cost models based on the provided context will be discussed with a group of economists and consultants specializing in the digital divide to understand their insights and gain feedback on the 5G cost model as part of the community implementation while seeing their thoughts on its applicability in different areas as well. This research is integrated into the cost models that are proposed as part of the paper, ensuring that it can provide the best, balanced model for competitiveness for locals within rural areas.

4. COST MODEL

The advent of 5G technology will bring about changes in pricing structures, and this will also impact community-based broadband providers in rural areas. These providers will need to adapt to these changes in order to stay competitive against larger providers. According to research conducted by Suryanegara (2018), the transition toward 5G will shift the focus of financial performance from average revenue per user (ARPU) to average revenue per machine (ARPM). This means that revenue will be calculated based on the number of machines connected to the internet in each household. This shift towards ARPM would be a fairer measurement for rural households that still lack access to computers and other internet-enabled devices. It would also help to narrow the broadband gap between rural and urban areas. With ARPM, pricing for rural households can be set based on the number of machines they have access to, rather than having to balance prices equally based on ARPU. The equation proposed can be seen in Equation 1.

$$ARPM(x,y,z) = \frac{R(x,y)}{z} \tag{1}$$

In the equation, R(x,y) is the total revenue for an application x in the sector y, ARPM shows the revenue per z machine, per x service, per y sector, x shows the type of service application, y shows the type of sector, and z shows the number of machine units. As part of considering how the ARPM will fit into the overall cost a community will incur, it is important to consider the network externality effect that will be apparent based on the adoption of 5G networks and how to reap the effects based on the users that are currently on the platform. To represent this, we can make use of the Bass model developed by Frank Bass, originally used for how new products get adopted but can be used in this case scenario to represent the importance of putting a sample of users to test out the solution and letting the other users within the community observe the successes and join as a subscriber to the network, as shown by figure 2.

$$f(t) = \frac{1 - e^{-(p+q)t}}{1 + \frac{q}{p}e^{-(p+q)t}} \tag{2}$$

In this equation, p is the coefficient for innovation and q is the coefficient for imitation, both expressed as constants. This equation is supported by Figure 1, showing that the model does not allow for f(0) = 0 and needs an initial subscriber set for the network externality effect to hold. The successes experienced in these communities can then be used as a case study to convince more communities to create their initiatives as well, encouraging these communities on a more global scale to adopt such solutions despite their initial skepticism towards it. With 5G, it is imperative that communities understand that it is more important than ever to ensure that the provision of the internet never comes from a monopoly, given that everyone needs and has the right to access the internet for themselves.

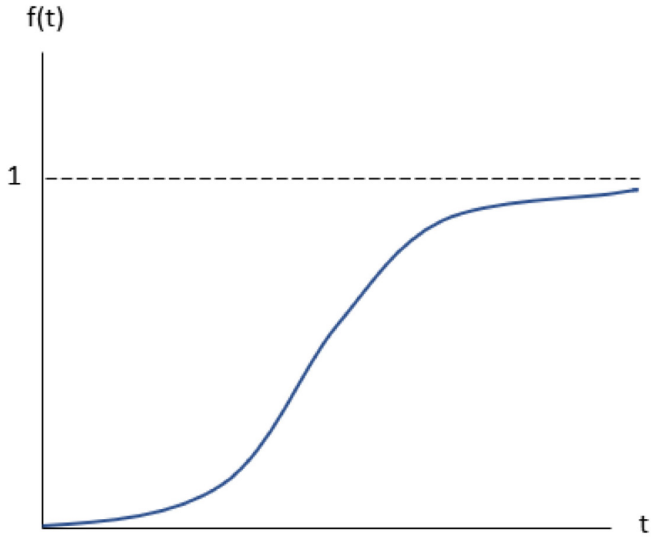

Figure 1. The Bass Model representing the fraction of users of a community-based broadband solution represented by *f(t)* of a community network over time represented by *t*

Source: Author

There will be two parties who mainly will be part of the network externalities; as such, we focus on two relevant equations: the government cost and the community cost, which can be modeled inspired by the equations proposed by Oughton et al. (2022). The community cost will be made assuming that the community will be sustaining the costs as opposed to private individuals owning the network, as discussed in the case studies based in rural locations mentioned in the literature review.

The equation of the cost towards the government will be seen in equation 3 below.

$$Government = Subsidy - (Spectrum + Tax) \quad (3)$$

The equation of the cost towards the community will be seen in equation 4 below.

$$Community\ cost = Network + Administration + Spectrum + Tax + Profit \quad (4)$$

As part of this, we can then utilize the profit gained from administering the network as a function of the ARPM, leading to equation 5.

$$Community\ cost = Network + Administration + Spectrum + Tax + Profit(\frac{R(x,y)}{z}) \quad (5)$$

In the equation, P is a profit function as a function of the total number of machines currently operating based on the ARPM function specified above. We can see how the new ARPM measure will impact the cost towards the community, while also having the government tax the profits more fairly this way and not necessarily necessitating a change from the government's costs, given that the reflection of the new ARPM measure is not reflected as part of their equation.

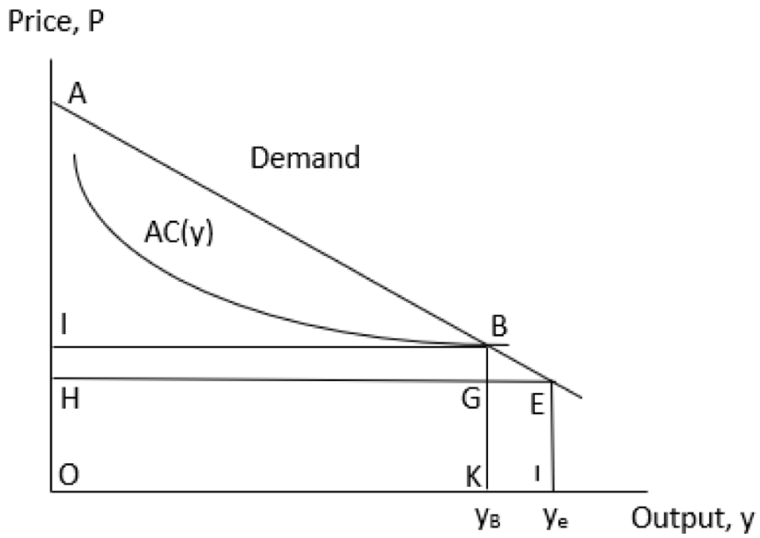

Figure 2. A demand curve showing the maximization of social profit by setting the price of the access to first best price.

Source: Author

It is imperative that as the executive branch and Congress work towards subsidizing fees for community-based broadband networks based on 5G as part of the system of government and community cost equations, the pricing of these fees for these networks follows first-best pricing. This way, as shown in Figure 2, social welfare is maximized in the area of ABI, which should be the main goal of setting these networks in the first place, given that the provider should most likely be non-profit in the first place. This would obtain the first-best price, subject to the three parameters Townsend et al. (2013) mentioned but with subsidization based on the socio-economic status determined, hence matching their willingness to pay (WtP) and thus personalizing the prices. This will hence also be able to ensure that fair, competitive access is granted while the community provider does not monopolize the provision of access to the internet, making it a regulated monopoly within the community.

5. RESULTS

Within the focus group, it was unanimous that participants liked the proposal of the model and believed that it is beneficial for the implementation of 5G networks within rural areas. However, some participants have additional thoughts and concerns regarding the cost model and its implementation. One of the participants suggested a more detailed breakdown of the community cost equation used to better see the costs that would be incurred, along with basing it off a case study of an already implemented system. Another suggested that there would be a consideration of the equation within the context of the national budget for rural broadband initiatives. There was also a major concern within the group of them not being convinced that the proposed model fully accounts for the socio-economic factors that influence the cost of broadband access in rural areas. Without this consideration, it is possible that some individuals may still be unable

to afford access to the 5G network, even with subsidies in place. Other suggestions were taken into the model and iterated accordingly as presented above, such as inputting spectrum costs into the equations given that it is clearly a needed consideration while also putting how to manage such spectrums sustainably and competitively into the discussion below based on what has been discussed within the focus group.

6. DISCUSSION

From the responses that have been obtained, there is much agreement, though it did bring up points to look at, such as where this would sit within the budget for rural broadband initiatives and the different problems that may be associated with the implementation. One challenge faced by community-built networks is their ability to utilize the signals and technologies that 5G requires and operates on, as many network providers leverage ownership over such rights to stay competitive (Plantin, 2021). However, the Open RAN initiative may be the solution to this issue, as it advocates for creating an open-source-based ecosystem that allows for interoperability for telecommunication providers' equipment. It enables neutral host architectures, which would allow for community-based initiatives to build on their existing community-based broadband networks or start implementing them if they have not yet done so. This initiative also opens the possibility for more infrastructure sharing between communities, allowing for cooperation to set up and share a community-based broadband service on 5G, leading to lesser costs in the long run and increased benefits for both communities.

In March 2022, President Biden allocated US$600 million towards rural broadband initiatives (The White House, 2022). The FCC and Congress should distribute funds based on initiatives put forth by communities and provide training and 5G network setup initiatives to those communities to enable the network externality effect, as per the Bass model discussed. Many communities may still lack the knowledge to utilize such initiatives as Open RAN and understand its benefits over normal broadband. Thus, a sample size from the communities should be invited to participate in a program that introduces such technologies and invites them to set up their community-based broadband solutions with 5G, as this benefits both their communities and increases competition so that not only the major telecommunications players control internet access in communities.

Regulatory issues such as licenses are another major component to consider for exploring 5G's potential changes, especially for smaller communities. Milgrom et al. (2017) proposed the innovative idea of depreciating licenses and creating a liquid secondary market for the sale of spectrums that may depreciate depending on the time and the price paid for it. To make this market more accessible for smaller communities, a separate market should be created that only allows communities with a population threshold of less than 2,500 to participate. The FCC should provide a spectrum of licenses for this purpose. This would be an extension of Mexico's social licensing program that allows communities with less than 3,000 people to apply for a special license to obtain a spectrum for their usage, as discussed by Wallace et al. (2015).

7. FUTURE RESEARCH DIRECTIONS

Based on the findings of this paper, several potential future research directions can be explored. One of the key recommendations for future research is to conduct a longitudinal study to evaluate the effectiveness of the proposed 5G cost model for community implementation. This study

would observe and measure the impact of 5G technology on the broadband and wireless access of rural areas, and whether the ARPM-based cost model is sustainable and effective in promoting fairness and competitiveness among local and nationwide providers. By monitoring the results of the community implementation over time, it would be possible to identify any areas of improvement and make changes to the cost model and regulatory considerations based on the feedback obtained.

Furthermore, the proposed cost model based on average revenue per machine (ARPM) presents an opportunity for further exploration, such as assessing the cost implications of deploying 5G networks using this model and how it compares to the traditional average revenue per user (ARPU) model. Research could also be conducted to explore the potential for other innovative cost models that can address the unique challenges of providing high-speed internet access in rural areas. Combined with the longitudinal study, this can certainly help evaluate the best model to be used and appropriately help with the concerns of those that this model may not be the most sustainable for those living in rural areas.

Finally, the research could benefit from further study in the design of affordable, scalable hardware for community networks. While 5G technology offers the potential for high-speed connectivity, it can be expensive to deploy and maintain. Developing affordable hardware that can be easily installed and maintained by community members would be a major step towards making 5G-powered networks more accessible to rural communities, and certainly would erase more barriers to entry for local players to also enter the market within the community and hence promote more affordability to those living in the areas.

8. CONCLUSION

In summary, the widespread adoption of 5G technology, particularly in rural areas with community-based networks, would present significant opportunities for these communities to experience economic development and bridge the current broadband divide. 5G technology will surpass previous wireless standards in several ways, including changes to the financial measurement from APRU to APRM and the increase in speed offered. This technology will enable communities to meet and even exceed the minimum broadband recommendations established by the FCC. By working together, with the cooperation of Congress, the FCC, and the Executive branch, proposed programs can be successfully planned and executed. As a result, the US will make significant progress towards achieving internet accessibility for all. The journey towards bridging the digital divide with 5G is to be an arduous journey that is still in its experimental stages but holds the key to getting us even closer to achieving it holistically if we make good use of the opportunity given to us by the technology. Ultimately, access to the internet is a fundamental right that should be available to everyone, rather than being treated as a privilege.

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Market Predictability and Mean Reversion in MENA Markets: An Empirical Study of Equity Market Efficiency

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Variance ratios;
Random walk;
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Abstract: *This research aims to provide evidence for investors and regulators of the MENA stock markets, including Bahrain (BASI), Egypt (EGX 30), Abu Dhabi (FTSE ADX), Pakistan (KSE 100), Morocco (MASI), Oman (MSM 30), Qatar (QSE), Saudi Arabia (TADAWUL ALL), and Tunisia (TUNNIDEX), from March 1, 2018, to February 23, 2023. Because variance ratios are less than one, the results show that indexes do not follow the random walk hypothesis (RWH), suggesting autocorrelation in returns over time and average reversal in all indexes. These findings refute both the RWH and the financial market information efficiency hypothesis. According to the study, market regulators should take initiatives to improve information in these regional markets.*

1. INTRODUCTION

Efficiency is a fundamental concept in financial markets, and one of the most influential theories in this area is the efficient market hypothesis (EMH). According to EMH, financial asset prices reflect all available information; therefore, it is impossible to continually outperform the market by utilizing any knowledge currently available to the public. This indicates that a stock market is efficient when all of its participants are equally competent and the market prices of any securities represent their theoretical or intrinsic price (Fama, 1965a, 1965b, 1970).

Efficiency is a fundamental concept in financial markets, and one of the most influential theories in this area is the efficient market hypothesis (EMH). EMH states that financial asset prices reflect all available information and that a stock market is efficient when all participants are equally competent and market prices represent their theoretical or intrinsic price (Fama, 1965a, 1965b; Fama & French, 1988).

The rate at which new information is incorporated into bond prices is one of the essential characteristics of an efficient market. Prices respond fully and swiftly to the latest information, and it is hard to gain an advantage by acting on knowledge that is already known to the public. This means that the market is always reacting to new information, and as a result, bond prices are continually changing (Dias & Santos, 2020).

In addition to assuming that the information available on the market is free of charge, EMH also assumes that market participants are rational and act in their interests, making decisions based on all available information. However, recent studies have shown that emotions and other psychological factors can play a significant role in financial decision-making (Dias et al., 2022; Pardal et al., 2022).

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The efficient market hypothesis is a widely accepted theory in finance, but no theory is perfect and financial markets can be influenced by a variety of factors. It is important to proceed with caution and analyze all available information before making any investment choice (Guedes et al., 2022; Zebende et al., 2022).

This study focuses on the efficiency and predictability of the stock markets of the MENA countries, including Bahrain, Egypt, Abu Dhabi, Pakistan, Morocco, Oman, Qatar, Saudi Arabia, and Tunisia, from March 1, 2018, to February 23, 2023. The study is motivated by recent developments that have had an impact on the global economy, and the stock markets, including the COVID-19 pandemic, the oil price war, and geopolitical tensions, such as the Russian invasion of Ukraine in 2022. The research results show that the random walk hypothesis, which assumes that stock prices follow randomness and cannot be predicted, is rejected in all markets, indicating that markets are inefficient in their weak form and that returns are autocorrelated over time. Furthermore, the existence of an average reversal on all indexes implies that returns tend to fall back to their long-term average if they deviate significantly from it. These findings have significant implications for investors and market regulators, highlighting the need for greater information efficiency in regional markets to ensure fair competition between participants and reduce the potential for market manipulation.

In terms of structure, this paper is organized into 5 sections. Section 2 presents a Review of the Literature concerning articles on the efficient market hypothesis in international financial markets. Section 3 describes the methodology and data. Section 4 contains the results. Section 5 is concluded.

2. LITERATURE REVIEW

The concept of market efficiency was introduced by Gibson (1889). The author argued that the value of the shares at the time of their public disclosure was the most accurate representation of their value since it reflected complete information. Later Bachelier (1900), a French mathematician who shared this view, began to formulate the random walk hypothesis. According to this hypothesis, the behavior of commodity prices is unpredictable and independent of past fluctuations. Bachelier's work contributed to the development of the market efficiency hypothesis, one of the most well-known theories in finance. Cowles (1933, 1944), and Working (1949) reinforced the random walk hypothesis. They explained that investors could not use historical prices to predict future returns and therefore could not get extraordinary profits in a seemingly "perfect" market.

Previous work by Gibson, Bachelier, Cowles, and Working has reinforced the random walk hypothesis, with Roberts (1959) providing more evidence and Osborne (1959) supporting the idea that asset prices behave randomly and are difficult to predict.

Granger and Morgenstern (1963) further reinforced the random walk hypothesis by describing the behavior of asset prices as a stochastic process. They explained that securities' future forecasts are not affected by their historical prices, meaning past trends or patterns are not a reliable indicator of future trends. In other words, the market efficiency hypothesis suggests that it is difficult or impossible to consistently overcome the market by using publicly available information. This has significant implications for investors and financial professionals, as it suggests that investing in a well-diversified asset portfolio may be the most effective way to achieve long-term financial success.

Lagoarde-Segot and Lucey (2008) studied efficiency in seven emerging stock markets in the Middle East and North Africa region (MENA). The authors use a combination of random testing and commercial technical analysis to create an efficiency index and analyze the effects of market development, corporate governance, and economic liberalization on this index. MENA stock markets have distinct levels of efficiency, with market depth and corporate governance having an impact, but economic liberalization does not seem to be significant. Later, Al-Zaubia and Al-Nahlehb (2010) analyzed the random walk hypothesis (RWH) in the stock indexes of Morocco, Tunisia, Egypt, Jordan, and Turkey between January 1, 2004 and December 31, 2006. According to RWH, speculative strategies are expected to produce zero expected returns, but the authors found that RWG was rejected in all the markets studied. In addition, Sensoy (2013) used a rolling window technique to examine time efficiency in 15 stock markets in the Middle East and North Africa (MENA) region from 2007 to December 2012. The study found that all exchanges present varying degrees of long-term dependence, and the Arab Spring has had a detrimental effect on market efficiency. Turkey is the least inefficient, followed by Israel, while Iran, Tunisia and the United Arab Emirates are the least efficient. Turkey and Israel have characteristics of developed financial markets.

Heliodoro et al. (2020) as well as Takyi and Bentum-Ennin (2020), conducted studies to test the random walk hypothesis and evaluate the efficiency of various international markets. Heliodoro et al., (2020) studied the capital markets of Argentina, Brazil, Chile, Colombia, Mexico, Peru, and the US between 2015 and 2020 to determine if the global pandemic of 2020 had caused contagion in these markets and assess the effectiveness of diversification strategies. They found that the pandemic did not result in higher levels of contagion than expected, which may be of interest to investors looking for opportunities in these markets. On the other hand, Takyi and Bentum-Ennin (2020) found that the global pandemic of 2020 had a negative effect on African capital markets between October 2019 and June 2020. This suggests that the pandemic may have had a significant impact on the performance of African capital markets and highlights the importance of considering the potential effects of global events on investment strategies.

Ananzeh (2021) examined the efficiency of Arab stock exchanges in the MENA region based on the random walk hypothesis (RWH). Test results showed that RWH was rejected for all markets, contradicting the results of studies conducted in developed and emerging markets. The study suggests that the ineffectiveness of reforms adopted by responsible bodies in these markets could be a contributing factor. Efforts should be intensified to improve liquidity, transparency, investment culture, and legislative and regulatory reforms to attract investment and the financial sector in these markets.

Zebende et al. (2022) and Dias et al. (2022) assessed the efficiency of various financial markets by examining whether their returns followed a random walk process and whether there was evidence of autocorrelation over time. Zebende et al. (2022), focused on the G20 capital markets and used intraday data to measure efficiency in its weak form. The study found that during the COVID-19 pandemic, stock exchanges tended to be efficient for less than five-day time scales, while for times greater than ten days, stock markets tended to be inefficient. Cross-correlation analysis using the DCCA method showed variable behaviors for each stock exchange index separately. Meanwhile, Dias et al. (2022) tested the efficient market hypothesis in several capital markets, including Botswana, Egypt, Kenya, Morocco, Nigeria, South Africa, Japan, the UK, and the US. Their study concluded that returns were autocorrelated, highlighting that the random walk hypothesis is not applicable in all markets. There were no differences between mature and emerging markets.

According to a recent study by Aslam et al. (2023), Islamic exchanges perform differently than conventional exchanges, particularly when there is economic policy uncertainty (EPU) or other vulnerability, such as geopolitical tensions. The study examined the US EPU's cross-correlation with conventional and Islamic stock exchanges from the perspective of multifractality, using daily exchange prices from 5 major countries. It found a strong law of power and multifaceted characteristics, which is relevant for market participants in both conventional and Islamic markets, and for investors to draw useful conclusions for portfolio diversification.

Another recent study by Santana et al. (2023) explored the relationship between the energy sector, including oil, gas and renewables, and the stock market, focusing on the impact of global crises such as COVID-19 on the economy. The authors used an econophysical analysis to examine the interdependence and contagion effect between crude oil and two precious metals, gold, and silver, before and during the crisis. The study concluded that COVID-19 had no influence on the interdependency between crude oil indexes but increased the impact of raw oil and precious metals.

In short, this investigation aims to provide valuable insight to investors and regulators of the stock markets of the MENA countries, including Bahrain (BASI), Egypt (EGX 30), Abu Dhabi (FTSE ADX), Pakistan (KSE 100), Morocco (MASI), Oman (MSM 30), Qatar (QSE), Saudi Arabia (TADAWUL ALL), and Tunisia (TUNNIDEX). To promote evidence of how these markets are becoming increasingly attractive to individual and institutional investors seeking diversification, this study aims to promote the implementation of policies that increase the efficiency of those markets and contribute to the overall effectiveness of international markets.

3. METHODOLOGY AND DATA

3.1. Data

The data used to develop the investigation is the price index (day) of the stock markets of the MENA countries, namely Bahrain (BASI), Egypt (EGX 30), Abu Dhabi (FTSE ADX), Pakistan (KSE 100), Morocco (MASI), Oman (MSM 30), Qatar (QSE), Saudi Arabia (TADAWUL ALL), and Tunisia (TUNNIDEX), taken from the Thomson Reuters Eikon platform for the period from March 1, 2018, to February 23, 2023.

Table 1. Indexes and respective countries considered in this study

Index	Country
BASI	Bahrain
EGX 30	Egypt
FTSE ADX	Abu Dhabi
KSE 100	Pakistan
MASI	Morocco
MSM 30	Oman
QSE	Qatar
TADAWUL ALL	Saudi Arabia
TUNNIDEX	Tunisia

Source: Own elaboration

3.2. Methodology

This investigation was developed in three stages. In the first stage, we proceeded to the graphic representation of the fluctuation of time series over time and their statistical description (average,

standard deviation, kurtosis and asymmetry coefficients). The Jarque and Bera (1980) test was performed in this phase to verify whether the time series followed a normal distribution.

In a further step called Diagnostics, the existence or absence of autoregressive unit roots in time series was determined using the panel tests of Levin et al. (2002) and for validation Dickey and Fuller (1981), and Perron and Phillips (1988) with Fisher transformation. Also, to recognize the effect of shocks on the movements of the time series under investigation, which is very important because we are studying a period of high complexity for financial markets, we used the Clemente et al. (1998) test.

We also analyzed the observed versus adjusted residues to assess whether the time series are nonlinear or have a substantial nonlinear component, using the BDS test (Brock & de Lima, 1996). This method is used to discover time series dependency by evaluating the null hypothesis of a series being i.i.d. (independent and identically distributed).

The non-parametric test proposed by Wright (2000), the Ranking Test, and the Signal Test for heteroscedastic series were used to address the investigation question. In the presence of serial correlation, they provide better estimates with smaller sample sizes and have higher statistical power than conventional variance ratio tests (Vats & Kamaiah, 2011).

The statistics that define the rank and signs of the Wright test are derived assuming the following:

Considering Y_t the return of a time series with a dimension of the t sample, then:

$$Y_t = X_t - X_{t-1} \tag{1}$$

Assuming that $r(Y_t)$ is the rank of Y_t between a set of t observations, then $r(Y_t)$, is a number between 1 and t given by:

$$r'_{1t} = \frac{\left(r(r_t) - \frac{T+1}{2}\right)}{\sqrt{\frac{(T-1)(T+1)}{12}}} \tag{2}$$

$$r'_{2t} = \Phi^{-1}\left(\frac{r(r_t)}{T+1}\right) \tag{3}$$

Where Φ is the standardized inversed cumulative normal distribution. The inverse is Φ^{-1}. And r'_{1t} is a standardized linear transformation of the rankings with sample average 0 and variance 1 while r'_{2t} has a sample average of 0 and variance of approximately 1. Thus, the statistics of the rankings test are obtained as follows for the considered lags:

$$R_1(q) = \left(\frac{\frac{1}{Tq}\sum_{t=q+1}^{T}(r'_{1t} + r'_{1t-1} + \cdots + r'_{1t-q})^2}{\frac{1}{T}\sum_{t=q+1}^{T}(r'_{1t})^2}\right) \times \left(\frac{2(2q-1)(q-1)}{3qT}\right)^{-1/2} \tag{4}$$

$$R_2(q) = \left(\frac{\frac{1}{Tq}\sum_{t=q+1}^{T}(r'_{2t} + r'_{2t-1} + \cdots + r'_{2t-q})^2}{\frac{1}{T}\sum_{t=q+1}^{T}(r'_{2t})^2}\right) \times \left(\frac{2(2q-1)(q-1)}{3qT}\right)^{-1/2} \tag{5}$$

The variance ratio test statistics based on S_1 signals are defined as follows:

$$S_1(q) = \left(\frac{\frac{1}{Tq}\sum_{t=q+1}^{T}\left(S_t + S_{t-1} + \cdots + S_{t-q}\right)^2}{\frac{1}{T}\sum_{t=q+1}^{T}(S_t)^2} \right) \times \left(\frac{2(2q-1)(q-1)}{3qT} \right)^{-1/2} \quad (6)$$

Where:

$$S_t = 2u(r_t, 0) \quad (7)$$

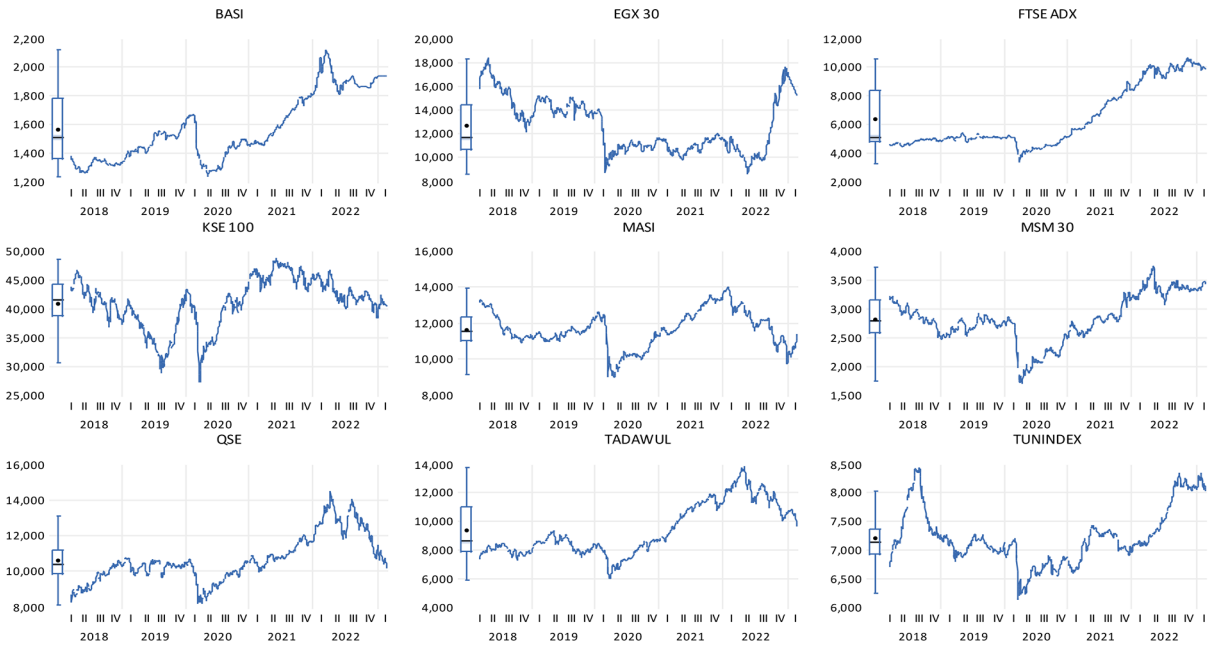
is a series i.i.d. with an average 0 and variance 1.

$$v(x_t, p) = \begin{cases} 0{,}5 & \text{where } x_t > p \\ -0{,}5 & \text{where } x_t \leq p \end{cases} \quad (8)$$

The ratio of variance is given by the ratio between the variance of q periods and a single period, being the same equal to 1. In this sense, when $VR(q) = 1$, the series follows a random walk process. When the random hypothesis is rejected, but $VR(q) > 1$, the series indicates the existence of a positive correlation, and when $VR(q) < 1$, the series demonstrates a negative correlation.

4. RESULTS

The evolution of the 9 stock markets from March 1, 2018, to February 23, 2023, as shown in **Figure 1**, reveals the presence of more robust structural breaks in most markets throughout the first and second quarters of 2020 (COVID-19) and 2022 (Russia-Ukraine Conflict). It should be emphasized, however, that markets have reacted more exaggeratedly to the COVID-19 pandemic announcement than to the start of a military conflict between Russia and Ukraine. The authors Horta et al. (2022) and Dias et al. (2022) corroborate this as well.



Note: Data worked by the authors (software: EViews12).

Figure 1. Evolution in levels of the financial markets under study from March 1, 2018, to February 23, 2023
Source: Own elaboration

Table 2 summarizes the descriptive statistics as well as the Jarque and Bera test results for the 9 stock markets under consideration: Bahrain (BASI), Egypt (EGX 30), Abu Dhabi (FTSE ADX), Pakistan (KSE 100), Morocco (MASI), Oman (MSM 30), Qatar (QSE), Saudi Arabia (TADAWUL ALL), and Tunisia (TUNNIDEX) from March 1, 2018, to February 23, 2023.

The average returns for each of the 9 stock markets are close to zero, except for Egypt (EGX 30), Pakistan (ESF 100), and Morocco (MASI). The Bahrain stock market (BASI) has the highest average daily return (0,000277) and the Pakistan stock market (KSE 100) has the lowest daily return (-0,0000613). Morocco (MASI) is the most volatile stock market with a standard deviation of 0.12777, while Tunisia (TUNNIDEX) has the lowest level of volatility with a standard deviation of 0.004788.

In terms of asymmetry and shortness coefficients, all markets have values that differ from those used as a reference for a normal distribution. The findings of the Jarque and Bera (1980) test indicate rejection of the normality hypothesis, which has been verified to a level of significance of 1%.

Table 2. Descriptive statistics of the financial markets under study from March 1, 2018, to February 23

	BASI	EGX 30	ADX	KSE 100	MASI	MSM 30	QSE	TADAWUL	TUNINDEX
Mean	0.000277	-2.86E-05	0.000611	-6.13E-05	-0.000117	5.08E-05	0.000124	0.000209	0.000146
Std. Dev.	0.005552	0.012777	0.010910	0.011613	0.007926	0.011289	0.009354	0.010593	0.004768
Skewness	-1.551737	-0.653020	-0.508066	-0.592360	-2.196636	-0.938259	-1.026867	-1.315486	-1.500757
Kurtosis	20.78030	9.405177	18.56270	7.232594	28.72994	14.99735	16.67749	14.43702	15.94773
Jarque-Bera	16953.64***	2223.846***	12658.10***	1005.362***	35457.58***	7673.945***	9955.127***	7167.565***	9193.303***
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000
Observations	1249	1249	1249	1249	1249	1249	1249	1249	1249

*** represents the rejection of the null hypothesis at a significance level of 1%
Note: Data worked by the authors (software: EViews12).

Source: Own elaboration

The research topics are addressed by use of econometric models. We examine the presence of auto-regressive unit roots in the observable components of the time series using price indices that, by nature, need a prior diagnosis. We used panel unit root tests for this since they have better statistical power and provide more robust results (Hadri, 2000; Maddala & Wu, 1999). We also applied the Levin et al. (2002) test, whose results show stationarity in first differences, evidence corroborated by Dickey and Fuller's (1981) and Perron and Phillips (1988) tests with Fisher transformation, as seen in **Table 3**.

Table 3. Unit Root Tests applied to the financial markets under study from March 1, 2018, to February 23, 2023

Method	Statistic	Prob.**	sections	Obs.
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-106.065	0.0000	9	11220
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-91.6771	0.0000	9	11220
ADF - Fisher Chi-square	1535.68	0.0000	9	11220
PP - Fisher Chi-square	1476.57	0.0000	9	11223

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.
Note: Data worked by the authors (software: EViews12).

Source: Own elaboration

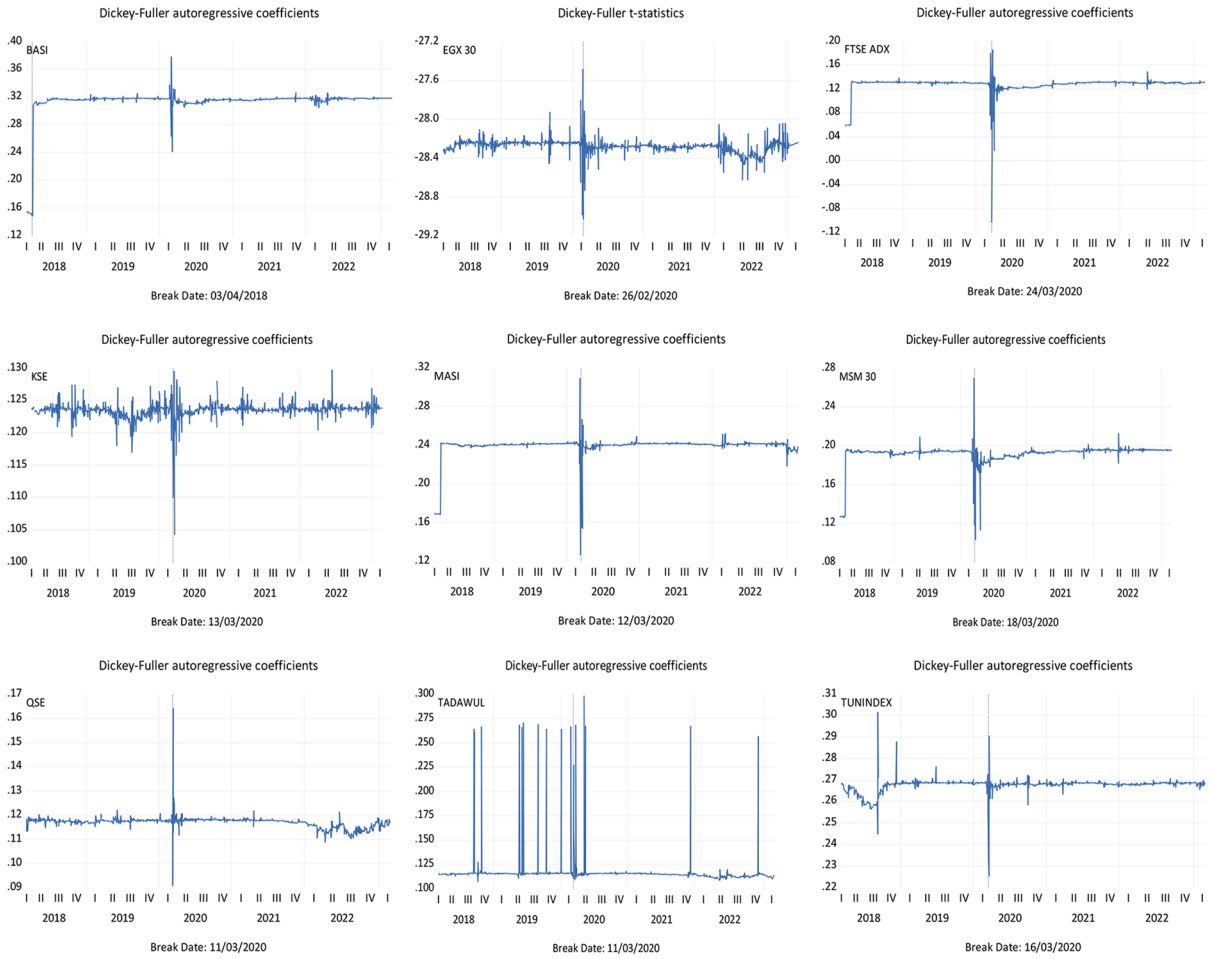
To validate the reliability of the results obtained by conventional unit root tests, and because we are working with data from a turbulent period in the financial markets, the test developed by

Clemente et al. (1998) was used, which, in addition to validating the presence of unit root, identifies the most significant structure breakdown and the date it occurs.

The most important shocks in most markets occurred during the outbreak of the COVID-19 pandemic and had only a transitory effect, reducing the possibility of unit roots in the data series (see **Figure 2**).

Residual stability tests measure the occurrence of breaks in time series structures caused by abrupt drops in prices. **Figure 3** shows the presence of disturbances in the variance and violations of the probability limits at 95%, indicating unstable behavior in the markets under consideration.

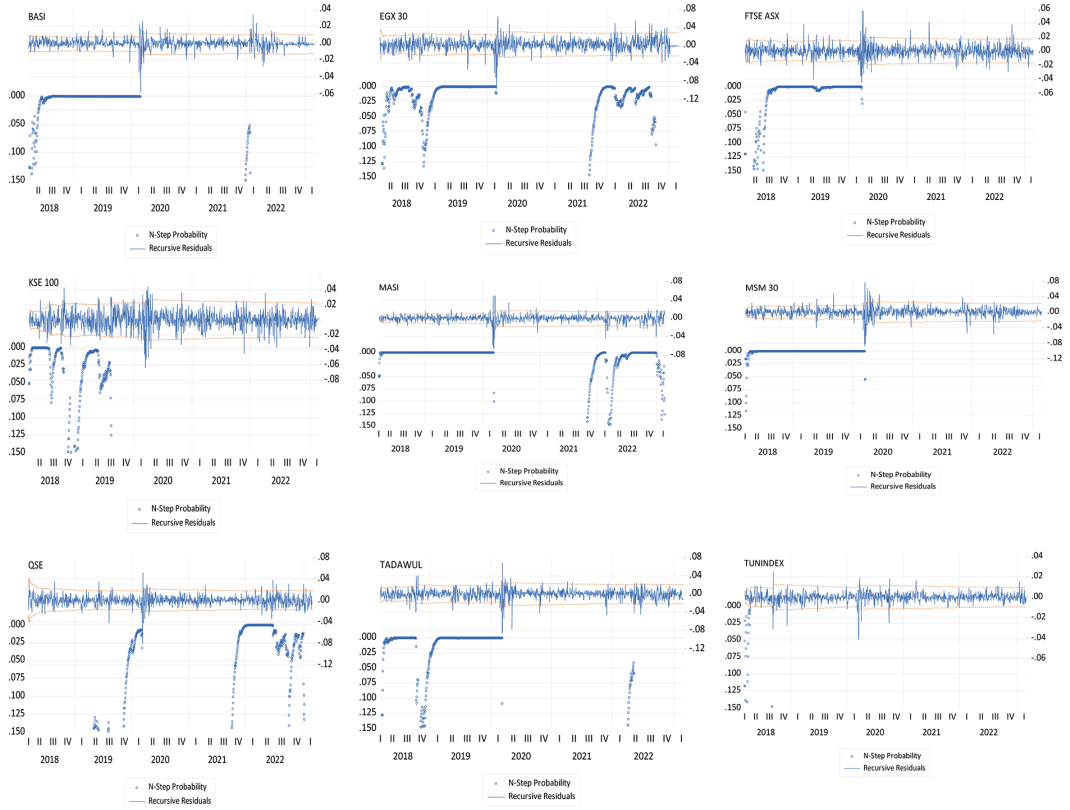
We exhibit a graphic that compares observed residuals against estimated residuals to analyze residual distribution. Non-linearity, outliers, and unequal error variances are all prevented by using the plot. A negative residual suggests that the expected value is too high; a positive residual indicates that the projected value is too low. According to **Figure 4**, all the financial markets studied exhibit unequal dispersion or a systematic change in residual distribution within the range of observed values (heteroscedasticity).



Note: Data worked by the authors (software: EViews12).

Figure 2. Clemente et al. (1998) Unit Root Test, with structural breaks, applied to the financial markets under study from March 1, 2018, to February 23, 2023

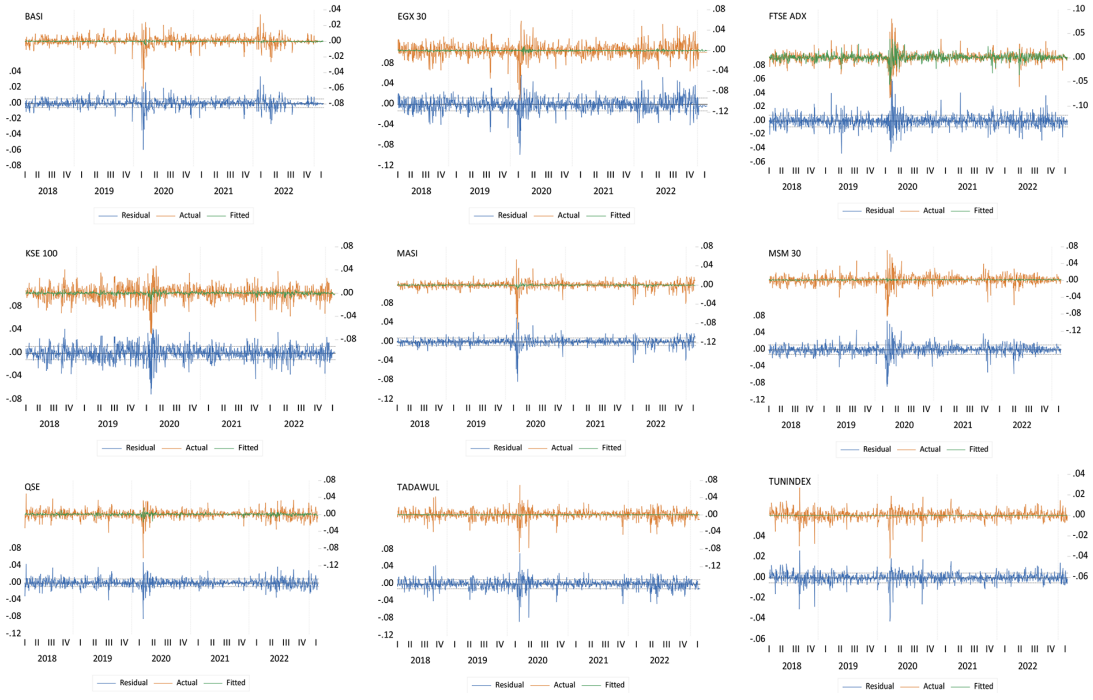
Source: Own elaboration



Note: Data worked by the authors (software: EViews12).

Figure 3. Stability Test to the recursive residuals of the financial markets under study from March 1, 2018, to February 23, 2023

Source: Own elaboration



Note: Data worked by the authors (software: EViews12).

Figure 4. Residuals vs. fits plot for the financial markets under study during the period from March 1, 2018, to February 23, 2023

Source: Own elaboration

The BDS test (Brock & de Lima, 1996) was used to confirm the data presented above, which proposes a null hypothesis H_0, the classification of residuals as independent and identically distributed and, as an alternative H_1, the presence of linear or non-linear dependency on residuals. The results of the z statistics, i.e., the residuals filtered through an ARMA estimate (BDS test), are shown in **Table 4** and propose the rejection of the null hypothesis with a statistical significance of 1% for all-time series beginning with dimension 2, reinforcing the idea that the profitability of stock indices is nonlinear or has a significant nonlinear component. The rejection of the null hypothesis implies that the data are not independent and identically distributed, which can be explained by the presence of heteroscedasticity in terms of error in the time series under consideration, among other factors.

Table 4. Results of the BDS Test applied to the financial markets under study during the period from March 1, 2018, to February 23, 2023

BDS Test for BASI				
Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.035314	0.002986	11.82580	0.0000
3	0.064788	0.004760	13.60973	0.0000
4	0.084081	0.005688	14.78192	0.0000
5	0.094289	0.005950	15.84756	0.0000
6	0.098295	0.005759	17.06845	0.0000
BDS Test for EGX 30				
Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.021876	0.002449	8.934326	0.0000
3	0.044155	0.003891	11.34903	0.0000
4	0.056930	0.004632	12.29005	0.0000
5	0.063233	0.004827	13.09878	0.0000
6	0.063284	0.004655	13.59556	0.0000
BDS Test for FTSE ADX				
Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.036180	0.002866	12.62193	0.0000
3	0.059195	0.004560	12.98092	0.0000
4	0.069480	0.005437	12.77849	0.0000
5	0.072587	0.005675	12.79019	0.0000
6	0.072215	0.005481	13.17505	0.0000
BDS Test for KSE 100				
Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.016679	0.002560	6.514144	0.0000
3	0.034800	0.004062	8.567278	0.0000
4	0.049045	0.004829	10.15639	0.0000
5	0.055431	0.005025	11.03095	0.0000
6	0.057567	0.004838	11.89786	0.0000
BDS Test for MASI				
Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.028117	0.002830	9.936610	0.0000
3	0.049403	0.004492	10.99725	0.0000
4	0.063279	0.005345	11.83823	0.0000
5	0.068535	0.005568	12.30957	0.0000
6	0.068441	0.005366	12.75431	0.0000
BDS Test for MSM 30				
Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.025520	0.002571	9.926284	0.0000
3	0.048702	0.004086	11.92028	0.0000
4	0.058641	0.004865	12.05237	0.0000
5	0.062312	0.005072	12.28625	0.0000
6	0.061682	0.004892	12.60966	0.0000

BDS Test for QSE				
Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.011658	0.002560	4.553096	0.0000
3	0.030183	0.004069	7.416943	0.0000
4	0.042450	0.004847	8.758191	0.0000
5	0.048452	0.005053	9.588621	0.0000
6	0.051392	0.004874	10.54320	0.0000
BDS Test for TADAWUL				
Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.019372	0.002581	7.505483	0.0000
3	0.041386	0.004101	10.09217	0.0000
4	0.056178	0.004882	11.50622	0.0000
5	0.067329	0.005088	13.23237	0.0000
6	0.071188	0.004906	14.50911	0.0000
BDS Test for TUNINDEX				
Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.029573	0.002617	11.30175	0.0000
3	0.052612	0.004159	12.65098	0.0000
4	0.066023	0.004953	13.32922	0.0000
5	0.071538	0.005164	13.85313	0.0000
6	0.072185	0.004982	14.49070	0.0000

Note: Data worked by the authors (software: EViews12).

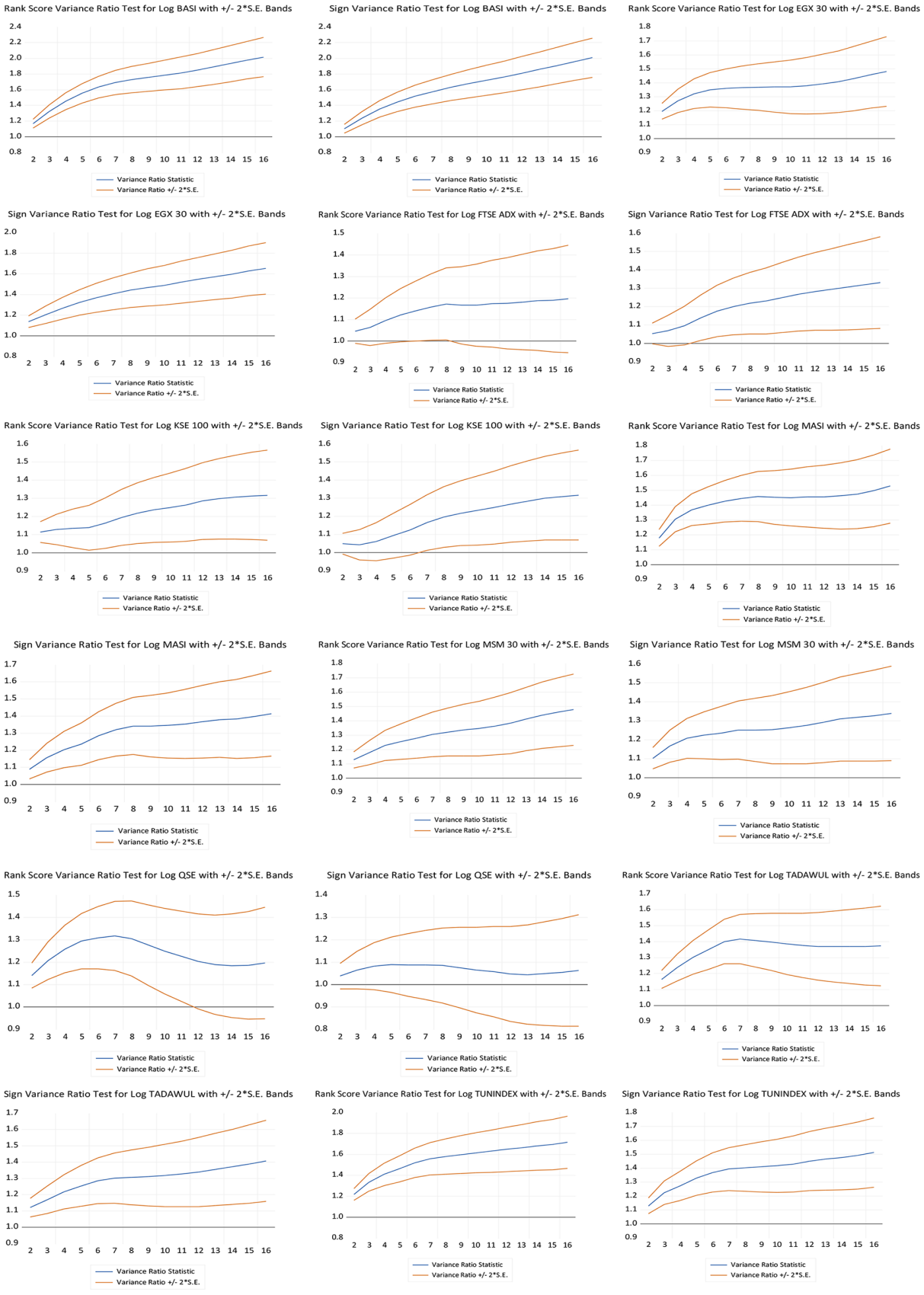
Source: Own elaboration

5. DISCUSSION

The variance tests were calculated using Wright's (2000) methodology, which involves the Tests of Variance Rates of Rankings and Signals for 2, 4, 8, and 16 lags, from March 1, 2018, to February 23, 2023, to test market efficiency, in its weak form.

According to the results shown in **Figure 5**, the Variance by Rankings and Signals test rejects the null random walk hypothesis (RWH) on all indices and for all lags. The rejection of RWH under the homoscedasticity hypothesis might be linked to the presence of heteroscedasticity, as evidenced by the BDS Test results. By observing the values of the ratios and signs in variance, we may conclude that, in all cases, they are greater than the unit (positive autocorrelation). Positive autocorrelation implies that MENA markets exhibit persistent movements over time, i.e., stock prices on their respective stock exchanges tend to move in the same direction over the period in consideration.

Positive autocorrelation may have different implications for investors from an economic perspective because it may indicate that an investor, based on historical stock price patterns, is able to buy after a positive move and sell after the subsequent downward move, allowing for abnormal returns; or because prices do not reflect all available information, it can lead to stock price disinformation, inefficient resource allocation, and potentially lower long-term economic growth. As a result, the economic importance of positive autocorrelation in the findings of Wright's Rankings and Signals test applied to the MENA stock markets will always be underlying the standard, whether it leads to profitable trading opportunities or inefficient market results. The authors Zebende et al. (2022), Guedes et al. (2022), Santana et al. (2023), Dias, Chambino and Horta (2023), Dias, Horta and Chambino (2023) all validate these findings.



Note: Data worked by the authors (software: EViews12).

Figure 5. Results of the Rank and Sign Variance Ratio Tests for financial markets under study from March 1, 2018, to February 23, 2023

Source: Own elaboration

6. CONCLUSION

In conclusion, this study provides solid evidence for investors and regulators in the MENA stock markets from March 1, 2018, to February 23, 2023. The study's findings suggest that indices do not follow the random walk hypothesis (RWH), since variance ratios are lower than the unit, showing autocorrelation in returns over time and average reversal in all indices. These findings reject the RWH theory as well as the financial markets' informational efficiency. The study highlighted the need for market authorities to make efforts to improve information in these regional markets, as the findings indicate that markets are inefficient in their weak form. As a result, investors can identify opportunities for profitable trading strategies based on market historical trends. Lastly, the findings have significant implications for investors and market regulators, underlining the importance of improving information efficiency in these regional markets to ensure fair competition among participants and reduce the potential for market speculation.

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COVID-19 vs. Russia-Ukraine Crisis: Capital Market Response

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Abstract: *From the pure health crisis that countries faced at the very beginning of the COVID-19 pandemic, in later stages it led to the creation of multiple economic and financial vulnerabilities. When the world economies started recovering from the pandemic negative impacts, Russia started its invasion of Ukraine. The study aims to add to the growing body of literature on the topic of crises caused by the COVID-19 and Russian–Ukraine war by analyzing and comparing the volatility of the world's leading stock market performance benchmarks in the pre-crisis and crisis periods. For the analysis, Levene's test is used to check the homogeneity/heterogeneity of variances of stock market returns. Analysis shows that all indexes performed better in the Russian–Ukraine crisis compared to the COVID-19 crisis, i.e., the volatility of returns of all indexes is significantly lower in the Russian-Ukraine crisis compared to the COVID-19 crisis.*

1. INTRODUCTION

Since the beginning of the human race, two calamities have scared people the most - disease and war. Especially, if they spread quickly and if many people are exposed to them. Pandemics and wars affect civilization on many levels - people die and are injured, families fall apart, property is destroyed, and overall economic activity suffers as well.

Financial markets, and especially stock exchanges, are considered by many to be the ultimate achievement of human creativity in the field of economics. Apart from the basic function of connecting business entities with surplus and deficit in capital and channeling funds, stock markets are considered the most agile indicator of the state and changes in the economic system.

We live in difficult times. In a short period of just a few years, civilization was hit by two serious disasters - the COVID-19 pandemic and the Russian Federation's aggression against Ukraine. Global stock markets reacted instantly to both events. After the closure of the regions of Lombardy and Veneto in the north of Italy on February 23, 2020 (which was the first "lockdown" outside of China), the drop in capitalization on global stock markets by the end of February exceeded 6 billion dollars. On the first day of the Russian invasion (February 24th, 2022), the S&P 500 index lost 1.6% of its value, the FTSI 250 fell by 2.83%, and the DAX 40 lost 3.96% of its value.

Both crises have inexorably changed the contours of the global economy. However, additional questions arise: did the crises have the same impact on the financial markets, did the recovery proceed similarly, is the nature of these crises similar, and can they be reacted to in the same way?

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2. LITERATURE REVIEW

The outbreak and rapid spread of the COVID-19 pandemic, and especially the pandemic control measures, caused reactions in financial markets around the world, which immediately aroused the interest of researchers. In the economic environment, research was mainly focused in two directions - on the effects on international trade flows and international investment flows. In the first case, the researcher's focus is on measures taken by governments to protect and preserve trade activity, and in the second mainly on the effect on stock markets, measured by the volatility of prices and yields on securities and indices.

Mirza et al. (2020) already at the very beginning of the pandemic investigated the reaction and timing of the price volatility of European investment funds. On a sample of 266 funds from all categories (equity, bond, treasury, corporate, etc.), in the period January-June 2020, using the Sharp ratio, they measure the reaction of the fund's performance, and using the GARCH model, they test the variance in returns. The research results indicate a different effect of the pandemic, depending on the type of funds. Capital market funds (equity and bond) recorded the fastest and strongest negative reaction, while the most robust were funds that invest in socially entrepreneurial companies. Treasury funds had a positive yield reaction in the first stage of the pandemic, but their indicators also declined in the continuation of the pandemic.

Beirne et al. (2020) look at the reaction of the financial markets of 38 countries, focusing specifically on 14 emerging economies. The authors base the research on a panel of data with fixed effects for bond yields, share prices, exchange rates, and the volume of the flow of equity and debt capital, on January 4, 2010. until April 30, 2020. Using regression analysis and a structural VAR framework, they showed that emerging markets were more affected by the crisis than advanced economies. Emerging economies in Asia and Europe experienced the sharpest drop in stock prices, bond yields, and exchange rate values due to pandemics, followed by a sudden and significant capital outflow.

The scale of the effects of the COVID-19 crisis on financial markets is perhaps most clearly seen in the research by Baker et al. (2020), using data on daily changes in the prices of securities on American stock exchanges of more than 2.5% since 1900, determined that no previous epidemic of infectious disease had increased the volatility of the American stock market as strongly as COVID-19 (not even an epidemic of the Spanish flu of 1918, which was far more devastating in medical and humanitarian terms).

The world has never been more connected. This contributes to the quick "spillover" of crises, but also to a faster recovery because trade relations and the flow of funds were relatively quickly established, as soon as the "lockdown" measures were eased and communication solutions were found in pandemic conditions.

Zaimović and Dedović (2021) compared the reaction of the American capital market to the COVID-19 crisis with the reaction to the onset of the Global Financial Crisis of 2008. Based on data on the return on the S&P 500 index for the period May 5, 2008, to February 5, 2009 (Global Financial Crisis) and September 10, 2019, to June 10, 2020 (COVID-19 crisis) found that the market reaction to the COVID-19 crisis was shallower and shorter than in the case of the 2008 financial crisis. The recovery from the COVID-19 crisis was faster, among other things, due to the strong business performance and price growth of six technology companies (Facebook,

Amazon, Netflix, Alphabet, Apple and Microsoft) whose shares are constituents of the S&P 500 index. The role of IT technology in controlling and adapting living and working conditions during the pandemic benefited these companies, but also indirectly the recovery of the financial market.

The European financial market recovered just as quickly. This is supported by the research of Su et al. (2022) who observed the dynamics of returns before and after the COVID-19 crisis, in ten European financial markets (Germany, France, Italy and Spain, from the group of developed countries, and Russia, Poland, the Czech Republic, Ukraine, Romania and Hungary, as European developing countries). The authors found that the markets recovered in 252 working days (calendar year), and they found a high degree and an increase in the index of market connectivity (from 63.48% to 75.14%), which explains the strong "spillover" effect on the market. Spillover was one of the key features of this crisis.

And just as the global economy recovered from the COVID-19 crisis, the tension in the relations between the Russian Federation and Ukraine escalated again. First, Russia concentrated troops and military equipment in Belarus (a formal ally), and then on February 24, 2022, it began a large-scale military operation in the north and east of Ukraine. Financial markets in Europe and the world are under attack again.

One of the first papers dealing with the impact of Russia's invasion of Ukraine on European financial markets, on global capital markets, by Boungou and Yatié (2022) observes the market reaction in 94 countries. As an indicator of the reaction, the authors use daily returns on stock market indices, dividing the data into two subsets - for one month before and one month after the beginning of the Russian invasion. Using a logarithmic regression model on a panel of market data, the authors conclude that the markets recorded a negative yield reaction even before the start of the conflict, in anticipation of the invasion, but that the reaction was stronger after the start of the war. Also, the drop in returns on indices hit the markets of neighboring countries more strongly, as well as countries that were the first to demand an end to the offensive at the United Nations.

The research of Dias et al. (2022) supports the thesis of increased "contagion" of crisis events in the modern financial markets environment. The authors analyzed the movement of correlation factors among stock market indices of nine Central and Eastern European countries. They measured the dynamics of index volatility, using a family of t-tests, and determined that the level of contagion among markets is highly significant. Through 72 contagion tests, the authors confirmed the existence of 62 market pairs that show significantly high levels of spillover.

A very interesting and innovative approach to the analysis of the effect of Russia's invasion of Ukraine was applied by Yousaf et al. (2022). The authors used the "event study" approach, believing that was a sudden and unpredictable event for the financial markets ("black swan"). They defined the beginning of the war (February 24, 2022) as an event and took the five days before and after this date as the period that the event was limited to. The adjustment period ("estimation window") was 120 days before the start of the event. The research is based on normal daily returns from the financial markets of the G20 countries, as well as characteristic countries that border the G20 countries and are sensitive to the conflict in question (Romania, Hungary, the Netherlands, Slovakia, Poland), and Ukraine, which is directly affected by the conflict. The results showed that the stock markets of Hungary, Russia, Poland, and Slovakia were the first to

react in anticipation of military actions in Ukraine, achieving negative returns in the days before the event, while the stock markets of the G20 countries, as well as some of the stock markets of neighboring countries, were adversely affected in the days after the invasion.

The work by Ahmed et al. (2021) is also based on the "event-study" approach, but the authors do not take the beginning of the invasion as the key event, but the day on which the Russian Federation recognized the independence of two regions in the east of Ukraine (February 21, 2022). On that day, European markets recorded abnormally negative returns. The "Estimation window" in this research is 25 days before and after the characteristic event. Using logarithmic regression, the authors determined the highest cumulative abnormal returns in the financial, telecommunications and consumer products sectors, while high abnormal returns are recorded by shares of European companies from the energy sector. In geographical distribution, the markets of Germany, Sweden and Finland suffered the largest negative cumulative returns.

Izzeldin et al. (2022) compare the effect of Russia's invasion of Ukraine on global financial and commodity markets with the effect of two other global crises (the 2008 financial crisis and the COVID-19 pandemic). The period on which the research is based is three months before and three months after the characteristic day chosen as the beginning of the crisis (declaration of bankruptcy of the Lehman Brothers bank on September 15, 2008, announcement of lockdown in Italy on March 9, 2020, and invasion of Russian troops on the territory of Ukraine on February 24, 2022). As a representative of volatility, authors use data on the realized variance of intraday returns in five-minute intervals. The modeling is based on the heterogeneous autoregression model (HAR), and only the volatility test is based on the Markov model, together with the GARCH models. The research results indicate that the stock and commodity markets reacted the fastest to the Russian invasion, but that the intensity of the crisis after the invasion is significantly lower compared to COVID-19 and the financial crisis of 2008. On commodity markets, the highest degree of volatility is recorded in wheat and nickel, because the two countries in conflict are global exporters of these commodities.

3. METHODOLOGY AND DATA

3.1. Data

For the comparison of the COVID-19 and Russian – Ukraine war impact on the stock markets we analyzed and compared the volatility of the world's leading stock market performance benchmarks in the pre-crisis and crisis periods. The data used in this study were collected using the Market Watch website and included daily adjusted close prices for the S&P 500, DAX 40, and FTSE 250. The periods analyzed are as follows:

- Pre-COVID-19 Crisis period - August 1, 2019 – January 31, 2020;
- COVID-19 Crisis period - February 1, 2020 – July 31, 2020;
- Pre-Russian-Ukraine Crisis period - August 24, 2021 – February 23, 2022;
- Russian – Ukraine Crisis period - February 24, 2022 – August 24, 2022.

Indexes examined in the study are S&P500 - the best overall measurement of American stock market performance, FTSE250 - a stock market index comprised of mid-capitalised companies on the London Stock Exchange, and DAX 40 - the benchmark stock market index for the German economy. Index daily prices were converted to returns as follows:

$$R_t = lnP_t / lnP_{t-1} \quad (1)$$

where, R_t, P_t, and P_{t-1} is the daily return, the adjusted closing price of the stock at time t, and the previous day's adjusted closing price at time t–1; ln represents the natural logarithm.

Checking for stationary return series was done by Dickey and Fuller (1979). The Augmented Dickey-Fuller (ADF) test is estimated by the following equation:

$$\Delta Y_t = \alpha_0 + \gamma_1 y_{t-1} + \sum_{p_{i=1}} \beta_i \Delta y_{t-i} + \varepsilon_t \quad (2)$$

where α_0 signifies constant, p represents lag, γ_1 and y_{t-1} are the equation parameters and ε_t denotes a stochastic error term. If the value of the test is less than 0.05, then the test is significant, and the time series is set to be stationary (Bora & Basistha, n.d.).

Table 1 summarizes the descriptive analysis of price and returns for each index in the COVID-19 crisis period. According to the sample taken (N = 253) for the S&P 500 index during the period of August 1, 2019, to July 31, 2020, its values ranged from a minimum of 2237.4 to a maximum of 3386.15 with a mean value of X = 3025.345 and a standard deviation of SD = ± 216.0294. British stock market, FTSE 250 index recorded movement in the given period from a minimum of 12829.7 to a maximum of 22108.29 with a mean value of X = 18841.78 and SD = ± 2273.812. The values of the DAX index in the same period ranged from a minimum of 8441.71 to a maximum of 13789, with a mean value of X = 12170.12 and SD = ±1194.065. Additionally, if we observe the volatility of returns, the biggest volatility in this period was realized by the S&P 500. The skewness values in this analysis carry negative signs, which confirms that the returns are negative and indicates the presence of asymmetry. Furthermore, a negatively skewed return with a high kurtosis value signifies a very high risk of losses in all three stock markets.

Table 1. Descriptive statistics of S&P 500, FTSE 250 & DAX 40 in COVID-19 crisis

	S&P 500		FTSE 250		DAX 40	
	Price	**Return**	**Price**	**Return**	**Price**	**Return**
Obs	253	253	260	260	252	252
Mean	3025.345	0.0003976	18841.78	-0.0005765	12170.12	0.0000403
Max	3386.15	0.0896832	22108.29	0.0804	13789	0.1041429
Min	2237.4	-0.1276521	12829.7	-0.0982	8441.71	-0.1305486
Std. Dev.	216.0294	0.0213647	2273.812	0.0183092	1194.065	0.0199165
Variance	46668.69	0.0004564	5170223	0.0003352	1425791	0.0003967
Skewness	-0.9189121	-0.8877507	-0.4362319	-0.6926816	-1.014206	-1.018784
Kurtosis	4.17431	12.49252	2.210535	9.750837	3.418035	13.76217
Shapiro-Wilk test		0.81512		0.86746		0.84937
		(0.0000)		(0.0000)		(0.0000)
Skewness- Kurtosis test		61.28		48.39		68.50
		(0.0000)		(0.0000)		(0.0000)
ADF test		-23.097		-13.351		-15.605
		(0.0000)		(0.0000)		(0.0000)

Source: Authors

Table 2 summarizes the descriptive analysis for each index in the Russian-Ukraine crisis. As a representative of the US stock market, S&P 500 index during the period of August 24, 2021, to August 24, 2022, ranged from a minimum of 3666.77 to a maximum of 4796.56 with a mean value of X = 4347.304 and a standard deviation of SD = ±280.0905. The values of the DAX index in the same period ranged from a minimum of 12401.2 to a maximum of 16271.75, with a

mean value of X = 14681.65 and SD = ±1047.455. The FTSE 250 index had a movement in the given period from a minimum of 18315.31 to a maximum of 24250.83 with a mean value of X = 21520.34 and SD = ±1655.244. If we look at the mean returns of all three indexes, they are negative which indicates a loss on stock in all three markets in the observed period. Furthermore, the biggest volatility for the period is observed in the DAX 40 index. The skewness and kurtosis values are significantly lower compared to their COVID-19 crisis values which indicates less asymmetry.

Table 2. Descriptive statistics of S&P 500, FTSE 250 & DAX 40 in Russian – Ukraine crisis

	S&P 500		FTSE 250		DAX 40	
	Price	**Return**	**Price**	**Return**	**Price**	**Return**
Obs	253	253	262	262	258	258
Mean	4347.304	-0.002828	21520.34	-0.0007893	14681.65	-0.0007039
Max	4796.56	0.0301055	24250.83	0.0433587	16271.75	0.0762319
Min	3666.77	-0.0412338	18315.31	-0.0370957	12401.2	-0.0450837
Std. Dev.	280.0905	0.0130582	1655.244	0.011156	1047.455	0.0139639
Variance	78450.67	0.0001705	2739832	0.0001245	1097161	0.000195
Skewness	-0.5364806	-0.3289479	-0.0921465	-0.1507574	-0.2807056	0.2397657
Kurtosis	2.324066	3.532856	1.685452	4.595302	1.765501	6.75964
Shapiro-Wilk test		0.98403		0.97704		0.95577
		(0.0000)		(0.0031)		(0.0000)
Skewness- Kurtosis test		7.02		11.51		24.96
		(0.0299)		(0.0032)		(0.0000)
ADF test		-15.614		-15.477		-16.463
		(0.0000)		(0.0000)		(0.0000)

Source: Authors

3.2. Research Methodology

The research questions that we aim to address with this study are: if the nature of the COVID-19 crisis and the Russian-Ukraine crisis is similar and how can we compare the effects of these two crises on stock markets? Particularly, we are interested to find out if the two analysed crises have caused stock markets to react similarly or differently and to compare their recovery patterns. Finally, we would like to examine if the reaction of financial markets, given that the financial markets are driven by investor sentiment, can help us to understand and distinguish the nature of economic crises.

To answer these research questions, Levene's test has been employed. Levene's test is a statistical hypothesis test used to assess whether the variance of a particular variable is the same across different groups or categories (Levene, 1960). Its application in stock market analysis has provided valuable insights into the volatility, risk characteristics, and spillover effects of different stock markets, periods, and industries. For instance, González et al. (2019) used Levene's test to the performance of sector portfolios from Islamic and conventional stock markets before, during, and after the recent Global Financial Crisis (GFC). Similarly, Bevanda et al. (2021) examined the performance of value and growth stock portfolios after the GFC, and among other statistical methods, Levene's homogeneity test was applied. Ahmed et al. (2021) used the test to investigate the impact of COVID-19 on the Indian stock and commodity markets during the different phases of the lockdown. In addition, the authors compared the effect of COVID-19 on the Indian stock and commodity markets during the first and second waves of the COVID-19 spread. Levene's test was also applied for the assessment of the comparison of government policies during the Global Financial Crisis and the COVID-19 Crisis (Zaimović & Dedović, 2021).

Levene's test is an alternative to the Bartlett test and is less sensitive to departures from normality and thus more suitable for the analysis of index returns. The Levene's test is defined as:

$$H_0: \delta_1^2 = \delta_2^2 = \cdots = \delta_k^2$$
$$H_\alpha: \delta_i^2 \neq \delta_j^2 \quad (3)$$

If the p-value of this test is less than 0.05 significance level, it means that we can reject the null hypothesis of equality of variances of two samples, and vice versa if p-value of this test is higher than 0.05 significance level, we accept the null hypothesis (Tudor, 2008).

4. FINDINGS

Figure 1 shows the graphical representation of the movement of the return series of three indexes analyzed in the COVID-19 crisis. COVID-19 has suddenly increased volatility. The S&P 500 index price reached its highest and lowest points on February 19, 2020, and March 23, 2020, respectively. It took this index 33 days to reach its minimum, and it fell by 33.92%. This is also shown by the fact that a minimum return value of -12.77% occurred on March 16, 2020, and a maximum of 8.97% occurred on March 24, 2020. The DAX index's maximum value and minimum values happened on February 19, 2020, and March 18, 2020, respectively. It took this index 30 days to reach its minimum, and it declined by 38.78%. Additionally, a minimum return value of -13.06% occurred on March 11, 2020, and a maximum of 10.41% occurred on March 23, 2020. When it comes to the FTSE 250 index price, the maximum value occurred on January 2, 2020, and the minimum value occurred on March 19, 2020. It took this index 55 days to reach its minimum, and it fell by 41.97%. This is also shown by the fact that a minimum return value of -09.10% occurred on March 12, 2020, and a maximum of 8.04% occurred on March 24, 2020.

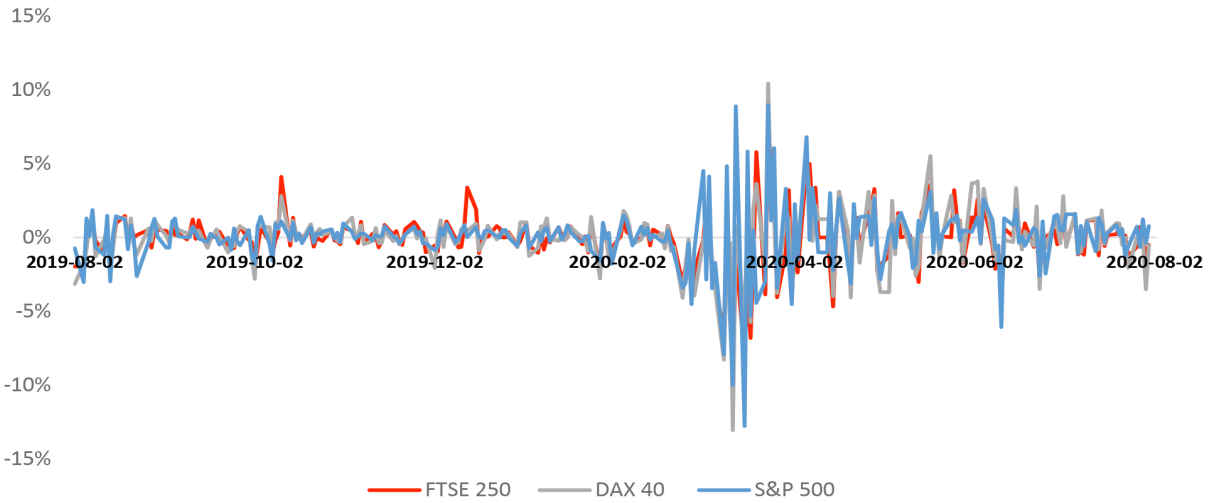

Figure 1. COVID-19: Stock market performance – Return series

Source: Authors

From this analysis of the trend of S&P 500, DAX 100, and FTSE 250, it is seen that within the data set analyzed the minimum value of the index was due to the COVID-19 pandemic and it is what caused a big turmoil in markets in the observed dataset. It can be deduced that the COVID-19 crisis is a V-shaped crisis as all the indexes experienced a sharp and sudden drop in value, but also recovered quickly (within a year from the start of the COVID-19 pandemic). In addition, it is obvious

from the return series below that the COVID-19 pandemic has caused increased volatility in the crisis period compared to pre-crisis and caused clustering volatility (where periods of low volatility are followed by low volatility and periods of high volatility are followed by periods of high volatility).

Figure 2 presents the graphical representation of the movement of the return series for three indexes observed in the Russian-Ukraine war. It is obvious that during the whole period, the volatility was present, and there is no clear cut to see what exact event started the crisis as there is on the COVID-19 return series graph. Both the pre-crisis and crisis period has been quite volatile, and the DAX index is the most volatile mainly due to its geographical closeness to Ukraine. For the DAX index, the maximum value happened on January 5, 2022, and the minimum value happened on July 5, 2022. It took this index 128 days to reach its minimum, and it declined by 23.79%. Additionally, a minimum return value of -4.05% occurred on March 4, 2022, and a maximum of 7.62% occurred on March 9, 2022. For S&P 500 index price, the maximum value occurred on December 31, 2021, and the minimum value occurred on June 16, 2022. This index dropped by 23.55% and took 116 days to reach its minimum. S&P 500 minimum return value of -4.1% occurred on May 18, 2022, and a maximum return value of 3.01% occurred on June 24, 2022. The FTSE 250 index price ranged from its highest value on September 1, 2021, to its lowest value on July 5, 2022. This index dropped by 24.48% and took 220 days to reach its minimum. In the observed period, the FTSE 250 minimum return value of -3.7% occurred on January 24, 2022, and a maximum return value of 4.33% occurred on March 9, 2022.

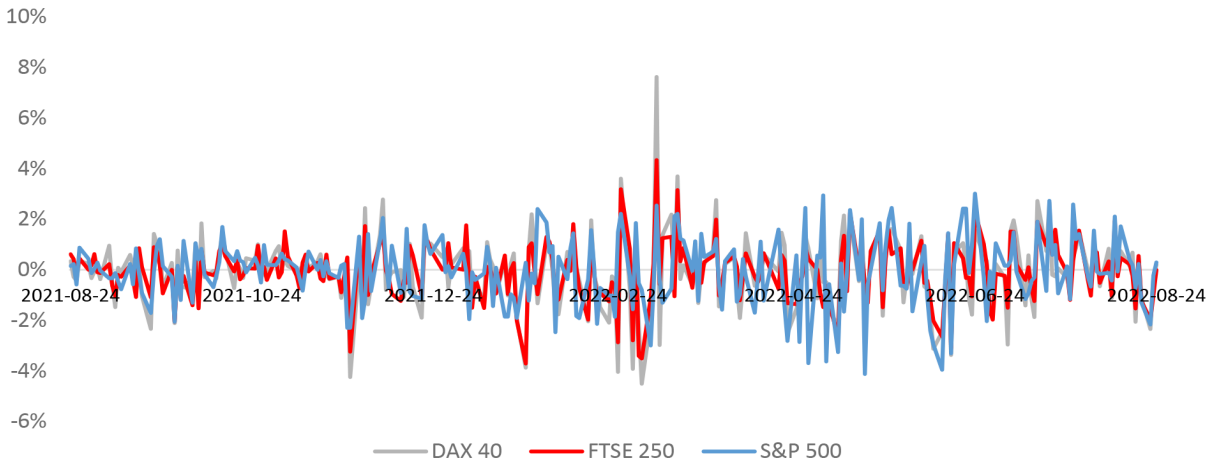

Figure 2. Russian-Ukraine crisis: Stock market performance – Return series

Source: Authors

What is seen from the Russian-Ukraine dataset trend analysis for S&P 500, DAX 100 and FTSE 250 indexes is a constant downward trend and the fact that the recovery did not happen in the period analyzed. This crisis is characterized by a more prolonged period of economic downturn compared to the sudden drop in the COVID-19 crisis. This is further seen from the fact that indexes in the analyzed period dropped half as much as in the COVID-19 crisis, with much lower oscillations and twice as much time to reach its minimum value.

We used Levene's test for equality of variances to find out whether the variances of two periods are equal. The calculated p-values for all three datasets are lower than the level of significance of 0.05, which allows us to reject the null hypothesis and accept the alternative hypothesis of unequal variances for all three datasets. From period before the COVID-19 to the COVID-19 period, the standard deviation of returns increased 3.7 times, 2.9 times, and 3.0 times for the S&P 500, FTSE

250, and DAX 40, respectively. On the other hand, from the period before the Russian invasion to the period after the invasion, the standard deviation of returns increased 1.6 times, 1.4 times, and 1.6 times for S&P 500, FTSE 250, and DAX 40, respectively. We demonstrate that both crises significantly impacted the volatility of all examined indexes, with the COVID-19 crisis experiencing a greater increase in volatility than the Russian-Ukraine crisis. While comparing the effects of the COVID-19 crisis and Russian-Ukraine on stock market volatility, we discovered that they were statistically different. Volatility, measured by the standard deviation of the index, in the COVID-19 crisis, is roughly twice as high as it was in the Russian-Ukraine crisis.

This proves that the two crises are fundamentally different. Namely, in the COVID-19 crisis after the first shock caused by anti-crisis measures (epidemiological) the markets started a sharp recovery, while the recovery after the Ukrainian crisis was slow (and questionable). This leads to the conclusion about the "artificial" character of the COVID-19 crisis where international trade and investment funds were forcibly and unexpectedly interrupted. As soon as the basic conditions and adaptation modalities were created the situation was stabilized, and recovery started. In the Ukrainian crisis, the disruption is fundamental - the food and energy markets are distorted, and the EU introduced economic sanctions against Russia. Value chains are irreversibly broken, and all market participants know that they will not recover (certainly not quickly), more than likely they will have to be replaced. The markets reacted even in anticipation of the (inevitable) crisis. These conclusions can be supported by the faster recovery of the S&P index than the European indices.

Table 3. Analysis of differences in the volatility of S&P 500, FTSE 250 & DAX 40 caused by COVID-19 and Russian – Ukraine crisis

COVID-19 CRISIS						
	S&P 500		FTSE 250		DAX 40	
	Before Jan. 31, 2020	After Jan. 31, 2020	Before Jan. 31, 2020	After Jan. 31, 2020	Before Jan. 31, 2020	After Jan. 31, 2020
Mean	0.00068153	0.00011141	0.00055846	-0.00171154	0.00050019	-0.00041966
Std. Dev.	0.00810183	0.02922109	0.00852861	0.02444822	0.00907526	0.02671554
Obs	127	126	130	130	126	126
W0	45.974344		40.444394		38.067516	
Pr > F	0.0000000		0.0000000		0.0000000	
RUSSIAN-UKRAINE CRISIS						
	Before Feb. 24, 2022	After Feb. 24, 2022	Before Feb. 24, 2022	After Feb. 24, 2022	Before Feb. 24, 2022	After Feb. 24, 2022
Mean	-0.00045969	-0.00010451	-0.00098663	-0.00058901	-0.0061676	-0.00079244
Std. Dev.	0.00986899	0.01566918	0.00901525	0.01300737	0.0107529	0.01664713
Obs	127	126	132	130	130	128
W0	16.790849		13.741631		15.656393	
Pr > F	0.00005637		0.00025634		0.00009842	
COVID-19 CRISIS VS. RUSSIAN-UKRAINE CRISIS						
	After Jan. 31, 2020	After Feb. 24, 2022	After Jan. 31 2020	After Feb. 24, 2022	After Jan. 31, 2020	After Feb. 24, 2022
Mean	0.00011141	-0.00016076	-0.00170837	-0.00058901	-0.00041966	-0.00079244
Std. Dev.	0.02922109	0.01562492	0.02444694	0.01300737	0.02671554	0.01664713
Obs	126	126	130	130	126	128
W0	11.350709		14.626330		7.8012679	
Pr > F	0.00145319		0.00016443		0.00562162	

Source: Authors

5. CONCLUSION

COVID-19 has shocked financial markets across the globe with its sheer and extraordinary impact that is further intensified by the lockdown measures imposed by the majority of countries' governments. Not long after the global economy recorded recovery from the COVID-19 crisis, the tension in the relations between the Russian Federation and Ukraine worsened and on

February 24, 2022, Russia invaded Ukraine. Both crises have inevitably changed the shape of the global economy, however, the following questions arise: Was the impact of these two crises the same, did the recovery progress similarly, is the nature of these crises similar? The main aim of this paper was to respond to these questions and for the analysis we employed Levene's test. Its application in stock market analysis has provided valuable insights into the volatility, risk characteristics, and spillover effects of different stock markets.

The findings of our analysis proved that the effects of the COVID-19 crisis and Russian-Ukraine on stock market volatility were statistically different. Volatility, measured by the standard deviation of the observed index, in the COVID-19 crisis, is roughly twice as high as it was in the Russian-Ukraine crisis.

Our analysis also implies that COVID-19 and the Russia–Ukraine crisis are fundamentally different. From the presented results it can be concluded that the COVID-19 crisis is a V-shaped crisis as all the indexes experienced a sharp and sudden drop in value, but also recovered quickly (within a year from the start of the COVID-19 pandemic) due to anti-crisis measures (epidemiological). However, in the case of the Ukrainian crisis, the market disruption is of a fundamental nature, and it is characterized by a more extended period of economic downturn compared to the rapid drop in the COVID-19 crisis. This is further supported by the fact the indexes in the analyzed period dropped half as much as in the COVID-19 crisis, with much lower oscillations and twice as much time to reach its minimum value compared to the COVID-19 crisis.

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Evolving Efficiency of Exchange Rate Movements: A Test for Major International Currencies

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Keywords:
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Econophysic;
Long memories;
Exchange rates

Abstract: *In this study, we analyse efficiency, in its weak form, in the exchange rates AUD/USD (Australian dollar/US dollar), BRL/USD (Brazilian real/US dollar), CHF/USD (Swiss franc/US dollar), EUR/USD (Euro/US dollar), GBP/USD (British pound/US dollar), JYP/USD (Japanese yen/US dollar), RUB/USD (Russian rouble/US dollar) and SGD/USD (Singapore dollar/US dollar), for the period from January 1st, 2018 to December 31st, 2022. According to the findings, foreign exchange markets in the Tranquil subperiod have mixed results, i.e. The AUD/USD, SGD/USD, and EUR/USD exchange rates are anti-persistent, but the JYP/USD, BRL/USD, RUB/USD, and CHF/USD markets are persistent, and the GBP/USD market is in equilibrium. In the period including the 2020 and 2022 events, we identify long memories in the AUD/USD, BRL/USD, SGD/USD, RUB/USD exchange rates, anti-persistence in the GBP/USD, JPY/USD, and EUR/USD markets, and signs of equilibrium in the CHF/USD exchange rate. Overall, our findings suggest that market efficiency is hybrid, i.e., the exchange markets studied are rarely in equilibrium during periods of calm or stress. The evidence of oscillation between efficiency and inefficiency may lead currency traders to take full advantage of arbitrage possibilities that appear when market circumstances change.*

1. INTRODUCTION

Both the exchange rate and the interest rate are essential monetary policy tools. The exchange rate is the price of one country's currency in terms of the currency of another country. Monetary policy is used by central banks to manage exchange rates by purchasing and selling their currency in the foreign exchange market. This can assist sustain its currency's value, promoting economic development and stability (Dias & Carvalho, 2021).

In addition, the interest rate represents the cost of borrowing money. Monetary policy is used by central banks to influence interest rates by adjusting the money supply in the economy. Central banks may restrain inflation by raising interest rates, and by decreasing interest rates, they can promote borrowing and spending, which can drive economic development. The exchange rate and the interest rate work together to help central banks stabilize their economies, stimulate economic growth, and accomplish their monetary policy objectives (Dias & Carvalho, 2021).

This research will test the efficiency, in its weak form, of the exchange rates AUD/USD (Australian dollar/US dollar), BRL/USD (Brazilian real/US dollar), CHF/USD (Swiss franc/US dollar, EUR/USD (euro/US dollar), GBP/USD (British pound/US dollar), JYP/USD (Japanese yen/US dollar), RUB/USD (Russian ruble/US dollar) and SGD/USD (Singapore dollar/US dollar), over the period from January 1st, 2018 to December 31st, 2022. The observations reflect a mixed

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picture, with long persistence and anti-persistency in both sub-periods, except for the GBP/USD and CHF-USD currency pairings, which show signs of equilibrium throughout the Tranquil and Stress periods, respectively.

This research adds relevant contributions to the literature. The first contribution is related to efficiency estimation, which is significant in the analysis of exchange rate dynamics because it gives insights into the randomness and predictability of changes in exchange rates. The second contribution relates to the models utilized: Lo and MacKinlay's (1988) econometric method and the econophysical DFA (Detrended Fluctuation Analysis) are two frequently used methodologies for estimating efficiency. The approach developed by Lo and MacKinlay (1988) is based on a statistical test of the martingale hypothesis, which argues that previous fluctuations in exchange rates do not contribute valuable information for forecasting future changes. This methodology has been widely used to study the efficiency in a variety of financial markets, including the foreign exchange market. The DFA method, on the other hand, is a non-parametric approach based on time series data detrending. In its most basic version, this approach offers a measure of the long-term correlations existing in a time series, which may be used to estimate the degree of efficiency. DFA has been used in foreign exchange data to examine the persistence of exchange rate variations as well as the market's predictability. These models have been used in financial data to understand the structure of volatility and reliance. They have been frequently used to analyze exchange rate efficiency during uncertain times, integrating the effects of macroeconomic news releases, and capturing the interdependence of exchange rates, macroeconomic factors, and monetary policy. This study is also significant for analyzing efficiency throughout the events of 2020 and 2022 since it can provide insight into how global events and economic conditions may affect currency values and international trade. It may also help with investment and business decisions, as well as understanding the larger economic and political panorama.

This paper is divided into five sections in terms of structure. Section 2 is a review of the literature on exchange rate efficiency. The methodology and data are described in Section 3. The results are presented in Section 4. Section 5 concludes.

2. LITERATURE REVIEW

The efficient market hypothesis (EMH) is a theory that claims financial markets are always perfectly efficient and that it is impossible to continuously generate profits greater than the average market return by using any information that is already expressed in current securities prices (Fama, 1965, 1970, 1991).

There are three forms of HME: weak, semi-strong and strong.

- The weak form implies that previous prices and returns are useless for predicting future prices and returns;
- The semi-strong form suggests that current pricing and returns are based on all publicly available information;
- The strong form implies that current pricing and returns consider all publicly and privately accessible data.

Critics of the HME say that there are numerous examples of market inefficiencies, such as insider trading, behavioural biases, and market manipulation, indicating that markets are not always

perfectly efficient. However, supporters of the HME argue that, while there may be some market inefficiencies, they are often minimal and have little influence on the overall market efficiency (Dias et al., 2020, 2021, 2022).

The efficiency of the foreign exchange market is a subject of debate among researchers. Some studies revealed evidence of inefficiencies, such as technical trading rules' propensity to create abnormal returns, while others found evidence of efficiency, such as fundamental trading strategies' inability to generate abnormal returns.

The Bank for International Settlements (BIS) has considered the FX market as one of the world's most liquid and efficient. It is crucial to note that the results of these researches may be inconclusive, and various studies may provide different results depending on their approach and time horizon of analysis. Some studies suggest market inefficiency in some aspects of the FX market, but not in the long run, as evidenced by the findings of authors Dias and Carvalho (2021), and Pardal et al. (2022).

Many scientific investigations have been done to examine the efficiency of foreign exchange markets. Some research found evidence of market inefficiencies, while others presented evidence of market efficiency. Chiang et al. (2010), for example, observe that the exchange markets of Japan, South Korea, and the Philippines are efficient in their weak form, but Taiwan's exchange rate shows evidence of (in)efficiency. Additionally, authors Lazăr et al. (2012) have shown that the 2008 financial crisis had a significant effect on the efficiency of foreign exchange markets. Turkish lira, Russian ruble, Czech koruna, Romanian leu, Polish zloty, and Hungarian forint markets exhibit evidence of (in)efficiency in the second half of 2008 and the early months of 2009. However, markets in Hungary, Poland, and Romania show evidence of equilibrium in the second phase of the 2008 crisis, while exchange markets in Russia, Turkey, and the Czech Republic show signs of (in)efficiency.

Later, authors Matebejana et al. (2017), and Njindan Iyke (2019) analyzed exchange rate efficiency. Ning et al. (2017). Matebejana et al. (2017) examined the random walk hypothesis in Botswana's foreign exchange market, finding evidence of efficiency, in its weak form. Njindan Iyke (2019) investigated whether Indonesia's foreign exchange market is efficient and found that the efficient market hypothesis is rejected in 50% of the cases.

In more recent studies, Hortense and Dias (2020) evaluated the efficiency of the US-RMB, US/EUR, US/JPY, US/MYR, US/PHP, US/SGD, US/THB, US/CHF, and US/GBP exchange rate markets from July 1st, 2019 to October 27th, 2020. The authors emphasize that the exchange rates US/THB (0.60), US/MYR (0.59), and US/SGD (0.59), as well as, to a lesser extent, the exchange rate pairings US/GBP (0.56) and US/EUR (0.59), have long memories (0.53). US/RMB (0.47), US/JPY (0.43), US/CHF (0.46), and US/PHP (0.38) exchange rates, on the other hand, exhibit anti-persistence. The authors, Pardal et al. (2022), tested the efficient market hypothesis, in its weak form, in the capital markets of Germany (DAX), USA (Dow Jones), France (CAC 40), UK (FTSE 100), Italy (FTSE MIB), Russia (MOEX), Japan (NIKKEI 225), Canada (S&P TSX), China (Shanghai and Shenzhen), as well as the Rouble/Canadian, Rouble/Euro, Rouble/Swiss, Rouble/UK, Rouble/US exchange rates during the 2020 and 2022 events. The authors emphasize that, for the most part, capital markets and exchange rates have moved from equilibrium to persistent, although the Russian market exhibits signals of equilibrium during the Tranquil period and switches to anti-persistent during the crisis period.

In summary, the purpose of this paper is to contribute to the provision of information to investors and regulators in the international foreign exchange markets, where individual and institutional investors are attempting to effectively diversify their portfolios during a period of uncertainty and lack of confidence caused by events in 2020 and 2022.

3. METHODOLOGY AND DATA

3.1. Data

The data used for the elaboration of the paper were the prices index (daily) of exchange rates AUD/USD (Australian dollar/US dollar), BRL/USD (Brazilian real/US dollar), CHF/USD (Swiss franc/US dollar), EUR/USD (Euro/US dollar), GBP/USD (British pound/US dollar), JYP/USD (Japanese yen/US dollar), RUB/USD (Russian ruble/US dollar) and SGD/USD (Singapore dollar/US dollar), for the period from January 1st, 2018 to December 31st, 2022. To increase the robustness of the research, we divided the sample into two sub-periods: Tranquil (January 2018 to December 2019), and Stress (January 2020 to December 2022). The data was obtained from the *Thomson Reuters* platform.

3.2. Methodology

The research will be developed in several stages. To understand if we are dealing with Gaussian distributions, a summary table containing the major statistical measures will be created, and the adherence test of Jarque and Bera (1980) will be used to validate it. To validate the assumption of time series stationarity, we will use the panel unit root tests developed by Levin et al. (2002), Im et al. (2003), and the tests of Dickey and Fuller (1981), Perron and Phillips (1988) with Fisher transformation. To answer the research question, we will apply the methodology of Lo and MacKinlay (1988). This model is based on a statistical test of the martingale hypothesis, which argues that previous changes in exchange rates do not provide useful information for predicting future changes. This approach has been frequently used to analyze efficiency in a variety of financial markets, including the foreign exchange market. To validate the results, we will use the Detrended Fluctuation Analysis (DFA) methodology. DFA is an analysis method that examines the time dependency in nonstationary data series. By assuming that time series are nonstationary, this method prevents spurious results when analyzing data series relationships in the long term. The Detrended Fluctuation Analysis can be interpreted as follows: $0<\alpha<0,5$: anti-persistent series; $\alpha=0,5$ series presents random walk; $0,5<\alpha<1$ persistent series. The purpose of this technique is to explore the relationship between x_k and $x_{(k+t)}$ at different moments in time (see Dias et al., 2019, Dias, Pereira, et al., 2022, Guedes et al., 2022, for further information).

4. RESULTS

Figure 1 depicts the evolution in levels, during the period from January 1st, 2018 to December 31st, 2022, of the exchange rates AUD/USD (Australian dollar/US dollar), BRL/USD (Brazilian real/US dollar), CHF/USD (Swiss franc/US dollar), EUR/USD (euro/US dollar), GBP/USD (British pound/US dollar), JYP/USD (Japanese yen/US dollar), RUB/USD (Russian ruble/US dollar), and SGD/USD (Singapore dollar/US dollar), where it can be inferred that the pandemic in 2020 or the armed conflict between Russia and Ukraine in 2022, have led to a widespread decline in exchange rates. The authors Dias, Pardal, et al. (2022), and Dias, Pereira, et al. (2022) corroborate this volatility in international markets.

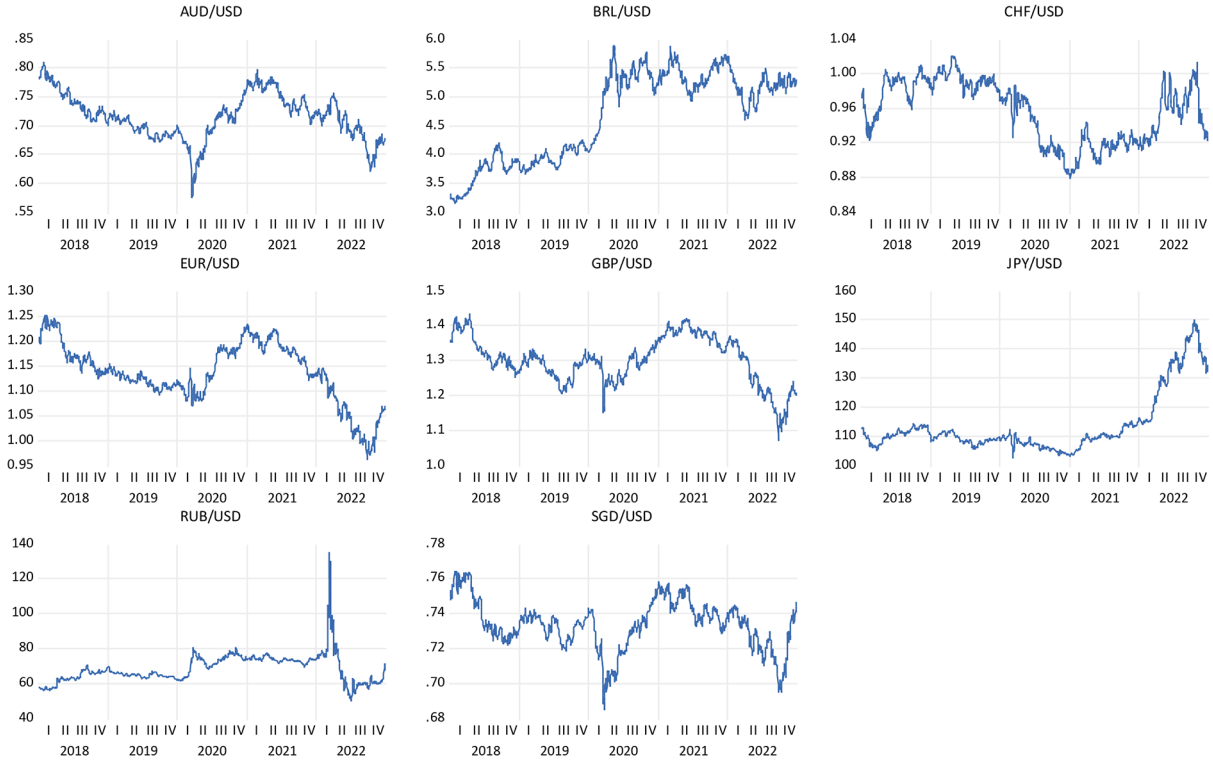

Figure 1. Evolution, in levels, of the 8 exchange rates, during the period from January 1st, 2018, to December 31st, 2022

Source: Own elaboration

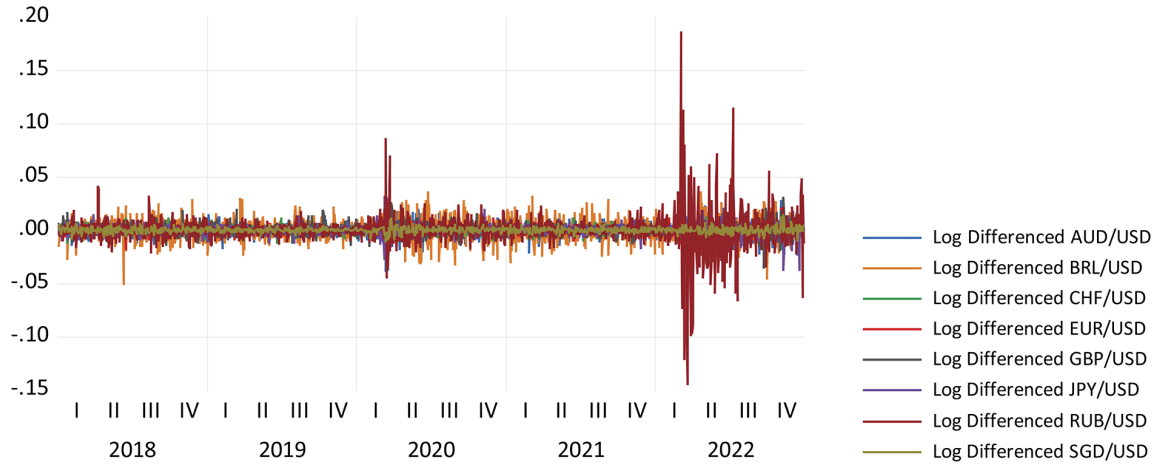

Figure 2. Evolution, in returns, of the 8 exchange rates under analysis, during the period from January 1st, 2018, to December 31st, 2022

Source: Own elaboration

In **Figure 2** we can observe the evolution, in returns, of the exchange rates AUD/USD (Australian dollar/US dollar), BRL/USD (Brazilian real/US dollar), CHF/USD (Swiss franc/US dollar, EUR/USD (Euro/US dollar), GBP/USD (British pound/USD), JYP/USD (Japanese yen/USD), RUB/USD (Russian rouble/USD) and SGD/USD (Singapore dollar/USD), for the period from January 1st, 2018, to December 31st, 2022. The graphical observation demonstrates an increase of volatility in the behaviour of exchange rates during the first and second quarters of 2020, when the COVID-19 pandemic crisis was announced, and very significantly during the year 2022, marked by the conflict between Russia and Ukraine. The more significant changes in the

exchange rate between the Russian rouble and the US dollar (RUB/USD) are particularly noticeable. This data is corroborated by the authors Pardal et al. (2022), Dias, Pardal, et al. (2022), and Teixeira et al. (2022), who indicate that the 2020 and 2022 occurrences increased volatility in international financial markets.

Table 1. Descriptive statistics, in returns, of the 4 exchange rates (AUD, BRL, CHF, EUR), during the period from January 1st, 2018, to December 31st, 2022

	AUD/USD	BRL/USD	CHF/USD	EUR/USD
Mean	-0.000107	0.000358	-4.08E-05	-8.84E-05
Median	0.000000	0.000188	0.000101	0.000000
Maximum	0.028668	0.036668	0.018428	0.021207
Minimum	-0.039319	-0.051853	-0.028053	-0.020646
Std. Dev.	0.006447	0.010587	0.004433	0.004536
Skewness	-0.273049	-0.122102	-0.419495	0.012658
Kurtosis	5.990753	4.156377	5.681924	4.558961
Jarque-Bera	502.5786	75.95338	429.3788	132.1857
Probability	0.000000	0.000000	0.000000	0.000000
Observations	1305	1305	1305	1305

Source: Own elaboration

Table 2. Descriptive statistics, in returns, of the 4 exchange rates (GBP, JPY, RUB, SGD), during the period from January 1st, 2018, to December 31st, 2022

	GBP/USD	JPY/USD	RUB/USD	SGD/USD
Mean	-8.56E-05	0.000121	0.000130	-1.33E-06
Median	0.000000	0.000179	-5.14E-05	0.000134
Maximum	0.030953	0.031642	0.185935	0.014761
Minimum	-0.036939	-0.038578	-0.145455	-0.011791
Std. Dev.	0.005918	0.005049	0.017000	0.002696
Skewness	-0.140970	-0.442133	0.606811	0.043505
Kurtosis	6.800317	12.33233	30.33673	4.948271
Jarque-Bera	789.6284	4778.170	40714.36	206.8061
Probability	0.000000	0.000000	0.000000	0.000000
Observations	1305	1305	1305	1305

Source: Own elaboration

Tables 1 and 2 show the results of statistical measures, such as the mean, standard deviation, skewness and kurtosis, namely of the exchange rates AUD/USD (Australian dollar/US dollar), BRL/USD (Brazilian real/US dollar), CHF/USD (Swiss franc/US dollar, EUR/USD (euro/USD), GBP/USD (British pound/USD), JYP/USD (Japanese yen/USD), RUB/USD (Russian rouble/USD) and SGD/USD (Singapore dollar/USD), for the period from January 1st, 2018, to December 31st, 2022. In terms of average daily returns, all exchange rates were close to zero, with the RUB/USD, BRL/USD, and JPY/USD exchange rates all showing positive values, with the BRL/USD exchange rate (0.000358) exhibiting the highest return. As regards standard deviation (risk), the RUB/USD exchange rate has the highest standard deviation (0.01700), while the SGD/USD has the lowest (0.002696). It is also possible to confirm that the time series of the exchange rates under consideration exhibit moderately asymmetrical distributions, with the AUD/USD, BRL/USD, GDP/USD, CHF/USD, and JPY/USD exchange rates exhibiting asymmetrical distributions to the left and the EUR/USD, RUB/USD, and SGD/USD exchange rates expressing asymmetrical distributions to the right. The analysis of kurtosis values, a measure of the degree of flattening of a distribution, demonstrates positive values indicating that the time series follows a leptokurtic distribution, with the RUB/USD exchange rate having the highest kurtosis value (30.33673) and the SGD/USD exchange rate having the lowest kurtosis value (4.948271). The Jarque and Bera (1980) adherence test

was used to examine the normality of the time series data under study, and it was discovered that H_0 is rejected at any significance level, and it is not possible to conclude on the exact normality of the data. Given that a sufficiently large set of observations was integrated into the sample, based on the Central Limit Theorem (CCT), we can ensure an approximately normal distribution.

In addition to the assumption of data normality, it is crucial to assess the stationarity of the time series under study to avoid spurious regressions and retain the integrity of the econometric models to be estimated. It is important to realize that the stationarity of a time series is a key assumption in many statistical and econometric models since it implies that the series' mean, and variance do not change over time. For this purpose, we applied panel unit root tests created by Levin et al. (2002), Im et al. (2003), and to confirm panel unit root tests, we estimated the Dickey and Fuller (1981), Perron and Phillips (1988) tests with Fisher transformation. Stationarity is accomplished using logarithmic transformation, as seen in **Table** 3. This transformation is used to make time series more stationary and reduce data volatility. The logarithmic transformation is applied by taking the natural logarithm of the price index values. This transformation can be beneficial in reducing the influence of high values on the overall index and making the data more symmetric (Dias & Santos, 2020; Dias et al., 2021; Dias & Carvalho, 2021; Pardal et al., 2021).

Table 3. Unit Root Test, applied to the 8 exchange rates under analysis, during the period from January 1st, 2018, to December 31st, 2022

Group unit root test: Summary				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-123.489	0.0000	8	10417
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-102.794	0.0000	8	10417
ADF - Fisher Chi-square	888.698	0.0000	8	10417
PP - Fisher Chi-square	879.824	0.0000	8	10424

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality

Source: Own elaboration

Table 4 shows the results of Lo and MacKinlay's (1988) variance ratio methodology for assessing autocorrelation among time series. In all cases, the statistics were calculated for lags from 2 to 16 days, for the 8 exchange rates under study: AUD/USD (Australian dollar/US dollar), BRL/USD (Brazilian real/US dollar), CHF/USD (Swiss franc/US dollar), EUR/USD (euro/US dollar), GBP/USD (British pound/US dollar), JYP/USD (Japanese yen/US dollar), RUB/USD (Russian rouble/US dollar) and SGD/USD (Singapore dollar/US dollar). Based on the results, it's possible to verify the martingale hypothesis is rejected for all exchange rates over the period under consideration, except for the RUB/USD exchange rate, at a significance level of 10% and a 16-day lag. In terms of variance ratios, it is discovered that their returns are autocorrelated across time in all-time series for all lags and that there is mean reversion when they exhibit ratios less than unity (1). Overall, the findings lead us to believe that exchange rates during the period studied tended to react sensitively to information, and this heightened price sensitivity to the arrival of new information can be explained by the sense of panic that was experienced by investors, during the sample period due to the uncertainty that events such as the COVID-19 pandemic and the Russia-Ukraine armed conflict triggered. The authors Horta, Dias, Revez and Alexandre (2022), Horta, Dias, Revez, Heliodoro, et al. (2022), Revez et al. (2022), Teixeira, Dias, and Pardal (2022) support these findings by highlighting that extreme events in the global economy cause significant imbalances in financial markets.

Table 4. Tests of the Variance Ratios of Lo and Mackinlay, applied to the 8 exchange rates under analysis, during the period from January 1st, 2018, to December 31st, 2022

Null Hypothesis: AUD/USD is a martingale				
Joint Tests		Value	df	Probability
Max |z| (at period 2)*		12.36830	1304	0.0000
Individual Tests				
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.511760	0.039475	-12.36830	0.0000
4	0.258537	0.068581	-10.81149	0.0000
8	0.139014	0.103153	-8.346661	0.0000
16	0.066039	0.149041	-6.266491	0.0000
Null Hypothesis: BRL/USD is a martingale				
Joint Tests		Value	df	Probability
Max |z| (at period 2)*		13.88928	1304	0.0000
Individual Tests				
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.469701	0.038180	-13.88928	0.0000
4	0.238915	0.066526	-11.44046	0.0000
8	0.117911	0.098945	-8.914949	0.0000
16	0.063651	0.139925	-6.691788	0.0000
Null Hypothesis: CHF/USD is a martingale				
Joint Tests		Value	df	Probability
Max |z| (at period 2)*		12.0552	1304	0.0000
Individual Tests				
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.530434	0.038951	-12.05528	0.0000
4	0.265233	0.067712	-10.85140	0.0000
8	0.141723	0.100367	-8.551407	0.0000
16	0.069259	0.142280	-6.541635	0.0000
Null Hypothesis: EUR/USD is a martingale				
Joint Tests		Value	df	Probability
Max |z| (at period 2)*		12.87693	1304	0.0000
Individual Tests				
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.508673	0.038156	-12.87693	0.0000
4	0.265798	0.066536	-11.03463	0.0000
8	0.130167	0.101201	-8.595077	0.0000
16	0.062726	0.148741	-6.301391	0.0000
Null Hypothesis: GBP/USD is a martingale				
Joint Tests		Value	df	Probability
Max |z| (at period 2)*		10.73235	1304	0.0000
Individual Tests				
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.536187	0.043216	-10.73235	0.0000
4	0.275860	0.076628	-9.450029	0.0000
8	0.138237	0.113732	-7.577131	0.0000
16	0.068071	0.160331	-5.812549	0.0000

Null Hypothesis: JPY/USD is a martingale				
Joint Tests		Value	df	Probability
Max |z| (at period 2)*		7.424901	1304	0.0000
Individual Tests				
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.469988	0.071383	-7.424901	0.0000
4	0.241336	0.121477	-6.245317	0.0000
8	0.123737	0.180505	-4.854497	0.0000
16	0.056825	0.241125	-3.911565	0.0001
Null Hypothesis: RUB/USD is a martingale				
Joint Tests		Value	df	Probability
Max |z| (at period 2)*		4.158546	1304	0.0001
Individual Tests				
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.558122	0.106258	-4.158546	0.0000
4	0.253060	0.184143	-4.056307	0.0000
8	0.150649	0.279896	-3.034518	0.0024
16	0.071546	0.395222	-2.349194	0.0188

* Probability approximation using studentized maximum modulus with parameter value 4 and infinite degrees of freedom

Source: Own elaboration.

Table 5 shows the results of the econophysical method Detrended Fluctuation Analysis (DFA). This method was used to test the efficient market hypothesis, in its weak form, of the exchange rates AUD/USD (Australian dollar/US dollar), BRL/USD (Brazilian real/US dollar), CHF/USD (Swiss franc/US dollar, EUR/USD (Euro/US dollar), GBP/USD (British pound/US dollar), JYP/USD (Japanese yen/US dollar), RUB/USD (Russian rouble/US dollar) and SGD/USD (Singapore dollar/US dollar), for the period from January 1st, 2018, to December 31st, 2022. The DFA allows estimated exponents that describe the correlation properties of the time series, with an exponent closer to 1 may indicate stronger persistence and correlation between time series, which might imply a greater predictive ability of short-term changes. To better understand the impact of more complex events on the memory properties of exchange rates, such as the COVID-19 pandemic and the Russia-Ukraine conflict, we divide the sample into two sub-periods: the Tranquil period, which corresponds to a period of calm in financial markets, and the Stress period, which relates to the period marked by these two events. When we compare the Stress and Tranquil periods, we can see that the AUD/USD (0.46 - 0.56) and SGD/USD (0.48 - 0.55) exchange rates moved from an anti-persistent to a persistent trend. The BRL/USD (0.56 - 0.54) and RUB/USD (0.53 - 0.57) exchange rates, on the other hand, maintained their persistence during the period of greater turbulence in the financial markets, and the RUB/USD exchange rate even verified an increase in this persistence. This increase in persistence during the period of higher complexity may indicate that these exchange rates are associated with higher risk and (positive) persistence. Conversely, the JPY/USD (0.53 - 0.45) and GPD/USD (0.50 - 0.47) exchange rates started to show signs of anti-persistence. EUR/USD, meanwhile, remained anti-persistent (0.45 - 0.48). During the Stress period, these exchange rates are associated with fast reversing price moves away from the mean. On the other hand, the CHF/USD exchange rate, which had exhibited an anti-persistent trend throughout the Tranquil period, neared the random walk (equilibrium) reference value during the crisis (0.58 - 0.49). The results collected throughout the Stress period show that most price fluctuations do not completely represent the available

information and that price changes are not i.i.d. This evidence leads us to believe that investors have a greater capacity to predict future prices, which allows them to create arbitrage opportunities and abnormal profits, i.e., to earn returns above the market average without incurring additional risk. These findings support the evidence shown by Dias, Heliodoro, and Alexandre (2020), Vasco et al. (2021), and Dias et al. (2021) showing that long-term memory exists in international financial markets.

Table 5. DFA exponent for index and return. The values of the linear adjustments for α DFA always had R2 > 0.99

Exchange rates	DFA exponent (Tranquil)	DFA exponent (Stress)
AUD/USD	0.46 ≦ 0.0109***	0.56 ≦ 0.0011***
GBP/USD	0.50 ≦ 0.0223	0.47 ≦ 0.0221***
JPY/USD	0.53 ≦ 0.0028***	0.45 ≦ 0.0030***
BRL/USD	0.56 ≦ 0.0020***	0.54 ≦ 0.0090***
SGD/USD	0.48 ≦ 0.0141***	0.55 ≦ 0.0014***
RUB/USD	0.53 ≦ 0.0010***	0.57 ≦ 0.0027***
EUR/USD	0.45 ≦ 0.0065***	0.48 ≦ 0.0015***
CHF/USD	0.58 ≦ 0.0010***	0.49 ≦ 0.0978

Note: The hypotheses are H0: $\alpha = 0.5$ and H1: $\alpha \neq 0.5$.
***, **, * represent significance at 1%. 5% and 10%. Respectively

Source: Own elaboration.

5. CONCLUSION

In this paper we analyzed efficiency, in its weak form, in the exchange rates AUD/USD (Australian dollar/US dollar), BRL/USD (Brazilian real/US dollar), CHF/USD (Swiss franc/US dollar), EUR/USD (Euro/US dollar), GBP/USD (British pound/US dollar), JYP/USD (Japanese yen/US dollar), RUB/USD (Russian ruble/US dollar) and SGD/USD (Singapore dollar/US dollar), over the period from January 1st, 2018, to December 31st, 2022. The findings show that the foreign exchange markets performed differently in the two sub-periods. During the Tranquil period, the AUD/USD, SGD/USD, and EUR/USD exchange rates exhibit anti-persistence, while the JYP/USD, BRL/USD, RUB/USD, and CHF/USD markets show persistence in their returns, and GBP/USD market seems to be in equilibrium. In the period that incorporates the 2020 and 2022 events, we identify the presence of long memories in the AUD/USD, BRL/USD, SGD/USD, RUB/USD exchange rates, anti-persistence in the GBP/USD, JPY/USD, and EUR/USD markets, while the CHF/USD exchange rate shows signs of equilibrium. In conclusion, persistent returns can increase predictability and stability in the foreign exchange market, as well as minimize uncertainty and transaction costs in international trade and investment. The presence of long memory and anti-persistence may have positive effects on the real economy, in other words, persistence in returns may help to ensure stability in the foreign exchange market, which may have positive effects on economic growth and development. Overall, persistence in foreign exchange market returns can have positive impacts on the global economy by reducing uncertainty, increasing stability, and promoting economic growth and development.

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Exploring the Drivers and Constraints in Intra-EU Trade

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Abstract: *The objective of this paper is to explore the factors that stimulate trade among EU countries and pinpoint areas that require improvement to foster a further increase in trade intensity within the region. The focus is on the effect of aggregate trade restrictions, which are based on the novel indicator Measure of Aggregate Trade Restrictions (MATR), developed by the IMF. The empirical analysis consists of the estimation of a gravity panel model for the 28 EU member countries (including Great Britain) for the period from 1999-2020, by implementing both Ordinary least squares (OLS) and Poisson Pseudo Maximum Likelihood (PPML) estimators. The results show that the Eurozone membership has positive effects on increasing intra-EU trade, whereas the MATR indicator has significant negative effects, suggesting that the elimination of the remaining trade restrictions could lead to a further boost of intra-EU trade.*

1. INTRODUCTION

The European Union is one of the most popular research topics for economists and researchers throughout the world. In only half a century since the beginning of the integrative process, the EU has achieved remarkable economic development which put its member-states in a privileged position within the world economy. At the turn of the 21st century and by the end of its first decade, inhabited with only 6% of the world population, the EU became the biggest world trader creating about 20% of the total world trade. The EU exchanged about 1/5 of the total world exchange of goods; was the dominant trader in services responsible for 23.9% of the total world trade in services; and at the same time became the biggest source of FDI outflow, being the second biggest importer of FDI in the world just next to the USA. Since 2018 the USA, the EU and China have reached 45% of the world exchange of goods, where the EU has become the second biggest exporter and importer of goods in the world economy (Eurostat, 2022).

The effects of the regional integration process became especially visible after the biggest enlargement of the EU in 2004-2007 which significantly boosted its total trade flows in goods. This especially applied to the new member-states, as the integrative process involved them not only in significantly more intense trade in goods on the Internal Market but also in global trade flows in goods, as well. Ten out of thirteen new member-states experienced an increase in total trade exchange of goods of more than 200%, with Latvia holding the absolute record of 631%. However, the enlargement was not in favor of only the newcomers. Seven of the older member-states of the EU, Germany being one of them, experienced an increase of total trade exchange in goods between 100-200%, while seven other member-states, among which only Malta is a newcomer, experienced growth of less than 100% (Eurostat, 2022).

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To understand the real economic and trade capacity of the EU it is important to point out that intra-EU trade deserves special attention as during the last two decades it has outpaced the extra-EU trade exchange in goods reaching 1.5 times bigger value than the latter at the end of 2022. Also, it is valuable to note that the structure of the intra-EU trade in goods is predominantly intra-industrial (Eurostat, 2022).

The big success of the integrative process within the EU inspired researchers to provide valid analyses of and insight into the combination of factors that have led to remarkable economic results. Most of their efforts were oriented towards revealing the effects of elimination of the existing tariff and non-tariff barriers in the process of the accomplishment of the Internal Market, considering the introduction of the euro as a common currency, the creation of the Schengen Area and providing free movement of labor, simultaneously changing the core business environment through the deepening of the regional integration and additional accepting of new member-states. Most of the research papers provide analyses based on the construction of gravity models inspired by the Newtonian gravity theory which evaluates the gravitation force among different objects by taking into consideration their mass and the distance between them. Translated in economic terms and theory, gravity models provide insight into the propensity to trade regarding the economic capacity of two trading partners measured by their GDP and the geographic distance between them, keeping in mind that transportation costs have a huge impact on the price competitiveness of products placed on geographically remote markets. To improve the results of their gravity models, researchers use additional variables besides the two mentioned which reflect barriers to trade created by the existence of common borders, usage of different languages, usage of different currencies, etc. The negative impact of still-existing, non-eliminated trade barriers is important to be quantified to provide evidence that would be in favor of further trade liberalization. The economic theory supports the idea that the bigger the existing trade barriers among trading partners are, the bigger the non-trade barriers among them, as well. For measuring the effects of both tariff and non-tariff barriers in 2005 the so-called Trade Restriction Index (TRI) was constructed as a standard metric that should evaluate the effect that a uniform tariff would produce among member states as a trade restriction that would resemble the restrictiveness of the implemented trading policies (Anderson & Neary, 2005). Five years later TRIs were recommended as adequate for general equilibrium analyses (Coughlin, 2010). However, this model relied on too many assumptions which made other researchers resentful of using TRIs, especially as they are not widely available.

Regarding all above mentioned, we decided to construct a gravity model to measure the effects of the Internal Market upon the intra-EU trade by using a new measure – Measure of Aggregate Trade Restrictions (MATR) which is based upon the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) (Estefania-Flores et al., 2022). Besides measuring the usual tariff and non-tariff barriers among member-states, this aggregate measure includes the usage of the common currency and the effects of the eurozone upon payments and the current accounts of all member-states, thus encompassing a total of 18 different barriers still existing on the Internal Market. The model was constructed by using data on MATR for the period from 1999-2020 for 28 member-states (including the United Kingdom). For the same period, used MATR data included Croatia as a member state out of the eurozone. Our basic aim was to provide an evaluation of still existing barriers to trade in intra-EU trade to point out the eventual potential for further trade liberalization on the Internal Market.

The structure of the paper is as follows: a brief introduction followed by a literature review about the effects of the creation and functioning of the Internal Market; an explanation of the

construction of MATR and recent developments in the EU; an explanation of the construction of the model and running four different equations using MATR; analyzes of the results; and finally concluding remarks.

2. LITERATURE REVIEW

In the following segment, we present the findings from more recent research on the various effects of the establishment of the Internal Market on EU economies.

According to the European Commission (2023), the Internal Market is one of the most remarkable accomplishments of the EU. With a consumer base of nearly 450 million people, the Internal Market comprises 18% of the global GDP and accounts for almost one-third of global trade (European Commission, 2023). Gunnella et al. (2021) argue that European integration played a key role in establishing a common framework for consumer and labor protection, as well as creating common product standards and production rules. These measures, along with the introduction of a common currency and a monetary union, have helped to lower trade-related costs and facilitate the integration of European markets. Indeed, using Bayesian model averaging (BMA), Beck (2020) finds that real GDP, trade openness, EU and Euro area membership, corruption, and factor abundance differentials are the primary determinants of intra-industry trade among the EU countries, while transportation costs and cultural similarity do not have an effect. Indeed, Member States engage in more trade within the EU (18% of world trade) than with the rest of the world (13% of world trade) (European Commission, 2023). The movement of capital and goods has seen the most significant progress under the Internal Market, with trade in goods within the EU doubling over the past three decades. This is reflected by the report by The National Board of Trade (2015), which finds that the main channel through which the Internal Market has promoted the economic growth of Europe is the free movement of goods and capital, leading to a rise in intra-EU trade and investment. This development has contributed to higher levels of competition, greater innovation, and a wider range of products. While trade in services and the movement of people have also expanded, these sectors have faced challenges due to their nature and persistent barriers.

The effects of trade integration for EU countries are extensively researched and quantified. The study by Imbruno (2021) estimates that there were annual welfare gains of approximately 2.5% from trade integration during the period of significant EU enlargement (2004-2012). Specifically, trade integration in intermediate input markets is found to primarily improve efficiency within firms, while trade integration in final goods markets leads to the reallocation of businesses toward more productive firms. Using a structural gravity framework, the study by Spornberger (2022) finds that the initial integration degree of the EU-15 members had a significant impact on intra-EU trade shares, increasing them by 70% until 1995. Since then, trade integration has not deepened for the EU-15, but trade shares among the newly joined CEE countries have doubled. The study estimates that further deepening of the Internal Market could potentially result in an additional 50% increase in trade and around a 3% increase in real income.

Many authors point to the heterogeneous impact of trade integration among EU countries. Freeman et al. (2022) find significant benefits provided by the EU and the Internal Market for the trade of goods and services, which are greater for the more recent EU members from CEE and are increasing gradually. This is not only due to the ongoing reduction of trade costs as economic integration deepens but also because the EU's internal market for goods and services

continues to expand. The gravity model by Mayer et al. (2019) shows that the Internal Market has promoted deep trade integration beyond just tariff reductions, with a trade impact more than three times greater than a regular RTA. The results show that the Internal Market has boosted goods trade by 109%, tradable services trade by 58%, and welfare by 4.4%, on average. Moreover, small open economies, and particularly Eastern European countries, have benefited more than large EU members. Also, specialization patterns of intra-EU exports among EU Member States are observed. Stehrer et al. (2016) find that EU integration has led to a higher intensity of bilateral exports in both goods and services, resulting in a concentration and clustering of exports in some EU countries. Moreover, the trade-to-GDP elasticities for EU-28 exports have become notably smaller when considering the exporter's GDP, while there has been little change or even an increase in these elasticities with respect to the importer's GDP.

The favorable impact of the establishment of the Internal Market on EU trade and activity is also confirmed through counterfactual analyses. By simulating a counterfactual scenario in which tariffs and non-tariff barriers are reintroduced, the study by in 't Veld (2019) shows that intra-EU trade flows would be reduced, leading to a smaller market size and less competition. Considering the effect of the Internal Market on firms' mark-ups over marginal costs, the total estimate of the Internal Market's impact on GDP is around 9% higher on average for the EU, with significant variation across EU countries. In addition, to estimate the economic implications of "unraveling Europe', Felbermayr et al. (2018) utilize a computable general equilibrium (CGE) model and perform econometric evaluations of various stages of European integration. Their gravity analysis shows that the Internal Market has led to the largest benefits to goods trade (36% increase in trade and 9% decrease in non-tariff trade costs) and services trade (82% increase in trade and 34% reduction in trade costs). Also, membership in the common currency and Schengen has contributed significantly to growth. The study highlights substantial heterogeneity among EU members, with smaller, poorer, and more open countries at a relatively greater risk of losing out.

In summary, there is a vast body of research that points to significant economic advantages of the establishment and functioning of the Internal Market for the EU countries. Within the Internal Market, there is a clear and widely accepted agreement that trade in goods has experienced the largest degree of integration, with a need for further deepening of the trade in services. Finally, many studies have shown that smaller and newly joined EU economies have experienced the largest and most notable gains in terms of trade and economic growth.

3. STYLIZED FACTS

The following analysis of the trade restrictions present in the EU economies (intra-EU trade) is based on the developments in the indicator Measure of Aggregate Trade Restrictions (MATR), developed by the IMF and introduced in detail by Estefania-Flores et al. (2022).

MATR is a quantitative tool used to summarize the various trade barriers imposed in the international trade of goods and services. It encompasses tariffs, non-tariff barriers, and limitations on the use of foreign exchange for current transactions. The data used to create the MATR covers more than 150 countries from 1949 to 2020, making it a comprehensive and detailed tool for analyzing trade policy. MATR is based on binary variables related to exchange measures, payment arrangements, imports and exports, and invisible and current transfers. Each sub-indicator is assigned a score of one if a restriction exists in a specific country for a given year (and zero

otherwise). MATR is strongly correlated with other measures of trade policy and openness but has the added benefit of greater country and time coverage, as well as more detailed granularity. Previous efforts to construct composite indicators of trade restrictions include Trade Restrictiveness Indices (TRI) by Anderson and van Wincoop (2003)[5], TRI by Looi Kee et al. (2009)[6] and the Trade Freedom component of the Heritage Foundation's Index of Economic Freedom (IEF)[7]. These data are complementary to the comprehensive data on tariffs, available by WTO, and data on non-tariff measures (NTMs) developed by UNCTAD.

Figure 1 shows the evolution of the MATR score across the EU countries. These results point to already reached considerable trade liberalization, which is reflected in the low to moderate scores of aggregate trade restrictions. Also, there is an evident improvement in the trade restriction (average score of 5.44 in 2020, compared to 6.75 in 1999).

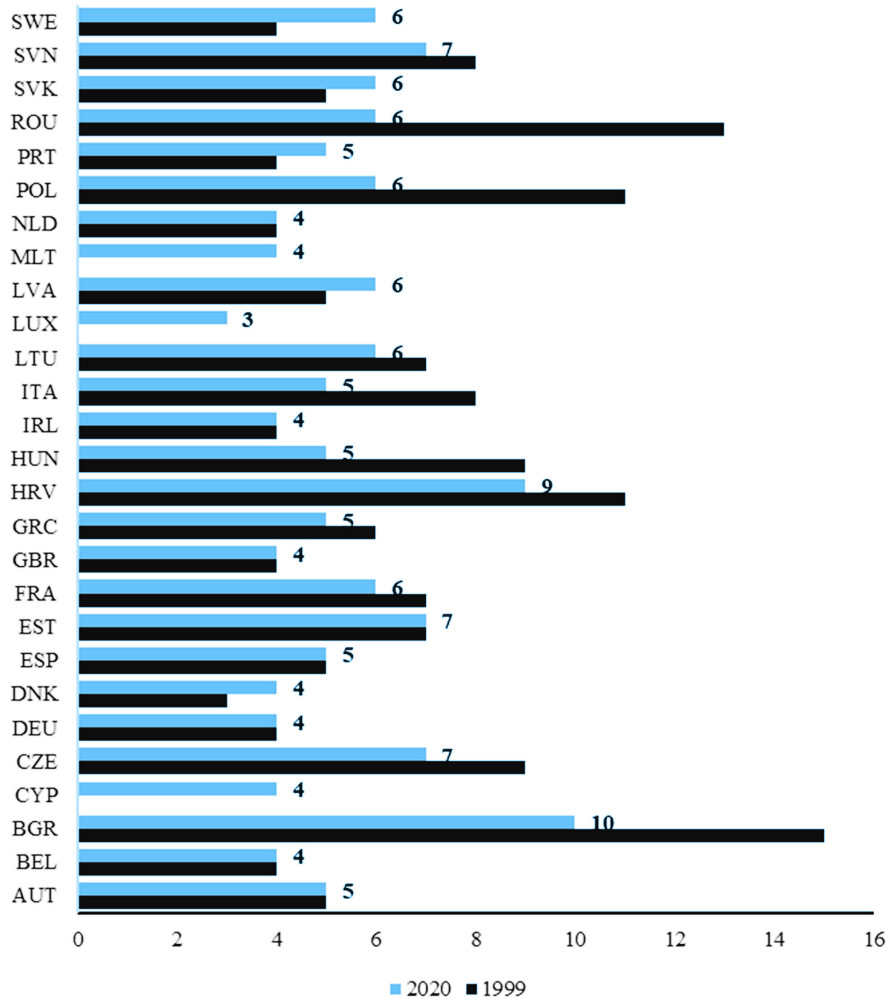


Figure 1. The Average Score of MATR For 1999 And 2020, By Countries

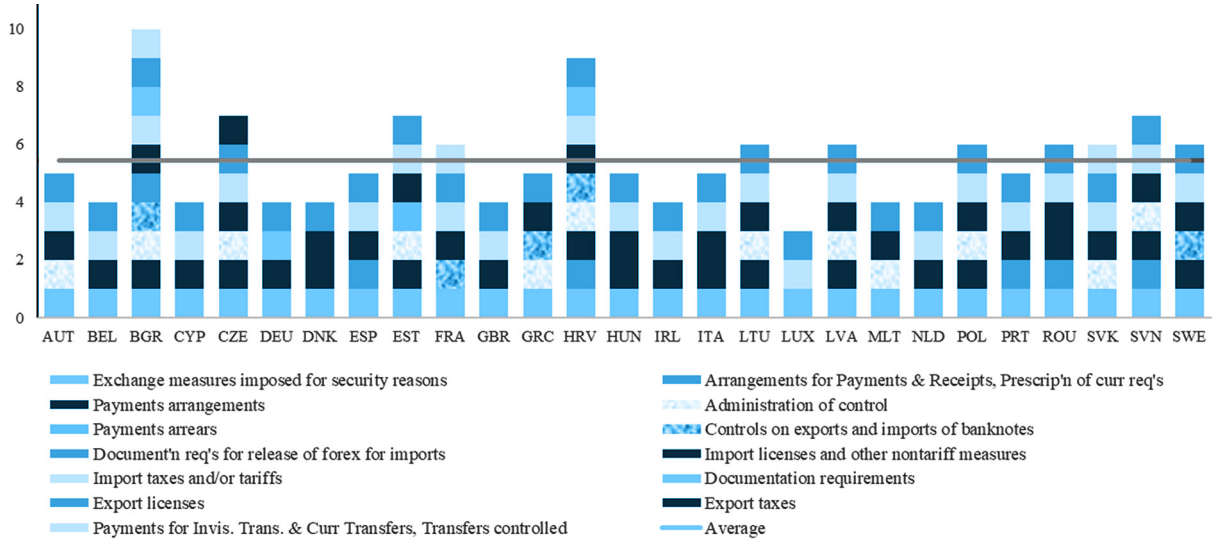
Source: MATR database, Estefania-Flores et al., 2022

[5] TRIs are difficult to implement, since they require disaggregated data on protectionism for many goods, countries, and years, along with the associated import levels and demand elasticities. Consequently, they are available for a limited number of countries and years.

[6] Authors provide estimates of trade restrictiveness for 78 countries; they combine tariffs and ad-valorem tariff equivalents of NTBs at the tariff line level and aggregate these data. Still, their analysis is limited across countries and by time (only covers the period between 2000 and 2004).

[7] Trade Freedom is a composite measure of the absence of tariff and non-tariff barriers that affect imports and exports of goods and services. It is available for many countries annually back until 1995.

Figure 2 analyzes the sup-components of the MATR indicator across the sample of EU countries. The results for 2020 show that the largest restrictions, on average, persist in the areas of "Exchange measures imposed for security reasons", "Export licenses", "Import licenses and other nontariff measures" and "Import taxes and/or tariffs". Among the countries, Bulgaria and Croatia appear to have comparably higher levels of trade restrictions (10 and 9, respectively), surpassing the average for the entire sample of EU countries. This indicates that there is still room for improvement and that the positive effects from the integration process and the Internal market should come in the longer term.



Note: For brevity, zero – amounting MATR subcomponents, are omitted from the figure. These include State import monopoly, Exports and Export Proceeds, Repatriation requirements, Financing requirements, Proceeds from Invis Trans's & Current Transfers, Repatriation req's, Surrender requirements, Restrictions on the use of funds, Restrictions and/or multiple currency practices, Imports and Import Payments, Foreign exchange budget, Financing requirements for imports.

Figure 2. The Average Score of MATR For 2020, By Country And Sub-Components
Source: MATR database, Estefania-Flores et al., 2022

In sum, MATR indicators in the EU countries point to an improvement in their trade liberalization performance. Still, there remains room for further advancement in terms of the completion of the Internal Market, which should be addressed in the years ahead.

4. MODEL AND DATA

This paper aims to estimate the effect of aggregate trade restrictions on the bilateral export flows among the EU countries by using the gravity model of international trade. The dataset is constructed as a panel, covering 28 EU member countries (including Great Britain). Annual data are used over 22 years (from 1999 to 2020). The dependent variable EXPORT corresponds to the logarithm of the nominal bilateral trade flows from exporter *i* to importer *j* at time *t*. Except for standard independent variables used in the model of Anderson and van Wincoop (2003), additional variables such as the "remoteness indexes" are added to the equation to account for multilateral resistance (Yotov et al., 2016). Two different equations using the OLS estimator are used in this paper:

$$LnEXPORT_{ijt} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln DISTANCE_{ijt} + \alpha_4 EURO_{ijt} + \alpha_5 BORDER_{ijt} + \alpha_5 LANG_{ijt} + \alpha_5 \ln MATR_{it} \quad (1)$$

$$LnEXPORT_{ijt} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln DISTANCE_{ijt} + \alpha_4 EURO_{ijt} + \alpha_5 BORDER_{ijt} + \alpha_5 LANG_{ijt} + \alpha_5 \ln MATR_{it} + \alpha_4 \ln REM\_EX_{it} + \alpha_5 \ln REM\_IM_{jt} \quad (2)$$

To control the unobserved multilateral resistance and potentially for any other observables and unobservable characteristics that vary over time, we use exporter and importer fixed country effects in the third equation. Since the created matrix had too many rows, we were not able to use fixed-time effects. The final (fourth) equation is reformulated in multiplicative form and re-estimated by applying the PPML estimator instead of the OLS estimator. The use of the PPML estimator accounts for heteroscedasticity (Silva & Tenreyro, 2006) and ensures that the gravity-fixed effects are identical to their corresponding structural terms.

$$LnEXPORT_{ijt} = \pi_{it} + \chi_{jt} + \alpha_1 \ln DISTANCE_{ijt} + \alpha_2 EURO_{ijt} + \alpha_3 BORDER_{ijt} + \alpha LANG_{ijt} + \alpha_5 \ln MATR_{ijt} + \varepsilon_{it} \quad (3)$$

$$EXPORT_{ijt} = \exp[\pi_{it} + \chi_{jt}\, \alpha_0 + \alpha_1 lnDISTANCE_{ijt} + \alpha_2 EURO_{ijt} + \alpha_3 BORDER_{ijt} + \alpha_4 lnLANG_{ijt} + \alpha_5 lnMATR_{ijt}] + \varepsilon_{it} \quad (4)$$

The influence of certain independent variables on EU members` exports is investigated by using the statistical software STATA. Since we want to explore the factors that influence the level of bilateral trade between an importing country and an exporting country, the dependent variable is *TRADE* (EXPORTijt). The trade variable represents the logarithm of the export of each individual EU country to its EU trading partners in absolute values, in million US dollars and it is extracted from the Direction of Trade Statistics, IMF.

Independent variables included in the regressions are the real GDP of the domestic county, real GDP of the trade partner, distance, common border, common language, membership in the Eurozone, the geometric mean of the values of the MATR index of both imported and exported and remoteness indexes of exporter and importer.

Gross domestic product is a standard variable used in gravity models since the model is based on Newton's law of universal gravitation. In other words, the gravity equation for trade states that the trade flow from country *i* to country *j*, is proportional to the product of the two countries' GDPs. The variable GDP in this paper is expressed in American dollars in prices from 2015, and it is extracted from the World Bank Development Indicators. The expectation is that the coefficient should be statistically significant and positive, thus meaning that an increase in the GDP of the domestic or GDP of the trading partner should increase the intensity of mutual trade. The coefficient usually has a value of around 1, but even smaller values can be logical since smaller countries tend to be more open to international trade.

The variable *EURO* is a binary variable, meaning that if both EU countries are members of the Eurozone in a specific year, the variable has a value of 1. We expect a positive correlation with the trade flows since the introduction of the common currency influenced the elimination of transactional costs and capital restrictions.

The variable *DISTANCE* is a standard variable applied in gravity models measuring the geographical distance between trading partners. The coefficient measuring distance should be significant and negative since the expectation is that when the distance between two countries is higher, it should likely negatively impact their bilateral trade. In this paper, we used data on the geographical distance between the economic centers of two countries from the website WorldAtlas (n.d.).

The variables BORDER and LANG are binary variables. The possession of a common border and common language between trading partners *i* and *j,* is noted with 1, or 0 otherwise.

The indicator *Measure of Aggregate Trade Restrictions (MATR)* uses data from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. MATR is an empirical measure of how restrictive official government policy is towards the international flow of goods and services. As a result, MATR potentially varies between 0 and 22, with a higher score indicating more restrictions (in practice MATR varies between 2 and 21) (Estefania-Flores et al., 2022). To better interpret the results, we descale the index from 0-100. The relationship between the indicator and the trade is inverse, meaning that the more the country has restrictions the less will trade with its partners.

This model also includes an indicator of economic *REMOTNESS*. The remoteness variable, both on the exporter side, lnREM_EXPi,t, and on the importer side, lnREM_IMPj,t, are constructed, respectively, as the logarithms of output- and expenditure-weighted averages of bilateral distance (Head, 2003). The index statistically identifies each country's distance from world economic activity. It means that the countries that are geographically distant, have higher international trade costs, and that causes a lower volume of trade as a proportion of GDP. Trade between two countries depends not only on the direct trade costs between these countries but also on how remote they are from the rest of their trading partners, which is captured by the multilateral resistance.

5. RESULTS

For estimating the effect of aggregate trade restrictions on the bilateral trade flows among the EU countries we have run four regressions. The results are given in Table 1. The first regression is ordinary least squares regression (1), in the second we control for multilateral resistance (2), in the third one we add fixed effects on the second regression (3), and in the fourth regression, we use the PPML model to account for heteroscedasticity (4).

Table 1. Results from the estimated models

	OLS	OLS controlling multilateral resistance	OLS controlling multilateral resistance with fixed effects	PPML
	(1)	(2)	(3)	(4)
Sample	1999-2020	1999-2020	1999-2020	1999-2020
Cross-Section	756	756	756	
Observations	16497	16497	16497	16497
Log (Distance)	-1.2141***	-1.2960***	-1.3305***	-0.8570***
Log (GDP_home)	0.9971***	1.3249***		
Log (GDP_partner)	0.8145***	0.8124***		
Eurozone	0.1522***	0.0958***	0.6746***	0.5877***
Common border	0.6588***	0.6479***	0.3835***	0.3677***
Common language	-0.1767***	-0.1683***	0.1136***	0.0320
Log (MATR)	-0.2424***	-0.1130***	-1.4535***	-0.7246***
Log (Exporter remoteness index)		0.3146***		
Log (Importer remoteness index)		0.2530***		
Constant	-31.4190***	-58.5910***	20.9886***	15.9715***
R-square	0.8561	0.8583	0.8848	0.8808
Adjusted R-square	0.8560	0.8583	0.8613	0.8808

Note: The p-values read as follows: *p<0,10;**p<0.05; ***p<0.01

Source: Author`s estimates

The effect of most independent variables is stronger in equations (2), (3) and (4), than in column (1) or OLS regression. These results suggest that estimates in the first equation did not account for multilateral resistances, which can lead to biases in the estimates of the gravity model. The second and third equations take into consideration the remoteness indexes and prove that both exporter and importer remoteness indexes are positive and statistically significant. Adding fixed effects in the third equation, reinforce the results in the second equation. And final equations using the PPML model, account for heteroscedasticity, or in case there are zero trade flows, which is not the case in this dataset. Therefore, the preferred model is the third equation, and we will base our explanation on the results from the third regression.

The general fit of the model is high, explaining more than 80% of the variation in trade (export). Since the results are stable in all four equations, except for the language variable, the results are robust. It is evident that the analyzed variables are statistically significant in all four regressions and bear the same sign (except language). This gives the impression that the results are stable and robust. R2 and adjusted R2 are more than 85% which points out that the independent variables explain on a satisfactory level the dependent variable trade (export).

The results for the variable GDP are significant with a positive sign explaining that higher GDP between the exporter and the importer countries could have a positive effect on increasing their mutual trade. This explanation is very logical from the international economics point of view and thus the results are expected.

The result for the variable Distance is significant and negative as expected. Increasing the distance between the trading partners influences decreasing their mutual trade. In this case, a 1% increase in the mutual distance between the trading partners could lead to a 1.33% decrease in their trade.

The variable Eurozone is also significant and with a positive sign. This indicates the positive effects of the implementation of a common currency among EU member countries. Thus, in this direction, our results show that if both EU countries are part of the Eurozone, it could increase their mutual trade by 0.67%.

The results from the dummy variables: common border and common language are also as expected: significant and with positive signs meaning that countries that share the same border and use a common language could easily increase their trade.

The results for the MATR index are significant and with negative signs. This implies that a 1% decrease in mutual trade restrictions could lead to a 1.45% increase in their mutual trade. The value of this variable indicates that there is still significant space that EU member countries could work on to alleviate certain policies that have restrictive influence over trade. In this regard, we could say that the points where EU member countries could work more to annulate these trade restrictions are those where the countries have the highest values of the MATR index: exchange measures imposed for security reasons, export licenses, import licenses and other nontariff measures and import taxes and/or tariffs. It is also worth stressing that the values of the subcomponents of the MATR indicator give the direction where policy measures should be directed to ease trade. In the case of these four components of the MATR indicators, the countries have reported that there is at least one restriction persisting. Each sub-indicator is assigned a score of one if a restriction exists in a specific country for a given year, and zero if there is no restriction. So, these values should be analyzed in more detail to discover their magnitude and influence over trade.

6. CONCLUSION

The goal of this paper is to explore the drivers and constraints of intra-EU trade. Eurostat data and results from many empirical studies indicate the positive effects of the process of regional economic integration on increasing intra-EU trade and the functioning of the Internal Market. However, with this analysis, we try to explore what could be the remaining constraints for increasing the benefits for all EU members and especially paying attention to the newcomers and small EU economies. For this purpose, we have applied the MATR indicator to summarize the various trade barriers imposed in the international trade of goods and services. In the analysis, we have covered 28 EU member countries, including Great Britain, and a period of 22 years, from 1999 to 2020.

For better robustness of the results, we have applied four estimations of the model and we have decided that the best results are obtained with the OLS model controlling for multilateral resistance and with fixed effects. The results have shown that countries that have higher GDPs, that are closer to each other, and that share a common border and common language trade more and could trade more. Apart from these classical gravity model aspects, in this analysis, we have estimated the influence of the application of common currency and the composite IMF measure – Measure for Aggregate Trade Restrictions. In this regard, the estimations have shown that participation in the Eurozone has positive effects on increasing intra-EU trade. EU member countries that are not part of the Eurozone could consider this result and it is expected the application of the common currency could lead to an increase in trade of 0.67%. As far as the MATR indicator is concerned the estimation has shown that its importance is significant for increasing trade and that a 1% decrement in mutual trade restrictions between the countries could lead to 1.45% of intra-EU trade. We consider that this is a very important result and should be analyzed more deeply to estimate which are the real constraints for increasing intra-EU trade and thus enjoying all the benefits from the EU Internal market. What we could say from a more detailed analysis of the values of the separate categories of measures included in the calculation of MATR is that the worst values, or the area where EU-member countries have the worst results are: exchange measures imposed for security reasons, export licenses, import licenses, and other nontariff measures and import taxes and/or tariffs. Apparently, in these four fields, there are certain measures that EU member countries apply and those hinder their mutual trade and represent a constraint.

In this regard, we suggest that this analysis should be considered, and a more precise investigation could be performed to enable the transformation of those constraints into drivers for increasing intra-EU trade. The results from this study should be specially considered by the small and newcomer economies and the members that are still not part of the Eurozone.

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EMAN 2023 – Selected Papers
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The Influence of Foreign Direct Investment on Research and Development in EU Countries

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Abstract: *Over the last few decades, in modern conditions of globalization, the innovation landscape has changed quickly, affecting the world. In developed countries and economies in transition, Foreign Direct Investment (FDI) has become a driver of economic development and modernization. Research and Development (R&D) is widely acknowledged as a critical factor that stimulates innovation and technological advancement to increase productivity and economic growth. FDI promotes rapid economic restructuring and facilitates the acquisition of new technologies. FDI, as a crucial conduit of cross-border technology diffusion, is a significant factor influencing R&D activities in an economy. One of the most efficient ways for national economies to overcome the technology gap with their global competitors is to use knowledge spillovers from FDI. In order to improve their technical capacity, countries may encourage companies to invest more in R&D through FDI and absorb technology transfers from it. This paper's objective is to test the influence of FDI net inflows on the R&D investment in the sample of 27 EU countries for the period 2015-2021. To provide an empirical investigation of the influence of FDI on R&D, regression analyses were performed. The results of the analysis confirm the importance of FDI for R&D in the case of EU countries. This study revealed that FDI has a positive influence on R&D. The evaluation of the obtained results can serve as a foundation for drawing further conclusions, contributing to the existing literature and FDI strategy of EU economies.*

1. INTRODUCTION

Nowadays, in a highly globalized world, the wealth of natural resources is no longer a major determinant of competitiveness. For countries that want to improve their competitiveness, it is essential to develop new technologies and products due to the sharp and intensive structure of global competition. The capacity to develop various and more innovative high-tech products, generated through R&D and innovation, supported by FDI, has recently gained greater significance (Erdal & Göçer, 2015, p. 749). Due to the substantial technological gap in emerging economies, it is challenging for domestic firms to reach the level of technology-developed companies. To overcome the technological gap with their international competitors, local firms in developing countries can benefit from knowledge spillovers from FDI. As a result, the presence of FDI might encourage local enterprises to invest in R&D and innovation and to take advantage of technology transfers from it (Khachoo & Sharma, 2017). One of the common methods that companies increase their technological capacity and enhance their market intelligence is through FDI in R&D (Li et al., 2022).

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The 21st century has been described as the "knowledge-based economy" following the growth of high-tech industries, which is being formed through significant scientific R&D activities (Wang, 2010, p. 103). A well-organized process of knowledge production, diffusion and application is well-known as research and development (R&D). One of the main factors affecting the economic growth of a country is the accumulation of knowledge. A deliberate investment in R&D or the widespread use of current technologies may both expand the stock of knowledge. Technology spillovers from the stock of knowledge, generated by R&D activities, have a significant role in improving a company's productivity. R&D fosters innovation as well as enhances a company's capacity to discover, integrate and utilize outside knowledge. Besides that, R&D indirectly leads to a greater level of technology spillovers and boosts the firm's capacity for absorption.

The ability to develop countries to compete in a dynamic international market structure depends on a combination of the technological capabilities of national companies and the impact of external factors such as FDI (Erdal & Göçer, 2015, p. 751). FDI is one of the most significant vehicles for the diffusion of technology because it allows the transfer of technology embedded in human capital. FDI is particularly significant due to that promotes faster economic restructuring, stimulates stronger corporate governance, and makes it easier to acquire new technologies (Kathuria, 2008, p. 46).

This research paper is organized as follows. Firstly, after the introduction, the theoretical aspect and the relevant existing literature on the relationship between FDI and R&D is given. The second section gives a quick overview of the data used, the important methodological concerns, as well as an overview of the results and their discussion. A summary of the conclusions is presented at the end of the paper.

2. LITERATURE REVIEW

The impact of FDI on R&D has been a topic of discussion at the macro and micro levels. From a macro-perspective, it is related to the issue of de-industrialization, while from a micro-perspective, the case focuses on how FDI affects R&D at the corporate level (Lin & Yeh, 2005, p. 1790). From a macro aspect, some authors (Lin & Yeh, 2005, p. 1790) emphasize that FDI may substitute for domestic investment. Still, they also note that better resource allocation and technical advancement can boost industrial productivity. Conversely, macroeconomically, FDI motivation and strategic goal may be used to infer the impact of FDI on business internal R&D. FDI is intended to acquire strategic assets or develop firm-specific advantages.

Several theories have been presented in the literature that FDI inflows increase the R&D conducted in the host economy. In order to examine the effects of FDI on R&D and innovation in 10 Asian economies between 1996 and 2013, Erdal and Göçer (2015) employed the panel causality and integration technique. They discovered that FDI inflows increase the host country's R&D and innovation efforts. In a sample of 21 developed and emerging countries, Alvi et al. (2007), explored whether patent protection and knowledge transfer encourage R&D. The findings imply a threshold effect, according to which FDI only has a positive impact, if the country depends heavily on FDI inflows. Sandu and Ciocanel (2014) affirmed that FDI is boosting the output of high-tech products, the number of patent applications and national intellectual capital through R&D investment. According to a study on Indian manufacturing companies "FDI inflow induces foreign-owned firms in high-tech industries and firms with minority ownership to invest in R&D" (Sasidharan & Kathuria, 2011, p.126). Findings of some academics (Anwar & Sun, 2015; Khachoo & Sharma, 2017),

confirm that FDI has a significant effect on local firms' R&D investment. Likewise, Taiwanese authors (Lin & Yeh, 2005), found a strong positive relationship between FDI and R&D in the IT sector. As the authors rightly think that FDI and R&D should be treated as endogenous variables in empirical studies, they used an endogenous switching regression model to examine the mutual influence of FDI and R&D in Taiwan's IT sector. Another study has attempted to investigate the effects of FDI on R&D and innovation using the panel causality and cointegration model in ten developing countries (China, South Korea, India, Iran, Pakistan, Malaysia, Singapore, Thailand, Saudi Arabia, and Turkey) in Asia (Erdal & Göçer, 2015). The results show that one one-point increase in the amount of FDI inflow is associated with a 0.83 % increase in R&D expenditures and, a 0.42% increase in patent applications in these countries for the 1996-2013 period.

The idea that FDI has a negative impact on R&D is widely accepted in the literature. This argument is predicated on the premise due to that FDI makes foreign technology accessible, and imitation becomes more affordable and credible (Tan & Azman-Saini, 2017, p. 469). Instead of conducting their R&D, domestic companies that lack financial and research resources will simply copy or import foreign technology. Wang (2010), used an extreme bound analysis approach to investigate the factors influencing R&D investment in 26 OECD countries. The results of his study revealed that the transfer of foreign technology through trade and FDI has a significant negative influence on R&D.

3. METHODOLOGY AND DATA DESCRIPTION

This paper aims to investigate the influence of Foreign direct investment (FDI) on the R&D activity of EU countries. The research is based on the data of the following indicators: Foreign direct investment, net inflows (FDI) and Research and development expenditure (R&D). Both indicators are expressed as percentages of GDP. Bearing in mind the various research presented in the literature review, the following hypothesis was defined:

Hypothesis H1: *Foreign direct investment and net inflows (FDI) have a positive impact on the Research and development expenditure (R&D) in the next year.*

In the research of this paper, data was obtained from the official website of The World Bank (World Bank, 2022a, 2022b). In the model of the research, FDI is an independent variable, while R&D is the dependent variable. The proposed model was tested using the program Stata (version 12.0). Firstly, all raw data was transferred in natural logarithm values. Secondly, panel regression analysis was used to evaluate the influence of the independent variable on the dependent variable in the research model. Lastly, after the identification of a balanced dataset and the assumptions are met, the fixed effects model (FEM) and random effects model (REM) were tested. Afterward, the Hausman test for the model was performed to select FEM or REM. The Hausman test had a significance cut-off point of 0.05. Therefore, the value statistically significantly less than 0.05 indicates the selection of FEM, otherwise, REM should be interpreted.

Based on the data presented in Figure 1, it's evident that among all EU member states, Cyprus (58,07%), Hungary (26,72%), Ireland (23,65%), Luxembourg (24,50%) and Malta (28%), recorded the greatest average FDI net inflow (% of GDP), throughout the period from 2015 to 2021. Analysing the presented data, Estonia (7,36%), Latvia (4,06%), Lithuania (3,93%) and the Czech Republic (3,61%) registered an average FDI net inflow below 10%. As can be seen in Figure 1, the average net inflow of FDI, expressed as a % of GDP, decreased in Austria (-2,57%) and Belgium (-0,66%). The average FDI net inflows were below 3% in all other EU countries.

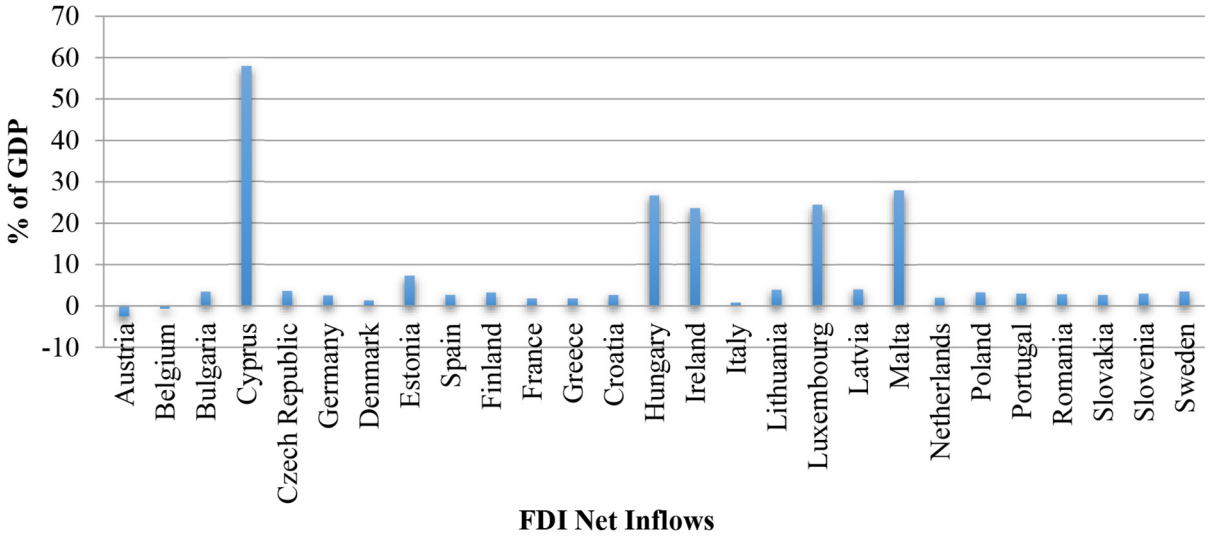


Figure 1. Average FDI net inflow (% of GDP) per EU countries for the period from 2015 to 2021

Source: World Bank, 2022a; authors' work

Observing the R&D data shown in Figure 2, it can be noticed that Sweden had the highest average R&D expenditures (3,35%), followed by Austria (3,12%) and Germany (3,07%) between 2015 to 2021. Denmark (2,96%), Belgium (2,95%) and Finland (2,88%) had the next-highest rates. With the lowest average R&D expenditures recorded in Ireland and Poland (1,19%), Luxembourg (1,18%), Croatia (1,01%) and Lithuania (1%), six more member states reported average R&D expenditures that were less than 1% of their GDP from 2015 to 2021 (Romania – 0,48%; Cyprus, 0,53%; Latvia – 0,61%, Malta – 0,62%; Bulgaria – 0,81%).

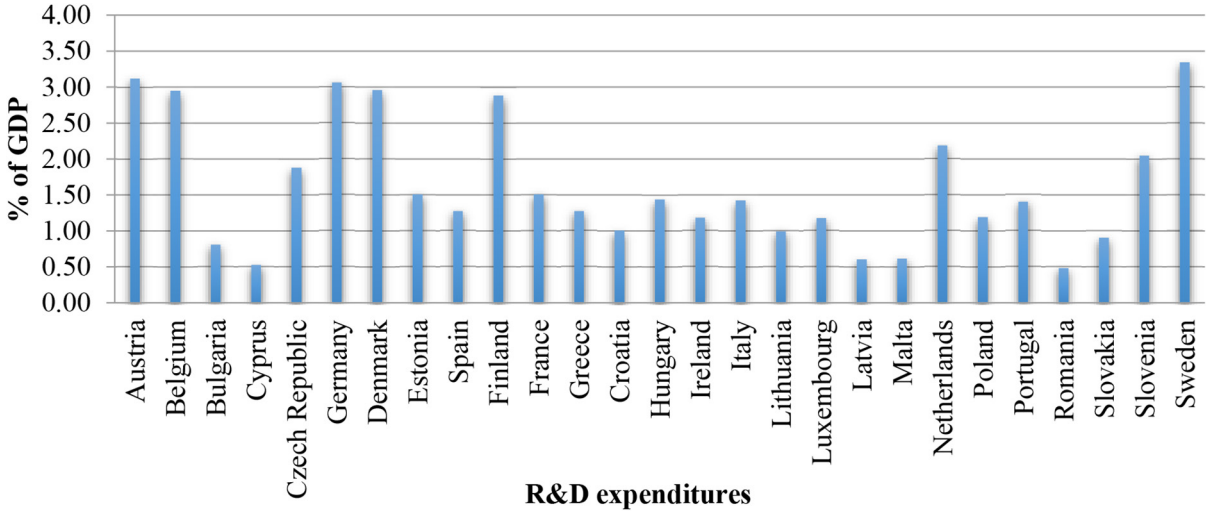
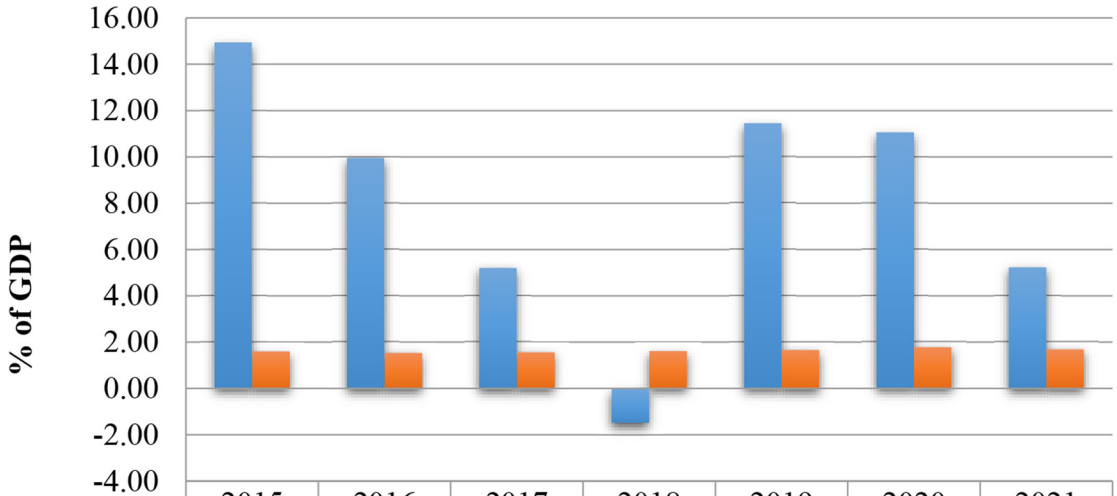


Figure 2. Average R&D expenditures (% of GDP) per EU countries for the period from 2015 to 2021

Source: World Bank, 2022b; authors' work

Figure 3 presents information on the average FDI net inflows compared with the average R&D expenditures by year for 27 EU member states. Primary, we can notice that the highest increases in the average net inflow of FDI were recorded in 2015 (14,94%), 2019 (11,45%), 2020 (11,08%), 2016 (9,96%), whereas the average FDI net inflow dropped the most in 2018 (-1,49%). However, compared to the aforementioned years, a tendency of a decreased average net inflow of FDI

may be seen in 2017 (5,21%) and 2021 (5,23%), as a result of the COVID-19 pandemic. When we look at the trend of average R&D expenditures in the EU, we can conclude that there were no significant variations during the observed period. The biggest increases between 2015 and 2021 were recorded in 2020 (1,78%), 2021 (1,70%) and 2019 (1,67%), while in the other years, there were only minor decreases (2015 – 1,61%; 2016 – 1,54%; 2017 – 1,57% and 2018 – 1,62%).



	2015	2016	2017	2018	2019	2020	2021
FDI net inflow	14.94	9.96	5.21	-1.49	11.45	11.08	5.23
R&D expenditure	1.61	1.54	1.57	1.62	1.67	1.78	1.70

Figure 3. Average FDI net inflow and R&D expenditures (% of GDP) per year for the member states of the EU

Source: World Bank, 2022a, 2022b; authors' work

4. RESULTS

The following part of the work presents the research model, which is investigated by employing panel regression analysis of the data. The analysis of the influence of the indicator Foreign direct investment, net inflows (FDI), as an independent variable, on the value of the indicator Research and development expenditure (R&D) in the following year is presented in Table 1. It was hypothesized that the influence is positive.

Table 1. Results of regression analysis

Independent variable	Dependent variable lnR&D
Constant	0.1915196 [7.94] (0.000)
lnFDI	0.0624463 [3.97] (0.000)
R^2	0.9750
$\bar{R}^2$	0.9686
Hausman test	4.75 (0.0293)
F (FEM)	15.75 (0.0001)

Note: t statistic in [ ] p-value in ( )

Source: Authors

The Hausman test indicates $\chi 2$ of 4.75 ($p = 0.0293$) so the FEM should be assessed. According to the previously defined methodological assumptions of the panel regression analysis, it can be noted that Foreign direct investment and net inflows (FDI) had a positive and statistically significant impact on the value of the indicator Research and development expenditure (R&D) in the following year. An increase in the value of Foreign direct investment, and net inflows (FDI) by 1% contributes to an increase in the value of Research and development expenditure (R&D) by 0.06% in the following year. Fixed effects model (FEM) results confirm that the model is statistically significant at the 1% significance level. This model explained 97.5% of changes in the value of Research and development expenditure (R&D) in the following year. Therefore, the research hypothesis H1 is confirmed according to the presented results.

5. CONCLUSION

In modern conditions, the R&D function is the core that drives the company forward. Research is the critical study of various concepts to discover new knowledge to create new products, processes and services. Development refers to the process in which the results of research work will be applied in practice. The purpose of research is to learn about laws (natural and social), and the purpose of development is for these laws to find their practical application. Today's global competitiveness results in the production of high-tech products that are diverse and inventive. R&D investments and technological innovations determine competitiveness in the modern world. When countries invest in R&D facilities in the host company, the host country's R&D stock and high-tech development are accelerated.

R&D plays a significant role in FDI decision-making, and FDI also influences R&D decision-making. Over the last decades, economic growth has been driven mainly by FDI inflows, while globalization has created a fierce battle for countries and companies to enhance their market share and competitive position. Thus, R&D has contributed to capital formation, export of services and FDI. In other words, R&D has played a fundamental role in investing.

In the field of R&D, FDI is considered a driver of innovation in emerging economies, thereby significantly facilitating access to foreign techniques and technology, development of employee skills and high labor productivity.

In examining the effect of Foreign Direct Investment (FDI) on R&D, this paper has contributed to providing fresh and new results. The paper derives an important result from the empirical analysis using panel data consisting of 27 member states of the EU from 2015 to 2021, which revealed the positive and significant impact of FDI net inflows on R&D expenditures.

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The Impact of Income Quintile on the Frequency of Fruit and Vegetable Intake by Inhabitants of European Countries

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Keywords:
Frequency of fruit and vegetable intake;
Income quintile;
Similarity of preferences

Abstract: *Many studies agree that the population's income affects compliance with the principles of rational nutrition. The basis of rational nutrition is the consumption of fruits and vegetables. The paper aims to identify European countries in which inhabitants of the same income groups have similar preferences regarding the weekly frequency of fruit and vegetable consumption. EU-SILC data from 2019, from 30 European countries, available at Eurostat, were used for the analyses. The frequency of consumption of fruit and vegetables was selected at least once a day, from 1 to 3 per week, from 4 to 6 per week and never or occasionally. Descriptive analysis, factor analysis, principal component analysis method and cluster method of hierarchical clustering, Ward's method, were used for the analyses.*

The results of the descriptive analysis show that, on average, the most preferred frequency of consumption of fruits and vegetables is at least once a day in the monitored countries. It is most preferred by inhabitants of the fifth quintile (55.707% for fruit consumption, and 54.796% for vegetable consumption). The least preferred frequency of fruit and vegetable consumption is never or occasionally. It is the least preferred among the inhabitants of the fifth quintile (5.826% for fruit consumption, and 2.767% for vegetable consumption). Factor analysis identified 7 factors that affect the preferences of inhabitants regarding the consumption of fruits and vegetables in the monitored countries. These factors were the inputs to the cluster analysis, which divided the countries into 5 clusters. The largest cluster of countries was made up of the inhabitants of the Czech Republic, Denmark, Estonia, Greece, Austria, Poland, Slovakia, Finland, Sweden, Iceland, and Turkey, where up to 35% of the monitored countries were included.

1. INTRODUCTION

The consumption of fruits and vegetables and adherence to the principles of rational nutrition are demonstrably influenced by the social status of the population. "Low and medium parental education, material deprivation and non-Western migrant status tend to be associated with a higher risk of low fruit and vegetable consumption" (Boelens et al., 2022). Studies have revealed that "significantly lower proportions of adults living in the greatest poverty consumed fruit at least twice a day or vegetables at least three times a day compared to those who were least poor, with larger differences in vegetable intake" (Grimm et al., 2012). "Differences in fruit and vegetable consumption between social groups are at least partly explained by exposure to fruit and vegetable information from the media and the reflective integration of this information" (Lee & Pena-y-Lillo, 2022). Increasing the consumption of fruits and vegetables is supported by several experiments. An educational intervention for young adults with low incomes (Do et al., 2008), the impact of school meals on the diet of adolescents with low incomes (Longacre et al., 2014), the implementation of a school garden (Wells et al., 2023), a supplementary

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nutrition program (Saxe-Custack et al., 2021), a market program farmer incentives (Durward et al., 2019), semi-structured interviews to increase the consumption of fruits and vegetables of elderly people with low income (Jung et al., 2017), providing nutrition advice, (Bihan et al., 2010). "Policy and environmental strategies to increase affordability, access, availability and information at the decision point are approaches that can help households decouple F/V purchase and consumption" (Grimm et al., 2012).

The contribution aims to determine the degree of influence of income on fruit and vegetable consumption and to identify European countries with similar population preferences.

Hypothesis: With higher income, the share of inhabitants who consume fruits and vegetables more often increases and the share of inhabitants who consume fruits and vegetables rarely decreases.

2. METHODS

The inputs to the analysis were data collected using the EU-SILC sample survey (Anonymous Statistical Survey on Income and Living Conditions of Households) from 2019, available at Eurostat. Data on the frequency of fruit and vegetable consumption by inhabitants of 31 European countries by income quintile were used. The proportion of inhabitants of individual countries who stated that they consume fruit and vegetables at least once a day, 1-3 times a week, 4-6 times a week, never or occasionally was selected for the analysis. Descriptive analysis is used to describe the fact about the frequency of fruit and vegetable consumption depending on the amount of income. Descriptive analysis is performed separately for each preferred frequency of fruit and vegetable consumption and each income quantile. When describing the consumption frequencies, a correlation analysis was performed. Its goal was to find out what kind of dependence exists between income and the preferred frequency of fruit and vegetable consumption in individual countries. The aim of the next F-Test Two-Sample for Variance is to find out whether the difference between the preferences for the frequency of fruit and vegetable consumption of inhabitants in the first and fifth quantiles of income is statistically significant. The data is further subjected to factor analysis, the aim of which is to identify the factors that cause the choice of frequency of fruit and vegetable consumption by inhabitants of selected countries in individual income quantiles. The principal component analysis method is used. The outputs of the factor analysis are the input to the cluster analysis, the aim of which is to identify countries in which inhabitants make similar decisions based on income. Using cluster analysis, countries are identified in which inhabitants classified according to income quantiles behave similarly and prefer a similar frequency of fruit and vegetable consumption per week. Ward's hierarchical clustering method is used.

3. RESULTS AND DISCUSSION

3.1. The Influence of Income Quantile on the Frequency of Fruit and Vegetable Consumption at Least Once a Day (ALAD)

The proportion of the population that consumes fruit at least once a day is around 50% in the monitored countries in all income quantiles, Table 1. The share of the population increases as the income quantile increases. The average share of the population will thus increase between quantiles from 46.68% (first quintile) to 55.71% (fifth quintile). Between income quantiles and the average share of the population who consume fruit at least a day (ALAD), the most significant positive

correlation is especially in Greece, Latvia, Denmark, Bulgaria and France (correlation coefficient >0.97). The distribution is right-sided in the first four income quantiles, more pointed than the normal distribution. In the fifth quantile, the distribution is left-sided, flatter than normal. The highest standard deviation is in the second income quantile. The minimum share of the population that consumes ALAD fruit was in the 1st income quantile in Romania. In all quantiles of income, Romania had the lowest proportion of inhabitants who prefer this frequency of fruit intake of all monitored countries. The highest proportion of inhabitants who consume ALAD fruit was in the 5th income quantile, namely in Spain. In the first two quantiles of income, the highest share of the population was in Italy, and in the third and fourth quantiles of income, it was in Ireland.

The average proportion of inhabitants who consume vegetables at least once a day increases with increasing income. It is most pronounced in the countries of Luxembourg, Latvia, then Greece, France, and Sweden (correlation coefficient >0.97). The average share of inhabitants who prefer this frequency of vegetable consumption ranges from 43.65% in the first quantile to 54.80% in the fifth quantile. The values are only slightly lower than for fruit. The distribution of vegetable consumption in individual countries is flat, left-sided in the third income quantile, and right-sided in the other income quantiles. The highest standard deviation is in the second and third income quantiles. The minimum share of the population that consumes ALAD vegetables was in all income quantiles in Romania. The lowest was in the second quantile, 13.3%. The highest share of the population was in the fifth quantile in Belgium at 83.9%. In Belgium, the highest proportion of the population consuming ALAD vegetables was also in the second and third income quantiles. Ireland had the highest proportion of ALAD inhabitants in the first two income quantiles.

Table 1. Descriptive analysis of the share of inhabitants consuming fruits and vegetables ALAD

Fruit intake– at least once a day					
Statistics	**First quintile**	**Second quintile**	**Third quintile**	**Fourth quintile**	**Fifth quintile**
Mean	46,678	50,889	52,607	52,867	55,707
Standard Error	2,133	2,320	2,135	2,059	2,014
Median	49,300	50,500	50,900	53,600	53,100
St. Deviation	11,082	12,056	11,096	10,698	10,467
Kurtosis	0,661	0,819	0,674	0,592	-0,512
Skewness	-0,808	-0,733	-0,424	-0,272	0,263
Range	46,300	51,300	47,900	47,000	40,500
Minimum	16,800	17,500	23,100	25,200	34,400
Maximum	63,100	68,800	71,000	72,200	74,900
Vegetable intake at least once a day					
Statistics	**First quintile**	**Second quintile**	**Third quintile**	**Fourth quintile**	**Fifth quintile**
Mean	43,652	47,059	48,911	50,133	54,796
Standard Error	2,250	2,507	2,533	2,459	2,430
Median	43,200	46,400	48,200	49,200	53,000
St. Deviation	11,691	13,025	13,163	12,775	12,626
Kurtosis	0,849	1,173	1,184	1,366	0,865
Skewness	-0,020	-0,091	0,125	-0,031	-0,018
Range	53,300	61,800	63,300	61,300	60,200
Minimum	14,400	13,300	16,600	17,300	23,700
Maximum	67,700	75,100	79,900	78,600	83,900

Source: Author`s calculations

The correlation between the proportion of inhabitants who prefer fruit consumption and vegetable consumption at least once a day is particularly high in Bulgaria, Denmark, Greece, France, Italy, Latvia, Lithuania, Romania, and Slovakia.

3.2. The Influence of Income Quantile on the Frequency of Fruit and Vegetable Consumption from 1 to 3 Times a Week (1T3)

The average share of inhabitants who prefer to consume fruit and vegetables from 1 to 3 times a week (1T3) is significantly lower than it was for the frequency of at least once a day. In the case of fruit, the average share of the population gradually decreases between quantiles from 22.90% in the first income quantile to 17.43% in the fifth income quantile, Table 2. The most pronounced negative correlation is in Latvia and Luxembourg (correlation coefficient <-0.97). The standard deviation is also lower, the lowest is in the fifth income quantile. The distribution is left-sided, pointed in all income quantiles except the fifth. The fifth income quantile is right-sided and flat. The lowest share of inhabitants preferring to consume 1T3 fruit is in the first and fourth income quantiles in Ireland, in the other income quantiles it is in Portugal. The minimum value is in Portugal, where consumption of 1T3 was preferred by 8.5% of the fourth income quantile. The highest share of the population was in all income quantiles in Romania, it was most pronounced in the first income quantile. Based on the results of the F-Test Two-Sample for Variance, there is a statistically significant difference ($P<0.05$) between the proportion of inhabitants who prefer the consumption of 1T3 fruit in the first and fifth income quantiles.

Table 2. Descriptive analysis of the share of inhabitants consuming fruits and vegetables 1T3

Fruit intake from 1 to 3 times a week					
Statistics	**First quintile**	**Second quintile**	**Third quintile**	**Fourth quintile**	**Fifth quintile**
Mean	22,893	20,396	19,859	18,956	17,433
Standard Error	1,180	1,217	1,078	0,990	0,853
Median	22,200	19,600	19,800	18,100	17,500
St. Deviation	6,133	6,322	5,601	5,145	4,432
Kurtosis	2,652	4,599	2,772	1,414	-0,882
Skewness	1,162	1,633	1,084	0,569	-0,228
Range	29,400	31,500	26,900	24,800	16,300
Minimum	12,800	10,800	10,700	8,500	9,300
Maximum	42,200	42,300	37,600	33,300	25,600
Vegetable intake from 1 to 3 times a week					
Statistics	**First quintile**	**Second quintile**	**Third quintile**	**Fourth quintile**	**Fifth quintile**
Mean	23,470	21,122	19,089	17,670	15,222
Standard Error	1,437	1,497	1,550	1,425	1,271
Median	23,100	21,200	18,600	17,700	14,100
St. Deviation	7,469	7,777	8,053	7,406	6,603
Kurtosis	2,011	4,138	2,811	1,107	0,755
Skewness	0,787	1,335	1,280	0,857	0,651
Range	35,200	39,800	36,200	31,500	27,100
Minimum	10,600	7,500	7,900	6,200	4,300
Maximum	45,800	47,300	44,100	37,700	31,400

Source: Author`s calculations

The highest average share of inhabitants who prefer to eat vegetables from 1 to 3 times per week is in the first income quantile, namely 23.47%. It gradually decreases to 15.22% in the fifth income quantile. There is a significant negative correlation with the income quantile especially in the countries of Belgium, Bulgaria, Estonia, Greece, Latvia, Sweden (correlation coefficient <-0.97). The minimum share of the population preferring to consume vegetables 1T3 is in Ireland in the fifth income quantile, namely 4.3%. Of all the monitored countries, this frequency of vegetable consumption is the least preferred in Ireland in all income quantiles except the third. The third income quantile is in Belgium. On the contrary, the consumption of

1T3 vegetables is preferred mainly by the inhabitants of Romania in all quantiles of income. The highest preference is given to Romanian inhabitants of the second income quantile, 47.3%. Based on the results of the F-Test Two-Sample for Variance, there is a statistically significant difference ($P<0.05$) between the proportion of inhabitants who prefer the consumption of 1T3 vegetables in the first and fifth income quantiles.

The correlation between the proportion of inhabitants who prefer fruit consumption and vegetable consumption from 1 to 3 times a week is particularly high in France, Greece, Latvia, Poland, and Finland.

3.3. The Influence of Income Quantile on the Frequency of Fruit and Vegetable Consumption from 4 to 6 Times a Week (4T6)

The average share of inhabitants who prefer the frequency of fruit consumption from 4 to 6 times a week (4T6) is around 20%, Table 3. The lower average share is in the first income quantile (18.86%) and gradually increases with increasing income to 21.03% in the fifth income quantile. The correlation between the income quantile and the share of the population that consumes 4T6 fruit is most pronounced in the countries of Austria and Romania (correlation coefficient >0.97). The distribution is flatter than normal in all income quantiles, left-sided except for the first income quantile, where it is right-sided. The lowest proportion of inhabitants preferring 4T6 fruit is in the countries of Malta, namely in the first quantile of income 8.4% and in the second quantile of income 11.5%, Ireland (third quantile of income), Belgium (fourth quantile of income), Spain (fifth quantile of income). The highest share of the population is in the first quantile in Serbia, 26.9%, in the second to fourth in Latvia, and in the fifth income quantile, it is in Romania (33.7%).

Table 3. Descriptive analysis of the share of the population consuming fruits and vegetables 4T6

Fruit intake from 4 to 6 times a week					
	First quintile	**Second quintile**	**Third quintile**	**Fourth quintile**	**Fifth quintile**
Mean	18,859	19,893	20,281	20,948	21,026
Standard Error	0,903	1,125	1,115	1,229	1,169
Median	19,300	19,200	21,600	20,600	21,300
St. Deviation	4,692	5,845	5,792	6,384	6,073
Kurtosis	-0,280	-1,268	-1,145	-0,496	-0,661
Skewness	-0,377	0,039	0,003	0,370	0,233
Range	18,500	18,200	19,100	22,800	22,300
Minimum	8,400	11,500	11,200	11,200	11,400
Maximum	26,900	29,700	30,300	34,000	33,700
Vegetable intake from 4 to 6 times a week					
	First quintile	**Second quintile**	**Third quintile**	**Fourth quintile**	**Fifth quintile**
Mean	25,933	26,870	27,985	28,585	27,230
Standard Error	1,199	1,464	1,597	1,710	1,616
Median	25,800	26,600	28,500	28,500	27,100
St. Deviation	6,228	7,608	8,296	8,885	8,399
Kurtosis	7,712	3,247	4,210	4,414	3,725
Skewness	1,958	1,080	0,833	1,263	1,102
Range	33,900	37,100	45,200	45,500	44,200
Minimum	15,800	14,400	10,200	13,600	10,600
Maximum	49,700	51,500	55,400	59,100	54,800

Source: Author`s calculations

The average share of inhabitants who consume vegetables in the frequency from 4 to 6 times a week is higher than it was for fruit. The share of the population ranges from 25.93% in the first income quantile to 27.23% in the preferred income quantile. A strong correlation between income quantile and 4T6 population share was confirmed only in Romania. The distribution is flatter than normal, left-skewed in all income quantiles. The minimum share of inhabitants who prefer to consume 4T6 vegetables was in the third income quantile and it was in Belgium. In this country, the share of the population consuming 4T6 vegetables was also the lowest in the other income quantiles, except for the fourth. In the fourth income quantile, this consumption of vegetables was least preferred in Ireland. The maximum share of inhabitants who prefer to consume 4T6 vegetables was in the fourth income quantile in Malta, where it reached 59.1%. Malta is characterized by the fact that inhabitants of all income quantiles prefer the frequency of consumption of vegetables 4T6 significantly more than inhabitants of other countries. Based on the results of the F-Test Two-Sample for Variance, there is a statistically significant difference ($P<0.05$) between the proportion of inhabitants who prefer the consumption of 4T6 fruit in the first and fifth income quantiles.

The correlation between the proportion of inhabitants who prefer fruit consumption and vegetable consumption from 4 to 6 times a week is particularly high in Greece, Slovakia, and Sweden.

3.4. The Influence of Income Quantile on the Frequency of Fruit and Vegetable Consumption Never or Occasionally (NOO)

The lowest share is of inhabitants who do not consume fruits and vegetables at all or consume them only occasionally (NOO). In the first quantile of income, it is 11.57% of the population with fruits, with the growth of income, their share gradually decreases, and in the fifth quantile of income it is 5.83% of the population, Table 4. The most significant negative correlation between the income quantile and the share of inhabitants who prefer to consume NOO fruit is in the countries of France, the Czech Republic, the Netherlands, and Portugal. The standard deviation is low in all income quantiles. The distribution is left-sided, flatter than the normal distribution in all but the fourth income quantile. It is more pointed in the fourth quantile. The minimum share of the population (2%) that prefers the consumption of NOO fruit is in the fifth income quantile in Lithuania. In this country, the lowest share of the population is also in the third and fourth quantiles. In the first quantile, the lowest share of inhabitants who prefer NOO is in Cyprus, in the second income quantile it is in Spain. The highest proportion of inhabitants who do not like fruit intake is in Belgium, in the first income quantile. In Belgium, the lowest share of the population is also among the fourth quantile. In the third and fifth quantiles of income, the highest share of inhabitants is in Malta, and in the second quantile of income, it is in Romania. Based on the results of the F-Test Two-Sample for Variance, there is a statistically significant difference ($P<0.05$) between the proportion of inhabitants who prefer the consumption of NOO fruit in the first and fifth income quantiles.

Likewise, with the growth of the income quantile, the share of inhabitants who do not prefer to eat vegetables also decreases. From 6.96% in the first quantile, the share gradually decreases to 2.77% in the fifth quantile. The correlation coefficient is less than -0.97 in the relationship between the income quantile and the share of inhabitants who do not prefer vegetables in the countries of France, Croatia, Portugal, and Sweden. The distribution is left-skewed in all income quantiles, more pointed than normal, except for the first quantile, where it is flatter than the normal distribution. The minimum values of the share of inhabitants who do not prefer

vegetables are for almost all income quantiles in the Netherlands. In the fifth income quantile, it is 0%. The second quantile of income is the minimum share of the population in Spain. The maximum values of the share of inhabitants who do not prefer vegetables (NOO) are in all income quantiles in Malta, the most striking in the first income quantile. Based on the results of the F-Test Two-Sample for Variance, there is a statistically significant difference ($P<0.05$) between the proportion of inhabitants who prefer the consumption of NOO vegetables in the first and fifth income quantiles.

In the nations of Bulgaria, Germany, Spain, France, Italy, Latvia, Luxembourg, Poland, and Portugal, there is a very strong association between the percentage of people who prefer eating fruits and vegetables one to four times a week.

Table 4. Descriptive analysis of the share of inhabitants consuming fruits and vegetables NOO

Fruit intake never or occasionally					
	First quintile	**Second quintile**	**Third quintile**	**Fourth quintile**	**Fifth quintile**
Mean	11,567	8,819	7,244	7,226	5,826
Standard Error	0,764	0,532	0,440	0,532	0,530
Median	11,100	8,500	7,000	6,200	4,900
St. Deviation	3,969	2,765	2,285	2,763	2,753
Kurtosis	-0,873	-0,686	-0,595	0,789	-0,428
Skewness	0,306	0,506	0,271	1,170	0,753
Range	14,500	9,600	8,800	10,500	9,600
Minimum	5,200	4,900	3,000	3,800	2,000
Maximum	19,700	14,500	11,800	14,300	11,600
Vegetable intake never or occasionally					
	First quintile	**Second quintile**	**Third quintile**	**Fourth quintile**	**Fifth quintile**
Mean	6,959	4,956	4,015	3,607	2,767
Standard Error	0,742	0,583	0,514	0,558	0,441
Median	7,000	4,000	3,500	2,700	2,300
St. Deviation	3,856	3,030	2,670	2,901	2,292
Kurtosis	-0,034	1,607	3,893	3,686	4,707
Skewness	0,477	1,124	1,602	1,810	1,957
Range	15,500	13,200	12,800	12,700	10,500
Minimum	1,000	0,900	0,200	0,500	0,000
Maximum	16,500	14,100	13,000	13,200	10,500

Source: Author`s calculations

4. SIMILARITY OF PREFERENCES OF INHABITANTS IN EUROPEAN COUNTRIES

The data were further used to identify factors that condition the choice of inhabitants' preferences for fruit and vegetable consumption according to individual quantiles of income. The principal component analysis method was used, 7 factors (MSA in anti-image matrix >0.8, aggregate MSA >0.8). Factor analysis identified the most suitable 7 factors that influence the frequency of fruit and vegetable consumption according to income quantiles in individual countries. A rotated factor analysis identified factors according to income quantile (the first factor more influenced low-income inhabitants in the frequency of vegetable consumption, the second influenced them in fruit consumption, the third influenced middle-income inhabitants in vegetable consumption, the fourth influenced them in fruit consumption, the fifth influenced higher-income inhabitants in vegetable consumption, the sixth influenced them when consuming fruit, the seventh factor was supplementary. Residuals are computed between observed and reproduced correlations. There are 0 (0.0%) nonredundant residuals with absolute values greater than 0.05. The

identified factors were input for Ward's hierarchical clustering method. The result of the clustering was five clusters of countries in which similar preferences of the population for the frequency of fruit and vegetable consumption prevailed, Table 5.

Inhabitants in countries from the first two income clusters, along with increasing income, increase the frequency of fruit and vegetable consumption at least once a day and the frequency of fruit consumption from 4 to 6 times a week. Other frequencies of fruit and vegetable consumption decrease with increasing income. The first cluster of countries is characterized by the fact that the proportion of inhabitants who prefer to eat vegetables at least once a day is the highest in these countries, compared to other clusters of countries. Likewise, the proportion of inhabitants who prefer to eat fruit at least once a day is very high (especially among inhabitants in lower-income groups). Another frequency of consumption from 1 to 3 times a week is low compared to other clusters of countries. Inhabitants in countries in the first cluster also strongly prefer the frequency of fruit and vegetable consumption from 4 to 6 times a week.

This frequency is most preferred among the observed clusters of countries by inhabitants in the countries included in the second cluster, especially for vegetables. An equally high proportion of the population prefers this frequency of consumption even for fruit, especially inhabitants from lower-income groups. The inhabitants of the countries of the second cluster, unlike the inhabitants of the countries of the first cluster, also strongly prefer the frequency of consumption from 1 to 3 times a week.

For other clusters of countries, it is characteristic that as income increases, the preference for fruit and vegetable consumption at least once a day, as well as the frequency of fruit and vegetable consumption from 4 to 6 times a week, increases. Other frequencies of fruit and vegetable consumption decrease with increasing income. The behavior of inhabitants from the most numerous clusters of countries does not reach the minimum or maximum value for any frequency of fruit and vegetable consumption among the monitored clusters of countries. However, it is characterized by the balance of inhabitants' preferences for fruit and vegetable consumption from 1 to 3 times a week and from 4 to 6 times a week. Inhabitants in the fourth cluster of countries prefer the frequency of fruit consumption at least once a day among the monitored clusters of countries, especially in higher income groups. The fifth country cluster consists of only one country because inhabitants in this country preferred different frequencies of fruit and vegetable consumption than inhabitants in the other country clusters. Inhabitants of the fifth cluster of all income groups especially preferred the frequency of fruit and vegetable consumption from 1 to 3 times a week, the most among the observed clusters of countries. In higher income groups, they preferred the frequency of fruit and vegetable consumption from 4 to 6 times a week. In the fifth cluster, among the observed clusters of countries, there was also the highest proportion of inhabitants who did not consume fruits and vegetables at all or only rarely.

Table 5. Classification of countries into clusters

Cluster	Country
1	Belgium, Ireland, France, Croatia, Italy, Slovenia, Norway
2	Bulgaria, Latvia, Lithuania, Luxembourg, Netherlands, Serbia
3	Czechia, Denmark, Estonia, Greece, Austria, Poland, Slovakia, Finland, Sweden, Iceland, Turkey
4	Germany, Spain, Cyprus, Hungary, Malta, Portugal
5	Romania

Source: Author`s calculations

Many factors influence the consumption of fruit and vegetables in individual countries. “In the US, for example, education and social capital were positively associated with media exposure, which in turn was positively associated with reflexive integration and ultimately led to fruit and vegetable consumption. Education and income were associated with social capital”, (Lee & Pena-y-Lillo, 2022). "Consumption of vegetables 4 days a week or less is reported by 22.1% of children", (Boelens et al., 2022). "The percentage of adults consuming vegetables at least daily was significantly lower (21.3%) among those living in poverty (<130% PIR) compared to 30.7% among those in the least poverty (≥400% PIR). Daily consumption of vegetables, at least, was significantly lower among those with the largest states and poverty in terms of wealth (43 of 54). the overall percentage of adults consuming fruit at least 2 times a day was also lower among those living in the lowest relative poverty, but the difference was (32.0% vs. 34.2%), with 14 states not believing the difference was significantly lower among those most in poverty' (Grimm et al., 2012). "Almost 30% of the selected French population did not eat fruit and vegetables every day. Determinants of low consumption of fruits and vegetables were: under 55 years of age, lower education than tertiary and lack of financial resources for daily purchase of fruits and vegetables. Other determining factors were affordability (whether fruits and vegetables are affordable, lack of money to prevent healthy eating) and attitude (whether one's diet is healthy, whether fruits and vegetables promote health, whether eating vegetables is a pleasure). The decisive factor is the influence of financial difficulties, as well as the perception of the affordability of fruits and vegetables" (Bihan et al., 2010).

5. CONCLUSION

The results of the descriptive analysis showed that the most preferred frequency of fruit and vegetable consumption in the 31 monitored European countries was at least once a day and the least preferred frequency was never or occasionally. The results of the correlation analysis most often identified the dependence between income and preference for the frequency of fruit and vegetable consumption in Bulgaria, Sweden, Latvia, Greece, France, and Portugal. As income grew, the share of inhabitants who consumed fruit and vegetables at least once a day and from 4 to 6 times a week increased, and the share of inhabitants with a frequency of intake from 1 to 3 times a week and never or occasionally decreased. The Two-Sample F-Test for Variance confirmed a statistically significant difference in the share of inhabitants of the first and fifth income quantiles, especially in the frequency of fruit and vegetable consumption from 1 to 4 times a week. Countries with populations that had similar preferences for fruit and vegetable consumption frequency were grouped into five clusters. Inhabitants of the first cluster mainly preferred consumption of fruits and vegetables daily, inhabitants of the fifth cluster preferred consumption from 1 to 3 times a week.

6. FUTURE RESEARCH DIRECTIONS

Future research should focus on the effects of own price and other prices on fruit and vegetable consumption in individual countries.

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Do the NMS-10 Develop Sustainably in the EU? A Kuznets Curve Approach

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Abstract: *Research background: Sustainable development with its three dimensions (economic, social, and ecological) is of key importance to the existence of human civilization. Sustainability is a complex category and in this research, each of its components is analyzed separately and in connection with others. Economic stability is related to the level of real income per capita, indicating the standard of living of a nation; social resilience is shown by income inequality, and environmental sustainability is expressed by the amount of greenhouse gas emissions per person. Purpose of the article: The focus is on the empirical analysis of the nexuses between income inequality, environmental quality, and purchasing power with a view to sustainability in 10 European Union member countries from Central and Eastern Europe, known as the NMS-10. To achieve its purpose, the study derives the original and ecological Kuznets curve for the NMS-10 as a group. The links between income inequality and living standard, on the one hand, and environmental degradation and living standard, on the other hand, are estimated. Methods: The research methodology includes two autoregressions with distributed lag (ARDL) with annual data from Eurostat and Transparency International for the period 2007–2020. Findings & Value added: The obtained empirical results indicate a long-term N-shaped relationship between income inequality and purchasing power in the NMS-10, while living standard affects the quality of the environment in NMS-10 neither in the long term nor in the short term.*

1. INTRODUCTION

The modern world, torn between comfort and the challenges of globalization, attempts to achieve a wholesome balance between living standards, social inequality and environmental quality. Its main problem is sustainable development, also referred to as stability. At the beginning of 2023, its sound is increasingly sharp, and the influence of ecological factors on social life and the economy becomes more and more tangible. Against this background, Luhmann's statement from 1986 that there would be no public impact on solving environmental issues, while they are not discussed, sounds indisputable (Bancheva-Preslavska, 2019).

There are many definitions of sustainability/sustainable development, all gravitating around the starting point proposed in the report "Our Common Future," also known as the Brundtland report (World Commission on Environment and Development, 1987). Sustainable development comprises the relations man-nature and individual-society, and is based on three fundamental dimensions: economic growth, social development and environmental conservation (Ivanova & Stankova, 2021; Stankova & Kirilov, 2019).

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The objective of this study is to estimate empirically the relationships between living standards, income inequality and environmental degradation in the 10 European Union (EU) member countries from Central and Eastern Europe, known as the NMS-10. To achieve this aim, the original and the environmental Kuznets curves for the NMS-10 are derived. The research is structured as follows: the theoretical basis of sustainability and the empirical research on the Kuznets curves in the NMS-10 are systematized in section 1; the nexus between income inequality and purchasing power in the NMS-10 group is empirically estimated in section 2; the relationship between environmental degradation and living standard in the NMS-10 as a group is empirically investigated section 3. In conclusion, the empirical results are interpreted and macroeconomic policies for sustainable development in the NMS-10 group are recommended.

The NMS-10 includes ten European Union countries from Central and Eastern Europe: Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovakia and Slovenia, classified however by the World Economic Situation and Prospects (WESP) in the A group of developed economies, based on the economic country conditions (World Economic Situation and Prospects, 2014). While there are many investigations on economic issues of the NMS-10 (Stoilova & Todorov, 2021; Todorov & Boneva, 2022; Todorov et al., 2021, 2022; etc.), their social resilience and environmental degradation are relatively less studied.

The NMS-10 lags behind the "old Europe" (the EU members before 2004) (Djankov, 2016). Under the conditions of war in Ukraine and especially in connection with the Recovery and Resilience Mechanism (RSM) of the EU, the study of the possibilities for sustainable development in the NMS-10 group is of particular interest.

2. LITERATURE REVIEW

Regarding sustainable development, two key areas can generally be outlined. The first one is related to economic development and economic approaches to sustainable development. Two opposed approaches can be distinguished in this aspect of economics - the neoclassical approach and the ecological approach (UKEssays, 2018). Trimming between a high degree of commitment to sustainability (within the ecological approach) to a low degree of commitment (within the neoclassical version) - in both approaches it is assumed that the processes of economic development are dependent on the environmental resources. Given this, the second area, identified as key, concerns the analysis and the evaluation of these processes, to understand the mechanism for achieving balance and coordination between the environment and the economy.

The theoretical foundations of environmental economics consider the relationship between economic development and the environment, taking into account the efforts of the economy to meet the growing material needs of the population (Felício et al., 2021). According to neoclassical economists, sustainable development is directly related to the desire of societies to have well-being that does not diminish over time (Hussen, 2004). Both the concepts of the ecological economy and those of the neoclassical economy are found in the specialized literature, as well as in many legislative frameworks (e.g. Costanza, 1991; Dolderer et al., 2021; Heal, 1998; Krautkraemer, 1985; Söderbaum, 1990; van den Bergh, 2000; van den Bergh et al., 2000). The neoclassical approach is considered to take precedence after the economists, although the environmental economists do not back down from their claims. However, beyond the divisions and disagreements, unifying concepts related to sustainability shared by both schools of thought could also be found. Thus, the paradigmatic debates described in the literature and

institutional divisions can be applied and contribute to better research, understanding and achievement of sustainability (Illge & Schwarze, 2006).

The question of synchronization between economic development and the environment, respectively between man and nature, with an emphasis on maintaining the ecological balance as a prerequisite for development, is also raised within the research. Thus, environmental economics, although indirectly, has its importance for achieving sustainable results. Relying on Wamba's cogitations (2022), it must be emphasized that the protection of the environment is of benefit to society. The improvement of the quality of the resources presupposes the generation of market benefits and social resources through which to create a better social image, and competitive advantages, as well as to achieve sustainable development. Links between environmental economics and sustainable development have also been integrated into the UN's 2030 Agenda for Sustainable Development: in particular, Article 9 from our vision which envisions "a world in which every country enjoys sustained, inclusive and sustainable economic growth and decent work for all" (UN General Assembly, 2015). As the 2030 Agenda points out, the modern world is facing "a time of immense challenges to sustainable development" (Article 14, UN General Assembly, 2015). In these changed circumstances, economic development must be in harmony with the environment, to overcome the challenges of inequalities, whatever their nature. At the same time, these are opportunities that can be placed "on the crest of the wave" in planning the sustainable development of the world as a hall and of the countries themselves. However, for this to happen, economic processes must be explored, observed, known, studied and managed sustainably.

Placed within the framework of economic and environmental theories, the focus of the research refers to the generally subjective assessment of continual combined evolution between the economy and environment, marginal utility, subjective costs, technologies used, and the market mechanism that allocates limited resources to alternative uses (Katsoulakos et al., 2016). Viewed in relation to sustainability and sustainable development however, this focus can actually be concretized, expanded, and illustrated hypothetically for specific conditions, for which the Kuznets curve could be used as a tool. Primarily, because the access and use of limited resources presupposes inequality, and finding alternatives can be identified as an opportunity for development, which could be sustainable.

It can be assumed that the Kuznets curve implies a direct relationship with sustainable development, acknowledging that with the industrialization of societies, the center of the economy shifts (in the original version from rural areas to cities). From the standpoint of time (bearing in mind that Kuznets worked in the middle of the 20th century), today it turns out that the relationships derived by Kuznets can be used as a guide in deriving environmental and economic policies, as they depict changes in economic growth and income distribution (Kuznets, 1955).

Kuznets accepts that a hypothesis can be built that as an economy develops, market forces first increase, then decrease the overall economic inequality of the society (Moffatt, 2021). The original Kuznets curve, popularized in the 70s of the 20th century, was further developed contextually to gain fame with its environmental modification (Environmental Kuznets Curve) in the work of Grossman and Krueger (1994) which is considered to be foundational.

The two curves represent different dimensions concerning sustainability but also complement each other, therefore in the context of development, they can be useful for the elaboration of policies at different managerial levels and for society as a whole.

3. RESEARCH METHODOLOGY

Towards a methodological assurance of the research, the triple nature of sustainable development is bound as follows: the economic line is assessed by the level of real per capita income, which shows a nation's living standard (purchasing power); the social sustainability is shown by income inequality, which is estimated by the Gini coefficient; as a measure of environmental sustainability, the amount of greenhouse gas emissions per person is employed.

The choice of such an approach is guided by the working list of the United Nations Commission on Sustainable Development (UNCSD), including the indicators for measuring sustainable development, following Agenda-21 and their distribution by categories - social, economic, environmental, and institutional. As well as being consistent with the fact that some of them are adopted by the European Statistical Commission for the countries of the European Union (Kovachev, 2001).

The research methodology is derived from the field of generalized autoregression processes and their use for solving various economic tasks, as well as for research in the field of linear transformations of independent exponentially distributed random variables and representation of their densities. The original Kuznets curve is drowned to depict the nexus between income inequality and economic sustainability (living standard or purchasing power per capita), while the environmental Kuznets curve displays the link between environmental degradation and living standard (Kuznets, 1955).

To ensure the analysis, data corresponding to its time and information needs were sought. Such were discovered and extracted from the Annual data of Eurostat and Transparency International for the period 2007–2020 (Eurostat, n.d.; Transparency International, 2020).

The methodological framework of the study, with a view to systematicity in the derivation of the Kuznets curve, consists of two steps. In the first one, an empirical analysis of the relationship between income inequality and purchasing power (the living standard) in the NMS-10 is held. The second step consists of a similar empirical analysis, which, however, investigates the nexus between environmental degradation and living standards in the NMS-10.

The nexus between income inequality and living standard in the NMS-10 is analyzed by an autoregression with distributed lag (ARDL), which comprises the following variables:

$GINI_{ij}$ – value of the Gini coefficient of country **i** in year **j**;
$GDPPC_{ij}$ – real per capita output of country **i** in year **j** in Purchasing Power Standard (PPS);
R_D_{ij} – gross domestic expenditure on research and development of country **i** in year **j** (percentage of GDP);
RES – share of energy from renewable sources of country **i** in year **j** (percentage);
TRADE – trade openness (the sum of exports and imports divided by GDP) of country **i** in year **j**;
COR – value of the Corruption Perceptions Index of country **i** in year **j**;
EDU – government expenditure on education (percentage of total government expenditure) of country **i** in year **j**.

The target (dependent) variable is **GINI.** To account for possible non-linear links between income inequality and living standard, the square and the cube of **GDPPC** are also included in the regression model. **R_D, RES, TRADE, COR** and **EDU** are control variables, which reflect the

impact of technology level, energy policy, foreign trade, institutional quality and human capital on income inequality.

The relationship between environmental degradation and living standards in the NMS-10 is derived in a similar way by an autoregression with distributed lag (ARDL), consisting of the following variables:

$GGEPC_{ij}$ – net greenhouse gas emissions of country **i** in year **j** (tones per capita);
$GDPPC_{ij}$ – real per capita output of country **i** in year **j** in Purchasing Power Standard (PPS);
R_D_{ij} – gross domestic expenditure on research and development of country **i** in year **j** (percentage of GDP);
RES – share of energy from renewable sources of country **i** in year **j** (percentage);
TRADE – trade openness (the sum of exports and imports divided by GDP) of country **i** in year **j**;
COR – value of the Corruption Perceptions Index of country **i** in year **j**;
EDU – government expenditure on education (percentage of total government expenditure) of country **i** in year **j**.

The target variable is **GGEPC.** To capture possible non-linear connections between environmental quality and living standards, the square and the cube of **GDPPC** also participate in the regression model. **R_D, RES, TRADE, COR** and **EDU** are control variables, which account for the effects of scientific progress, energy policy, trade openness, quality of institutions and human capital on environmental degradation.

4. RESULTS

In accordance with the conceptual framework of the methodology, the results are also presented in two aspects - in terms of the nexuses income inequality/living standard (results displayed in tables 1-6/figures 1-2) and environmental degradation/living standard (results displayed in tables 7-12).

In search of the connections and interdependencies in income inequality and living standard, the unit root tests (see Tables 1 and 2) indicate that GINI, GDPPC and COR are stationary at first difference, while R_D, RES, TRADE and EDU are stationary at level. The different order of integration of the variables requires the application of an ARDL.

The test for the optimal number of lags in the ARDL shows that according to the FPE, SC and HQ criteria, this number is one (see Table 3). The ARDL is estimated with one lag.

Table 1. Levin et al. (2002) unit root test on the level values of GINI, GDPPC, R_D, COR, RES, TRADE and EDU

Variable	Probability
GINI	0.3301
GDPPC	0.8706
COR	0.2323
R_D	0.0338
RES	0.0000
TRADE	0.0000
EDU	0.0001

Source: Authors

Table 2. Levin et al. (2002) unit root test on the first differences of GINI, GDPPC, R_D and COR

Variable	Probability
D(GINI)	0.0000
D(GDPPC)	0.0000
D(COR)	0.0000

Source: Authors

Table 3. Optimal lag length in the ARDL

Number of lags	FPE	AIC	SC	HQ
0	3.30e+13	50.99125	51.21610	51.08056
1	944342.3*	33.61636	35.41516*	34.33087*
2	1333371.	33.92113	37.29388	35.26083
3	2459154.	34.42635	39.37304	36.39124
4	2963091.	34.39605	40.91668	36.98612
5	3184081.	34.07926	42.17385	37.29453
6	3646630.	33.55360	43.22213	37.39405
7	1642638.	31.63464*	42.87711	36.10029

* Shows the optimal number of lags according to the respective criterion

Source: Authors

The ARDL is expressed by the equation

(1) D(GINI) = C(1) + C(2)*D(GINI(-1)) + C(3)*D(GDPPC(-1)) + C(4)*D(GDPPC(-1))^2 + C(5)*D(GDPPC(-1))^3 + C(6)*D(EDU(-1)) + C(7)*D(COR(-1)) + C(8)*D(R_D(-1)) + C(9)*D(RES(-1)) + C(10)*D(TRADE(-1)) + C(11)*GINI(-1) + C(12)*GDPPC(-1) + C(13)*GDPPC(-1)^2 + C(14)*GDPPC(-1)^3 + C(15)*EDU(-1) + C(16)*COR(-1) + C(17)*R_D(-1) + C(18)*RES(-1) + C(19)*TRADE(-1)

The results from the econometric estimation of the ARDL are presented in Table 4.

Table 4. Results from the econometric estimation of the ARDL

Variable	Coefficient	Standard error	t-Statistic	Probability
C	-36.48934	9.018707	-4.045961	0.0001***
D(GINI(-1))	-0.105274	0.090750	-1.160040	0.2494
D(GDPPC(-1))	-3.69E-05	0.000429	-0.086125	0.9316
D(GDPPC(-1))^2	4.04E-08	9.68E-08	0.417970	0.6771
D(GDPPC(-1))^3	-7.92E-11	8.39E-11	-0.943687	0.3481
D(EDU(-1))	0.111433	0.097054	1.148156	0.2543
D(COR(-1))	0.095063	0.053482	1.777487	0.0792*
D(R_D(-1))	-0.762603	0.887721	-0.859056	0.3928
D(RES(-1))	0.019105	0.102926	0.185616	0.8532
D(TRADE(-1))	-0.046614	0.022124	-2.106947	0.0382**
GINI(-1)	-0.528804	0.089839	-5.886141	0.0000***
GDPPC(-1)	0.008409	0.001372	6.130348	0.0000***
GDPPC(-1)^2	-3.82E-07	6.55E-08	-5.823361	0.0000***
GDPPC(-1)^3	5.98E-12	1.07E-12	5.579598	0.0000***
EDU(-1)	-0.214716	0.101440	-2.116673	0.0374**
COR(-1)	-0.182077	0.048974	-3.717793	0.0004***
R_D(-1)	1.570154	0.664941	2.361342	0.0206**
RES(-1)	0.114261	0.090078	1.268472	0.2083
TRADE(-1)	-0.012889	0.018632	-0.691760	0.4911

***, **, and * indicate significant p values at the 1, 5, and 10% levels, respectively

Source: Authors

The value of the coefficient of determination (R-squared = 0.57) implies that 57% of the variation of income inequality in the NMS-10 can be explained by changes in the independent variables in Equation (1). The probability of the F-statistic (0.00) indicates that the alternative hypothesis of adequacy of the model used is confirmed. It should be made clear that this does not mean that the model is the best possible, but simply that it adequately reflects the relationship between the dependent and the independent variables.

In the short run, income inequality in the NMS-10 is influenced by institutional quality and trade openness. In the long run, income inequality in the NMS-10 is affected by living standards, human capital, institutional quality and technology level. A cubic polynomial relationship exists between income inequality and living standard, which means that the original Kuznets curve is N-shaped.

The residuals in the ARDL are normally distributed (see Figure 1). The ARDL bounds test (see Table 5) provides evidence of the existence of a long-run relationship between the variables in the ARDL, which requires the estimation of an error correction model (ECM).

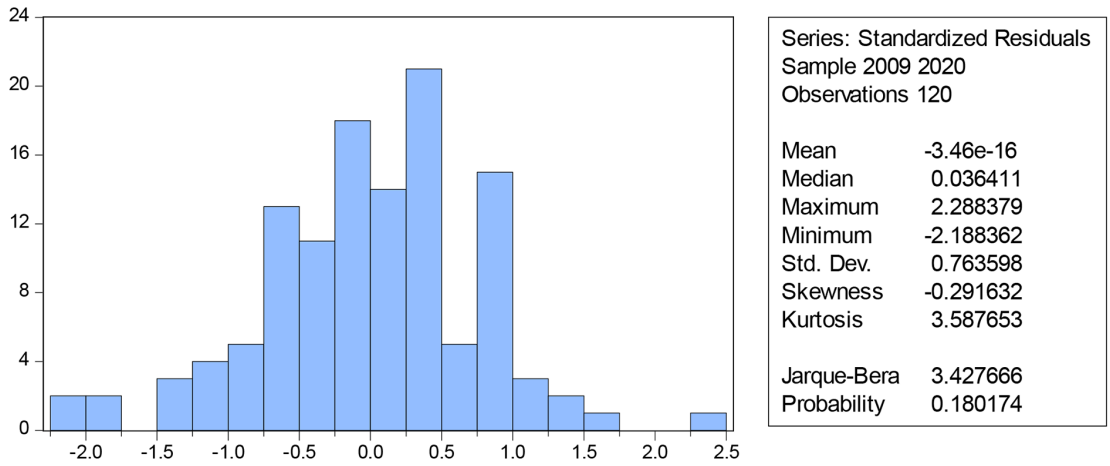

Figure 1. Normal distribution test on the ARDL residuals

Source: Authors

Table 5. ARDL bounds test

Null Hypothesis: C(11)=C(12)=C(13)=C(14)=C(15)=C(16)=C(17)=C(18)=C(19)=0			
Test Statistic	**Value**	**Degree of freedom**	**Probability**
F-statistic	6.559607	(9,81)	0.0000
Chi-square	59.03646	9	0.0000

Source: Authors

The ECM has the form

(2) D(GINI) = C(1) + C(2)*D(GINI(-1)) + C(3)*D(GDPPC(-1)) + C(4)*D(GDPPC(-1))^2 + C(5)*D(GDPPC(-1))^3 + C(6)*D(EDU(-1)) + C(7)*D(COR(-1)) + C(8)*D(R_D(-1)) + C(9)*D(RES(-1)) + C(10)*D(TRADE(-1)) + C(11)*ECT(-1)

The results from the econometric estimation of the ECM are presented in Table 6.

The regression coefficient before the error correction term (ECT) is statistically significant and negative, which implies the existence of a long-run equilibrium relationship between the

dependent variable and the independent variables in the ECM. The absolute value of this coefficient – 0.61 – means that each deviation from the long-term equilibrium is eliminated at a rate of 61 percent per annum.

The short-run regression coefficient before D(TRADE(-1)) is also significant, which suggests that in the short run income inequality in the NMS-10 is impacted by trade openness. The sign of D(TRADE(-1)) is negative, which means that increasing trade openness contributes to decreasing income inequality in the NMS-10.

The value of the coefficient of determination of the ECM (R-squared = 0.29) means, that 29% of the variation of income inequality in the NMS-10 can be explained by changes in the independent variables in Equation (2). The probability of the F-statistic (0.03) implies that the alternative hypothesis of adequacy of the model used can be accepted. This does not mean that the model is the best possible but simply indicates that it adequately reflects the relationship between the dependent and the independent variables. The residuals in the ECM are normally distributed (see Figure 2), which is an indirect indicator of a good model specification.

Table 6. Results from the econometric estimation of the ECM

Variable	Coefficient	Standard error	t-Statistic	Probability
C	-0.189079	0.258412	-0.731698	0.4663
D(GINI(-1))	0.304879	0.251359	1.212920	0.2284
D(GDPPC(-1))	0.000475	0.000459	1.035820	0.3031
D(GDPPC(-1))^2	9.32E-09	1.12E-07	0.083147	0.9339
D(GDPPC(-1))^3	-1.14E-10	9.97E-11	-1.138637	0.2579
D(EDU(-1))	-0.022221	0.097883	-0.227012	0.8209
D(COR(-1))	-0.080512	0.057642	-1.396763	0.1660
D(R_D(-1))	0.817473	0.910092	0.898232	0.3715
D(RES(-1))	0.049329	0.099307	0.496734	0.6206
D(TRADE(-1))	-0.067751	0.022702	-2.984393	0.0037***
ECT(-1)	-0.609120	0.275184	-2.213504	0.0294**

***, **, and * indicate significant p values at the 1, 5, and 10% level, respectively

Source: Authors

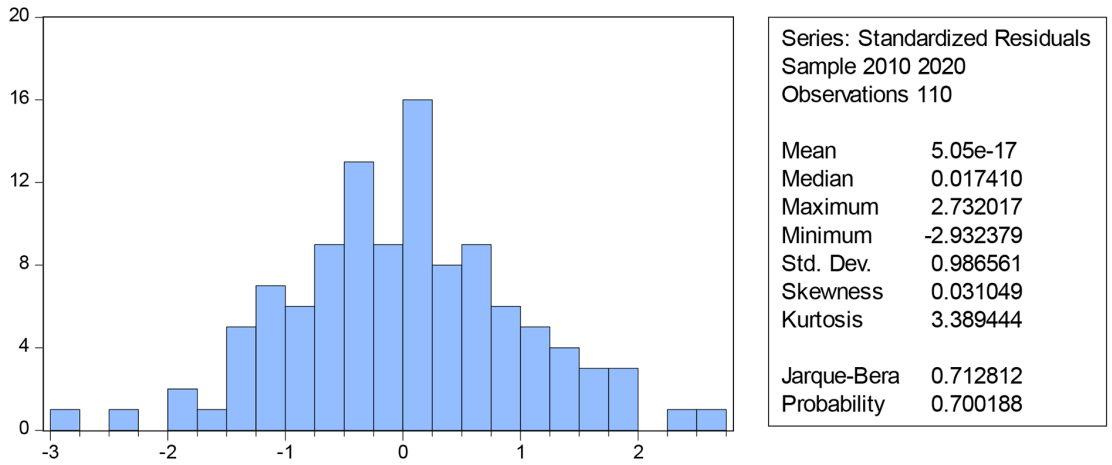

Figure 2. Normal distribution test on the ECM residuals

Source: Authors

The second aspect explores empirically the relationship between environmental degradation and living standards in the NMS-10.

The unit root tests (see Tables 7 and 8) indicate that GDPPC and COR are integrated into order one, while GGEPC, R_D, RES, TRADE, and EDU are integrated into order zero. The different order of integration of the variables demands the employment of an ARDL.

Table 7. Levin et al. (2002) unit root test on the level values of GGEPC, GDPPC, R_D, COR, RES, TRADE and EDU

Variable	Probability
GDPPC	0.8706
COR	0.2323
GGEPC	0.0004
R_D	0.0338
RES	0.0000
TRADE	0.0000
EDU	0.0001

Source: Authors

Table 8. Levin et al. (2002) unit root test on the first differences of GDPPC and COR

Variable	Probability
D(GDPPC)	0.0000
D(COR)	0.0000

Source: Authors

The test for the optimal number of lags in the ARDL shows that according to the FPE, SC and HQ criteria, this number is one (see Table 9). The ARDL is estimated with one lag.

Table 9. Optimal lag length in the ARDL

Number of lags	FPE	AIC	SC	HQ
0	1.32e+13	50.07297	50.29782	50.16229
1	482350.4*	32.94454	34.74334*	33.65905*
2	625265.2	33.16384	36.53659	34.50354
3	968440.0	33.49447	38.44116	35.45935
4	1237149.	33.52263	40.04326	36.11270
5	1285123.	33.17195	41.26654	36.38722
6	1576599.	32.71506	42.38359	36.55552
7	757857.5	30.86107*	42.10355	35.32672

* Shows the optimal number of lags according to the respective criterion

Source: Authors

The ARDL has the form

$$
\begin{aligned}
(3)\quad D(GGEPC) = {} & C(1) + C(2)*D(GGEPC(-1)) + C(3)*D(GDPPC(-1)) + C(4)*D(GDPPC(-1))^2 + \\
& C(5)*D(GDPPC(-1))^3 + C(6)*D(EDU(-1)) + C(7)*D(COR(-1)) + \\
& C(8)*D(R\_D(-1)) + C(9)*D(RES(-1)) + C(10)*D(TRADE(-1)) + \\
& C(11)*GGEPC(-1) + C(12)*GDPPC(-1) + C(13)*GDPPC(-1)^2 + \\
& C(14)*GDPPC(-1)^3 + C(15)*EDU(-1) + C(16)*COR(-1) + \\
& C(17)*R\_D(-1) + C(18)*RES(-1) + C(19)*TRADE(-1)
\end{aligned}
$$

The results from the econometric estimation of Equation 3 are shown in Table 10.

The value of the coefficient of determination (R-squared = 0.61) implies that 61% of the variation of environmental quality in the NMS-10 can be explained by changes in the independent variables in Equation (3). The probability of the F-statistic (0.00) indicates that the alternative hypothesis of adequacy of the model used is confirmed. It should be made clear that this does

not mean that the model is the best possible, but simply that it adequately reflects the relationship between the dependent and the independent variables.

In the short term, environmental degradation in the NMS-10 is affected by scientific advancement. In the long run, environmental degradation in the NMS-10 is influenced by institutional quality and energy policy. Living standard impacts environmental quality neither in the long run nor in the short term, which means that there is no environmental Kuznets curve for the NMS-10.

Table 10. Results from the econometric estimation of the ARDL

Variable	Coefficient	Standard error	t-Statistic	Probability
C	1.993481	6.533194	0.305131	0.7610
D(GGEPC(-1))	0.228434	0.106167	2.151636	0.0344**
D(GDPPC(-1))	0.000131	0.000315	0.414730	0.6794
D(GDPPC(-1))^2	4.87E-08	7.05E-08	0.690221	0.4920
D(GDPPC(-1))^3	2.82E-11	6.24E-11	0.451915	0.6525
D(EDU(-1))	-0.036465	0.071509	-0.509938	0.6115
D(COR(-1))	-0.011867	0.038735	-0.306361	0.7601
D(R_D(-1))	-2.171117	0.692875	-3.133491	0.0024***
D(RES(-1))	0.001180	0.076219	0.015488	0.9877
D(TRADE(-1))	-0.019637	0.016420	-1.195954	0.2352
GGEPC(-1)	-0.791543	0.121182	-6.531847	0.0000***
GDPPC(-1)	0.000330	0.000926	0.356940	0.7221
GDPPC(-1)^2	-6.46E-09	4.49E-08	-0.143976	0.8859
GDPPC(-1)^3	5.13E-14	7.43E-13	0.069027	0.9451
EDU(-1)	-0.119660	0.077261	-1.548777	0.1253
COR(-1)	-0.058420	0.033753	-1.730827	0.0873*
R_D(-1)	0.811967	0.535365	1.516662	0.1332
RES(-1)	-0.118829	0.066047	1.799154	0.0757*
TRADE(-1)	0.006102	0.013453	0.453610	0.6513

***, **, and * indicate significant p values at the 1, 5, and 10% levels, respectively

Source: Authors

The ARDL bounds test (see Table 11) provides evidence of the existence of a long-run relationship between the variables in the ARDL, which requires the estimation of an error correction model (ECM).

Table 11. ARDL bounds test

Null Hypothesis: C(11)=C(12)=C(13)=C(14)=C(15)=C(16)=C(17)=C(18)=C(19)=0			
Test Statistic	**Value**	**Degree of freedom**	**Probability**
F-statistic	6.947444	(9, 81)	0.0000
Chi-square	62.52699	9	0.0000

Source: Authors

The ECM can be expressed by the equation

$$(4)\quad D(GGEPC) = C(1) + C(2)*D(GGEPC(-1)) + C(3)*D(GDPPC(-1)) + C(4)*D(GDPPC(-1))^2 + C(5)*D(GDPPC(-1))^3 + C(6)*D(EDU(-1)) + C(7)*D(COR(-1)) + C(8)*D(R\_D(-1)) + C(9)*D(RES(-1)) + C(10)*D(TRADE(-1)) + C(11)*ECT(-1)$$

The results from the econometric estimation of the ECM are displayed in Table 12.

The regression coefficient before the error correction term (ECT) is statistically significant and negative, which implies the existence of a long-run equilibrium relationship between the dependent variable and the independent variables in the ECM. The absolute value of this coefficient

– 0.76 – means that each deviation from the long-term equilibrium is eliminated at a rate of 76 percent per annum.

Table 12. Results from the econometric estimation of the ECM

Variable	Coefficient	Standard error	t-Statistic	Probability
C	-0.239001	0.174183	-1.372128	0.1735
D(GGEPC(-1))	0.341024	0.128828	2.647127	0.0096***
D(GDPPC(-1))	0.000277	0.000311	0.891988	0.3748
D(GDPPC(-1))^2	2.71E-08	7.56E-08	0.358770	0.7206
D(GDPPC(-1))^3	-3.03E-11	6.75E-11	-0.448624	0.6548
D(EDU(-1))	-0.083440	0.066436	-1.255953	0.2124
D(COR(-1))	-0.089318	0.039112	-2.283636	0.0248**
D(R_D(-1))	-0.113321	0.628762	-0.180229	0.8574
D(RES(-1))	-0.127396	0.067242	1.894602	0.0614*
D(TRADE(-1))	0.003079	0.015479	0.198939	0.8428
ECT(-1)	-0.764508	0.185180	-4.128463	0.0001***

***, **, and * indicate significant p values at the 1, 5, and 10% levels, respectively

Source: Authors

The short-run regression coefficients before D(COR(-1)) and D(RES(-1)) are also significant, which suggests that in the short run environmental quality in the NMS-10 is affected by the quality of institutions and energy policy. The signs of these coefficients are negative, which implies that lowering corruption and raising the share of energy from renewable sources improve environmental quality in the NMS-10.

The value of the coefficient of determination of the ECM (R-squared = 0.38) means, that 38% of the variation of environmental quality in the NMS-10 can be explained by changes in the independent variables in Equation (4). The probability of the F-statistic (0.00) implies that the alternative hypothesis of adequacy of the model used can be accepted. This does not mean that the model is the best possible but simply indicates that it adequately reflects the relationship between the dependent and the independent variables.

5. DISCUSSION

The empirical results from this study indicate an N-shaped long-term relationship between income inequality and living standards in the NMS-10. This implies that after a certain point is reached, the rise in purchasing power will increase income inequality and policymakers in the new member countries from Central and Central Europe will have to find new ways to raise social resilience. Another challenge to policymakers in the NMS-10 is the positive long-run nexus between income inequality and expenditure on research and development. The results from this research suggest some possible solutions to these problems. In the short term, income inequality in the NMS-10 can be mitigated by harnessing corruption and encouraging foreign trade. In the long run, a decline in income inequality in the NMS-10 may be achieved by higher government spending on education and improved control of corruption.

As to the relationship between environmental degradation and living standards, the study results show no significant short- or long-term impact of purchasing power per capita on net greenhouse gas emissions per capita. This means that the NMS-10 societies do not face the difficult choice between environmental quality and living standards. Net greenhouse gas emissions per capita in the NMS-10 can be decreased by increasing research and development expenses in the short run by raising the share of energy from renewable sources and by lowering corruption in the long run.

6. CONCLUSION

The empirical results from this study indicate a long-term N-shaped relationship between income inequality and purchasing power in the NMS-10 while living standard influences the quality of the environment in NMS-10 neither in the long term nor in the short term.

The fundamental conflict between income inequality, environmental quality, and purchasing power cannot always be resolved through economic development. Sustainability requires the development opportunities for future generations to be preserved. Therefore, complementing economic development policies with social and environmental elements of sustainability further supports these opportunities. The question that remains is how this should be reflected in the development policies of these countries. Its answer is further complicated by expectations of a slowdown in growth in the Euro area in 2023, as the forecasted values indicate significant heterogeneity between individual member countries (International Monetary Fund, 2022). To an additional extent, the war in Ukraine also has an impact, which in practice destabilizes the lean European policy for sustainability. The studied countries of the NMS-10 group are even more exposed to threats of a social nature, mainly due to the cuts in Russian gas supplies and the monetary restrictions, imposed by the European Central Bank. And, if the large market economies in the EU are relatively well positioned, for the studied group of countries the danger of exposure to additional risk is very high. It has a direct bearing on the sustainability of these countries. Especially, if the right political decisions are not made and sovereign spreads are not increased, sustainability will be threatened.

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The Role of Technological Progress in Social Development: Evidence from Europe in the Light of Sustainable Development Goals

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Abstract: *This study aims to analyze the relationships between two variables associated with the growth of modern economies: technological progress and social development. The research intends to test these relations within the framework of the Sustainable Development Goals set by the UN in 2015 in order to achieve the preservation of the planet, the welfare of the population, peace and prosperity. To this end, the research analyzes the correlations, within the European Union, between technological progress and social development in the period 2015-2021, that is from the year in which the 2030 Agenda for Sustainable Development was adopted by the United Nations Member States to today. The variables representative of technological progress are drawn from the indicators belonging to Goal 9 - Industry, Innovation and Infrastructure, while for social development the study referred to the indicators of Goal 8 - Decent Work and Economic Growth. The results show that, although the two phenomena are positively correlated, not all connections are equally strong.*

1. INTRODUCTION

This study aims to analyze the impact of technological progress on social sustainability, starting from the observation that the two aspects examined represent respectively the most powerful strengths and weaknesses in this historical moment. The relationship between technological progress and social sustainability is a complex phenomenon and not necessarily unambiguous. On the one hand, technological development creates or should create, the premises for an improvement in human well-being. On the other hand, however, it is also capable of causing distortions of competition and markets – especially of work – which conflict with the expected common good.

In order to analyze the relationship between technological development and social sustainability, the study selected the significant variables in the context of the Sustainable Development Goals (SDGs) set out in the 2030 Agenda by United Nations (UN) member states. The 2030 Agenda for Sustainable Development represents a common project for peace and prosperity for people and the planet, now and in the future. It is based on 17 Sustainable Development Goals (SDGs), which require action by all countries – developed and developing – in a global partnership (Avtar et al., 2020). The goal of ending poverty and its serious consequences must be pursued together with strategies for improving health and education, eliminating inequalities and stimulating economic growth. This process must also look at climate change and act to ensure that our oceans and forests are preserved.

The results of the survey for the period 2015-2021 show that, although investment in R&D has substantially increased, not all the variables on which technological progress should have had a positive influence improved in all years of the period under consideration. While, in general,

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the study shows that there are mostly positive relationships between technological innovation and social progress, some indicators of sustainable development show to be more sensitive than others in reacting to the growth of R&D investments. This suggests the presence of leeway on which it is still possible to intervene to make the social improvements associated with progress more powerful.

This study helps to deepen the research line concerning the existing relationships between the SDGs. Its originality lies in the use of sustainable development indicators to identify the dominant relationship – positive or negative – between technological innovation and collective well-being.

The research has both theoretical and practical implications. From a theoretical point of view, it contributes to the literature that aims to investigate the multiple implications of progress and the contrasting effects that it can have on society. From a practical point of view, the usefulness of the study lies in providing trend signals helpful for understanding in depth the contribution that innovation – if managed according to sustainability criteria – can give to humanity's progress.

2. LITERATURE REVIEW AND HYPOTHESIS FORMULATION

Relations between SDGs play a crucial role in achieving sustainable economic growth. First of all, only 7 years are left before the deadline set by the 2030 Agenda, and the complexity of the program requires a considerable time frame. Secondly, the greater the synergies between the 17 goals, the faster they can be achieved. On the contrary, trade-offs or opposing goals make the simultaneous implementation of all targets more difficult and slower.

In this regard, the study of Kuc-Czarnecka et al. (2023) showed that the synergies between the SDGs are greater than the trade-offs, which are found in only one case, i.e. the negative correlation of Goal 15 - Life on Land with Goal 3 - Good Health and Well-Being and Goal 17- Partnerships for the Goals, while Goal 7 - Affordable and Clean energy does not correlate with others.

Other studies have analyzed SDGs' relationships with factors external to them, such as the food supply chain (Chandan et al., 2023), industry 4.0 technologies (Bai et al., 2023), local cultural factors (Ordonez-Ponce, 2023), SDGs engagement intensity and gender board diversity (Gutiérrez-Fernández et al., 2023), core competence and core resources (Hsu, 2023), climate change disclosure (Toukabri & Mohamed Youssef, 2023), ESG factors and economic growth (Sadiq et al., 2023).

However, as highlighted by Allen et al. (2018), while some progress has been made in planning the implementation of SDGs, key gaps remain in the assessment of the interconnections, trade-offs and synergies between goals. This study aims to contribute to the reduction of these gaps through the highlighting of relationships that can be useful to policymakers to make the achievement of targets more effective.

The relationships between technologies and social development are far from secondary, as shown by Palomares et al. (2021), who highlight the role of artificial intelligence and other digital technologies with respect to human economic, technological, social and environmental needs. These relations reveal the wide potential of digital technologies, which, thanks to the ability to process a large amount of data, can help to improve the flow of information between the actors involved in achieving the SDGs. On the contrary, considered in terms of the quality of working

conditions, artificial intelligence causes an effect opposite to Goal 8 because it degrades the nature of decent work (Braganza et al., 2021).

A further positive impact on the SDGs generated by technological development, and in particular by innovation, as well as by the structural transformation of the economy, is achieved through the improvement of energy efficiency, as shown by Chen et al. (2021) for the MENA (Middle East and North Africa) countries. Technological innovation not only facilitates the transition to the use of renewable energy but also improves production processes by reducing energy intensity. However, despite the presence of positive interconnections between the 17 Goals, some critical issues make it essential to use a comprehensive approach, able to simultaneously consider all targets and intercept not only their mutual strengthening but also their possible conflicts (Fu et al., 2019).

Since technological innovation is at the heart of progress in renewable energy, it also promotes the achievement of climate goals, especially in countries with high pollution potential, such as China, at the forefront of global carbon emissions (Xing et al., 2023).

Economic growth and industrialization, which in modern economies are fuelled by technological development, may, however, conflict with the goals of environmental sustainability. This is the case of the Next 11 countries which, while showing continued growth and progressive industrialization, could follow an unsustainable development trajectory in nature (Sinha et al., 2020).

A similar potential conflict exists between the development of certain technologies and the SDGs. One example is Carbon Capture and Utilization (CCU) applications, which have both positive and negative indirect effects, such as strengthening the competitive advantage of developed countries over developing countries (Olfe-Kräutlein, 2020).

Moreover, the impact of technological innovation on sustainability goals, although positive, differs depending on the stage reached by economic development and the level of income of the countries involved. Technological innovation tends to be effective only in the richest countries, while its impact is almost absent in low-income countries (Omri, 2020).

At the same time, it is also necessary to recall some advantages of developing countries in achieving sustainable goals. Indeed, among developing countries, those in an early stage of industrialization are capable of achieving economic and industrial growth with limited environmental consequences. A further competitive advantage of developing countries is their ability to provide labor at below-average costs, increasing employment opportunities in labor-intensive sectors such as food and drink, chemicals, textiles and clothing (Kynčlová et al., 2020).

Although the literature acknowledges the presence of significant connections between the SDGs, studies analyzing them using indicators associated with these goals are not yet particularly widespread. Among these studies is that by Kenny and Patel (2017) examining the relationship between GDP per capita and some key development indicators as "Technological gains". These relationships are positive and explain why the major performers are significantly above average at a given income level. However, for the targets set by the SDGs to be reached technological progress must be present rapidly along the path of economic growth.

Goal 9, and specifically industrial innovation, is also used in the literature to analyze other effects, such as those exerted on sustainable urban development. In particular, the study of Gao

et al. (2022) analyzes how sustainable urbanization affects the protection of intellectual property and considers its consequences in terms of economic growth, technological progress and strengthening of social welfare.

The simultaneous presence of both positive and negative relations between technological progress and social development is noted by Ioannides et al. (2021), who emphasize how digital transformations, although useful to improve labor flexibility, can lead to further aggravation of the already existing hyper-exploitation in labor relations.

Overall, literature has highlighted the existence of multiple, and sometimes discordant, relationships between different goals. This study aims to contribute to research on this topic, by reconstructing some significant trends useful in understanding the phenomenon.

To this end, the study formulated the following research hypotheses:

H1. *Technological progress has a positive impact on the average standard of living of the population.*

H2. *Technological progress has a positive impact on economic growth.*

H3. *Technological progress has a positive impact on employment.*

3. METHODOLOGY

3.1. Variable Selection

In this research, the relations between technological progress and social development are observed through the analysis of Goal 9 - Industry, Innovation and Infrastructure and Goal 8 - Decent Work and Economic Growth, as defined by the 2030 Agenda. Specifically, the study examines technological progress using three of the nine indicators associated with Goal 9: (a) gross domestic expenditure on R&D; (b) R&D personnel; and (c) patent applications. As indicators of social development, the study considered three of the ten indicators related to Goal 8: (a) real GDP per capita; (b) investment share of GDP by institutional sectors; (c) young people neither in employment nor in education and training. The geopolitical context of reference is the European Union and the analysis covers the seven years 2015-2021, which was considered sufficiently extensive to identify significant trends.

Table 1. Selected variables

Eurostat definition of the variable	Symbol in this study
Gross domestic expenditure on R&D - Gross domestic expenditure on R&D (GERD) as a percentage of the gross domestic product (GDP). (Eurostat).	R&D_Exp
R&D personnel - The share of R&D personnel broken down by the following institutional sectors: business enterprise (BES), government (GOV), higher education (HES), private non-profit (PNP). Data are presented as a share of the economically active population. (Eurostat).	R&D_Pers
Patent applications - The number of requests for patent protection of an invention filed with the European Patent Office (EPO). (Eurostat).	PATENT_App
Real GDP per capita - The ratio of real GDP to the average population of a specific year. (Eurostat).	GDP_Per capita
Investment share of GDP by institutional sectors - The share of GDP that is used for gross investment (rather than being used for e.g. consumption or exports). (Eurostat).	GDP_Inv
Young people neither in employment nor education and training - The share of the population aged 15 to 29 who is not employed and not involved in education or training. (Eurostat).	UNEMPLOYED_Young

Source: Eurostat

The variables are taken from the Eurostat database and the data was processed through the software Statplus 7. Table 1 shows the definition of variables according to Eurostat and the symbols by which they were identified in this study.

The variables representing technological progress are R&D_Exp, R&D_Pers and PATENT_App and have been taken over by the study as independent variables. The variables representing social development are GDP_Per capita, GDP_Inv and EMPLOYED_Young and have been assumed as dependent variables.

3.2. Empirical models

The study used the following multiple regression models to test the hypotheses.

For H1 model 1 is as follows:

$$GDP\_Per\ capita_t = \beta_0 + \beta_1 * R\&D\_Exp_t + \beta_2 * R\&D\_Pers_t + \beta_3 * PATENT\_App_t + \varepsilon_t$$

$GDP\_Per\ capita_t$ expresses the average standard of living of the population at time t and is a function of Gross domestic expenditure on R&D (R&D_Exp), the share of R&D personnel (R&D_Pers) and patent applications (PATENT_App).

For H2 model 2 is as follows:

$$GDP\_Inv_t = \beta_0 + \beta_1 * R\&D\_Exp_t + \beta_2 * R\&D\_Pers_t + \beta_3 * PATENT\_App_t + \varepsilon_t$$

Model 2 uses the same independent variables as model 1 but considers economic growth as an indicator of population well-being and assumes it as a dependent variable expressed as a share of GDP for gross investment (GDP_Inv).

For H3 model 3 is as follows:

$$UNEMPLOYED\_Young_t = \beta_0 + \beta_1 * R\&D\_Exp_t + \beta_2 * R\&D\_Pers_t + \beta_3 * PATENT\_App_t + \varepsilon_t$$

Model 3 considers the unemployment indicator (UNEMPLOYED_Young) as a variable dependent on technological progress.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics and Correlation Analysis

Table 2 presents the main statistical results – minimum, maximum, mean and standard deviation – referred to all variables. The trend of the selected variables in the observation period is shown in Table 3. As Table 3 shows, over the period observed, all indicators of technological progress and social sustainability increased almost continuously, while the unemployment indicator of the young population decreased. This first observation confirms the presence of a positive relationship between progress and social sustainability. However, not all relationships are equally strong, as the correlation analysis below shows. Table 4 presents Pearson correlation coefficients for all variables.

Table 2. Descriptive statistics

Variable	Min	Max	Mean	Standard deviation
R&D_Exp	2.14	2.34	2.2257	0.0781
R&D_Pers	1.3046	1.5903	1.4431	0.1041
PATENT_App	139.4	151.75	145.6771	4.5248
GDP_Per capita	29,280	31,300	30,271	819.8461
GDP_Inv	20.13	22.39	21.3443	0.9194
UNEMPLOYED_Young	12.8	15.3	13.8571	0.8979

Source: Author

Table 3. Trend of the variables in Euro area - 19 countries (2015-2021)

Variable	2015	2016	2017	2018	2019	2020	2021
Gross domestic expenditure on R&D (Percentage of GDP)	2.14	2.14	2.18	2.22	2.26	2.34	2.30
R&D personnel (Percentage of population in the labour force - numerator in full-time equivalent (FTE))	1.3046	1.335	1.3956	1.452	1.4945	1.5296	1.5903
Patent applications (Per million inhabitants)	140.96	139.40	143.31	148.17	148.78	147.37	151.75
Real GDP per capita (Chain linked volumes (2010), euro per capita)	29,280	29,730	30,440	30,910	31,300	29,340	30,900
Investment share of GDP by institutional sectors (Percentage)	20.13	20.49	20.81	21.19	22.39	22.21	22.19
Young people neither in employment nor in education and training (Percentage of total population)	15.3	14.6	14.0	13.3	12.8	14.0	13.0

Source: Eurostat

Table 4. Pearson correlation for all variables

	R&D_Exp	R&D_Pers	PATENT _App	GDP_Per capita	GDP_Inv	UNEM-PLOYED _Young
R&D_Exp	1					
R&D_Pers	0.9402	1				
PATENT_App	0.8432	0.9436	1			
GDP_Per capita	0.2488	0.5046	0.6604	1		
GDP_Inv	0.9293	0.9364	0.8740	0.5038	1	
UNEMPLOYED_Young	-0.6521	-0.8205	-0.8795	-0.8883	-0.8245	1

Source: Author

In general terms, correlation coefficients show that the most significant effects of technological progress are in terms of economic growth (GDP_Inv) and the reduction of unemployment (UNEMPLOYED_ Young). By contrast, the correlations with wealth per capita (GDP_ Per capita) are less strong.

However, while all variables representative of technological progress have positive relationships with social welfare indicators, some connections stand out for their intensity. In particular, concerning the average standard of living of the population (GDP_Per capita) the most significant effect is exerted by patent applications. This result is particularly significant since, compared with the indicators of technological progress indicating the input of the innovation process, i.e. the resources invested in it, the patent application indicator represents the output of the research, that is, the result that has materialized in innovation. This means that innovation improves the standard of living of the population.

For models 1, 2 and 3, since the independent variables are expressed in different units of measurement, the study calculated the standardized regression coefficients to make the data comparable and useful for identifying the most weighted coefficients.

Table 5 presents the standardized dependent and independent variables.

Table 5. Standardized dependent and independent variables

R&D_Exp	R&D_Pers	PATENT_App	GDP_Per capita	GDP_Inv	UNEMPLOYED_Young
-1,0979	-1,3306	-1,0425	-1,2093	-1,3207	1,6070
-1,0979	-1,0385	-1,3873	-0,6604	-0,9292	0,8273
-0,5855	-0,4562	-0,5231	0,2056	-0,5811	0,1591
-0,0732	0,0856	0,5509	0,7789	-0,1678	-0,6205
0,4392	0,4940	0,6857	1,2546	1,1374	-1,1774
1,4639	0,8312	0,3741	-1,1361	0,9416	0,1591
0,9515	1,4144	1,3421	0,7667	0,9199	-0,9546

Source: Author

For each of the 3 hypotheses H1, H2 and H3, Table 6 sets out the regression equations with standardized coefficients.

Table 6. Regression equations with standardized coefficients

Hypothesis	Regression equation
H1	GDP_Per capita = 0,0000 - 1,5431 * R&D_Exp + 0,9531 * R&D_Pers + 1,0623 * PATENT_App
H2	GDP_Inv = - 0,0000 + 0,4574 * R&D_Exp + 0,4159 * R&D_Pers + 0,0959 * PATENT_App
H3	UNEMPLOYED_Young = - 0,0000 + 0,7834 * R&D_Exp - 0,9468 * R&D_Pers - 0,6467 * PATENT_App

Source: Author

As regards the H1 hypothesis, while the negative relationship of the average living standard (GDP_Per capita) with R&D expenditure is difficult to interpret, the positive relationship with the share of R&D personnel (R&D_Pers) and with patent applications (PATENT_App) demonstrates the importance of research and innovation in fostering the well-being of the population.

Compared to the H1 hypothesis, the H2 is more consistent and clear as all relationships are positive. In this case, the regression equation shows that economic growth (GDP_Inv) is positively influenced by all independent variables, among which R&D expenditure is the most important.

Finally, with regard to the H3 hypothesis, it is relevant to consider the negative relationship between R&D personnel and the proportion of the population aged 15-29 who are not employed or involved in education or training (UNEMPLOYED_Young). This connection demonstrates the importance of innovation and research for the creation of skilled and equally paid work.

5. CONCLUSION

The analysis of the relationships between technological progress and social sustainability has shown the remarkable complexity of the theme. In fact, alongside virtuous connections, such as those of innovation and research with well-being, economic growth and the employment of young people, there are still other sub-optimal connections. Among these, it seems that the average wealth of the population (GDP_ Per capita) is not particularly sensitive to technical progress. From this consideration emerges the need for economic development supported by increasingly advanced technologies to be more inclusive and take place for the benefit of the entire population, in order to achieve effective and equally distributed prosperity.

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Environmental (Sustainability) Reporting in 2020 and 2021 by Real Estate Companies from German Speaking Countries*

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Abstract: *Environmental, social, and governance (ESG) regulations, such as the Non-Financial Reporting Directive (NFRD) and the forthcoming Taxonomy Regulation in the European Union (EU), have had and will continue to have a lasting impact on the real estate sector and various other stakeholders within the market. This study, therefore, compares the current European regulation with standard sustainability reporting practices in the real estate (RE) industry in Germany, Austria, and Switzerland. In particular, we aim to investigate what type of information related to environmental issues is being regularly provided and by how many of the 55 largest RE firms in the years 2020 and 2021. We show that the majority of the environmental indicators recommended by the European Real Estate Association (EPRA) are more often reported in 2021 than in 2020. For example, a 30% or higher reporting frequency in 2021 could be observed for the energy intensity of rentable area kWh/m^2, scope 1, 2, and 3 emissions t CO_2e, EPRA recommendations implementation, and citing of standards used. Irrespective of the positive development, however, there is still a lot of room for improving reporting quality as small reporting frequencies are identifiable for the following "E" measures: energy consumption BOP MWh (6 in 2020 and 4 in 2021), emissions intensity of BOP kg CO_2e/m^2 (8 in 2020 and 7 in 2021) and Scope 3 t CO_2e (7 in 2020 and 11 in 2021). The provided evidence highlights how low the reporting of "E" measures recommended by the EPRA generally is. In January 2023, the Corporate Sustainability Reporting Directive (CSRD) was officially enacted, marking a significant milestone in the field of corporate sustainability reporting. This newly established directive represents a significant advancement in the regulatory framework governing corporate social and environmental information disclosure. About 50,000 companies will now be required to report on sustainability. Thus, it is key for individuals, organizations, and politicians introducing new sustainability reporting rules in Europe to understand that too complex rules may not be appropriately complied with and keep uniform EU taxonomy reporting requirements besides CSRD easy to apply in the future.*

1. INTRODUCTION

The concept of sustainability and the corresponding reporting mechanisms have undergone rapid development over the last two decades. There has been an increased awareness in society, both by individuals and companies, of the need to combat climate change and to behave ethically in their dealings with various stakeholders such as communities, customers, suppliers, and employees. Although the United Nations (UN) defined the term sustainability as early as 1987, it took three decades to formulate the 2030 Agenda for Sustainable Development, which includes 17 Sustainable Development Goals (SDGs) and 169 related targets (United Nations,

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1987; United Nations General Assembly, 2015), eventually culminating in the 2015 Paris Agreement. The term "sustainability" is now understood as a comprehensive description of environmentally conscious principles and corporate responsibility. The acronym ESG, which stands for environmental, social, and governance, has become the preferred nomenclature among investors and capital markets. ESG reporting, with disclosure of ESG risks and performance metrics, provides insight into a company's risk landscape and its strategies for sustainable business operations and the generation of long-term financial returns. Regrettably, various stakeholders have problems with the inclusion of such information, as various ESG reporting standards and frameworks exist alongside non-mandatory reporting systems. For companies, the main concern is the significant costs associated with data collection and additional reporting requirements. Nevertheless, the efficient management of ESG data and sustainability reporting practices are indispensable prerequisites for compliance with existing mandates such as the Non-Financial Reporting Directive (NFRD) and the European taxonomy planned for 2024, supported by the Corporate Sustainability Reporting Directive (CSRD)."

This study examines the prevailing landscape in terms of mandatory and voluntary sustainability reporting, as the relevant regulations in the European Union (EU) are only very rudimentarily formulated. The main objective of this study is to clarify the extent to which companies provide information on environmental concerns and thus address the "E" component within the ESG dimensions. A key measure of success is improving the traceability of ESG information in annual reports and supplementary sustainability information, as it is essential for facilitating informed decision-making processes. The focus of this study is to assess the comparability of E(SG) figures among leading listed real estate companies in Germany, Austria, and Switzerland. The importance of E(SG) reporting within the real estate sector is underlined by the widely known fact that these companies together contribute to more than one-third of global CO2 emissions. The European Real Estate Association (EPRA) has issued recommendations describing the indicators to be reported and the methods to calculate them, with a particular focus on environmental indicators. Ultimately, the analysis seeks to promote best practices drawn from the experience of the largest companies within the sample, particularly those subject to mandatory sustainability reporting.

This study focuses on 55 companies with a market capitalization of more than 100 million euros, all of which have submitted either annual reports, sustainability reports, or both for the years 2020 and 2021. It is noticeable that there are no studies that explicitly address the environmental, social, and governance (ESG) reporting of real estate companies in the DACH region (Germany, Austria, and Switzerland). Existing academic research, mainly focusing on listed companies, highlights the growing investor demand for ESG-related information (e.g. Holder-Webb et al., 2009; Khan et al., 2013; Reverte, 2009) and offers rudimentary proxies for measuring stakeholders' sustainability orientation (e.g. Branco & Rodrigues, 2008; Campbell et al., 2006; Huang & Kung, 2010). Conversely, research by Contrafatto (2014) and O'Dwyer and Unerman (2016) sheds light on the determinants that drive mandatory corporate social responsibility (CSR) reporting in unlisted companies. Previous research has also highlighted the latent ability of companies to influence policy decisions through their ESG reporting practices, whether intentionally or unintentionally (Morsing & Roepstorff, 2015; Shirodkar et al., 2018; Weyzig, 2009; Zhao, 2012) and potentially influence consumer behavior (Asay et al., 2022; Carrigan & Attalla, 2001; Vogel, 2005). The findings emanating from this underlying study offer invaluable insights for companies across diverse sectors, especially about their sustainability reporting practices, with a specific emphasis on environmental considerations, predicated upon exemplary

practices observed within the real estate industry in German-speaking nations. Moreover, this research augments the existing body of literature by underscoring the sporadic nature of voluntary sustainability reporting within the real estate sector during the years 2020 and 2021. These nuanced findings carry significant implications for various stakeholder cohorts and advocate for heightened political action in response to the identified disparities.

2. OVERVIEW OF SUSTAINABILITY REGULATION AND REPORTING OBLIGATIONS – A BRIEF CHRONICLE OF THE SUSTAINABILITY MOVEMENT

The basic concept of sustainable development dates back to 1987, when it was officially defined in the report "Our Common Future" by the World Commission on Environment and Development, also known as the Brundtland Report (United Nations, 1987). This formulation of sustainable development aims to balance economic progress with the preservation of a delicate balance between social and environmental factors. Subsequently, the United Nations convened the Earth Summit in 1992, a landmark event that led to the development of the Sustainable Development Action Plan, commonly known as Agenda 21. This marked a crucial point in the development of sustainability, as Agenda 21 introduced improved methods for measuring progress in this area. Before this, sustainability was difficult to quantify without proper assessment tools. In 2005, the UN World Summit advocated the adoption of a watershed model that encompasses the three "E" elements of Environment, Economy, and Equity/Social Justice while emphasizing their intersections, referred to as "S" for Sustainability. This marked a decisive departure from the earlier paradigms of corporate social responsibility (CSR) and the triple bottom-line approach. Subsequently, the United Nations introduced the Millennium Development Goals (MDGs) in 2015, coinciding with the Paris Agreement, and the Sustainable Development Goals (SDGs). These global initiatives were underpinned by the 2030 Agenda, which was ratified in 2015 and came into force in 2016. In it, the United Nations commits to 17 overarching SDGs, accompanied by 169 sub-goals, all designed to promote a more equitable and sustainable future. The fundamental goal of the 2030 Agenda is to enable decent living conditions on a global scale while ensuring the sustainable conservation of natural resources, which encompasses economic, environmental, and social dimensions (Thaler, 2021).

One of the most important long-term risks, according to the World Economic Forum's Global Risk Report (WEF, 2020), is extreme weather events, the potential failure to address climate change, natural disasters, environmental catastrophes, and biodiversity loss. The ESG-related financial products are theoretically intended for specific sustainability or ESG-related projects, assets, or activities (PAAs). They should therefore exclude incompatible activities and projects, such as carbon-intensive fossil fuels (E) (Schumacher, 2022).

To address environmental and social challenges and thus promote the development of a sustainable economic ecosystem, the sustainability standards described below are intended to provide a way for companies to document them as well. Essentially, these standards can be divided into three overarching categories as outlined by Behnam and MacLean (2011): principles-based standards (e.g. the UN Global Compact), certification standards (e.g. external auditors certifying compliance with the minimum requirements of the ISO 14001 environmental standard), and reporting standards (e.g. disclosure and transparency frameworks such as those of the Global Reporting Initiative (GRI)). Collectively, these various standards serve as important tools to advance sustainability goals and facilitate the transition to a more sustainable economy. Especially in the EU, quite a few initiatives have been developed to encourage global jurisdictions and

governments to establish laws regulating various aspects of sustainable finance and ESG investments. The common goal is to prevent greenwashing and promote truly sustainable economic growth (Johansen, 2016).

EU Sustainability Reporting Regulation. For the first time, the European Commission (EC) recognized corporate social responsibility (CSR) as a voluntary initiative in a policy paper in 2001. Ten years later, the Commission recommended improving the reporting and disclosure of corporate social and environmental activities in the European Union (European Commission, 2011). This development culminated in Directive 2014/95/EU (The European Parliament and the Council of the European Union, 2014) commonly referred to as the CSR Directive or Non-Financial Reporting Directive (NFRD). The NFRD requires public interest entities to improve the comparability of their non-financial disclosures from 2017 onwards (EU member states had to implement the directive by 6 December 2016). In both 2017 and 2019, the EC issued guidelines for non-financial reporting, subsequently expanding their scope to encompass applicable sustainability standards such as the Carbon Disclosure Project (European Commission, 2017, 2021). On April 21, 2020, the EU Commission proposed the Corporate Sustainability Reporting Directive (CSRD), set to be effective from 2024. The CSRD seeks to amend and augment existing directives, encompassing a broader spectrum of companies and audits, while refining reporting prerequisites (European Commission, 2021). Moreover, on November 3, 2021, the IFRS Foundation's Trustees established the International Sustainability Standards Board (ISSB), headquartered in Frankfurt, Germany. The ISSB's primary objective is the development of a global framework for sustainability-related disclosure standards. To foster comparability, an EU reporting standard for sustainability reporting is slated for creation. This effort necessitates consideration of international frameworks, including the Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB), International Accounting Standards Board (IASB), Task Force on Climate-Related Disclosures (TCFD), UN Global Compact, and the Sustainable Development Goals (SDGs). The EU sustainability reporting standards will be promulgated through a delegated act of the EC, with supplementary guidelines scheduled for release by October 31, 2023.

Requirements for Sustainability Reporting. The minimum reporting requirements cover several important aspects such as environmental, social, and labor concerns, diversity policy, anti-corruption, human rights, and anti-corruption. The specific content that must be included in the non-financial statement or sustainability report is regulated in § 289c HGB. Furthermore, it is advisable to align the reporting with established national and international standards and to identify the standards used. The NFRD mentions several recognized standards, including the Eco-Management and Audit Scheme (EMAS), the United Nations Global Compact (UNGC), the Guiding Principles on Business and Human Rights, the Organization for Economic Co-operation and Development (OECD) Guidelines for Multinational Enterprises, the International Organization for Standardization ISO 26000 Social Responsibility Framework, and the Global Reporting Initiative (GRI). In summary, the NFRD includes the following key principles and recognizes the broad diversity of businesses and sectors involved: disclose material information, fair, balanced, and understandable, comprehensive but concise, strategic and forward-looking, stakeholder orientated, consistent and coherent (European Commission, 2017). Based on this, similar regulatory requirements also apply to Austrian companies of significant size, with the Non-Financial Reporting Directive (NFRD) being retroactively incorporated into Austrian legislation for the 2017 financial year. A key legislative development in this context is the Sustainability and Diversity Improvement Act (NaDiVeG), which came into force in 2016 and introduced changes for non-financial reporting in sections 243b and 267a of the Austrian Business Code. There are also notable changes

in the Austrian Companies Act and the Limited Liability Companies Act (Bernhard & Riedlberger, 2021; Thaler, 2021). Furthermore, the European Commission (EC) also endorsed a proposal for a Corporate Sustainability Reporting Directive (CSRD) in 2020.

Recent Developments in Swiss Sustainability Reporting Regulation. In Switzerland, the legal requirement for reporting sustainability measures remains absent, although ongoing discussions within the Federal Council are addressing this issue comprehensively. A notable development occurred on February 23, 2022, when the Federal Department of Justice and Police (FDJP) commissioned the Federal Office of Justice (FOJ) to investigate the implications of prevailing EU regulations concerning sustainability reporting, transparency, and due diligence obligations. This investigation aims to assess the necessity of integrating these regulations into Swiss law. Concurrently, the Global Reporting Initiative (GRI) is collaborating with the European Financial Reporting Advisory Group and the International Sustainability Standards Board to harmonize their respective sustainability reporting standards (Flach, 2022). In 2014, ESG (Environmental, Social, and Governance) recommendations were included in the Swiss Code of Best Practice for Corporate Governance. In 2015, the Swiss Federal Council issued a declaration on corporate social responsibility (CSR) in which it advocated voluntary transparency and non-financial reporting on corporate sustainability initiatives (Baumüller et al., 2018). The Federal Assembly responded 5 years later with an indirect counter-proposal in which it introduced two new regulations for the Code of Obligations (Swiss Confederation, 2020). First, it mandated non-financial reporting for organizations that meet the criteria of the Non-Financial Reporting Directive (NFRD) and include public interest entities with at least 500 employees in two consecutive financial years, a balance sheet total of more than CHF 20 million or a net turnover of more than CHF 40 million. The reports must be publicly available for a decade and comply with the content requirements of the NFRD. Second, companies were required to conduct due diligence and reporting on conflict minerals and child labor. This requirement applies to companies that import materials from conflict areas or high-risk regions, as well as to companies that offer products or services potentially involving child labor. It requires the definition of potential risks and the identification of appropriate mitigation measures (Swiss Confederation, 2020; Thaler, 2021). Looking ahead, the forthcoming EU sustainability reporting obligation is expected to extend to non-EU companies generating over 150 million EUR in the EU, with at least one subsidiary or branch within the EU, commencing in 2028. Besides the estimated 50,000 companies impacted by the new Corporate Sustainability Reporting Directive (CSRD) regulation within the EU, several large Swiss companies will also be subject to its provisions.

From 2024, there will be significant changes in sustainability reporting due to new regulations. This Corporate Sustainability Reporting Directive (CSRD), which was officially published in the Official Journal of the European Union in December 2022, represents a fundamental revision of the existing Non-Financial Reporting Directive (NFRD) of 2014. Underlying the CSRD is the establishment of uniform European reporting standards and the formulation of reporting guidelines based on the principle of "double materiality". As a crucial improvement of the CSRD, the audit of sustainability reporting is prescribed to improve the stringency and reliability of the published sustainability information. At the same time, the accessibility of this data is to be improved by requiring its publication in a digital, machine-readable format within the management report, which will enable more efficient data dissemination. The purview of these European Union regulations extends to encompass all large enterprises, as defined by specific criteria, encompassing those with a workforce numbering at least 250 employees, net sales exceeding 40 million EUR, and total assets surpassing 20 million EUR. Furthermore, these regulations apply universally to companies listed on regulated markets, except micro-enterprises

listed on such markets. Another noteworthy requirement within the CSRD is that subsidiaries can be exempted from compliance with the CSRD if they are included in the consolidated CSRD-compliant management report of the parent company. It is important to note here that companies currently complying with the NFRD will have to move to compliance with the CSRD from 2024, while other companies will only follow gradually in the following years.

3. DATA AND METHODOLOGY

The study examines the various sustainability reports of a total of 55 listed real estate companies from Germany, Austria, and Switzerland. These companies were selected based on their respective market capitalization (more than EUR 100 million in 2020 and 2021). The analysis includes a comprehensive quantitative evaluation of the annual reports and any explicit sustainability reports, if these were available. A special focus was also placed on the possible assessability of environmental indicators. To comply with the applicable EU regulations on sustainability, the environmental, social, and governance (ESG) reporting should be informative (materiality). Furthermore, it is also important that the reported data is comparable. The three largest German entities are Vonovia, Deutsche Wohnen SE and LEG Immobilien AG. In Austria, the largest entities are CA Immobilien Anlagen AG, IMMOFINANZ AG, and S IMMO AG. In Switzerland, the relevant top three companies are Swiss Prime Site AG, PSP Swiss Property AG, and Allreal Holding AG.

The methodology used in this study is content analysis. In this, individual documents (annual reports, sustainability reports) are examined, and, in particular, non-financial statements (Wooldridge, 2013). It is important to mention that in both Austrian and German legislation there is a legal mandate for minimum reporting on environmental, social, and labor issues, human rights, anti-corruption and anti-bribery, and diversity policies. In this context, the present study focuses primarily on reporting on environmental issues. The majority of the companies studied provided this information voluntarily, as the respective number of employees is below the threshold of 500. Mandatory disclosure would only be obligatory according to the regulations if a company was classified as a public interest entity, a classification that does not apply to the companies in the present study.

4. RESULTS

It has already been shown in research that even though the comparability of social and governance measures in the RE industry increased in recent times, there is still room for improvement (Galkiewicz & Wollmann, 2022). The annual or separate sustainability reports of the largest 55 real estate firms from the German-speaking area of Germany, Austria, and Switzerland provide an overview of common environmental (sustainability) reporting practices. **Table 1** shows how many entities provided environmental measures recommended by the EPRA together with the type of information provided in the years 2020 and 2021. A direct year-on-year comparison of the reported data reveals the dynamics associated with the reporting of environmental measures ("E" for Environmental).

More than 50% of companies show the number of rented units in both years, but the typical environmental measures are only reported by 20 to 40% out of 55 RE companies as can be seen in **Table 1**. The total energy consumption MWh was reported by 24 entities in 2020 and 18, which is 25,0% less in 2021, while the energy intensity of rentable area kWh/m^2 as recommended by EPRA was shown by 20 firms in 2020 and 16 in 2021 (-20,0%). The general heating

consumption in portfolio MWh was given by 20 firms in 2021 (16 in 2020), while the overall water consumption million m3 could be identified for 19 entities in 2021 (18 in 2020) – in both cases an almost constant development. The waste volume tonnes (t) are observable 16 times in 2020 and 12 in 2021 (-25,0%). The next measure, which is being reported by the EPRA recommendations, is the emission intensity of rentable area kg CO_2e/m^2 showing up 21 times in 2021 and 14 in 2020, which is equivalent to a decrease of approx. 33,3%.

Table 1. Overview of the Changing Number of Firms Reporting Environmental Measures and Values in 2020 and 2021 (55 Sample Firms)

Information type	**No. of reporting firms in 2020/2021**	
Number of rented units	33/33	(+/-0,0%)
Total Energy Consumption MWh	24/18	(-25,0%)
Energy intensity of rentable area kWh/m²	20/16	(-20,0%)
Heating consumption in portfolio MWh	20/16	(-20,0%)
Water consumption million m³	18/19	(+5,6%)
Waste volume t	16/12	(-25,0%)
Energy consumption BOP MWh	06/04	(-33,3%)
Emission intensity of rentable area kg CO_2e/m^2	21/14	(-33,3%)
Scope 1 t CO_2e	16/18	(+12,5%)
Scope 2 t CO_2e	17/18	(+5,9%)
Scope 3 t CO_2e	07/11	(+57,1%)
Emission intensity of BOP kg CO_2e/m^2	08/07	(-12,5%)
Limited engagement opinion by auditors (Yes/No)	02/02	(+/-0,0%)
EPRA Recommendations are followed on? (Yes or No)	11/18	(+63,6%)
Use of Environmental Standards like e.g. GRI, UNGC?	11/14	(+27,3%)

Source: Authors

Additionally, the Scope 1t CO_2e (emissions directly caused by the company) reporting increased by 12,5% from 16 entities in 2020 to 18 in 2021. Similarly, the Scope 2 t CO_2e (emissions indirectly caused by the company) reporting increased by ca. 6% from 17 entities in 2020 to 18 in 2021, while the Scope 3 t CO_2e (emissions caused by the company's suppliers) reporting rose by ca. 57,0% from 7 entities in 2020 to 11 in 2021. Only the measures of energy consumption BOP MWh and Emission intensity of BOP kg CO_2e/m^2 are seldom mentioned by ca. 10% of the 55 RE firms in both years. Finally, 18 companies stated in 2021 (11 in 2020) to actively follow the EPRA recommendations and another 14 entities in 2021 (11 in 2020) list the standards applied e.g. GRI, SASB, and UNGC, which means that in both cases a positive increase by around 60 % and 30% is observable, respectively.

Everybody who wants to gain insights into best practices in sustainability reporting can study the sustainability reports of (mostly large) real estate companies. The recommendations of the European Public Real Estate Association (EPRA) are also worth reading. An example of effective reporting is Vonovia's sustainability report. It documents in great detail the activities carried out, including clear graphics that are easy to understand even for the layperson and thus contribute to clarification. The development of the quantitative ESG key figures over time is also explained and all ESG performance indicators are published on the home page in an Excel file. This implementation can be described as reference documentation for those interested in ESG reporting systems. However, most of the other companies in the RE sector surveyed have also produced representative sustainability reports, suggesting that the need and urgency have now been recognized.

Overall, the majority of environmental measures were 30 to 60% more often reported in 2021 than in 2020, but the baseline figures were relatively low. The complexity of the topic and the parallel coexistence of multiple standards overwhelm companies. Many of those, who still search for the right approach, often purchase (pseudo-)sustainability certificates and show up to 10 certificates from various private firms, not necessarily known for their sustainability know-how, on their webpages. This is not necessarily how sustainability awareness and action were meant to be. The forthcoming EU regulation, set to take effect in 2024, holds the potential to drive enhancements in the quality of sustainability reporting in the years to come. It is important, that these requirements will not be too complex at the beginning and are transparent across all industries. After 3 to 5 years one could then extend the reporting requirements to be more specific, i.e. industry oriented, otherwise, the companies will follow the rules on paper and fill the measures with fantasy numbers.

To save the planet, we need only a few environmental measures to be improved and correctly reported. Requiring a high level of pseudo-precision from the companies from the beginning on, will most probably, lower their acceptance for ESG measures and increase reporting of fake facts, which will be difficult to detect for auditors, who are not engineers by definition. If this grey zone appears, we will reach the goal of CO2 neutrality in 2050 only on paper, but not in reality. The goal of regulators in the EU and elsewhere in the world should, however, be reaching the zero net goal to save the planet for future generations.

5. CONCLUSION

This study aims to show common environmental (sustainability) reporting practices of real estate firms in 2020 and 2021, given existing European regulations. In recent years, sustainability has become a buzzword, and sustainability reporting is often perceived only as a marketing tool. However, it is unclear, whether firms establish sustainable structures or whether they argue existing processes into being sustainable. In summary, sustainability transformation efforts are essential, especially considering the growing awareness among investors and consumers of the critical need to adopt environmentally sustainable practices. In general, comparing reported sustainability measures with a specific focus on environmental issues among entities within a single industry in a particular country can be a challenging endeavor (e.g. Real Estate in Germany, Austria, and Switzerland). In all three countries, there was evidence that several “E” measures from ESG are being mentioned more often in 2021 than in 2020, but one should not forget that only 20-40% of the large RE companies reported any of them to begin with. The largest companies use several sustainability reporting standards in parallel, which makes a direct comparison difficult – there are too many coexisting environmental reporting schemes. It is important to note that the results are only indicative, as only two years of data have been analyzed and a small sample of 55 companies from a single industry has been studied. For subsequent research, it would therefore be useful to extend the scope to smaller companies within the RE sector. In addition, conducting a comprehensive content analysis that spans several years and different industries and includes several environmental, social, and governance (ESG) measures could make sense. This would provide a more comprehensive perspective on sustainability reporting practices. Sustainability standards play an essential role today as they are used as a framework for companies to assess and disclose their sustainability initiatives. The complexity of sustainability standards continues to expand and there are now (too) many options. The launch of the International Sustainability Standards Board (ISSB) and the forthcoming extension of sustainability reporting requirements to different industries at the EU level, due to start

in 2024, have both the potential to improve the quality of reporting and the risk of flooding the reporting landscape with inaccurate data. Policymakers, lobbyists, and regulators should take note of our research findings and recommendations. They need to pay close attention to the potential complexity and red tape imposed on companies in sustainability reporting and find a balance that promotes transparency without overburdening companies.

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Determinants, Persistence and Dynamics of Energy Poverty in Morocco: An Empirical Assessment Using Spatial Markov

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Abstract: *The paper focuses on the issue of energy poverty in Morocco, which poses a significant challenge to the country's economic and social progress. To better understand the dynamics of energy poverty, the authors employ spatial Markov chains to evaluate it at a regional level using a dynamic approach that considers the changing nature of energy distribution and the economic environment. The study uses multidimensional measures of energy poverty, based on three key parameters: availability, access, and affordability of energy. The results show that most regions have a non-significant value, indicating that energy poverty between regions is generally similar. However, one region has a high value, and two regions have a low value, which means that energy poverty is higher or lower in these regions compared to others. The study also suggests future research investigating the impact of various variables, such as access to social services and economic growth, on energy poverty in Morocco.*

1. INTRODUCTION

As technology advances and human lifestyles change, energy has become an essential requirement that cannot be ignored. Its importance lies in fulfilling human needs and promoting economic and social progress. Despite the significant role of energy in supporting economic and social growth, energy poverty has been on the rise in several nations, including Morocco. This problem poses a considerable obstacle to the country's economic progress and impacts its socio-economic stability. In Morocco, energy poverty is primarily linked to several factors, such as income inequality, high energy prices, climate change, and limited access to public services. Moreover, the significant economic and territorial disparity among Morocco's regions poses a major challenge in standardizing and analyzing energy poverty assessment measures, which still require significant improvements.

To gain a better understanding of energy poverty in Morocco, it is crucial to evaluate it at a regional level using a dynamic approach that considers the changing nature of energy distribution and the economic environment (Zhang et al., 2019). The dynamic measurement of energy poverty can provide an overview of the economic environment in Morocco. It helps identify the most affected regions in terms of poverty and inequality, which can be targeted by public policies and strategies. Additionally, this measurement can offer insights into the effectiveness of existing policies aimed at reducing the gap in regional energy distribution (Salman et al., 2022).

In this context, the article employs spatial Markov chains to evaluate the dynamics of energy poverty (Dehghan Shabani & Shahnazi, 2020), although the proposed methodology requires collecting information on the evolution of population and energy poverty index by region in

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Morocco (Matenga, 2022). The index is based on multidimensional measures of energy poverty proposed by (Khanna et al., 2019), which consider three key parameters: availability, access, and affordability of energy. This approach uses relevant and quantifiable parameters to measure energy poverty, with a standardized and internationally approved methodology. This study serves as a starting point for analyzing regional energy poverty through the use of multidimensional measures that provide an overview of the issue in Morocco's various regions. It facilitates the identification of the unique challenges faced by each region and enables comparison of the results obtained.

The article is organized as follows: Section 2 describes the Spatial Markov stochastic models. Section 3 presents the data and methodology used in the study. Section 4 presents the results, and section 5 contains the conclusions and potential further research.

2. THE SPATIAL MARKOV STOCHASTIC MODELS

By incorporating spatial statistics into the DMC framework, the spatial Markov chain (SMC) stipulates that the transitions of each economy across various classes in the energy distribution are spatially interdependent. This is formalized by $k, m \times m$ transition matrices that condition spatial lag classes (Rey et al., 2016).

The spatial lag takes the following form for economy a at time t:

$$z_{a,t} = \sum_{b=1}^{n} w_{a,b,t} y_{b,t} \tag{1}$$

where $w_{a,b,t}$ represents the weight that economy b contributes to the local context of economy a at time t. Spatial lags for all of the economies can be thus written in matrix form:

$$Z_t = W_t Y_t \tag{2}$$

where w_t is a spatial weight matrix formalizing spatial interactions between economies at time t. Different neighbor definitions can be used to define the weights including contiguity, distance-based measures, or trade relationships.

To obtain the $k, m \times m$ conditional transition probability matrices, it is necessary to specify not only the number and cutoffs of regional energy classes (m) but also those of the spatial lag classes (k). Once this is accomplished, the conditional probabilities can be estimated using the following method:

$$\hat{p}_{i,j|l} = \frac{\sum_{t=1}^{T} \sum_{a=1}^{n} I\left(c_{i-1,t} < y_{a,t} \leq c_{i,t} \cap c_{j-1,t+1} < y_{a,t+1} \leq c_{j,t+1} \cap c_{l-1,t} < z_{a,t} \leq c_{l,t}\right)}{\sum_{t=1}^{T} \sum_{a=1}^{n} I\left(c_{i-1,t} < y_{a,t} \leq c_{i,t} \cap c_{l-1,t} < z_{a,t} \leq c_{l,t}\right)} \tag{3}$$

The formula for estimating the conditional probabilities is as follows: $\hat{p}_{i,j|l}$ denotes the probability of transition from class i to class j, given that the spatial lag falls in energy class l at the preceding time point. The function I(.) serves as an indicator, taking the value of one if the condition is true and zero otherwise.

3. DATA AND METHODOLOGY USED

To analyze the energy poverty dynamics across regions in Morocco, we refer to the existing literature that has explored the use of discrete Markov chains as approximations of highly persistent AR(1) models in the context of time series analysis (Flodén, 2008; Galindev & Lkhagvasuren, 2010; Kopecky & Suen, 2010; Tauchen, 1986; Tauchen & Hussey, 1991; Terry & Knotek II, 2011). In our study, we adopt a vector autoregression (VAR) model that is similar to the approach of (LeSage & Cashell, 2015). The VAR model is a stable first-order model that is applied to n regions, where each regional equation is represented by the following form:

$$y_{a,t} = v_a + \alpha_a y_{a,t-1} + \rho_a \sum_b w_{a,b} y_{b,t-1} + \epsilon_{a,t} \quad (4)$$

where $y_{a,t}$ is energy poverty index in region a in period t, v_a is a region-specific constant term, a_a is a region-specific temporal lag coefficient, ρ_a is a region-specific spatial autoregressive coefficient, $w_{a,b}$ is a row-normalized spatial weight expressing neighbor relations between regions a and b, and $\varepsilon_{a,t}$ is the temporally non-autocorrelated error term for region a. Collecting all n equations gives the VAR as:

$$Y_t = v + \hat{\alpha} Y_{t-1} + \hat{\rho} W Y_{t-1} + \epsilon_t \quad (5)$$

where y_t is an n × 1 vector of regional energy at time t, v is a vector of region-specific constant terms, $\hat{a}$ is a diagonal matrix with the region-specific own-lag coefficients, $\hat{\rho}$ is a diagonal matrix with region-specific spatial autoregressive parameters, and $\varepsilon_t \tilde{} N(0, \sigma^2 I)$.

In Table 1, we will present the different indicators used to calculate the energy poverty index by region in Morocco, expressed in various units such as %, MJ, etc.

Table 1. Variables of analysis

Parameters	Indicators	Sub-indicators	Study period
Accessibility	Access to electricity	% Population with Access to electricity	2004-2017
	Access to clean fuels and technologies for cooking	% Population with Access to clean fuels and technologies for cooking	2004-2017
Availability	Total primary energy supply	Total primary energy supply per capita	2004-2017
Affordability	Total final energy consumption	Total final energy consumption per capita	2004-2017

Source: Pereira et al., 2021

We will apply Principal Component Analysis (PCA) to these variables to obtain a correlation matrix between them and the components. Then, we will determine the number of principal components to retain by calculating the variance explained by each of them. This will allow us to create a composite index of energy poverty in Morocco. Finally, we will establish weights for each principal component to calculate the energy poverty index by region in Morocco.

4. RESULTS

Upon examining Figure 1, we discovered that Moran's I value was consistently positive and significant for each year from 2004 to 2017. This indicates that the time series of the regional

energy poverty index are not independent and that the regional context may significantly impact the dynamics of the index. However, the classical Markov approach does not directly address this issue. Therefore, to better understand the dynamics of regional energy distribution in Morocco, we utilize spatially explicit Markov methods, such as Spatial Markov and LISA. These methods explicitly incorporate spatial information into their analysis.

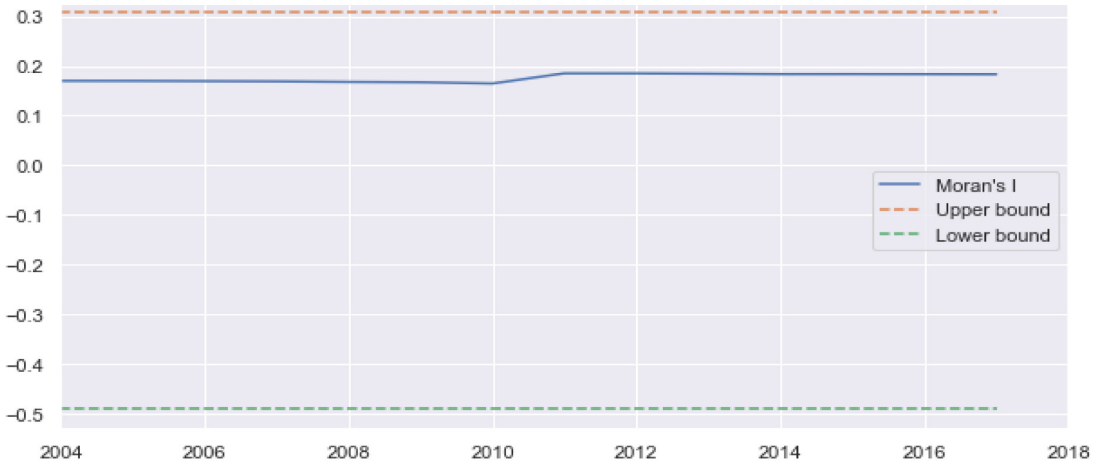

Figure 1. Global spatial autocorrelation for annual energy poverty index

Source: Authors

Using the spatial Markov model, it is possible to compare global changes with those influenced by regional context. Transitions are distributed among regions based on their spatial lag, defined in quintiles from the previous year. In our example with 5 classes, we estimated 5 different conditioned probability transition matrices: P(LAG0), P(LAG1), P(LAG2), P(LAG3), and P(LAG4).

The results are presented in the table below (Table 7) as probability matrices for each lag (i.e., time shift). The rows represent the initial state and the columns represent the final state. Additionally, the results show the regimes and their names, along with the test statistics (LR and Chi-2) and corresponding p-values. The test results are significant with p-values less than 0.05, indicating significant dependence between regions. The probability matrices display the likelihood of transition between each initial and final state for each lag and regime.

The figure below (Figure 8) shows that the probability of an energy-poor region remaining in that state is 0.500 if its neighbors are ranked in the first quintile and 0.333 if they are in the second quintile. However, the probability of an energy-rich region remaining in that category is 0.500 when its neighbors are in the fifth quintile, but drops to 0.000 when they are in the fourth quintile.

Table 2. Spatial Markov Test

Test	LR	Chi-2	Regime names: LAG0, LAG1, LAG2, LAG3, LAG4		
Stat.	119.258	101.621	Number of regimes: 5		
DOF	57	57	Number of transitions: 156		
p-value	0.000	0.000	Number of classes: 5		
P(H0)	C0	C1	C2	C3	C4
C0	0.320	0.152	0.088	0.091	0.290
C1	0.240	0.242	0.029	0.242	0.226
C2	0.200	0.273	0.382	0.091	0.129
C3	0.000	0.212	0.294	0.333	0.161

C4	0.240	0.121	0.206	0.242	0.194
P(LAG0)	C0	C1	C2	C3	C4
C0	0.385	0.333	0.000	0.000	0.000
C1	0.308	0.222	0.000	0.000	0.000
C2	0.308	0.000	1.000	0.000	0.000
C3	0.000	0.444	0.000	0.000	0.500
C4	0.000	0.000	0.000	0.000	0.500
P(LAG1)	C0	C1	C2	C3	C4
C0	0.000	0.000	0.000	1.000	0.000
C1	0.000	0.294	0.083	0.000	0.333
C2	0.000	0.412	0.667	0.000	0.333
C3	0.000	0.118	0.083	0.000	0.333
C4	0.000	0.176	0.167	0.000	0.000
P(LAG2)	C0	C1	C2	C3	C4
C0	0.286	0.250	0.333	0.125	0.167
C1	0.143	0.250	0.000	0.125	0.000
C2	0.000	0.250	0.000	0.250	0.250
C3	0.000	0.000	0.333	0.375	0.167
C4	0.571	0.250	0.333	0.125	0.417
P(LAG3)	C0	C1	C2	C3	C4
C0	1.000	0.333	0.067	0.000	0.000
C1	0.000	0.000	0.000	0.667	0.000
C2	0.000	0.333	0.267	0.000	0.000
C3	0.000	0.333	0.467	0.000	0.000
C4	0.000	0.000	0.200	0.333	0.000
P(LAG4)	C0	C1	C2	C3	C4
C0	0.000	0.000	0.000	0.067	0.500
C1	0.250	0.000	0.000	0.067	0.429
C2	0.250	0.000	0.000	0.067	0.000
C3	0.000	0.000	0.000	0.533	0.071
C4	0.500	0.000	0.000	0.267	0.000

Source: Authors

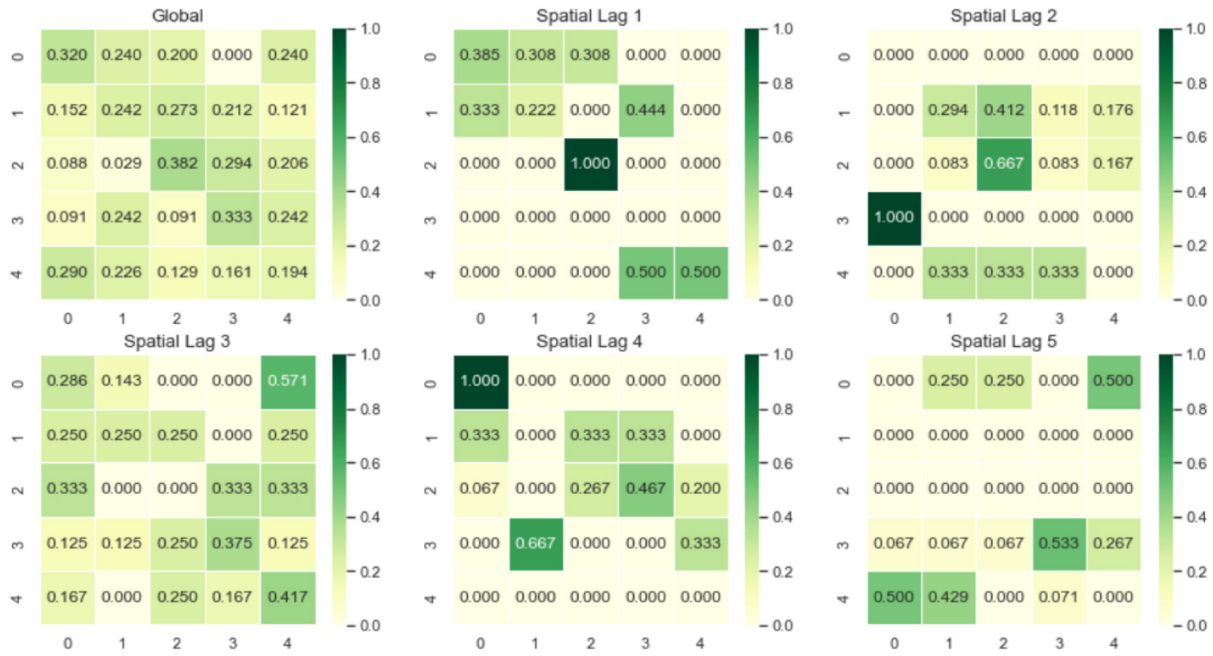

Figure 2. The spatial Markov transition probability matrix

Source: Authors

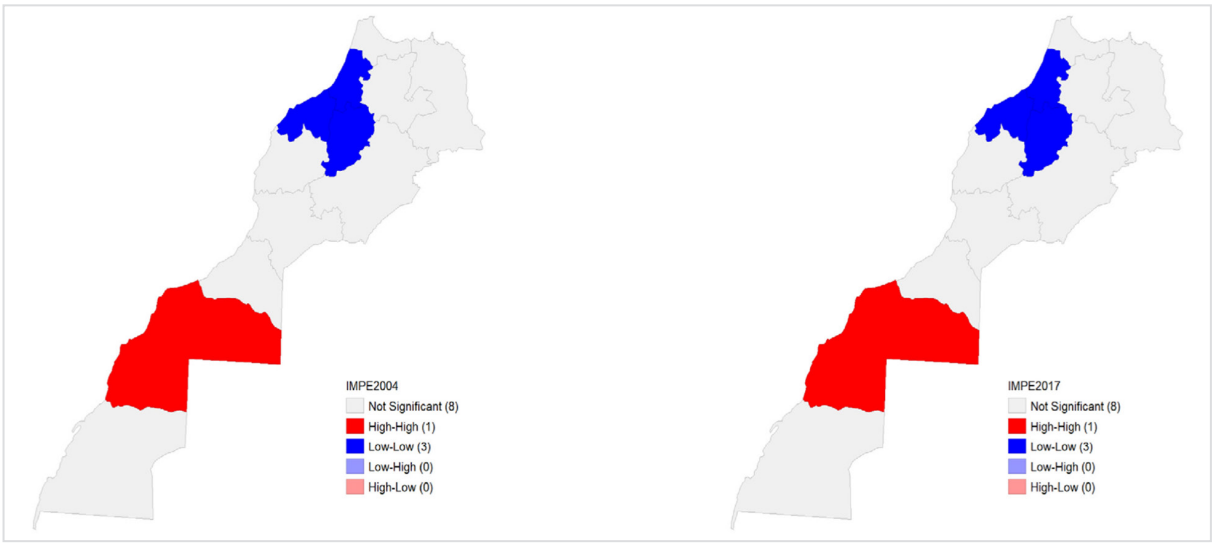

Figure 3. Local Spatial Autocorrelation
Source: Authors

The significance map of the multidimensional energy poverty index by regions in Morocco shows that most regions have a non-significant value (8), which means that energy poverty between regions is generally similar. However, there is only one region that has a high-high value, which means that energy poverty is higher in this region compared to the others. There are also 2 regions that have a low-low value, which means that energy poverty is lower in these regions compared to the others.

5. FUTURE RESEARCH DIRECTIONS

The future research directions of this paper focus on investigating the impact of various variables, such as access to social services and economic growth, on energy poverty in Morocco. The study also aims to explore the effectiveness of policies aimed at reducing energy poverty, including the use of renewable energy sources and improving energy efficiency. Additionally, the authors suggest further research on the spillover effects of energy poverty and its relationship with other forms of poverty.

6. CONCLUSION

The article discusses energy poverty in Morocco and its impact on the country's economic progress and socio-economic stability. The main factors contributing to energy poverty in Morocco are income inequality, high energy prices, limited access to public services, and climate change. To address this issue, the study employs spatial Markov chains and multidimensional measures of energy poverty to calculate the energy poverty index in each region, facilitating the identification of unique challenges faced by each area. The results reveal significant interdependence among regions, which may impact the index's dynamics. Future research directions include investigating the impact of various variables on energy poverty in Morocco and exploring the effectiveness of policies aimed at reducing it. The study provides important insights into energy poverty in Morocco and emphasizes the need for policies and strategies to narrow the gap in regional energy distribution.

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Stakeholder Engagement: Actionable or Symbolic Lever? Reflections on Barriers to Involvement

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Abstract: *Stakeholder involvement represents an evolved strategic approach, widely highlighted as an expression of openness and inclusiveness of organizations. However, stakeholder engagement processes and outcomes often reveal substantial issues and a lack of effectiveness. The work raises questions on how to activate this lever as a multiplier of plural value and aims to formulate possible answers based on the analysis of both the theoretical background and the reflections of specifically involved experts. An interpretative model is then formulated to enhance awareness of the barriers to engagement and to promote debate on how to overcome them.*

1. INTRODUCTION

Stakeholder engagement, as a governance philosophy and a working method, necessarily sinks its roots in the proactive approach to inclusion, in the ability to fully and significantly bring out different perspectives, in the aptitude to lead the dialogue between parties with empathy and transparency, to then compose inputs towards improvement solutions. Stakeholders are here approached from a strategic perspective as those who can influence or can be influenced by an organization's actions and decisions, that is in the "wide sense" as specified in the seminal work of Freeman and Reed (1983, p. 91). Engagement of stakeholders necessarily means the participation of stakeholders concerning company contexts, situations, issues, concerns and debates. At the same time, as a fundamental condition of effectiveness, it also requires the engagement of the company in its interlocutors, in a relationship of reciprocity and trust (Andriof & Waddock, 2002; Fassin, 2012). The scenario is that of the enterprise interpreted as a widespread good, which extends its value to many, based on stakeholder relationships seen as sources of value (Post et al., 2002, p. 6). It is this extended view that, within the processes of involvement, allows the parties to balance the physiological competitive drives with a commitment to collaboration.

The reference to the interlocutors' involvement is certainly recurrent within companies' profiles, strategic statements and sustainability reports. However, many scholars and professionals have observed how the process and results of involvement seem to be often affected by formalities, not developed to fully understand critical issues, nor to acquire relevant elements for the improvement of performances, relationships and opportunities. Involvement activities seem mainly developed without real trust between the parties, thus with a prevalence of antagonist drives – even if tacit – over collaborative ones. Dedicated stakeholder meetings, interviews and questionnaires often appear to be intended more as messages in themselves than as tools to develop understanding and drive improvements. For example, sustainability reports rarely deal with the critical issues that

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emerged in the context of the stakeholder consultation and the responses that the company has identified to overcome such issues. This is evidence that has also emerged forcefully from our previous studies (Giusepponi, 2021). Nonetheless, the great potential of stakeholder involvement – as a strategically and operationally relevant working method, in planning as well as in control – is extensively underlined in the literature. Furthermore, organizations that have included stakeholder engagement in their strategy, operations and culture widely highlight its importance to both better understand and enable people to better understand contexts – creating a community environment that accelerates the identification of problems and possible solutions.

1.1. Research Questions, Aims and Structure

Considering the above, questions emerge on why stakeholder engagement is used so frequently in a predominantly symbolic way; on why organizations so often give up on activating this lever. In other words, these are questions on *what are the main barriers that hinder the highest functioning of this lever* (RQ1) and on *how scholars and professionals can contribute to the identification and removal of such barriers to stakeholder engagement* (RQ2). This work aims to participate in the formulation of possible answers, based on the analysis of the literature and of reflections developed on the topic by a panel of experts.

The literature on stakeholder engagement is reviewed here particularly focusing on how it addresses the substantial actionability of stakeholder engagement, to understand areas of thought and point out the lack of response in this regard. While important gaps in the theory of stakeholder engagement can still be observed, several enlightening contributions offer logical and inspirational bases for the evolution of the theory. The theoretical background here outlined (section 2) represents the lens through which the contents expressed by the experts have been interpreted in the context of this work, to offer a contribution both to the theoretical evolution and to the diffusion of awareness on stakeholder engagement in practice.

The panel of experts – specifically involved in this study within a process of qualitative content analysis – includes managers, entrepreneurs, consultants and academics. These are experts who have had, within their work, the opportunity to experience and analyze methods, processes and difficulties of involving stakeholders. Their views are here analysed (sections 3 and 4) in order to reach a higher understanding of stakeholder engagement issues and to address some responses.

Stakeholder engagement is a powerful lever that leads to multiplying positive impacts only if the removal of important barriers is guaranteed. Understanding these barriers is a necessary step – certainly still in progress – both to identify possible ways to remove them, and to better contextualize the full potential of involving interlocutors in organizations. Based on the analysis developed here, an interpretative framework is proposed to raise awareness of these obstacles and prompt further reflections on engagement processes that multiply value (sections 3, 4, and 5).

2. THEORETICAL BACKGROUND

2.1. Stakeholder Engagement between Vagueness, Idealism and Risk of Exploitation

Kujala et al. (2022, p. 1138) point out that there is a lack of unified recognition of essential components of stakeholder engagement and that the uneven use of stakeholder engagement represents a barrier to the development of the same. They also point out that, to develop theorizing,

it is necessary to review the system of measuring within stakeholder engagement (Kujala et al., 2022, p. 1173). References for defining minimum conditions of effectiveness and for appreciating the quality of the results are indispensable to making stakeholder engagement theory evolve. Otherwise, this theory remains confined to a sphere of idealism in which nothing really impacts and everything can lend itself to exploitation, where the risk that stakeholder involvement may be linked to practices of social irresponsibility is not excluded (Greenwood, 2007).

As highlighted by Berman et al. (1999), within the normative, instrumental and descriptive fields of stakeholder theory defined by Donaldson and Preston (1995), the role assigned to the normative dimension has been very deeply studied in connection with ethics and integrity principles, well highlighted by Freeman (1994) and Paine (1994) among others. As underlined by Fassin (2012, p. 84), stakeholder theory is mainly concerned with the concept of the organization's responsibility towards its stakeholders (e.g. Freeman, 1984, 2004; Friedman & Miles, 2006). This is certainly a fundamental category; equally important is the category of reciprocity on which however, as Fassin effectively points out, less attention has been paid. The high relative weight of the normative approach has lasted for a long time and continues, and it is not rare to find in practice an idea of stakeholder engagement as an activity generally linked to ethics, to be carried out in order to behave well, but without full awareness of how to develop it in order to generate positive impacts. Many questions regarding the instrumental and descriptive spheres remain open.

Although stakeholder theory includes stakeholder engagement, it does not offer a conceptual framework for addressing and evaluating operational approaches to engagement itself. The result is vagueness and reliance on good outcomes on the good faith of those who take care of stakeholder engagement (Dawkins, 2014, p. 283). As also highlighted by Bellucci et al. (2019) this field of study "is still under-theorized". In this context, it is particularly important to bear in mind that stakeholder engagement does not necessarily mean a positive approach, since it is at the core a "morally neutral activity" that can be useful or not according to intentions, as amply underlined by Greenwood (2007, p. 325). Therefore, the responsible leader, the "weaver of social ties" capable of generating harmony between the organization and its environment – to use Maak's vision (2007, p. 340) – is certainly not to be taken for granted.

While on the one hand, the importance of stakeholder engagement is continuously underlined in studies, conferences and events, on the other hand, experiences effectively oriented towards improvement, with awareness of the role both on the part of the company and its stakeholders, rarely emerge (Giusepponi, 2021; Manetti, 2011, p. 119; Moratis & Brandt, 2017). One therefore asks her/himself the reason for this evidence, for these issues. In the very difficulty of defining the stakeholder, we find one of the answers. The lack of stakeholder theory allows us to understand the difficulties for organizations to orient themselves in the vast audience of their interlocutors (Carroll, 1989; Clarkson, 1995; Donaldson & Preston, 1995; O'Riordan & Fairbrass, 2014).

2.2. Call for a Culture of "Sense Co-creation" between Responsibility and Reciprocity

The definitions of stakeholder are innumerable, for example, Fassin (2012, p. 86) mentions as many as 18, but many others can be identified. Some definitions are very broad, such as the one adopted here (section 1) and linked to a strategic perspective, in the "wide sense" specified by Freeman and Reed (1983, p. 91). Always, however, engagement of stakeholders requires connections of mutual responsibility between the organization and its stakeholders. When one speaks

of reciprocity, the emphasis is placed on the relationship between the company and the stakeholders, on how to make it continuous and constructive, a source of value for both parties (Andriof & Waddock, 2002; Johnson-Cramer et al., 2003). As evidenced by many (among others, Andriof & Waddock, 2002; Fassin, 2012; Phillips, 1997) a focus on the concepts of reciprocity and mutuality is essential to understand and direct stakeholder engagement. Without a sense of responsibility on the part of interlocutors, there can be no trust from the company in the results of the consultation, nor a valuable contribution (Giusepponi, 2021). On the other hand, the sense of responsibility of the stakeholders cannot develop if the company does not demonstrate that it invests in engagement by seeking the value of stakeholders' points of view, reflecting on such points of view until following up with decision-making.

Morsing and Schultz (2006) extend to external interlocutors the concepts of "sensemaking" and "sensegiving" developed by Gioia and Chittipeddi (1991), with an internal focus above all on managers and employees. The authors highlight how an effective engagement process presupposes communication in which sensemaking and sensegiving are linked in an interactive and evolutionary process for both parties (Morsing & Schultz, 2006, p. 326). The dynamics of sensemaking and sensegiving define a learning rhythm that is based on a continuous flow of creation and sharing of a coherent strategic vision, to be refined and enriched iteratively in exchange with others. Project sharing is important to achieve high levels of engagement (Gable & Shireman, 2005). Comparing and challenging each other on common goals is essential for networking. Certainly, stakeholder engagement cannot be effective if there is not adequate participation on the part of stakeholders.

As also noted by Aakhus and Bzdak (2015, p. 190), participation brings attention to necessarily human-centric and collaborative dimensions of problem-solving, from the point of view of design thinking (Brown, 2008; Brown & Wyatt, 2010; Kolko, 2015). To build meaning and convey meaning, the approaches to accountability from the perspective of integrated sustainability (GRI, 2016-2022; AA, 2015-2020) and integrated thinking (IR, 2021) are certainly important. Rinaldi (2020) in particular focuses on integrated thinking as a way of creating value through the relationship with stakeholders. Sustainability reporting is usually associated with a need for engagement but it has to be considered that stakeholder engagement must be addressed beyond the reporting, as an essential element of the strategy (Noland & Phillips, 2010, p. 49; Stocker et al., 2020, p. 2078).

This presupposes a systemic approach to stakeholders and the inclusion of stakeholder engagement within company values and philosophy, as a source of opportunities for plural value creation. Certainly, this presupposes a terrain of transparency, trust, attention to reputation and clear definition of the game rules, because there may be large spaces of antagonistic and conflicting interests between the stakeholders and the company and among the stakeholders themselves. These are needs that one also finds in other situations, such for example those related to open innovation, an approach in which risks and opportunities must be carefully observed and where effective stakeholder engagement is decisive for the purposes of this balance (Wayne Gould, 2012). Talking about stakeholder engagement, one certainly enters a collaborative dimension. However, it should be noted that when dealing with stakeholder engagement, discussions often start from the perspective of the company, which is called to guide, interpret, create and give meaning in line with the corporate strategy. Since stakeholder engagement is mainly seen from an organization-centric perspective, the company is assigned the role of aggregator, of catalyst around corporate issues. Nevertheless, as highlighted by Roloff (2008, p. 245), when

stakeholder management focuses on specific issues, that are important for different parts, there is no longer centralization on the organization. By participating in the discussion on a specific topic (with a focus on facts, reasoning, and ideas), the organization stands as an actor among the actors, with the same role. This is a very important passage that fully contextualizes stakeholder engagement in the collaborative perspective of plural problem-solving and co-creation of value. In hindsight, this is also the approach at the basis of design thinking which makes empathy and judgment-free listening (therefore by definition non-organization-centric) essential foundations.

3. RESEARCH DESIGN AND METHODS

3.1. Involvement of Experts and Method of Investigation

In order to define coherent answers and formulate important areas for other questions, a project of expert involvement has been designed and developed. The objective is to outline a framework for improvement, to overcome the usual barriers and to enable new approaches to stakeholder engagement. This qualitative method, based on collecting informed and aware points of view and extracting meaning from them, has been chosen since consistent with the exploratory approach and the aim to bring out tacit knowledge (Nickols, 2013), dominant thoughts and focal views linked to experts' specific experience on the topic. Each expert was only invited to share her/his general thoughts on the main factors hindering the involvement of parties in both strategic business processes and sustainability reporting. No detailed nor closed questions were asked because these would have required a choice of specific areas that wanted to be avoided, given the exploratory aims of the work. In other words, the identification and detail of areas of attention were results expected from the investigation process, thus the latter was designed in a way that did not influence in any way the horizon of the experts' response.

This qualitative approach is consistent with evaluative research in current fields that do not have defined boundaries (Yin, 1994). In fact, with regard to stakeholder theory and referring to the normative, instrumental and descriptive fields distinguished by Donaldson and Preston (1995), it is possible to broadly observe the normative approaches, but the problems directly linked to the descriptive and instrumental profiles remain largely open. Indeed, there is a widespread perception of stakeholder engagement from ethical perspectives – broadly connected to the concept of corporate responsibility – but there are uncertainties and gaps in descriptive areas (on the ways of stakeholder engagement) and above all in instrumental areas (on the impact generated by stakeholder engagement) (Fassin, 2012). The qualitative content analysis was therefore developed to bring out unstructured tacit knowledge and study its convergence/divergence, and to allow a deeper understanding of the phenomenon. The aim is to outline a framework for improvement, overcoming widespread barriers and consolidate evolved approaches to stakeholder engagement. This means approaches based on ethical foundations and at the same time supported by descriptive and instrumental methodological logics, to increase awareness of the stakeholder network and of the conditions for activating this network, to generate value, and ultimately also fully enable the ethical dimension.

Specifically, this study was founded on: the structuring of resources through the identification and use of relevant coding frames, i.e. filters that allow to distinction of different categories in the expert statements (Schreier, 2012, p. 63); the extraction of meanings through a comparative approach of cross-case analysis, to identify elements of continuity/discontinuity (Khan & VanWynsberghe, 2008). Therefore, the analysis of the unstructured contents expressed by the experts and their

breakdown based on specific research topics led to the identification of relevant elements for understanding stakeholder engagement challenges and defining possible improvement trajectories. The concept of expertise here adopted is that of systemic experience and reflection (Fazey et al., 2006; Krueger et al., 2012). According to Ayyub (2001, p. 98), the perception of an expert's experience could be influenced by the expert's communication skills. In order to avoid the risks of an ineffective selection in this sense, the author proceeded with a purposeful sampling, focusing on the direct evaluation of the work evidence shown in the field (in terms of stakeholder involvement within strategic or reporting processes, or of consistent research).

3.2. Panel Composition and Data Collection

The panel includes Italian experts who, from various professional perspectives, have had relevant opportunities to reflect on stakeholder engagement issues, in the private (profit and non-profit) or public contexts. Regarding the scope of the findings, it has also to be considered that the majority of responding experts have experience in several organizations.

The goal was to reach at least twenty "voices" of experts. This is an ample reference, given what is indicated in contexts of qualitative analysis (on this profile see among others: Eisenhardt, 1989; Krueger et al., 2012; Palinkas et al., 2015). It was the reflection on the indefiniteness of the boundaries of the theme that oriented the choice toward this reference, guaranteeing a solid basis for the study. Within the investigation, 40 experts were invited, given an estimated response rate of around 50%: entrepreneurs (10), managers (10), consultants (10) and academics (10). The experts were directly involved by the author in March and April 2023, via email, WhatsApp and/or Linkedin. Each of them was asked to share with the author their thoughts on the main factors that according to her/him hinder the effective involvement of the parties (employees, suppliers, customers, financial institutions, and so on) both in strategic business processes and in sustainability reporting.

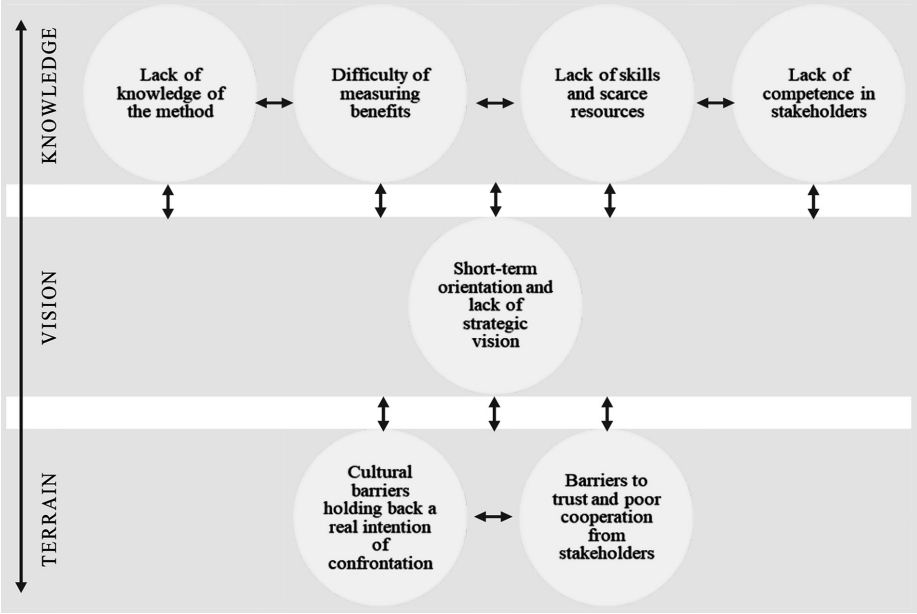
Following the invitation, 31 experts responded: entrepreneurs (9 out of 10), managers (6 out of 10), consultants (8 out of 10), and academics (8 out of 10). Feedback was provided as follows: 17 experts responded in writing only; 12 experts expressed their ideas during an interview; 2 experts replied both in writing and during an interview requested to provide explanations/details. The experts articulated their feedback extensively and generally underlined the importance of the topic. In the context of the interview, the author essentially placed herself in the role of listener, so as not to influence the choice of specific content in any way, since the purpose of the investigation was, as above indicated, to bring out the fundamental ideas on the topic. The author has therefore taken detailed note of what each interviewed expert said. Anonymity was expressly requested by some experts in the experimental phase of the investigation and was always adopted to guarantee complete privacy to respondents and their organizations.

4. MAIN FINDINGS AND DISCUSSION: CONVERGENCE AREAS EMERGED FROM EXPERTS' POINTS OF VIEW

What emerged from the experts' involvement was interpreted according to the methodology above illustrated. The contents shared by the experts were organized by theme based on the frequency of positions about specific topics. This resulted in the identification of the main focus areas, as indicated below, in order to answer the RQ1. The content analysis was also the basis of the formulation of propositions on how to overcome the different analyzed barriers, in order to answer the RQ2.

The identified focus areas were studied by the author as a whole, seeking logical connections based on the repeated and iterative study of what was declared by the experts, in order to offer a systemic framework. The author therefore formulated the terrain-vision-knowledge framework represented in Table 1. Terrain elements include culture and trust, sources of any approach and habit. Vision is the gaze on the future, with its system of expectations and fears. Knowledge is the driving force of all progress. They are connected in a virtuous circle. The organization of this scheme was defined by the author working on the focus areas to represent them in a rational and at the same time symbolic frame. This organization reflects logical connections and does not follow any ranking of areas. However, the frequency of experts' statements about different areas is reported in Table 2 to allow comparisons and evaluations. Frequencies of experts' focus reveal different views which are fruitfully integrable. In the research, it emerged that the entrepreneurs are mostly focused on trust (88,89% express contents in this dimension); the consultants on culture (75%) and trust (62,50%); the managers on short-term orientation (50%) and trust (50%); the academics on trust (62,50%), culture (50%) and lack of knowledge of the method (50%).

Table 1. Barriers to involvement: the terrain-vision-knowledge perspective



Source: Own elaboration

4.1. Main Barriers That Hinder the Highest Functioning of Stakeholder Engagement

Terrain

a. Cultural Barriers Holding Back a Real Intention of Confrontation

They are considered central and substantially attributable to an organization-centric approach, with a vertical logic of power management. Opening up to the other without fear of losing control seems hard, especially in front of a variety of potentially divergent specific interests. Organizations often do not want this kind of confrontation and when they face it, it is often due to some obligation to be met and not rarely do they ensure that critical elements do not emerge. Too often, the confrontation is understood purely as a negotiation. In the involvement of stakeholders, organizations see a lot of idealism.

b. Barriers to Trust and Poor Cooperation from Stakeholders

Placing trust in others appears difficult and this often leads to the defense of borders and the blocking of effective channels of genuine exchange. It's hard to plan together for the long term. The immediate advantage is sought, and the loss of an immediate advantage is feared. If stakeholders do not feel involved in the decision-making process and do not believe that their contribution is really important for corporate decisions, they easily lose interest and motivation, therefore they do not provide valuable contributions and their involvement loses effectiveness, fueling distrust.

Vision

c. Short-Term Orientation and Lack of Strategic Vision

Organizations are often too short-term oriented to invest in a tool designed to produce radical long-term change. Consequently, the involvement of stakeholders often appears to companies as a conceptualization that does not find adequate concrete evidence. In reality, the process would be particularly useful in times of great challenge that we are experiencing, but organizations often tend towards rapid involvement paths and fear finding themselves faced with developments in the confrontation that are difficult to manage. Experts' attention largely converges on the lack of strategic vision – the difficulty of projecting beyond the short-term – as a central and imposing barrier.

Knowledge

d. Lack of Knowledge of the Method

Another obstacle is the lack of knowledge of the potential of the method (especially in a strategic dimension). Stakeholder engagement is often limited to areas seen as technical/specialist and is not seen as a managerial and strategic approach, as a value multiplier lever. Often for this very reason, stakeholder engagement does not see the direct participation of top management. And even where the internal group directly involved expresses confidence in the process, the absence of a systemic investment frustrates the effort and creates disaffection. These considerations also apply to sustainability reporting: not rarely, it is confined to a moment decontextualized from a strategic path. Often, there is not even an awareness of how the materiality analysis itself must arise from a plural strategic perspective.

e. Difficulty of Measuring Benefits

Companies often tend to think that stakeholder involvement does not create real benefits in terms of profits and corporate growth. The current difficulty of defining significant indicators, useful for measuring the impact of stakeholder engagement on the quality of company decisions and performances, therefore represents another significant barrier with respect to the actual development of the tool. These are difficulties widely related to the nature of the benefits that are often expected more in immediate terms of market and profit than in terms of long-term equilibrium, capacity for innovation and anticipation of problems.

f. Lack of Skills and Scarce Resources

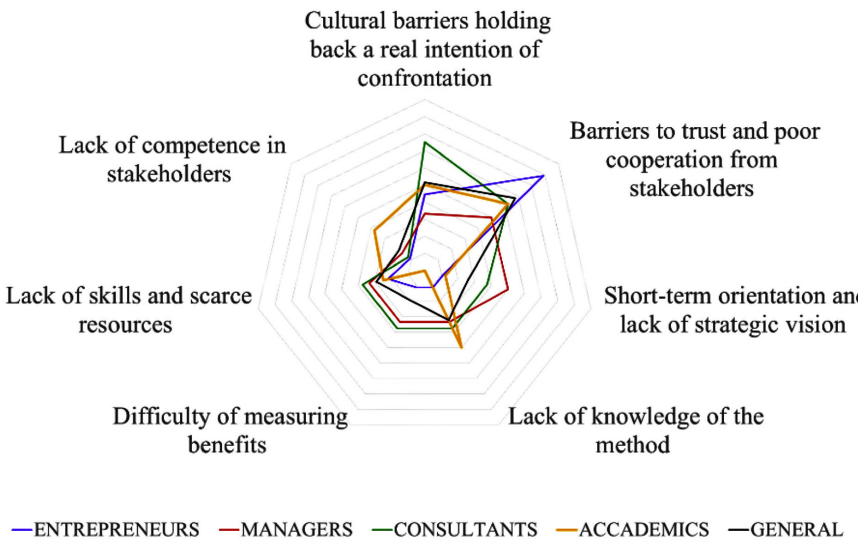
Paying deep attention to others and their diversity takes time, attitude, and dedication. This aspect is often not fully understood and is thought to be unproductive time. Furthermore, the management of stakeholder engagement requires articulated and solid skills, and therefore significant and sustained investments. Sometimes the company feels it can't afford the time and resources for relationships that don't have an immediate return. In short-term oriented companies and/or struggling with budget constraints, resources tend to be allocated to activities that, based on experience, are immediately perceived as having a direct and positive relationship with company results (eg. technology investments). In other cases, the organization ventures into engagement paths, perhaps in the field of reporting, without adequately evaluating the resources and skills necessary to do so, making the effectiveness of the path impossible from the outset.

g. Lack of Competence in Stakeholders

The lack of competence concerning the method and what it requires also concerns the stakeholders, who in order to participate proactively in a discussion should have awareness of their role in the process and knowledge of the topics. Their availability is often insisted upon, but organizations rarely work to ensure that stakeholders are appropriately knowledgeable and constructive within the process.

Table 2. Barriers to involvement: experts' focus areas
(% on number of experts)

	ENTREPRENEURS	MANAGERS	CONSULTANTS	ACADEMICS	**GENERAL**
Cultural barriers holding back a real intention of confrontation	44,44%	33,33%	75,00%	50,00%	**51,61%**
Barriers to trust and poor cooperation from stakeholders	88,89%	50,00%	62,50%	62,50%	**67,74%**
Short-term orientation and lack of strategic vision	11,11%	50,00%	37,50%	12,50%	**25,81%**
Lack of knowledge of the method	11,11%	33,33%	37,50%	50,00%	**32,26%**
Difficulty of measuring benefits	11,11%	33,33%	37,50%	0,00%	**19,35%**
Lack of skills and scarce resources	22,22%	33,33%	37,50%	25,00%	**29,03%**
Lack of competence in stakeholders	11,11%	16,67%	12,50%	37,50%	**19,35%**



Source: Own elaboration

4.2. Activate Stakeholder Engagement as a Strategic Lever: Improve Terrain, Clarify Vision, Enhance Knowledge

Improve Terrain

a. Cultural Advancement: From an Organization-Centric Perspective to a Network-Centric Perspective

From the voices of the experts emerges the need for a paradigm shift, to transition from the widespread idea of an enterprise that *calls* its interlocutors for consultation to one of an enterprise that moves towards the places of debate about relevant dimensions of integrated sustainability. It is therefore necessary to overcome self-referential approaches and participate in networks of interests projected on plurality and durability, moving from an organization-centric perspective to a network-centric perspective. The company is an actor among actors. Reciprocal and transparent links are needed, in a vision oriented towards the common good which necessarily also includes the orientation towards the company's lasting equilibrium. The transition from unidirectional to multidirectional perspectives must concern not only the company but also the interlocutors who sometimes exclusively express particular and antagonistic interests with respect to the company, lacking openness to a plural strategic design. A broad individualism is observed – also at a social level – which makes it difficult to apply the concept of synergy. The difficulties of involving stakeholders are in fact largely associated with the difficulties of society. Attention is largely directed to the theme of the fragmentation of interests and therefore to the need to recompose them by culturally enhancing more inclusive models and representations through theoretical arguments and practical references.

b. Development of Trust as a Dimension of Proactivity, with Awareness of the Risks

Promoting more horizontal (versus vertical) and participatory approaches within organizations and societies is important to enhance the trust cycle, which includes both working to earn trust and investing in trusting others (also aware of the risks this entails), because if others see distrust they in their turn don't trust. In this sense, it is helpful to observe how the new generations move, paying more attention to the objective contents and less to the roles, with greater release from vertical logic to the advantage of horizontal visions and collaboration. Systematic connections and the provision of feedback are essential for this trust. Eliciting proactive participation from stakeholders also requires, on the part of the company, a shift of attention towards a language centered on collective opportunities and risks, beyond the sphere of immediate results for the company and towards general impacts. Language plays a fundamental role in shedding light on how we see and convey reality. A fashion company, for example, by participating in a group aimed at reducing clothes waste can contribute through its evidence, reflections and data in reaching group positions, without placing at the center of the debate the company and its results but evolving together with relevant stakeholders within a given issue. Furthermore, with a specific focus on businesses, promoting an evolution towards more advanced business models, less concentrated around the figure of the entrepreneur (especially if solopreneur), is an important foundation for promoting a horizontal approach.

Clarify Vision

c. Promote the Habit of Strategic Vision, Orientation Towards Lasting Integrated Equilibrium, Reference to Impacts

It is necessary to strengthen the company's strategic vision from the perspective of an integrated, plural and lasting equilibrium. This requires a view of the company from above, to better understand its system of positive and negative impacts on different areas and audiences. Furthermore, with a strong commitment on the part of top management, it is important to clearly contextualize the involvement of stakeholders within broad-based and long-term strategic paths, avoiding short-term contexts characterized by prevalent negotiating activity. Those who promote, design, and coordinate processes of stakeholder engagement should trace them within paths of change anchored to representation and inclusivity, to be referred to in a systematic and non-chaotic way in order to obtain significant positive impacts. Only organizations and entrepreneurs who really challenge themselves and open up to discussions can obtain benefits from the dialogue with the various interlocutors and, in the medium/long term, reach competitive advantages.

Enhance Knowledge

d. Dissemination of Knowledge and Awareness of Stakeholder Engagement as a Governance Philosophy and a Working Method

It is crucial to support a cultural evolution by helping to make the potential of stakeholder engagement more evident at a strategic level, as a pervasive governance philosophy and collaborative working approach, avoiding contextualization limited to the reporting phase. Against the risks of an opportunistic approach, there is a need to undermine the widespread identification of stakeholder engagement as a methodological category considered exclusively to support sustainability reporting processes. In this role, it reflects the limitations of reporting, and this is particularly serious when the reporting is experienced mainly as compliance. Spreading the habit of stakeholder engagement in the context of full strategic paths requires convergent actions on the part of scholars and professionals both in the direction of seeking valid methodologies and tools for the effectiveness of the approach and in the direction of conveying the meaning of the different impact dimensions.

e. Advancement in Measuring the Effects of Specific Stakeholder Engagement Methods with Respect to Relevant Variables Such as Quality of Decisions and Intangible Dimensions

It is highlighted by the experts – with strength and convergence – that usually, those who propose and introduce stakeholder engagement pay much attention to the process but not as much to content issues and expectations in terms of outcomes. Instead, it would be more logical and constructive to start from the needs/problems and reflect on how to best address them in a participatory way, thus shifting the attention to the benefits that could be achieved in terms of solving those needs/problems. The orientation toward needs and problems also spontaneously generates a push toward the identification of significant indicators and coherent measurements. We often talk about the difficulty of expressing the impact of stakeholder engagement, but in hindsight, it is a question of the difficulties linked mainly to the nature of the benefits that are often expected, more in immediate market and profit terms than in terms of lasting equilibrium, capacity for innovation and

anticipation of problems. On these issues related to indicators such as dimensions of benefit and their measurement, further contributions are needed. The company should listen, observe, direct, and understand from a broader perspective; to do this it also should measure not the effectiveness of a formal exercise but the impact created in the perspective of plural well-being, therefore without venturing into excessive and not very credible indicator architectures.

f. Debate and Training on the Skills Required to Drive Effective Stakeholder Engagement Processes

Transversal skills are undoubtedly required to listen without judging the other, to guide participation and to enhance the acquired elements in the context of decision-making. Taking care of the other, paying attention to the other and to what is outside of us takes time and attitude. Often organizations perceive it as wasted, unproductive time. It is often thought that the company cannot afford time for relationships that do not have an immediate return. Stakeholder engagement requires profound skills and therefore investments that are sometimes significant and in any case extended over time. These are essential resources to start a process of strategic reflection with the various categories of stakeholders, but on which companies often try to "economise". In short-term oriented companies, which perhaps do not have large budgets available, resources tend to be allocated to activities which, based on experience, are perceived to have a direct and positive relationship with company results (technological, commercial, etc.). The evidence that we are not dealing with marginal and symbolic activities that everyone can govern and follow must be strengthened. Dealing with stakeholder involvement requires broad transversal skills – in coordinating the process by extracting value (in terms of points of view, perceptions, and analyses), measuring and allowing for the interpretation of the results, and using learning within the decision-making to support better decisions. The theme of interest emerges as central, in particular in the sense of capturing interest by questioning the value that the organization is creating in order to make it understood. There must be a concern to pour the value created by the different categories of stakeholders, on the organization's community of interests. In corporate contexts, one should also think about incentive systems in this direction (incentives linked, for example, to the ability to develop and maintain relationships of mutual involvement with specific groups of interlocutors). By giving value to the community, you get it back multiplied, to then continue with more resources. This should not be thought of as an immediate improvement in profits but in the dimension of those long-term impacts mentioned above. It is important to be rooted in the territory, to live in one's community, and to proceed with concreteness with respect to reality. The outlined framework envisages a systematic process of involvement, which can never be based only on external skills but always above all on the training and development of internal skills, starting from full awareness of the process up to the full adoption of the system.

g. Debate and Promote Training on the Skills Required to Effectively Contribute to Stakeholder Engagement Processes

The topic of skills has to be treated also with respect to stakeholders who should, above all, be able to develop awareness of their role, know the areas of involvement, and be followed in their effort to understand the cross-section of the organization's reality brought to their attention (often in very brief time). Furthermore, it is essential that the results of the consultation are shared with them. This also contributes to the development of skills, through training by doing. Stakeholder engagement is an actionable lever that multiplies plural value only if used rigorously and inspired by intentions of common value. The widespread misuse of the tool is the first source of

misinformation and miseducation on a general level and increases distrust in the tool's potential. A fundamental path to train stakeholders is to create references and positive, rigorous examples. In this sense, all professionals and operators should refuse any form of non-rigorous stakeholder engagement, not aimed at developing knowledge to be considered in the processes of decision improvement. Continuity of attention and relationship is also important because it allows for opportunities to develop trust and the necessary skills that should not be taken for granted.

5. CONCLUSION

Terrain elements (culture and trust) have been placed at the base, rooted in the way of thinking and positioning oneself in society. *Vision*, the approach towards the future, is necessarily influenced by culture and trust and influences choices related to the development of knowledge. The investment in *knowledge* – as the capital that enables understanding and action – depends on the vision for the future. *Terrain* elements influence knowledge through vision and vice versa. This work provides some insights and proposals based on the involvement of experts. This is a first step in a broader research project on stakeholder engagement. It is a starting point, with the limitations and the opportunities that this represents. The material provided by the experts is very broad, beyond the author's initial expectations, and is an expression of the wide interest in the topic. This source will be further used in the future to deepen the analysis of the different areas of interest and the articulation of the related propositions. In addition to this vertical development of the study, horizontal extensions of the analysis to other experts and interlocutors, at the international level, will be important to reach wider evidence and thus further support the development of awareness on the topic worldwide.

"Improve terrain, clarify vision, enhance knowledge" could be a symbolic synthesis of this contribution, not only in the sense of valorization but also against the risks of exploiting stakeholder involvement.

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The Importance of Human Capital as a Strategic Management Factor in the Banking Sector of the Republic of Serbia

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Abstract: *Resources that are rare, valuable, difficult to imitate and substitute are a key factor of competitive advantage. Human capital, which includes unique knowledge, skills, abilities and employee experiences, is one of the most important resources of modern organizations and a key constituent of intellectual capital. Because the competition in the banking sector of the Republic of Serbia is increasingly pronounced, as evidenced by the trend of frequent mergers and acquisitions of banks, it is clear that human capital is of particular importance, due to the fact that the performance of banking operations requires unique knowledge and competencies, as well as agility and willingness of employees to continuously learn and develop. Banks treat investment in human capital as a strategic process that can provide long-term benefits and sustainable competitive advantage, especially when it comes to financial performance. Therefore, creating a competitive advantage for banks requires a strategic approach to human resource management, which will enable the development, improvement and use of human capital. Taking into account the above, the main goal of this paper is to examine the importance of human capital, as a strategic factor, for bank performances in the Republic of Serbia.*

1. INTRODUCTION

With the opening of the market in the transition process of the Serbian economy, an increased inflow of foreign direct investments began to be realized. The financial sector of the Republic of Serbia, and certainly the banking sector, was financed to a significant extent by foreign capital, which led to an increase in the number of banks in the Republic of Serbia (Stojadinović Jovanović, 2013). As a result, the Serbian financial market became bank-centric (Živković & Vojinović, 2017). According to the latest report on the banking sector in Serbia, the National Bank of Serbia states that 23,087 employees worked in the banking sector at the end of 2019. In the aforementioned report, it is highlighted that the total net assets amount to 4,084.1 billion dinars, which is an increase of 2.6% compared to the period a year earlier. When it comes to profitability, the report of the National Bank of Serbia states that the banking sector in Serbia achieved a total Net income before tax of 67.7 billion dinars, with an average ROA of 1.72%, while ROE is 9.72% (Narodna banka Srbije, 2020).

Intellectual resources are the most important factors in the achieved performance. In a knowledge-based economy, needed resources must be rare, valuable and difficult to imitate (Soeawarno & Tjahjadi, 2020). As such, those resources will lead to a sustainable competitive advantage (Barney, 1991). Although different forms of intellectual capital have great strategic importance, human capital must be singled out for its value and specificity, which includes tacit knowledge, skills and abilities that competitors cannot copy (Peković et al., 2020). As a part of intellectual

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capital, human capital is one of the most important determinants that affect the financial performance of banks and as such can provide banks with a competitive advantage in the financial market (Bontis et al., 2013; Liu et al., 2021; Ousama et al., 2019). Taking into account the above, the main goal of this paper is to examine the importance of human capital as a strategic factor, for bank performances in the Republic of Serbia.

2. LITERATURE REVIEW

Competitive advantage is one of the most frequently emphasized factors of economic growth and development, which is studied both in macroeconomic and microeconomic theory. It is about the ability of participants in the business market to achieve success because of the accumulated knowledge and abilities in the delivery of products and services (Milićević et al., 2017). The four pillars of the knowledge economy that influence the increase in competitiveness on the global market are (Chen & Dahlman, 2005):

1. An economic incentive and an institutional regime that ensures good economic policies and institutions that enable efficient mobilization and allocation of resources and stimulate creativity and incentives for efficient creation, dissemination and use of existing knowledge.
2. Educated and skilled workers who can continuously develop and adapt their skills to effectively create and use knowledge.
3. An effective innovation system in enterprises, research centers, universities, consulting agencies and other organizations that can follow the knowledge revolution and take advantage of the increasing knowledge and adopt and adapt it to local needs.
4. Modern and adequate information infrastructure that can facilitate effective communication, dissemination and processing of information and knowledge.

The transition from a physically based economy to a knowledge-based economy initiated the need to use resources that are rare and valuable and that cannot be imitated in creating a competitive advantage, such as intellectual capital (Ousama et al., 2019). As one of the most important elements of intellectual capital, human capital enables the creation of added value and competitive advantage of the organization, because it is about the special knowledge, skills, creativity and experience of employees (Pavlović, 2018). According to Bontis (2001), human capital includes innovation, and agility of employees, but also organizational values and culture, where the central characteristics of such a culture must be continuous learning and knowledge sharing. Because of the above, human capital requires a special human resources management practice, which includes a strategic approach to employee development, training, developing flexibility, agility and knowledge management of employees (Yilmaz & Acar, 2018).

Human capital plays a particularly important role in banking. Measured as the average number of years spent in acquiring financial knowledge, human capital can increase a bank's level of competitiveness (Liu et al., 2021). A bank with high human capital has employees who are constantly learning, developing knowledge, possess leadership skills, have relevant communication skills, and are creative and innovative, as a result of which they provide services that have as an implication satisfied banking clients (Kovjanić & Vukadinović, 2021). As such, human capital necessarily has a positive impact on the achieved performances (Pavlović, 2018; Yilmaz & Acar, 2018). Human capital is undoubtedly of great importance for banking performance since knowledge is the most important element of banks' assets in the financial market. The realization of added value and competitive advantage in banking is achieved in the relationship between employees and

bank clients, and the quality of interaction itself depends on the emotional intelligence, creativity, agility and knowledge of employees (Peković et al., 2020). In order to confirm the stated claims, numerous studies were conducted in which the authors examined the influence of intellectual capital and its components on the performance of banks. Given that competitive advantage is a multidimensional construct (Milićević et al., 2017), precisely measuring the influence of human capital, as a strategic resource and the most important element of intellectual capital, on the financial performance of banks can be a way of determining the competitiveness of the banks themselves. Considering the above, various research in the world shows the positive influence of human capital on the financial performance of banks (Buallay et al., 2019; Ousama et al., 2019; Soeawarno & Tjahjadi, 2020). The aforementioned researches also exist in the Republic of Serbia, but they are still deficient. These are mainly studies that monitor the impact of intellectual capital on financial performance, where the impact of human, structural and relational capital is particularly monitored. Such studies also confirm the positive impact of human capital on financial performance (Bontis et al., 2013; Peković et al., 2020). Taking into account the mentioned studies and research results, the following research hypotheses can be defined:

H1: *There is a statistically significant and positive impact of banks' human capital on banks' Return on Assets (ROA).*

H2: *There is a statistically significant and positive impact of banks' human capital on banks' Return on Equity (ROE).*

H3: *There is a statistically significant and positive impact of banks' human capital on banks' Net profit margin (NPM).*

3. RESEARCH METHODOLOGY

In the latest report of the National Bank of Serbia on the banking sector, it is stated that 26 banks are operating in the financial market of the Republic of Serbia (Narodna banka Srbije, 2020). However, the development of the banking sector in the Republic of Serbia, as well as the importance of banks on the financial market, have led to significant status changes in the past three years, i.e. mergers and acquisitions of banks (Stojmenović, 2021). To strengthen intellectual resources and improve human capital, banks started integrating their assets, which once again shows the importance of these resources in creating a competitive advantage. Following the mentioned changes, and taking into account the moment when the research in this study was carried out, the total number of banks operating on the financial market of the Republic of Serbia was 21.

In order to test the set research hypotheses, the sample was formed from all banks operating in the financial market of the Republic of Serbia in the first half of 2023 (21 banks). The independent variable in the research is represented by human capital, which was measured using the VAIC methodology. The dependent variable is financial performance and this variable is operationalized through three indicators: ROA, ROE and NPM. To achieve an objective insight into the impact of human capital on financial performance, the period of the analysis includes 2019, 2020, and 2021 (2021 is the final year for which the financial reports of all banks in the Republic of Serbia are available).

When it comes to human capital, the measurement was performed using the VAIC methodology, which involves several steps in determining human capital. Since it is an indicator that measures

the intellectual capital of organizations, in the first step it is necessary to determine the value added (VA) as the difference between total revenues (OUT) and total costs (IN), whereby wages are subtracted from total costs. The reason is that the wages must not be treated as an expense, but as an investment in employees that will provide long-term value. In the second step, the determined value added (VA) is divided by the wages, and in this way the human capital efficiency (HCE) indicator is calculated (Pulić, 2000). ROA is calculated in the model as the ratio of Net profit to total assets; ROE is the ratio of Net profit to invested capital; NPM is the ratio of Net profit and total income of banks.

4. EMPIRICAL RESULTS

Descriptive statistics. The initial step in the statistical analysis involves the application of a descriptive statistical analysis of banks in the Republic of Serbia (Table 1).

Table 1. Descriptive statistics

	Minimum	Maximum	Mean	St. deviation
HCE	-1.72	6.91	0.4947	1,369
ROA	-3.99	4.17	0.3344	1,612
ROE	-9.46	36.04	8.5465	11,220
NPM	-171.51	78.63	3.6586	48,104

Source: Authors

The observed banks in the Republic of Serbia realize a positive value of human capital, as well as positive financial performance. Before conducting the correlation analysis, it is necessary to determine whether the collected data follows a normal distribution (Table 2).

Table 2. Kolmogorov-Smirnov and Shapiro-Wilk tests of normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
HCE	0.171	66	0.000	0.826	66	0.000
ROA	0.228	66	0.000	0.908	66	0.000
ROE	0.095	66	0.200*	0.958	66	0.024
NPM	0.285	66	0.000	0.772	66	0.000

* This is a lower bound of the true significance; a - Lilliefors Significant Correction

Source: Authors

Kolmogorov-Smirnov and Shapiro-Wilk tests of normality show that the only variable with a normal distribution is ROE. Considering the statistical significance of the results of the other variables, it is necessary to apply non-parametric tests in the continuation of the analysis. When it comes to correlation, it is necessary to apply Spearman's correlation analysis.

Correlation analysis. The results of Spearman's correlation analysis are presented in Table 3.

Table 3. Correlation analysis

	HCE	ROA	ROE	NPM
HCE	1	0.729**	0.656**	0.695**
ROA	0.729**	1	0.948**	0.951**
ROE	0.656**	0.948**	1	0.945**
NPM	0.695**	0.951**	0.945**	1

* Correlaton is significant at the 0.01 level (2-tailed)

Source: Authors

Leaving aside the mutual correlation of the indicator that constitutes the dependent variable, results show that between human capital (HCE) on the one side and ROA, ROE, and NPM on the other side, a high direct correlation was achieved. The highest correlation exists between HCE and ROA (0.729). To examine the nature of the correlation between human capital and financial performance, a regression analysis was conducted in the next step.

Regression analysis. Since the regression model involves examining the impact of one independent variable (HCE) on financial performance, it is necessary to apply a simple linear regression analysis (Table 4).

Table 4. Regression correlation analysis

Regression model	R^2	β	t	Sig.	Durbin Watson	VIF
HCE → ROA	0.403	0.635	6,571	0.000	1,742	1,000
HCE → ROE	0.432	0.657	6,972	0.000	2,105	1,000
HCE → NPM	0.263	0.513	4,781	0.000	1,871	1,000

Source: Authors

A Variance inflation factor (VIF) must be less than 5 to conclude the absence of multicollinearity (Field, 2000). In the observed models, the VIF factor is lower than 5, and as such points to the absence of multicollinearity. The results of the regression analysis show that human capital has a statistically significant impact on financial performance, as a result of which all three research hypotheses (H1, H2, H3) *can be accepted.* When it comes to the impact of HCE on ROA, the coefficient of determination (R^2) is 0.403, which means that human capital describes 40.3% of the variability of the ROA. In the second model (the influence of HCE on ROE), R^2 is 0.432, so human capital describes 43.2% of the variability of the ROE, which is an even more significant influence of the independent variable. Finally, in the model of the impact of HCE on NPM the lowest R^2 is achieved, but the impact is still statistically significant. Human capital describes 26.3% of the NPM of banks in the Republic of Serbia. The Durbin Watson test was applied to determine the presence of autocorrelation, where the value must be close to 2 to state the absence of autocorrelation (Bontis et al., 2013). According to the results in Table 4, only in the model in which the impact of HCE on ROE is monitored, there is a relatively higher value of the Durbin Watson test (2.105), which shows the slight presence of autocorrelation, as a result of which this model is less reliable than others.

5. DISCUSSION AND CONCLUSION

Human capital includes knowledge, skills and abilities, as well as employees' experiences, creativity, innovation, and willingness to learn and share knowledge. Bearing in mind that knowledge is one of the key success factors of banks, it can be assumed how important human capital can be for creating good performance and competitive advantage.

Following the objective of this study, research was conducted on the influence of human capital on the financial performance of banks in the Republic of Serbia. The stated financial performance is monitored through ROA, ROE and NPM. The results of the study showed that human capital has a statistically significant impact on ROA, ROE and NPM, thus confirming all the research hypotheses defined in the paper. Accordingly, it can be concluded that human capital is a relevant strategic resource, based on the competencies, emotional intelligence, agility and

knowledge of employees, which as such significantly determines the achieved performance, as well as the competitive advantage of banks in the Republic of Serbia. The high degree of correlation between human capital and financial performance is a recommendation to human resource managers in banks to increase investment in employees, especially in development, training, education and knowledge creation. Since employees are intangible and the most important element of the total assets of banks, investing in human capital is also investing in banking assets, whereby a positive return is realized on such investments, which is exactly what the results of this research show. Thanks to their competences, bank employees ensure a higher level of client satisfaction, but also find innovative and creative solutions, which reflect positively on the invested capital, including the banks' capital. As a result, there is an increase in the final profit, i.e. the profit after taxation.

From a theoretical point of view, the results of the research contribute to the existing scientific knowledge about the influence of human capital on the performance and competitiveness of banks, but at the same time create a basis for future research, bearing in mind the deficit of studies that exclusively examine the influence of human capital on banking performance in the Republic of Serbia. The practical contribution is reflected in the presentation of the obtained research results primarily to human resource managers in banks, who by investing in the development of human capital develop human capital, thus improving the performance and strategic advantage of banks. The limitations of the work are also guidelines for future research. In this paper, the period of the analysis of the impact of human capital on financial performance covers three years. In subsequent research, it is necessary to increase the time interval. Within the time series, there is also a year when due to the effects of the COVID-19 pandemic, a significant number of banks achieved lower or negative financial results, which can destructure the model. Consequently, it is necessary to possibly exclude that period in future research or to analyze it separately.

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The Place and Role of the Employer Brand in Building an Employee's Career

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Abstract: *The notion of career has been intensely debated in the literature, being an interdisciplinary topic. However, the challenges that organizations currently face are becoming much more numerous and different, as new generations of employees have significantly different characteristics from those of employees from previous generations. Organisations, on the other hand, no longer aim to simply recruit employees; they aim to attract talent, and the image built on the market often decisively influences the recruitment process. However, what is the situation in the Romanian market, what role does it play, and how important is building an employer brand? Is it a decisive factor in the evolution of employees' careers? This paper tries to answer these questions, placing them in a double context - through a theoretical approach, presenting the opinions already formulated by researchers in the field, respectively, through an applied approach, studying through our research what the attitude of employees is towards this subject.*

1. INTRODUCTION

The issue regarding the career is a subject of great interest, both from the point of view of specialised literature and especially from a practical perspective. The desire to build a professional path as attractive, complex, and successful as possible can be observed in the case of a large number of individuals, regardless of gender, age, or field of activity.

According to the Randstad report (2021), career progression is one of the top 5 reasons why people choose a certain employer, along with „attractive salary and benefits", „job security", „work-life balance", and „a pleasant work atmosphere".

Perhaps less debated at the individual level is the impact that the image of one's current employer may have in the future on a person's career path. There are, however, specific elements that usually attract a candidate to a certain company, whether it is a rich history of success on the market, whether talking about the material (Andreș, 2020), or non-material advantages offered to employees. As we can rarely talk about a single job throughout one's life, some organisations can become launching pads for employees due to their reputation, the experience they have gained, and the advantage brought to the CV through a strong brand. Although in some cases we can talk about mirages, the external image of the organisation in question does not necessarily reflect the real internal situation or not necessarily being a mirror image of reality, the idea of an employer brand construction gradually took shape in the labour market.

As we often approach the concept of career from an interdisciplinary point of view, the notion of "employer brand" is positioned at the confluence of management and marketing, better said, human resources management and human resources marketing, the "product" which sells and at

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the same time is sold in this case being, in fact, the organisation. We are therefore talking about the complexity of the approach, the concept itself not being a new one, and the history of literature positioning it as its origin in the early 1990s (Babcanova et al., 2010). Therefore, the first authors to approach this concept, namely Ambler and Barrow, define it as "the package of functional, economic and psychological benefits provided by employment and identified with the employer" (Ergun & Tatar, 2018). In addition, Mokina (2014) indicates the existence of three approaches regarding the employer brand, namely: a labour market approach connecting with the internal marketing (Backhaus, 2016) of the organisation, an approach based on the theory of "internal branding" as part of corporate branding, respectively, an approach that presents the link between psychological contract and organisational relationships.

The question thus arises: *What exactly contributes to the creation of an employer brand?* What determines the ability to be easily recognized by a large number of people, but also what causes future candidates to want to be a part of that organisation?

Customers, from the perspective of a significant microenvironmental factor, always influence the organisation's activity through the feedback provided and implicitly, the creation of a certain image of it. As Sokro mentions, branding is often used by companies as a "strategic tool" (Sokro, 2012). However, the creation of a strong brand of the organisation, more specifically, the creation of an employer brand, requires the outline of a complex strategy (Chacko & Zacharias, 2020), respectively, very good management of the respective organisation's image on the market. The ability to respect the declared values, as well as employee reward systems, how communication takes place in the organisation, and the ability to integrate them and offer them constant opportunities for professional development contribute to this.

The first term with which we may associate the concept of "employer brand" is that of a company's reputation, but human resources marketing explains it as the notion that "defines the personality of a company as a preferred employer" (Babcanova et al., 2010; Radford, 2009). If the concept of "reputation" refers more to how the "external public" evaluates the organisation in question (App et al., 2012), some authors present the concept of employer brand from the perspective of its purpose, namely "to attract, engage and retain employees" (Sokro, 2012; Sultana, 2020), it is necessary, however, that in this process, under the conditions of a "competitive business environment", organisations show intelligence in the marketing process in order to be able to attract the most suitable candidates (Shukla & Shrivastava, 2013). This is because the idea of the need to build an employer brand is based on the fact that "human capital brings value to the firm" (Backhaus & Tikoo, 2004).

The need for skilled employees (Rana & Sharma, 2019) is continuing. Bărbulescu and Ștefănescu (2021) in this sense, indicate the start of a "war for talent" (Aboul-Ela, 2016), in which differentiation on the market (Reis et al., 2021) becomes necessary to achieve a certain level of attractiveness for potential employees, especially if we are talking about the new generations (Randstad, 2020), much more selective in choosing their employer. Ensuring a high level of "transparency of information and communication" (Hepburn, 2018; Santos et al., 2018) thus becomes necessary.

Priya and Raman (2021) list many benefits that the employer brand brings to a company, among them cost efficiency regarding the hiring process, attracting the most qualified candidates, savings made by hiring the right people for a specific job, avoiding high staff turnover, while also offering employees the prospect of career development (Ibrahim et al., 2018).

2. MATERIALS AND METHODS

In order to study the link between the employer brand and an employee's career development, we conducted a study using an online questionnaire as a working tool. The main objective of the research consisted of determining the influence that the employer brand manifests on the career path of an employee, while the secondary research directions aimed at:

Table 1. Objectives of the study

Secondary objectives	Subordinate questions
Studying the level of importance perceived by employees regarding the image of the organization in which they work	Q1, Q2, Q3
Studying the link between the promotional actions undertaken by the organization and its image	Q4, Q5
Studying employees' perception of the impact of the organisation's image on employees' careers	Q6, Q7, Q8, Q11, Q13, Q14
Identifying the elements that contribute to the creation of an employer brand	Q9, Q10, Q15, Q16, Q17

Source: Author

The questionnaire consisted of 20 questions, of which 17 were about content and 3 about identifying the sample respondent, the study consisted of 144 respondents. Of these, 72.2% were women, and 27.8% were male, all between 20 and 65 years old. The period of the study was March - April 2022, and the selection of respondents was carried out randomly. However, the significance of the variables and the level of representativeness can be tested by calculating the statistical indicators: average, mean square deviation, dispersion and coefficient of variation, according to the relationships presented below.

3. RESULTS AND DISCUSSIONS

To answer the first objective, namely *Studying the level of importance perceived by employees regarding the image of the organisation in which they work*, following the centralisation of the answers given by the subjects to the questions in the questionnaire, we note the fact that most of the respondents (38.88%) are familiar at an average level with the notion of "employer brand", the percentage of those who believe they are familiar to a great or very great extent being 34.72%. However, regardless of the answer given to the previous question, the image of the employer becomes important to a large extent for a significant percentage of the subjects surveyed (79.17%).

In this sense, when studying an organisation in the idea of employment, the most significant criterion for candidates turns out to be the reputation of the respective organisation, with 72.22% of respondents mentioning this aspect as important. However, it is not a single element, and close percentages of respondents mention that they are interested in the duration of existence on the market of the organisation in question (56.94%), as well as the level of salary offered in the case of employment (54.17%). Other elements that matter to an average or lesser extent for the respondents are represented by: the information published on the company's website (27.78%), the company's name (23.61%), or its logo (13.88%).

If we address the issue of the existence of a *link between the promotional actions undertaken by the organisation and its image*, we observe a divergence in the respondents' perception of how the promotional actions contribute to the foundation of the organisation's brand. Therefore,

a significant proportion of people who answered the questions in the questionnaire (62.5%) believe that the most powerful tool in the process of shaping the image of an organisation is promotion through current and former employees. Through the experience gained within the company, they become messengers of high credibility in front of the general public, the reviews offered online or by word of mouth can increase the prestige of a company or, on the contrary, damage its image. Investments in the promotion are also considered important, with 40.28% of the surveyed subjects appreciating them as indispensable for supporting the image of an organisation, while 16.67% of respondents identify a direct link between the development of an organisation's brand and the efficiency of the managerial process.

In an attempt *to identify the elements that contribute to the creation of an employer brand*, the respondents identify as a decisive aspect in this regard: knowing the target audience (29.13%), providing truthful and clear information about the organisation (27.33%), periodic analysis of the image deficit and taking measures in time (25.23%), understanding the profile of potential employees (18.33%). In the view of the respondents, organisational culture, in turn, largely influences the employer brand, with more than 60% of the respondents indicating an increased level of influence.

To determine *the employees' perceptions of the impact that the image of the organisation in which they work has had on their careers to date*, we started by determining the extent to which the employer's reputation matters to respondents. Thus, for 6.95% of the subjects, the reputation of the employer matters to a small extent, with an average level of importance perceived by 19.44% of the respondents. 40.28% indicate that the employer's reputation matters a lot, while 33.33% consider it decisive for employees.

A percentage of 62.5% of the respondents believe that the impact was great, even very great in some cases. An average impact is perceived by 27.78% of the respondents, with the remaining 9.72% identifying a low impact in this sense. However, it should be noted that this impact felt to a greater or lesser extent can be both positive and negative. In this sense, of the 144 respondents, a percentage of 59.72% believe that the image of the employer positively influenced their career, representing a plus in the CV. 19.44% of the subjects surveyed indicated a low positive influence, a similar percentage indicating that the employer’s image has not significantly influenced their professional path so far. Those who identify a negative influence represent a smaller percentage, 1.4%.

The respondents were presented with three professional attributes, namely credibility, involvement, and professional capacity, and were asked to choose the one they considered the most important. 45.83% opted for professional credibility, while participation was identified as the most important by 26.39% of the respondents, with the remaining 27.78% indicating professional ability as essential.

When asked at what level are they currently satisfied with their career and, respectively, with their professional path, more than half of the respondents (56.94%) declare themselves satisfied, while an average level of satisfaction is indicated by 27.78% and 15.28% of the surveyed individuals consider themselves dissatisfied. In this sense, 76.39% of the surveyed individuals identify themselves as insiders in the organisation in which they work, while the remaining 23.61% of the respondents position themselves as outsiders.

The fact that respondents currently work within an organisation can help them in a future career or, on the contrary, create difficulties for them in accessing a new job. The percentage of people

who believe that their current job will help them to a great extent in a future career is relatively small (19.44%), with 40.28% stating that it will help them to a great extent. The rest 40.28% are positioned by the opinions expressed at the opposite pole.

To check the level at which the collected answers are also representative of the global population, we further checked the level of homogeneity, by calculating some descriptive statistical indicators, namely arithmetic mean, mean square deviation, dispersion, and coefficient of variation. In this sense, the calculation formulas below were used:

$$\bar{x} = \frac{\sum x_i f_i}{\sum f_i} \quad (1)$$

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2 f_i}{\sum f_i}} \quad (2)$$

$$V = \frac{\sigma}{\bar{x}} 100 \quad (3)$$

The test of the proposed hypothesis was carried out using the Chi-square test to measure the association between the variables under analysis and to determine the existence of a relationship between them.

The variables considered relevant and addressed in the content of the research were in this sense:
V1 – the level of importance of the employer's image perceived by employees
V2 – the level of impact manifested by the employer's image on the respondents' career
V3 – the current degree of satisfaction felt by the respondents about their career / their professional path
V4 – the degree of importance attributed by the respondents to the reputation of the employer.
V5 – the degree to which the current quality of being an employee in a company will help in a future career.

These were evaluated using a 5-step scale ranging from 1 (minimum value) to 5 (maximum value), or predefined options were proposed regarding the answers, through attributes equivalent to these five steps mentioned above. The calculated values are presented in the following table:

Table 2. Descriptive statistics

Variable	Corresponding objective	N	Minimum	Maximum	Mean	Dispersion	Standard deviation	Coefficient of variation
V1	OS1	144	1	5	4.08	0.7152	0.8457	20.71%
V2	OS3	144	1	5	3.76	0.8470	0.9203	24.45%
V3	OS3	144	1	5	3.66	0.9166	0.9574	26.11%
V4	OS3	144	1	5	4	0.8055	0.8975	22.43%
V5	OS3	144	1	5	3.68	0.8563	0.9253	25.14%
Scale	1 – total disagreement, 2 – partial disagreement, 3 – neutral, 4 – partial agreement, 5 – total agreement							

Source: Author

From the calculations, we observe a level of the coefficient of variation included in the interval [0%; 35%], which indicates a high degree of homogeneity, respectively, representativeness of the responses given by the respondents.

In order to measure the association between the variables under analysis and to determine the existence of a relationship between them, a null hypothesis and an alternative hypothesis were proposed, testing is done using the Chi-square independence test.
H_0 – the employer's reputation/image has no significant influence on the employee's career
H_1 – the employer's reputation/image has a significant influence on the employee's career

The distribution of the answers given was as follows:

Table 3. Distribution of responses

Question	Strongly agree	Partial agree	Undecided	Disagree	Total
Q2	50	64	22	8	144
Q6	34	56	40	14	144
Q11	20	82	20	22	144
Q13	48	58	28	10	144
Q14	28	58	44	14	144
Total	180	318	154	68	720

Source: Author

Taking into account the attribute fact that the "totally disagree" in most cases did not register any response, or the frequency was below 5, the last two columns were merged in the form of the attribute „disagree".

A significance level of the test α = 0.05 (5%) is considered.

The calculated value will be compared with the tabular value as follows:
- If χ2 is greater than the tabular value, Ho is rejected and the alternative hypothesis is accepted;
- If χ2 is lower than the tabular value, the null hypothesis is accepted and H_1 is rejected.

For the calculation of the value of χ2, the following relation will be used:

$$\chi^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \quad (4)$$

where Oij represents the frequency related to row i and column j, obtained by carrying out the study, and Eij, the frequency related to row i and column j expected to result, according to the null hypothesis, Eij being determined according to the formula:

$$E_{ij} = \frac{Total\ row \times total\ column}{Total\ global} \quad (5)$$

In our analysis, to be able to compare the value obtained from the calculations with the table value, we determine the number of degrees of freedom as follows:

$$df = (n_{R\text{-}1}) \cdot (n_{C\text{-}1}) = (5-1) \cdot (4-1) = 4 \cdot 3 = 12 \quad (6)$$

Table 4. Calculation of χ^2

R & C	O_{ij}	E_{ij}	$(O_{ij} - E_{ij})^2$	$(O_{ij} - E_{ij})^2 / E_{ij}$
R_1C_1	50	36	196	5,4444
R_1C_2	64	64	0	0
R_1C_3	22	31	81	2,6129
R_1C_4	8	13	25	1,9231
R_2C_1	34	36	4	0,1111

R_2C_2	56	64	64	1
R_2C_3	40	31	81	2,6129
R_2C_4	14	13	1	0,0769
R_3C_1	20	36	256	7,1111
R_3C_2	82	64	324	5,0625
R_3C_3	20	31	121	3,9032
R_3C_4	22	13	81	6,2308
R_4C_1	48	36	144	4
R_4C_2	58	64	36	0,5625
R_4C_3	28	31	9	0,2903
R_4C_4	10	13	9	0,6923
R_5C_1	28	36	64	1,7777
R_5C_2	58	64	36	0,5625
R_5C_3	44	31	169	5,4516
R_5C_4	14	13	4	0,3333

Source: Author

$$\chi^2 = \sum \frac{(O_{ij}-E_{ij})^2}{E_{ij}} = 49{,}7591 \quad (7)$$

The calculated value of χ^2 is equal to 49.7591, while the tabular value identified from the chi-square distribution table, related to df = 12 degrees of freedom, is 21.03.

Thus, $\chi^2_{calculated} > \chi^2_{critical}$, so 49.7591 > 21.03, thus the null hypothesis is rejected and H_1 is accepted. At a test significance level of $\alpha = 0.05$ (5%), the calculated P-value is < .00001, the result being representative. At a P-value < .05, the statistical link is perceived as significant between the variables proposed for analysis.

$$\chi^2 (12, N = 144) = 49.75, P < .00001$$

We therefore find that the hypothesis that the employer's reputation/image has a significant influence on the employee's career is confirmed.

4. CONCLUSION

The study carried out through the application of the questionnaire helped us determine the perception of the respondents about the research topic. We thus concluded that the way in which the organisation manages its image on the market and, respectively, the way in which it builds a positive reputation, manifests a significant influence on the evolution of human resources.

Although the concept of "employer brand" is not necessarily known at an in-depth level by all respondents, prevailing, as we observed, rather an average level of knowledge in this regard, employees largely intuit the importance that an employment history in a reputable company can have it for their future career path.

This is also proven by the elements of interest pursued in the process of studying a company with a view to employment, the reputation of the organisation ranking at the top as the importance for candidates. The credibility of the organisation, namely the transparency of the information provided and communication, are also decisive aspects in choosing a potential employer.

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Analyzing the Effectiveness of Internship Programs from Students' Perspectives: A Non-parametric Approach

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Abstract: *This article assesses the difference between economics students' expectations and actual internship experiences. Non-parametric statistical analysis was used to examine the variations. This research was divided into two phases. During the first stage, students' expectations for internships were evaluated. The faculty selected a group of students to participate in an experiment, which was an internship program that was thoroughly thought out. Both students and host organizations received support from the faculty throughout the entire process. Pre- and post-internship results showed substantial differences. This article concludes with a discussion of research limitations and conclusions.*

1. INTRODUCTION

Internships are common co-curricular activities that assist students in meeting business talent requirements as well as exposing faculty to a potentially larger intake of students (Knouse & Fontenot, 2008; Lam & Ching, 2007; McHugh, 2017). In recent years, numerous studies have confirmed that internships offer benefits to students, institutions, and businesses (McHugh, 2017; Silva et al., 2018). Employers seek well-prepared students in order to eliminate ambiguity in the recruitment process later on, while students aim to advance their professional skills through internship programs (Lam & Ching, 2007). As a result, internship programs promote the triangle of collaboration between students, employers, and academic institutions. As previous research has shown, these three actors, however, have various expectations for internship programs. This variation may jeopardize internship programs.

Fox (2001) argues that a bad internship experience can prompt young people to leave the industry quickly. That being said, the entire program calls for extra attention to what students hope to gain from internships. For a variety of reasons, it is crucial to recognize students' expectations. Firstly, there is little to no consideration of students' interests, experiences, or views when discussing students' employability (Tymon, 2013). The participation of students in discussions about employability in general and internships, in particular, reflects a broader and equal array of interests and viewpoints (Higdon, 2016). Secondly, internships are crucial to a student's professional development. The ability to understand student expectations can help higher education institutions create learning environments and internships that are appropriate, advantageous, and effective for specific student groups (Lown et al., 2009). Lastly, predicting student expectations might help to avoid conflicts with private sector expectations (Davies, 1990).

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Researchers have shown that students' vague and perplexing expectations result in a mismatch between expectations and satisfaction (Parilla & Hesser, 1998). By recognizing students' expectations, Collins (2002) argues that internship programs can be streamlined and students will be more satisfied. A qualitative study conducted by Ruhanen et al. (2013) supports this conclusion. Without these insights, higher education institutions would not create conceptual frameworks for internship programs that add value for employers, students, and the institutions themselves.

This article aims to understand students' expectations before starting internship programs and collect real perceptions after internship programs have begun. By using the Wilcoxon sign test, this study examines the gap between expectations and real experiences. Data was gathered using a structured survey instrument. This paper is structured as follows. Section 2 discusses the literature review. Section 3 describes the methodological aspects. Section 4 lays out the results. This paper closes up with conclusions, implications, and limitations.

2. LITERATURE REVIEW

The term "internship" is one of the most frequently used words to refer to partnerships between educational institutions and businesses. More specifically, an internship is an experiential learning model that gives students the chance to apply their theoretical knowledge in real-world and/or practical situations. By fusing classroom learning with real-world experiences, students can integrate and solidify their thinking and action (Lam & Ching, 2007). Internships are typically tied to a specified period of on-the-job training, which can last anywhere from a few weeks to a year or more and be completed in a single assignment or more.

Students are generally required to complete internships as part of higher education programs. Despite widespread recognition of its significance, higher education institutions still pay little attention to its process in favor of traditional educational classes. This requires students to fulfill all the requirements in class to pass the exam. In contrast to formal education, where the emphasis is on what students know, internship programs place more emphasis on what students do. A clear line between formal education and internships is lacking, though. For instance, Ronnestad and Skovholt (1993) stress the significance of combining both theoretical and practical knowledge acquired during an internship to successfully maximize that experience. They emphasize that their theoretical understanding heavily influences knowledge application. However, there are occasions when integration is impossible due to the enormous gap between what is learned in class and what happens in practice. Raskin (1994) empirically supports this. Due to this gap, there are numerous instances where students give the internship program the least attention.

While educational advisors or faculty members may fail to adequately train their students to take full advantage of internship opportunities, students may just observe the internship work environment. This is without applying their classroom knowledge to the business environment. A strong internship program for students may be achieved by acknowledging internship goals and relevant industry participants, choosing motivated students, and analyzing, monitoring, and providing feedback on the internship program. Additionally, educational institutions and academic advisers are essential to the development and implementation of this internship program.

Internship programs have many benefits. It first enables them to gain vital experience by applying what they learn in class to real-world situations (Johari & Bradshaw, 2008; Weible, 2009). In addition, internship experience affects students' performance and professional advancement

(Anjum, 2020). Furthermore, internships help students develop excellent character traits, professional habits, and confidence (Anjum, 2020). Internship increases the likelihood that students will receive quality job offers sooner (Rigsby et al., 2013). According to Mello (2006), conducting an internship is the most effective strategy for obtaining a permanent position. In order to build a strong network and connect directly with company specialists, internships help students become ready for their first job.

Internship benefits are well known, but several challenges could prevent internship success. Internship management is challenging. An experience that was produced with an academic aim in mind but is meant for non-academic use is challenging to plan, organize, and manage (Kay & DeVeau, 2003). For instance, 58 percent of students said they did not receive enough preparation before beginning their internship program, according to Collins (2002). It is logistically challenging to oversee the internship program. This is because it involves visiting and interacting with the intern on the ground as well as the intern's employer or supervisor. Therefore, to reap the benefits of internships, it is essential to first comprehend students' expectations before the internship takes place. Then, based on their expectations, design a structured internship program. Upon completion of the internship, the institution must evaluate the real impact, to see how students' expectations are met. To follow this logical process, we experimented with students at the Faculty of Economy, University of Tirana.

3. METHODOLOGY

This study employed a quantitative approach. A structured survey instrument was developed considering studies by Hite and Bellizzi (1986) and Kelley-Patterson and George (2001) who evaluated the expectations of students for internship programs by assessing: (i) the role of the supervisor (faculty and business supervisor); (ii) the job itself; and (iii) help from business and follow up upon the accomplishment of the internship. Each of these components comprised a set of statements. Each statement was rated on a five-point Likert scale (strongly disagree, disagree, no opinion, agree, strongly agree). The same survey instrument was completed twice. The first time, the survey instrument was transferred into digital form and distributed to the entire population. This was to gather responses from students who were in the second year of their master's program at the Faculty of Economy, University of Tirana. The population counts 1030 students, of whom 153 completed the survey. This first phase aimed to evaluate students' expectations about internships, before starting the internship. After completing the survey instrument for the first time, 30 students were selected from a commission established with the FET academic staff. They were asked to undergo an experiment, namely a well-structured internship program, with all the processes supported by the FEUT. A significant outcome of the selected group of students included the preparation of diploma theses for the company where they did the internship program. This was at least in the same economic sector where the company operates. Students were placed in specific businesses was the next step in the program. The selection of businesses was done based on the preferences of the students for the economic activity where they prefer to do the internship program. In addition, it covered as many sectors as possible. The FEUT has established contacts with 15 businesses in different economic sectors to attach students to the internship program. In-depth interviews were conducted with these businesses and at the same time a memorandum of cooperation was signed to specify the conditions of the internship program and also the support the companies had to give to the students. Of the 30 students selected only 26 completed the internship program and the diploma thesis on time. Only 16 of them completed diploma theses directly related to the company or in the same economic sector. The second time of survey instrument

completion happened with these 26 selected students that finished the program on time. However, only the group of 16 students who completed their diploma thesis in the same economic sector where the company operates was considered for comparative analysis. The purpose of this study was to determine whether perceptions changed before and after taking part in the internship program. Since we are dealing with the same group of students asked before and after attending the program and with nominal data, non-parametric statistical methods are used to analyze the differences in the student's perception of the specific objectives of the program (Hollander et al., 2015). For this purpose, the Wilcoxon sign test is used to compare two dependent samples. For each student in the internship program, we observed twice.

So if we write $X_{1,i}$ and $X_{2,i}$ the observation values before and after the internship for each student, then we are interested in the absolute values of differences which later are ranked as R_i (i = 1……. n).

Based on this calculation we estimate the value of W:

$$W = \sum_{i=1}^{n} Z_i R_i \tag{1}$$

Where:

W – the Wilcoxon signed-rank test statistic,

$Z_i = 0$ if $X_{1,I} - X_{2,I,}$ is negative and $Z_i = 1$ if $X_{1,i} - X_{2,I,}$ is positive.

The Wilcoxon sign test, tests the null hypothesis that the average signed rank of two dependent samples is zero. As we are interested to know the perception of students for different aspects of the program the two-side test has to be used.

$$H_0: \theta = 0$$
$$H_1: \theta \neq 0 \tag{2}$$

Where:

θ is referred to as the internship effect

So, we reject H_0 if:

$$W \geq t_{\frac{\alpha}{2}} \; or \; W \leq \frac{n(n+1)}{2} - t_{\frac{\alpha}{2}} \tag{3}$$

Where:

n – is the number of students that are part of the study.

α – is the level of significance.

This null hypothesis states that the differences are symmetrically distributed around 0, which corresponds to no difference due to the treatment. So, that means that if this hypothesis does not stand, then the training had a statistically significant effect.

The estimations were done using the SPSS program, which, among others, is well-developed for non-parametric tests. The program was used to compare if there is any significant difference in the students' expectations from the internship program with the experience that they have.

4. RESULTS

Students who joined the internship program were asked to evaluate whether their opinions had changed before and after joining it. As illustrated in Figure 1, before the internship, 56% of surveyed students considered taking a job in a specific position in the business. Training from guests and representatives of businesses is very important which will help them enhance their professional skills. None of the students, before and after the internship program, prefer an internship where they will get to know all business processes or be trained by guests and business representatives. The combination of training with a concrete job has been seen as the most preferable before following the internship program.

Interestingly, after the completion of the internship program, students evaluate the most critical component for their professional development, the recognition of all business processes, and taking additional information through training from guest speakers and business representatives (50%).

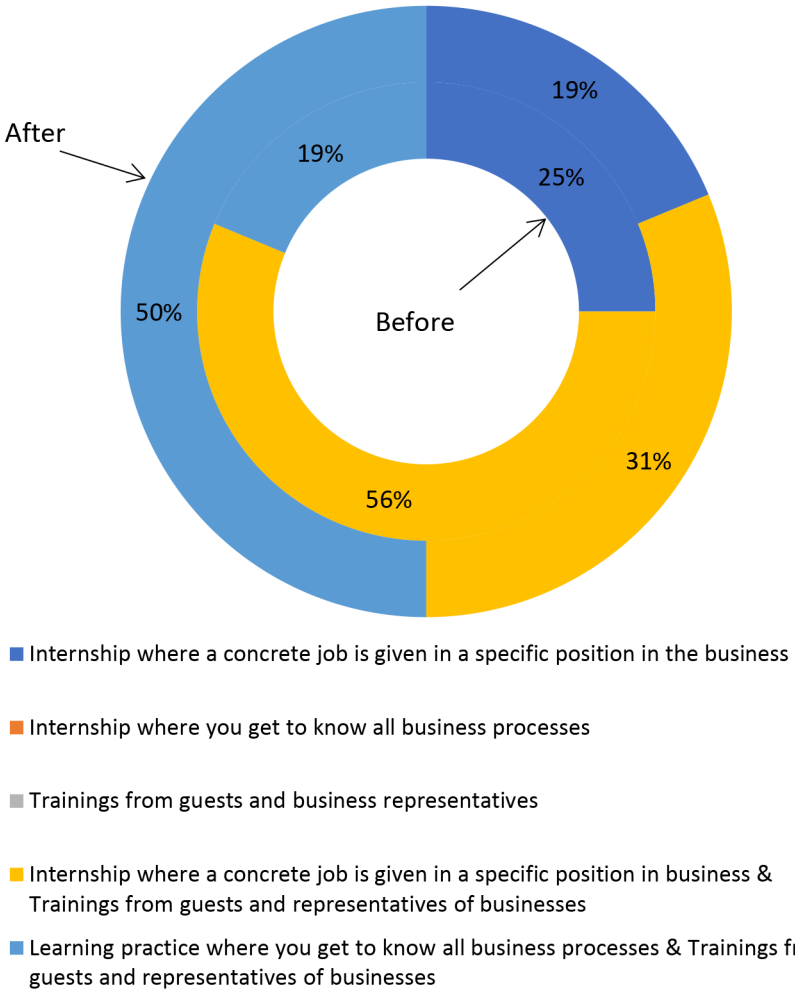

Figure 1. Impact on professional growth, before and after the internship

Source: Authors

Figure 2 displays the results related to the role the FEUT should play in the whole internship program. Before starting the internship program, students are asked about the role the FEUT should play in finding and monitoring an internship program. All of them agree that faculty must offer the right internship to students.

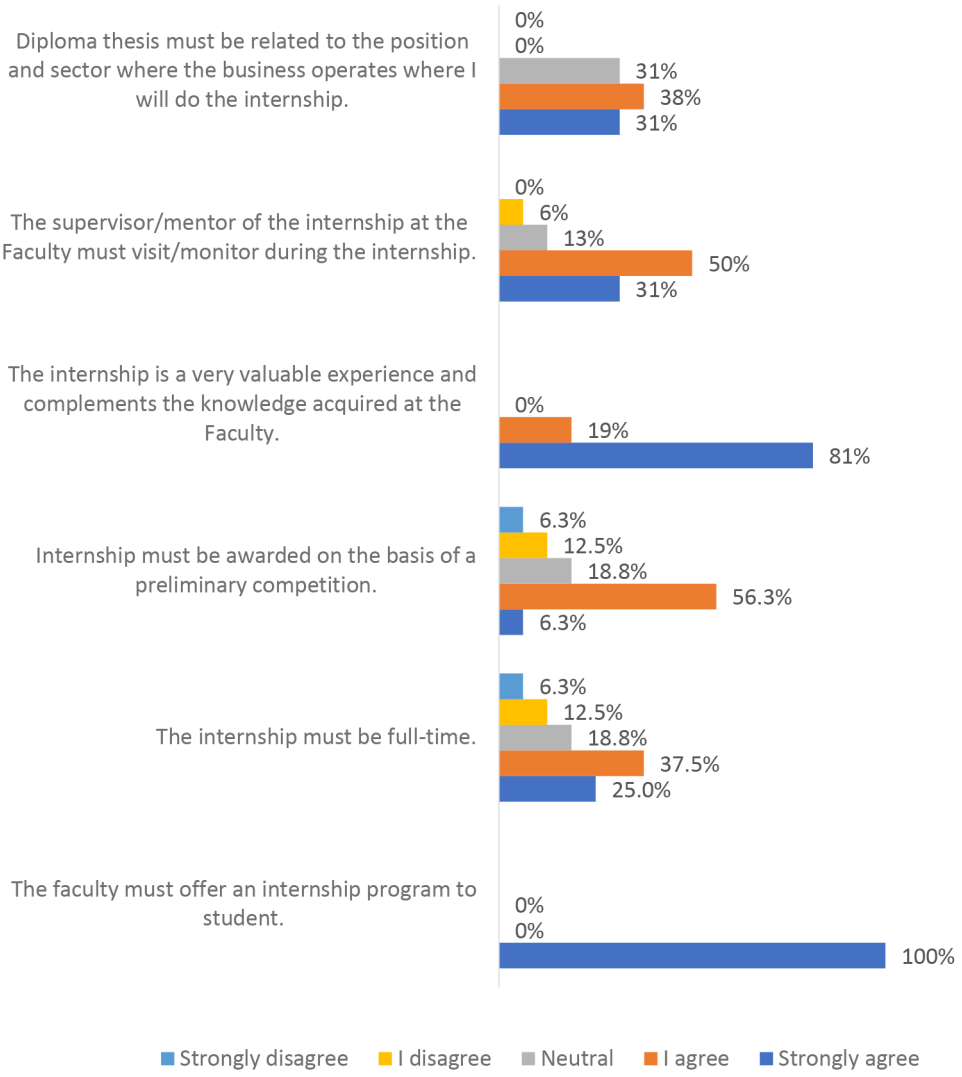

Figure 2. Internship and the role of the faculty, before the internship

Source: Authors

Furthermore, 62.5 % of students believe or strongly agree that the internship program should be full time while only 18.8 % disagree or strongly disagree with this. In addition, students prefer the internship to take place based on a preliminary competition (6.3 % strongly agree and 56.3 % agree) and 18.8 % think the opposite.

When asked about the general importance of internships, 81% agreed that this is a valuable experience for them while 19 % were neutral. Students were asked about the monitoring process of an internship, and they admitted that supervisor monitoring at the workplace (81%) adds value to their daily working activities. So, they support such monitoring.

Finally, the majority of respondents (69%) strongly agree or agree that the diploma theme should be related to the position and the sector where the internship is carried out while 31 are neutral regarding this question and no one disagrees or strongly disagrees.

In Figure 3, students' responses to questions about internships and the faculty's role are shown after they have already completed an internship. All of the students agreed that the faculty should make internships possible. This supports the views they expressed before the internship

program started. The remaining options have not been chosen by any students. 88% of students agree with the idea of developing a full-time internship program, while 6% are neutral.

From 66.7% to 88% of students, these results indicate that the internship program should be full-time. In contrast to the previous survey, just 50% of students now believe internships should be given out after a preliminary competition. This has decreased by 17%.

94% of the students who participated in the internship development felt that it was a worthwhile experience. They also feel that it complemented the knowledge they learned at the faculty. Only 6% of respondents said they disagreed. About 94% of students maintain regular communication with their faculty mentors for their internship. 43.3% of students who completed internships agree that the diploma's subject should be connected to the role and industry to which the company belongs. When compared to the responses before the internship, which was 73%, this percentage has dropped.

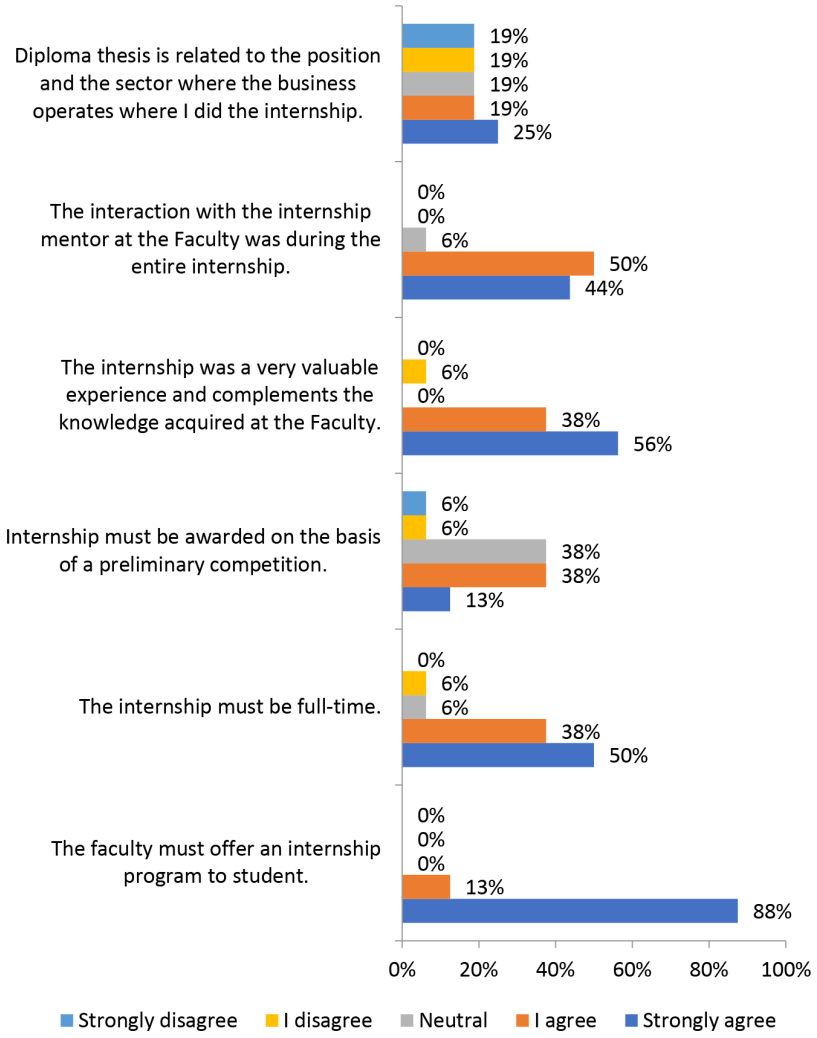

Figure 3. Internship and the role of the Faculty, after the internship

Source: Authors

Based on the Wilcoxon sign test, only six of the 18 questions related to the quality of the internship met the normal distribution criteria before and after the internship program.[4] From those

[4] The test z is approximately normal distributed for large samples that are n>10, excluding 0 values.

questions, three of them show significant differences in the students' perception with a 95% confidence level. Two of them show significant differences in the students' perception with a 90% confidence level before and after the internship period. Table 1 presents the results.

It's interesting to note that students who have completed the internship program believe the internship must be completed full-time. We reject the null hypothesis that there is no difference in the students' perceptions before and after the findings because this result is significantly different (p=0.026 0.05). This means that before starting the internship, the students did not see too much importance in the fact that the internship should be full-time, while after following the internship program there is a significant change in their perception that the practice should be full-time.

The students' expectation that the company where they will complete their internship will require them to complete additional reading materials relevant to the internship activity, suggests that reading materials connected to the internship activity are also of importance (p=0.022 0.05). So, after following the internship, the students find it very necessary to read additional materials before starting the practice. This was not assessed as significant before.

Even the student's impression of the idea of having a specific work directly tied to their study profile has changed significantly (p=0.017 0.05). Students believed this was crucial before the internship. However, it appears that there is now less of a connection between the work and their academic profile.

With a 90% confidence level (p=0.066 0.1), there is a significant difference in their perception concerning the question of whether they will leave their current residence solely to pursue the internship program in Tirana, which means that we reject the null hypothesis that there is no difference in the students' perceptions before and after the results. So, after completing the internship, the students are more convinced that they will return to their place of residence to pursue an internship. This is very helpful for their career.

These changes in perception are clear indicators of internship importance for students. They also indicate the significant role faculties should play in informing students about the benefits they receive from internships. They should also find opportunities for full-time internships in related sectors to their fields of study.

Additionally, with a 90% confidence level (p=0.094 0.1), students who have completed an internship program are no longer in favor of having a topic for a master's thesis that is closely related to the sector that their internship company operates.

The students who successfully completed the internships as part of this program have been offered some recommendations for additional enhancements by the faculty. These enhancements are to ease the transition from academic life to the workforce. The inclusion of such programs in bachelor's degrees is suggested.

Additionally, it is recommended that internships be distributed throughout the academic year of study rather than concentrated solely at the end of the study cycle. Students must have access to more organizations/businesses and internship opportunities to have a wider range of options. Students propose that if an intern's performance during the internship is adequate, there should be an alternative option for employment.

Table 1. Test Statistics

Questions	Z	Asymp. Sig. (2-tailed)
Internship should be done full-time	-2.230b	0.026
I would move from the city where I live just to follow the internship program in Tirana	-1.839b	0.066
I expect that the business where I do my internship will require me to do additional reading related to my internship activity	-2.292b	0.022
I expect that in practice I will have a concrete job/task to do which is directly related to my study profile	-2.389c	0.017
I expect that at the end of the internship, the business will test the knowledge gained during the internship period	-.313c	0.754
I think that the topic of the degree should be related to the position and the sector where the business operates where I will do the internship period	-1.674c	0.094

a. Wilcoxon Signed Ranks Test; b. Based on positive ranks; c. Based on negative ranks

Source: Authors

5. CONCLUSION

This research aimed to answer three main questions. First, what are students' expectations before starting an internship? Second, what are students' experiences and opinions after an internship? Third, are there any differences between "before" and "after" the internship?

To answer these questions, the first phase analyzed the responses of 153 students in the second year of their master's degree at FEUT. The second phase considered only 30 students, of which only 26 finished on time, who underwent a structured internship. The faculty matched the candidates with the right place, keeping in touch with the business and students, and making sure everything worked out well. This research revealed that faculty must take the leading role in shaping an effective internship program. This is done by matching students' desires and business needs. In addition, faculties should periodically analyze the demand and supply side, for a better understanding of market needs and academic gaps. As they see high interest in being deeply involved in work processes, internship programs should last at least three months and should be full-time.

This research has limitations. First, the limited sample size of students finishing the internship program was low. This study included only students with master's degrees from the FEUT, excluding students with bachelor's degrees and studies from other fields.

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Exploring the Ethical Dimensions of Influencer Communication in the Fashion Industry

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Keywords:
Influencer communication;
Ethics;
Fashion industry;
Social media consumer Perceptions;
Sponsored content

Abstract: *Influencer communication significantly impacts the fashion industry by shaping consumer preferences and purchasing decisions. This research aims to analyze social media consumer perceptions of the ethics of influencer communication in the fashion industry, focusing on understanding sponsored content, credibility, genuineness, and trust in influencer-generated content as a source of fashion product information. A global perspective is taken, with a representative sample of consumers surveyed online. Quantitative research methods are employed, using descriptive statistical analysis to better understand consumer perceptions. The study aims to provide a comprehensive understanding of consumer views on influencer communication ethics and offer potential best practices and guidelines for the fashion industry. The results could benefit fashion brands and influencers by helping them understand their target audience's expectations and improve the authenticity and quality of influencer communication.*

1. INTRODUCTION

The rise of influencers in the fashion industry began during the early development of social media platforms like Facebook, YouTube, Instagram, and Twitter, allowing influencers to build substantial followings (Tsimonis et al., 2020). As social media grew, the influencer marketing industry became a crucial tool for the fashion business, with brands realizing the value of influencer partnerships in reaching consumers and building brand awareness (Ye et al., 2021). Influencer content was perceived as more authentic and relatable, leading to increased trust, credibility, and sales for brands (Borchers & Enke, 2021). Both high-end and fast-fashion companies collaborated with influencers to generate content (Colucci & Pedroni, 2022; Yodi et al., 2020), and influencers significantly impacted consumer preferences and behaviors (Cabrera et al., 2020). However, the rise of influencer marketing raised questions about ethics, transparency, and credibility in influencer communication (Valsesia et al., 2020). Consumers' increasing consciousness and discernment about online information necessitate understanding their views on influencer communication ethics in the fashion industry (Wallerstein et al., 2019). This research examines consumers' awareness of sponsored content, beliefs about influencer credibility and authenticity, and confidence in influencer-generated content as a fashion product information source. It aims to offer insights into influencer communication ethics in the fashion industry and contribute to best practices and guidelines. This paper addresses the literature gap where social media users are often overlooked as active audiences, which is a similar mistake made in early mass communication research. Limited studies focus on consumers' perceptions of the ethical implications of influencer communication in the fashion industry, particularly regarding transparency and authenticity.

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Having all this in mind, the guiding research question in this study is: How do consumers perceive the ethical dimensions of influencer communication in the fashion industry, and what are their attitudes towards credibility, transparency, and authenticity in influencer-generated content?

Based on the research question, three hypotheses were formulated:

H: Consumers are more likely to engage with ethical, transparent, and authentic influencer-generated content in the fashion industry from credible and genuine influencers.

H1: Consumers perceive ethical issues in influencer communication in the fashion industry and value transparency and authenticity in influencer-generated content.

H2: The credibility and genuineness of influencers significantly impact consumers' perceptions of influencer-generated content.

These hypotheses contribute to understanding the importance of ethics, transparency, authenticity, and credibility in influencer communication in the fashion industry and their impact on consumers. They will be tested through a survey assessing consumers' perceptions and attitudes towards influencer-generated content in the fashion industry, providing insights into ethical influencer communication and promoting consumer trust and loyalty. The paper consists of an Introduction, Literature Review, Methodology, Results and Analysis, and Discussion and Conclusion sections. The findings in Results and Analysis demonstrate consumers' engagement with ethical, transparent, and authentic influencer-generated content, supporting hypotheses H, H1, and H2. The Discussion and Conclusion section interprets the results, discusses implications for the fashion industry and influencer communication, and proposes further studies.

2. LITERATURE REVIEW

Influencer communication is a growing trend in the fashion industry (Tankosic et al., 2020), with influencers significantly impacting consumer attitudes, beliefs, and purchase intentions (Javed et al., 2022; Nurfadila & Riyanto, 2020; Sudha & Sheena, 2017). Key factors contributing to influencer success include credibility, likeability, and expertise (Gomes et al., 2022). Fashion influencers play a role in setting the agenda, acting as opinion leaders and experts (Ercegovac et al., 2022), and can be effective communication channels for fashion brands (Esteban-Santos et al., 2018; Tankosic et al., 2017). Jacobson and Harrison (2022) found that influencers shape consumer perceptions and attitudes toward sustainable fashion, acting as individual media outlets (Ercegovac, 2022) that inform, educate, and entertain (Wei et al., 2022). Influencers' expertise and experience determine their opinion leadership and impact on consumer decision-making (Casaló et al., 2020). However, as influencer marketing started spreading across the fashion industry as a common marketing tool, it raised ethical questions about authenticity and credibility (Voorveld, 2019). Scholars emphasize the need for transparency and authenticity (Van Driel & Dumitrica, 2021) and consideration of influencer communication's impact on ethical beliefs and moral distress (Ye et al., 2021). Consumers are increasingly aware of influencers' commercial nature (Coco & Eckert, 2020) and may be skeptical of their endorsements (Wellman et al., 2020). Influencers face a challenge in presenting a personal, authentic image while being motivated by financial incentives (Abidin & Ots, 2016). The development of virtual influencers further complicates the ethics of authenticity (Mei, 2021). These computer-generated characters raise questions about the truthfulness of their representations (Conti et al., 2022; Robinson, 2020). The ethics of influencer communication also involve the impact on ethical beliefs and moral distress (Ye et al., 2021). Influencers should be aware of the responsibility that comes with their power (Davis et al.,

2012). Acikgoz and Burnaz (2021) emphasize the importance of considering the ethical implications of influencer marketing, as it significantly impacts image and brand perception.

3. METHODOLOGY

The methodology section outlines the research design, data-gathering strategies, and data analysis methods used in this study. A quantitative approach was employed, with data collected through an online survey distributed to a convenience sample of the public interested in fashion and fashion influencers. The sample included 704 participants, predominantly women, which was expected, considering that they are more interested in following fashion influencers and interested in fashion in general (Chae, 2018), with men making up almost a third of the sample. In terms of age, the largest group of respondents were aged 35-44 (40.4%), followed by those aged 25-34 (32,1 %), continuing to the group of 45-54 (14,7%). The smallest groups were those aged 65 and older (2,8 %) and 18-24 (5,5 %). The online survey consisted of 28 questions divided into five sections: Demographic analysis, Awareness of sponsored content in influencer posts, Perceptions of influencer credibility and authenticity, Trust in influencer-generated content as a source of information about fashion products, and Perception of the impact of influencer communication on the fashion industry's image and reputation. Descriptive statistics were used to analyze the quantitative data, and the correlation coefficient and Spearman's rank correlation coefficient were conducted. The research was conducted at the end of 2022 (November and December) and during the first months of 2023 (January and February).

4. RESULTS AND ANALYSIS

Data on consumers' perceptions of ethical aspects of influencer communication in the fashion industry was collected and illustrated using Charts 1-6, focusing on transparency, credibility, and authenticity (Chandler & Munday, 2020)[3]. Chart 1 and Chart 6 measured transparency, specifically regarding the disclosure of sponsored content. Word clusters like "sponsored posts should be clearly marked" were tagged as the transparency category. Chart 2 measured credibility, while Charts 3-5 measured both credibility and authenticity. Chart 2 focused on the influence of influencer posts on purchasing decisions, with the word cluster "how much influence do fashion influencer's posts have" tagged to credibility. Chart 3 assessed consumer trust in influencers' shared information, linking the word cluster "trust the information" to both credibility and authenticity. Charts 4 and 5 evaluated influencer communication effectiveness in reaching target audiences across age groups, tagging the word cluster "an effective way for the fashion industry to reach its target audience" to both authenticity and credibility. These charts offered insights into consumers' perceptions and attitudes toward ethical dimensions of influencer communication in the fashion industry. The results were analyzed and presented as an overview of the main themes and ethical challenges faced by the fashion industry in influencer communication. The analysis identified key themes and issues related to the ethical dimensions of influencer communication in the fashion industry. Results indicated a significant need for increased transparency in influencer communication, with consumers wanting clear disclosure of compensation (Belanche et al., 2021) or complimentary products for promotion (Chart 1). Users also value authenticity and credibility in influencers' opinions. Chart 1 showed that a majority (69.7%) strongly agreed that sponsored

[3] Terms transparency, credibility, and authenticity were defined according to Oxford Dictionary of Mass Communication since influencers are part of media communication as subjects who, during the communication process, are reaching a large number of people – a segment of mass audience. Therefore, influencers should have not only ethical but legal obligation as well to share transparent, credible and genuine media messages, just as any other media source.

posts should be clearly marked, with 21.1% somewhat agreeing. Only 8.3% neither agreed nor disagreed, while 0.9% somewhat or strongly disagreed. This finding highlights the importance of transparency (Stubb et al., 2019) and the need for ethical guidelines and regulations for influencer communication (De Cicco et al., 2021; Polli Leite & Baptista, 2022).

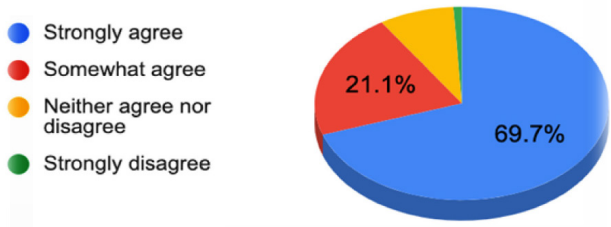

Chart 1. Question - Do you believe that fashion influencer posts that are sponsored should be clearly marked as such?

Source: Authors' research

Analysis revealed varying levels of transparency and authenticity among influencers, with some perceived to promote products solely for financial gain (Chart 2). However, there were also influencers recognized for their authenticity and trustworthiness. The study supported H1, showing that consumers perceive ethical issues in influencer communication and value transparency. H2 was also supported, suggesting that consumers are aware of influencers' credibility and genuineness, which can impact their perception of influencer-generated content. The findings emphasize the need for ethical guidelines and regulations to ensure transparent and accountable influencer communication practices and highlight the significant impact of credibility and genuineness on consumer perceptions.

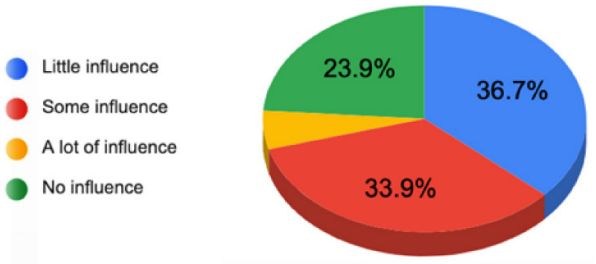

Chart 2. Question - In your opinion, how much influence do fashion influencer's posts have on your purchasing decisions?

Source: Authors' research

Chart 2 shows that fashion influencers have some impact on consumer purchasing decisions, with a majority (60.6%) acknowledging their influence. However, 36.7% reported little to no effect, suggesting that influencers are not the only determinant (Jegham & Bouzaabia, 2022; Lou & Yuan, 2019). This may also imply that consumers don't perceive themselves as influenced but don't discount others being opinionated (Cooley & Parks-Yancy, 2019). Despite the influence of fashion influencers (Gomes et al., 2022), there is a perception of lacking transparency and authenticity (Janssen et al., 2022), affecting credibility (Chart 2) and promotional effectiveness. Promotion for profit (Carpenter et al., 2022) can reduce trust and increase resistance (Farivar & Wang, 2022). Enhancing transparency and authenticity is essential to maintain trustworthiness and credibility (Sokolova & Kefi, 2020; Ye et al., 2021). Influencer credibility affects purchasing decisions (Andreani et al., 2021) and determines audience trust (Li & Peng, 2021; Martínez-López et al., 2020). Transparency and authenticity impact credibility (De Cicco et al., 2021),

which influences audience purchasing choices (Fakhreddin & Foroudi, 2022; Yodi et al., 2020). The results from Chart 2 support hypothesis H, H1 and H2 and suggest that fashion influencers have an impact on consumer purchasing decisions, but other factors like authenticity and credibility also play a role in consumer engagement.

A correlation analysis was conducted to investigate the relationship between the two survey questions: "Do you believe that fashion influencer posts that are sponsored should be clearly marked as such?" and "In your opinion, how much influence do fashion influencer's posts have on your purchasing decisions?" The analysis was performed on a sample of 704 respondents. To calculate the correlation between two questions (Chart 1 and Chart 2), numerical values to the responses were assigned. For the first question, a value of 1 to strongly disagree was assigned, 2 to neither agree nor disagree, 3 to somewhat agree, and 4 to s strongly agree. For the second question, a value of 1 to no influence, 2 to little influence, 3 to some influence and 4 to a lot of influence. Using these values, the correlation coefficient using the formula (1) was calculated:

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}} \quad (1)$$

where n is the sample size, ΣXY is the sum of (response to question 1 x response to question 2) for all respondents; ΣX is the sum of responses to question 1 for all respondents and ΣY is the sum of responses to question 2 for all respondents; ΣX^2 is sum of (response to question 1)^2 for all respondents and ΣY^2 is sum of (response to question 2)^2 for all respondents. Plugging in the values, it shows:

$r = 0.186$

The correlation coefficient (r) between the belief that sponsored posts should be marked clearly and the influence of fashion influencer posts on purchasing decisions is 0.186, indicating a weak positive correlation. This suggests that those valuing transparency might be slightly more influenced by such posts. It is also possible that social media consumers may need time to adjust and become more familiar with the concept of sponsored content in order to start trusting it more. As people become more aware of the prevalence of sponsored content on social media, they may also become savvier about recognizing it and understanding its impact on the content they see. As social media platforms and advertisers become more transparent about their sponsored content practices, consumers may feel more confident in their ability to differentiate between sponsored and non-sponsored content. However, since the correlation is not yet strong enough for definitive conclusions, it presents an encouraging basis for further research that could potentially lead to significant findings. Based on a weak positive correlation the Spearman's rank correlation coefficient was calculated in the study using the formula (2):

$$r_s = 1 - 6\sum \frac{d^2}{n^2 - 1} \quad (2)$$

where d^2 is the squared difference in ranks and n is the number of data points:

$r_s = 0.952$

The Spearman's rank correlation coefficient between these two questions is $r_s = 0.952$, indicating a strong positive correlation between the belief that fashion influencers should disclose sponsored posts and the influence of their posts on purchasing decisions. This means that users who believe that influencers should clearly label sponsored posts also believe that influencers

currently do not have a strong influence on their purchasing decisions. These findings align with H1, which emphasizes transparency and authenticity, and H2, which highlights credibility and genuineness, shedding light on the intricate relationship between consumers, influencers, and purchasing decisions in the fashion industry.

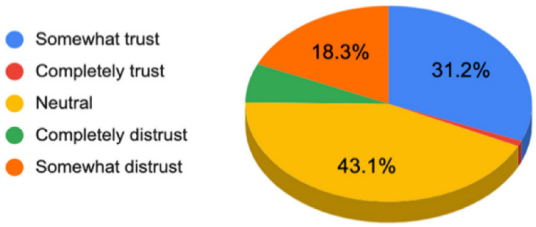

Chart 3. Question - How much do you trust the information shared by influencers about fashion products?

Source: Authors' research

Chart 3 results reveal that 24.7% of respondents have doubts about the accuracy of information shared by influencers, stressing the importance of ethical guidelines and transparency in influencer communication (Steils et al., 2022). It also highlights opportunities to improve influencer communication to increase trust among followers (Leung et al., 2022). The findings suggest the fashion industry should use diverse communication channels to reach different target audiences (Bala & Verma, 2018), as influencer-generated content may not resonate with everyone. Employing a variety of channels helps reach a wider range of consumers (Masuda et al., 2022). Interestingly, younger generations (18-34, Chart 4) have less confidence in influencer communication compared to older demographics (Chart 5). It is noteworthy that older respondents (70.6%) view influencer communication as more effective than younger audiences (56.1%). This trend could be attributed to influencer fatigue among younger consumers (Kay et al., 2020) or middle-aged and elderly audiences being more familiar with traditional advertising methods, perceiving social media influencers as authentic sources (Dwidienawati et al., 2020; Hutto et al., 2015).

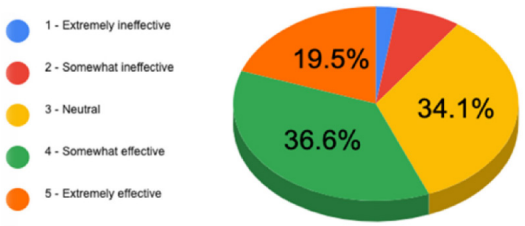

Chart 4. In your opinion, do you think influencer communication is an effective way for the fashion industry to reach its target audience? vs. Age 18-34

Source: Authors' research

This study supports both supporting hypotheses. Regarding H1, 24.7% of respondents have doubts about influencers' information accuracy, highlighting the need for ethical guidelines, transparency, and opportunities to improve influencer communication to build trust. In respect of H2, younger consumers experiencing influencer fatigue seek authenticity, impacting their perception of influencer-generated content. Meanwhile, middle-aged and elderly audiences perceive influencers as authentic sources, having higher confidence in the provided information. This supports the idea that credibility and genuineness significantly impact consumers' perceptions.

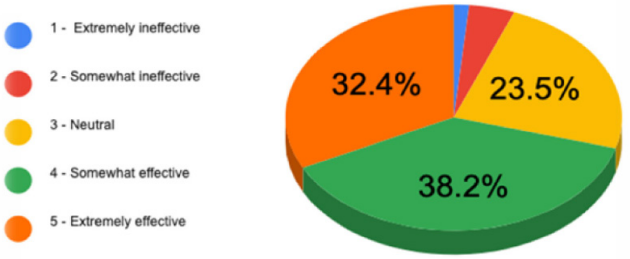

Chart 5. In your opinion, do you think influencer communication is an effective way for the fashion industry to reach its target audience? vs. Age 35-65

Source: Authors' research

For these reasons, it is crucial for brands to carefully choose their influencer partners and to work collaboratively with them (Campbell & Farrell, 2020) to promote products in a way that is authentic, informative, and transparent, which can lead to a more positive impact on consumer behavior and brand loyalty (Abidin & Ots, 2016).

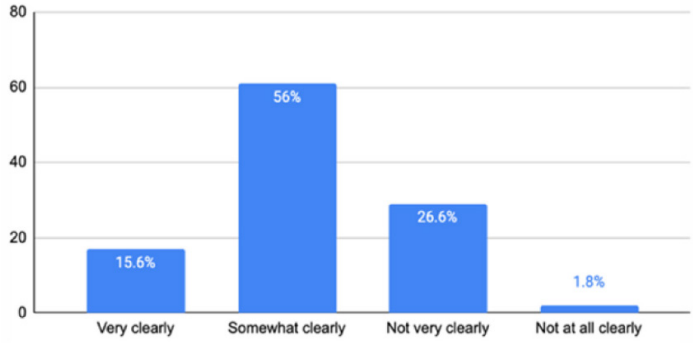

Chart 6. Question - In your opinion, how clearly do fashion influencers typically disclose when their posts are sponsored?

Source: Authors' research

The results show that 83.2% of participants believe influencers do not clearly indicate sponsored content (Chart 6), emphasizing the need for enhanced ethical practices, transparency, and authenticity in influencer communication (Mishra et al., 2021). Social media platforms already have guidelines for paid promotions (Van der Bend et al., 2022), which influencers and brands should follow to prevent deceptive practices (Giuffredi-Kähr et al., 2022). Promoting responsible and ethical communication can build a trustworthy environment and regain consumer confidence. Ethical considerations in influencer communication are complex (Ingrassia et al., 2022), as influencers balance potential income and exposure (Kim, 2022) with the pressure to maintain their image and deliver sponsored content, potentially leading to unreliable messaging (Bollinger, 2022). This confusion can damage both influencer and brand reputations. The presented data offers insights into the consumer's perspective on the ethics of influencer communication, including their views on transparency (15.6% clear, 56% somewhat clear, 26.6% not very clear, 1.8% completely unclear), authenticity, credibility, and the role of influencer-generated content in shaping consumer behavior.

Table 1 presents a concise summary of research findings for those interested in ethical considerations of influencer communication in the fashion industry. This information can help fashion brands, influencers, and stakeholders develop ethical and transparent practices, leading to a more trustworthy and credible fashion industry.

Table 1. Ethical dimensions of influencer communication in the fashion industry: summary of findings

Ethical Dimensions	Description
Authenticity	The extent to which influencer content accurately represents the influencer's personal views or experience, and whether it is created in collaboration with the brand.
Transparency	The extent to which sponsored content is clearly labeled as such, and whether the influencer discloses the nature of their relationship with the brand.
Credibility	The extent to which the influencer is seen as a credible and trustworthy source of information, and whether their content is free from conflicts of interest.

Source: Authors' research

The study supports hypotheses H1, H2, and H, emphasizing the importance of ethical considerations, transparency, and authenticity for influencers and brands to build trust and maintain a positive reputation in the fashion industry (Chen et al., 2023). H1 is supported as most participants agreed that sponsored fashion influencer posts should be explicitly labeled, highlighting the value of transparency in influencer-generated content. H2 is supported by varying levels of transparency and authenticity among influencers, with consumers aware of how credibility and genuineness impact their perceptions. Lastly, H is supported by the overall findings, suggesting consumers engage more with ethical, transparent, and authentic content from credible and genuine influencers.

5. DISCUSSION AND CONCLUSION

The study reveals that consumers hold varying views on the ethics of influencer communication in the fashion industry. They are aware of sponsored content and value transparency and authenticity (Abidin & Ots, 2016), while they question influencers' credibility and genuineness. The findings emphasize a strong demand for transparency in influencer communication. Influencer communication is an effective tool to reach the audience but not a universal solution. Brands should consider alternative channels to reach those less receptive to influencer-generated content. It's crucial for brands to collaborate with influencers to promote products authentically, informatively, and transparently. The study highlights the role of influencer-generated content in shaping consumer behavior. While fashion influencer posts may influence purchasing decisions, other factors like personal preferences, budget, and brand loyalty play crucial roles. Brands should focus on creating high-quality, engaging content (Mohammad et al., 2020) rather than solely relying on influencer content. The research also emphasizes the importance of age and demographics in influencer communication. Younger consumers seek authentic experiences, while older audiences view influencer communication as more effective. This highlights the need for brands to tailor their strategies to specific age groups and demographics. The results analysis shows the need for ethical guidelines and regulations to ensure transparency and accountability in influencer communication practices. Social media platforms have guidelines in place for paid promotions, which should be followed by influencers and brands. By promoting responsible practices, the fashion industry can build a trustworthy ecosystem and regain consumer confidence.

Table 2 sheds light on crucial factors influencing consumers' perceptions of ethical influencer communication in the fashion industry. The research focuses on concerns about the authenticity and transparency of influencer content, especially regarding sponsored posts and product endorsements. Factors include transparency in influencer communication, relevance and authenticity (Abidin & Ots, 2016) of endorsements, and the influencer's alignment with brand values.

Table 2 offers valuable insights into consumers' perceptions of the ethical implications of influencer communication, aiding in establishing trustworthy industry practices and enhancing consumer trust and credibility.

Table 2. Consumers' perceptions of ethical influencer communication in the fashion industry

Chart	Key Findings
Chart 1	Consumers perceive ethical issues in influencer communication and value transparency: 69.7% strongly agree; 21.1% somewhat agree which means that 90.8% of the surveyed population to some degree (strongly or somewhat) agree that transparency is important.
Chart 2	Fashion influencers affect buying choices, but with perceived limited transparency and authenticity as 36.7% see little influence, while 23.9% none. This suggests that 60.6% doubt influencers' information is genuine and transparent.
Chart 3	A significant proportion of respondents (24.7%) have doubts about the accuracy of information shared by influencers about fashion products, as they responded with "Somewhat distrust" or "Completely distrust".
Chart 4 and Chart 5	The older population of respondents (70.6%) viewed influencer communication as a more effective marketing tool than the younger audience (56.1%), which may be attributed to influencer fatigue among younger consumers and the middle-aged and elderly members of the audience being more used traditional advertising methods and therefore more trusting towards the influencers.
Chart 6	A significant number (37.4%) of respondents were unaware of sponsored content in influencer posts, emphasizing the need for improved transparency in fashion industry influencer communication.

Source: Authors' research

The study supports hypotheses H1, H2, and H regarding influencer-generated content in the fashion industry. H1 highlights consumers' awareness of ethical issues in influencer communication, while H2 emphasizes the value of transparency and authenticity. These ethical considerations are crucial for building trust and maintaining a positive reputation for both influencers and brands. The study found that credible and genuine influencers are trusted more by consumers, impacting their perceptions of influencer-generated content. This makes consumers more likely to engage with content from authentic influencers. Future research could focus on the quality and content of influencer posts, emphasizing transparency and authenticity. Investigations into ethical considerations across different regions and cultures are warranted, as well as the impact of regulations and enforcement mechanisms on influencer communication practices. This includes examining the effectiveness of social media platforms' guidelines and government regulations. The discrepancy between consumers' self-perception and general perception of influencer impact could be explored. Such research on ethical dimensions of influencer communication in the fashion industry could contribute to promoting responsible practices and building consumer trust. As social media and influencer culture continue to grow, ensuring ethical and sustainable communication aligned with fashion industry values is essential.

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The Impact of Gender, Education, and Age on Installing a Proximity Tracing Application: Survey on a German Population

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Abstract: *During a crisis such as COVID-19 citizens of countries all over the world were asked to use a proximity tracing application voluntarily and install it on their smartphones. Even though the use of the application in times of the pandemic crises was promoted as crucially important, many citizens refused to install it. In this paper, we raised the question of why. Previous literature confirmed the impact of universal UTAUT predictors, namely, social influence, performance expectancy and effort expectancy, on intention to use. However, the impact of the predictors has not yet been confirmed in actual use. We propose a research model to examine the direct influence of the predictors on actual use. Furthermore, we assess if the impact of age, gender and education on PTA's use behavior is significant. We present our preliminary results on data collected in Germany.*

1. INTRODUCTION

Proximity tracing applications (PTAs) are used to predict, monitor and minimise the spread of a contagious disease (Rowe, 2020). Many PTAs were developed and deployed by counties worldwide within a short time for large-scale use among citizens (Farrelly et al., 2022). However, most countries did not attract enough users to reap the planned benefits of PTA's use (Trkman et al., 2021). The question is which factors impact PTA's use?

The answer can be offered by the Theory of Acceptance and Use of Technology (UTAUT). Similar to Trkman et al. (2023) we assessed the impact of some of the theory's universal predictors, namely, performance expectancy, effort expectancy and social norms. Since the intention to use PTA as a dependent variable has been widely studied, we assessed their impact directly on the use. Furthermore, in our study, we assess the role of age, gender, and education in PTA's use behavior.

All the factors of the use were assessed with data from 361 respondents collected in 2022 in Germany. We used smartPLS to conduct the structural equation modelling (SEM) technique.

The structure of this paper is as follows: Section 2 presents the hypotheses and our research model. Section 3 informs about our research methodology, while section 4 shows the results. Finally, we provide a short discussion and conclusion.

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2. HYPOTHESIS DEVELOPMENT

The Unified Theory of Acceptance and Use of Technology (UTAUT) is a theoretical model that theorizes about factors that could have an impact on the intention of using the technology and/or its actual use (Mishra et al., 2023). Indeed, the UTAUT model has been used to investigate the adoption of various information technologies. The model includes three universal predictors of intention to use: performance expectancy, effort expectancy, and social influence (Venkatesh et al., 2003). Effort expectancy is a degree of ease associated with using information technology (Venkatesh et al., 2003). *Performance expectancy* is the degree of an individual's belief that using information technology helps enhance personal health (Trkman et al., 2023). Finally, social influence is the degree of an individual's belief that important others believe that information technology should be used (Venkatesh et al., 2003). The impacts of the UTAUT tree predictors on intention to use have been confirmed in a recent paper by Trkman et al. (2023). However, the assessment of their direct impact on use is missing (H1-H3). In our research, we measured the use of PTA by asking the respondents whether they had installed the PTA on their smartphones at any point in time in the past. Age, education, and gender might be respondent characteristics that might also have a significant impact on the use (H4-6). We propose a research model in Figure 1.

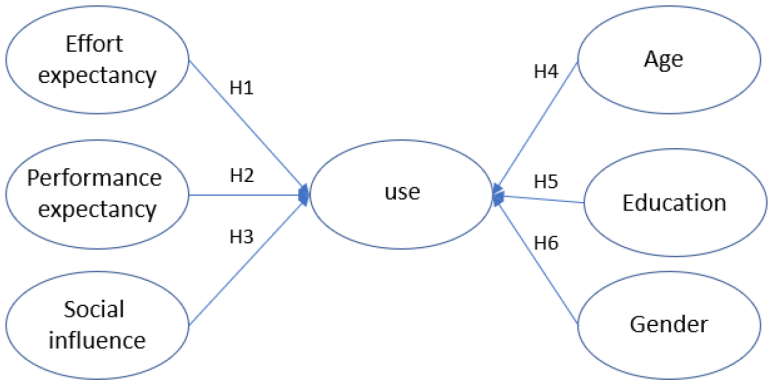

Figure 1. Research model
Source: Author

3. METHODOLOGY

3.1. Measures

The items for all constructs were adapted from previous studies as depicted in Table 1. All of the constructs above were modelled as reflective. The constructs' items were measured with a 7-point Likert scale (Sharma et al., 2022). Only the use construct was measured with a nominal variable (yes, no). We also included control variables: age (interval variable calculated for the year 2022), education level (ISCED 1-2, ISCED 3-4, ISCED 5-6, ISCED 7-8), and gender (male, female),

3.2. Data Collection

The survey was implemented with Qualtrics. The respondents were hired from Prolific's opt-in panel members. The survey was held in the English language. We collected data in June 2022. We gathered data from 361 adults living in Germany.

3.3. Data Analysis

We analysed data with structural equation modelling (SEM). Such modelling enabled us to incorporate unobservable constructs such are the UTAUT's constructs (Hair et al., 2017). The statistical analysis was conducted with the tool SmartPLS3 (Ringle et al., 2012). We used a bootstrap analysis with 5,000 subsamples (Hair et al., 2017).

Table 1. Measurement items

Ref.	Constr.	Code	Item
(Davis et al., 1989; Venkatesh et al., 2003)	Performance expectancy (PE)	PE1	Using the proximity tracing app would be helpful for monitoring my health.
		PE2	Using the proximity tracing app would make me feel safer in my daily life.
		PE3	Using the proximity tracing app would enhance the level of convenience in accessing medical care.
		PE4	Using the proximity tracing app would make it easier to manage my personal health.
		PE5	Using the proximity tracing app would enhance the quality of my life.
		PE6	I would find the proximity tracing app useful.
(Davis et al., 1989; Venkatesh et al., 2003)	Effort expectancy (EE)	EE1**	Learning to operate the proximity tracing app would be easy for me.
		EE2	I would find it easy to get the proximity tracing app to do what I want it to do.
		EE3	My interaction with the proximity tracing app would be clear and understandable.
		EE4	I would find the proximity tracing app flexible to interact with.
		EE5**	It would be easy for me to become skillful at using the proximity tracing app.
		EE6	I would find the proximity tracing app easy to use.
(Davis et al., 1989; Venkatesh et al., 2003)	Social influence (SI)	SI1	People who influence my behaviour think that I should use the proximity tracing app.
		SI2	People who are important to me think that I should use the proximity tracing app.
(Lin et al., 2021; Venkatesh et al., 2003)	USE	USE1	At this moment in time, I have the proximity tracing app installed on my phone.
	Age (Age)		What is your year of birth?
	Education (Edu.)		Select the level of your accomplished education from the list.
	Gender (Gen.)		Specify your gender from the list. Male/female

Source: adapted from Trkman et al. (2023)

4. RESULTS

4.1. Assessment of the Measurement Model

The item reliability assessment results in Figure 2 confirmed item loadings of 0.7 or higher as significant (Hair et al., 2012). Internal consistency reliability was assessed with composite reliability (CR) and Cronbach's alpha. All of their values are above 0.7 (Hair et al., 2012). The AVE values are also acceptable since they are all above 0.5 (Hair et al., 2012). Discriminant validity was evaluated using the heterotrait–monotrait ratio of correlations (HTMT) (Hair et al., 2017). All HTMT values (Table 3) are below 0.85, which is in line with the requirements (Henseler et al., 2015).

Table 2. Convergent validity and internal consistency reliability.

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
AGE	1.000	1.000	1.000
EDU	1.000	1.000	1.000
EE	0.928	0.944	0.737
GEN	1.000	1.000	1.000
PE	0.942	0.953	0.773
SI	0.931	0.946	0.745
USE	1.000	1.000	1.000

Source: Author

Table 3. Discriminant validity (HTMT)

	AGE	EDU	EE	GEN	PE	SI	USE
AGE							
EDU	0.267						
EE	0.178	0.039					
GEN	0.114	0.060	0.075				
PE	0.068	0.018	0.260	0.082			
SI	0.035	0.168	0.318	0.052	0.601		
USE	0.037	0.084	0.234	0.065	0.420	0.558	

Source: Author

4.2. Assessment of the Structural Model

We assessed the collinearity issues. The variance inflation factor (VIF) values in Table 4 do not exceed the recommended threshold of 5 (Hair et al., 2017). The values of the coefficient of determination (R^2) that are higher than 0.25, 0.50, and 0.75 are considered to hold weak, moderate and substantial explanatory power, respectively (Hair et al., 2011). The results showed a weak explanatory power for USE (0,322). Next, the effect sizes (f^2) that are higher than 0.02, 0.15 and 0.35 indicate small, medium and large effect sizes (Hair et al., 2019). In Table 5 the f^2 value from social norm is medium (0,167), while from performance expectancy is small (0,028).

Table 4.
Collinearity assessment; VIF values

	USE
AGE	1.128
EDU	1.113
EE	1.156
GEN	1.031
PE	1.522
SI	1.606
USE	

Source: Author

Table 5.
Effect sizes f^2

	USE
AGE	0.002
EDU	0.000
EE	0.005
GEN	0.007
PE	0.028
SI	0.167
USE	

Source: Author

Table 6. Significance testing results for hypothesis

	Original Sample	Sample Mean	Standard Deviation	T statistics	P values
AGE→USE	0.035	0.038	0.045	0.774	**0.439**
EDU→USE	0.002	0.002	0.043	0.046	**0.963**
EE→USE	0.060	0.067	0.042	1.422	**0.156**
GEN→USE	0.070	0.069	0.044	1.604	**0.109**
PE→USE	0.170	0.171	0.052	3.299	**0.001**
SI→USE	0.427	0.426	0.051	8.380	**0.000**

Source: Author

The statistical significance and relevance of the path coefficients in our research model are shown in Table 6. Hypothesis H2 (PE→USE) and H3 (SI→USE) were confirmed, while all the others were rejected.

5. DISCUSSION AND CONCLUSION

In our research model, we explained 32.2% of the total variance in downloading the PTA. Similar PTA adoption studies explain between 51% and 77% (Cobelli et al., 2021; Hassandoust et al., 2021; Sharma et al., 2022; Velicia-Martin et al., 2021). However, they all focused on predicting the intention to use and not use. We confirmed significant direct effects of two universal UTAUT constructs, namely, performance expectancy (H2) and social norms (H3), while the impact on effort expectancy (H1) was not confirmed. Our results regarding effort expectancy and performance expectancy are in line with the study of Trkman et al. (2023). The authors discovered that the impact of performance expectancy on intention to use faded with time as PTA was in use. We contributed to a study assessing the impact of the three UTAUT's constructs directly on the use construct.

Age (H4), education (H5) and gender (H6) showed no impact on downloading the PTA. Interestingly, Trkman et al. (2021) showed the impact of age as a nominal variable on intention to use. They made two groups. The first one is for respondents up to 59 years old, and the second one is for the older ones. However, later research by Trkman et al. (2023) has not confirmed their finding. We contributed with an assessment of the age as an interval variable and reported that there is no impact. In previous research, education and gender were not found to have a significant impact on intention to use (Trkman et al., 2021, 2023). We have confirmed their findings.

This paper shows that neither age, gender nor education makes a significant impact on citizens' decision to use the PTA.

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Application of Immersive Technology in Heritage Tourism: A Literature Review

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Bibliometric analysis

Abstract: *Due to digital growth and the need to discover new ways to communicate, promote, and maintain cultural heritage resources, the use of immersive technology to promote heritage tourism is becoming a more widespread practice. Based on a literature review and bibliometric analysis, this study provides insight into the development of this topic and potential directions for future research. The articles considered in this literature review were selected from the Web of Science (WoS) database and published in journals and conference proceedings in a period time from 2017 to 2022. The results obtained from analysis contribute to a comprehensive understanding of the application of immersive heritage tourism experience. Further studies are needed to track the development of these topics and their future application in the heritage tourism context. Directions for further studies are suggested to address the identified gaps.*

1. INTRODUCTION

Along with the rapidly developing heritage tourism business, heritage tourism research has expanded as well. Heritage refers to a legacy from the past that is cherished, used, and intended to be passed on to the next generations. Rahaman (2018) asserts that heritage interpretation is seen as a powerful instrument for management, learning, and communication that may raise visitors' understanding of and empathy for the cultural places and items they encounter.

Virtual reality (VR) and augmented reality (AR) have the huge potential to provide unforgettable visitor experiences, especially in the field of heritage tourism. Future potential for development within heritage tourism is anticipated to rise enormously as a result of investments in immersive technology. Additionally, digital technologies are emerging in tourist destinations to preserve history in an interesting way for the enjoyment and experience of future generations (Guttentag, 2010). However, little study has been done to give conceptual clarity on how history may be preserved as well as how often challenged heritage can be translated to the digital world, despite the rising significance of immersive technology in the tourist sector.

In light of this backdrop, it is important to examine the scientific literature and comprehend how it reflects changes in the use of immersive technologies in heritage tourism by providing answers to the following questions: (1) Which published studies have had the most impact, and on what topics? (2) Which scholars are the most productive? and (3) Which keywords are the most

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frequently used and what can be concluded about the current usage of immersive technology in the field of heritage tourism?

Therefore, the purpose of this study is to analyse the application of immersive technologies in the heritage tourism sector and to provide a comprehensive literature review. The paper reviews and analyses existing scientific literature on immersive technologies in heritage tourism, published from 2017 to 2022 by using a bibliometric analysis approach. The paper also proposes practical implications for future research that offer the potential to advance research on the use of immersive technologies in heritage tourism.

2. METHODOLOGY

2.1. Study Design

Based on a literature review and bibliometric analysis, a descriptive study was performed to answer the research questions. Reviews of the available literature serve as an essential starting point for all kinds of study. They have the potential to inspire fresh ideas and concepts for a specific subject while also creating rules for policy and practice. They may also serve as a foundation for knowledge creation and can provide the basis for further investigations. Moreover, the literature review is essential for developing theoretical frameworks and conceptual models, as well as for setting research agendas and identifying research gaps and areas that require additional study (Snyder, 2019). Baumeister and Leary (1997) stated that a literature review is very useful for theory development, while Grant and Booth (2009), and Law et al. (2012) pointed out that results derived from a literature review are valuable not only for scholars but for practitioners as well, since they give information on less researched topics. Thus, this article adopts a literature review analysis and bibliometric approach to synthesize and comprehensively analyse current literature on a specific topic to identify potential opportunities for contemporary research and to identify priorities for future research.

As a starting point for bibliometric analysis, a systematic review of published articles regarding specific topics is used (Ellegaard, 2018). According to Pritchard (1969), the bibliometric methodology applies quantitative techniques to bibliometric data. That implies the application of both bibliometric analysis and citation analysis. Pritchard (1969) defined the bibliometric concept as "the application of mathematical and statistical methods to books, articles, papers and other communication media". Similarly, Lawani (1981) stated that the concept of bibliometric implies "the application of mathematics and statistical methods to shed light on the processes and course of these sources by counting and analysing various aspects of written sources".

Bibliometric analysis results add significantly to the existing body of knowledge by offering the possibility for academic outputs assessment, enabling researchers to determine reliable scientific publications, scope and domain of the research field, thus creating foundations for conducting academic research. Therefore, for many researchers' bibliometric analysis is an important tool that can be used for identifying and bridging the research gaps and for development in the specific research area (Aída Martínez-Gómez, 2015).

2.2. Bibliometric Data Extraction and Analysis

Despite the lively research on augmented and virtual reality and heritage and cultural tourism, research on the application of immersive technology in heritage tourism is still lacking. This

paper aims to fill the gap through a literature review. Based on the literature review process, the following set of inclusion/exclusion criteria was established. In order to access scientific studies on heritage tourism and the application of immersive technology in heritage tourism, a data screening and retrieval was made in the Web of Science (WoS) database. The search was conducted in January 2023.

The beginnings of the bibliometric analysis process involve the selection of appropriate keywords. Boolean operators (AND) are used in the Web of Science (WoS) databases to search relevant papers in one search with keywords "immersive technology", "virtual reality", "augmented reality", "heritage tourism", "cultural tourism" and "heritage tourism experience". To search the corpus by the combination of title, abstract and keywords, the retrieved documents were evaluated to verify their affinity with the topic. Inclusion criteria focussed on peer-reviewed conference proceedings and journal articles. Resources also had to be available in full-text format. Following that, articles that did not match the inclusion criteria were removed. After a careful screening and after applying the research criteria (time frame, publication type and language), a total of 20 studies were included in the analysis.

2.3. Software Tools for Analysis

Researchers perform bibliometric analysis using different software. Previous research revealed that the most relevant tools are BibExcel (Persson et al., 2009), Cite Space (Chen, 2006), VOSViewer (van Eck & Waltman, 2010) and bibliometrix R package Bibliometrix (Aria & Cuccurullo, 2017). In order to perform bibliometric analysis in the current study, bibliometric R package Bibliometrix was used. For performance analysis, science mapping and network analysis, the biblioshiny package or R programming was utilized.

The titles and abstracts of those papers that appeared in the search results were evaluated by the authors of this study. Next, the core database was obtained in Bibtex format and submitted to the Bibliometrix R package, an open-source tool for performing quantitative bibliometric research. In this step, descriptive bibliometric analysis was performed using the R program and the biblioshiny online interface for bibliometrix in order to examine relationships within the scope of the research, such as co-citation networks and keyword occurrence. Figures and tables are used to present the study's outcomes.

3. DESCRIPTIVE BIBLIOMETRIC ANALYSIS AND FINDINGS

3.1. Descriptive Analysis

In order to respond to the research questions and to examine the contribution of research constituents (e.g., authors, countries and journals/proceedings) in immersive technologies in cultural heritage tourism literature, descriptive analysis was performed.

The analysis of the results starts with the essential description of the main bibliometric statistics which are presented in Table 1. The descriptive statistics of the data show that the research on immersive technologies in heritage tourism includes only 20 sources across time from 2017 to 2022. The average number of citations per document (11.25) is high, indicating the research topic's popularity. Analysis of available studies reveals that in the period from 2017 to 2022, 75 authors contributed to the literature corpus of immersive technologies (Virtual Reality and Augmented

Reality) application in cultural heritage tourism with 20 scientific publications. The most significant increase in publication occurred in 2020 (7 studies) and in 2022 (6 studies), while the lowest productivity was in 2021 (2 studies). Out of 20 scientific publications, only two papers are single-authored documents, while the remaining studies were multi-authored. In addition, authors' collaboration analysis shows that papers are usually written by almost four researchers.

Table 1. Descriptive statistics

Description	Results
Descriptive Statistics	
• *Timespan*	2017 – 2022
• *Sources*	20
• *Documents*	20
• *Average year from publication*	2,95
• *Average citation per document*	11,25
• *Average citation per year per document*	2,584
• *References*	841
Document Types	
• *Articles*	8
• *Proceedings paper*	12
Document contents	
• *Keywords Plus (ID)*	56
• *Author's Keywords (DE)*	93
Authors	
• *Authors*	75
• *Author Appearances*	78
• *Authors of single-authored documents*	2
• *Authors of multi-authored documents*	73
Author Collaboration	
• *Single-authored documents*	2
• *Documents per author*	0,267
• *Authors per documents*	3,75
• *Co-Authors per documents*	3,9
• *Collaboration Index*	4,06

Source: Authors

3.2. Source Analysis

The selected 20 papers are distributed across 8 journals (Tourism Management, Soft Computing, Journal of Heritage Tourism, Technological forecasting and social change, Sustainability, Information & Management, and Current Issues in Tourism) and 12 conference proceedings. The most significant research has been published in papers with the greatest local and international citation counts. International citations are those made to any paper throughout the whole field of research, whereas local citations are those made to the particular relevant material that was chosen to be included in the present study. Total citations per year, or TC per year, is one statistic that is becoming more and more useful for identifying important and trending publications. This indicates that new researchers often and consistently address papers with a larger number of TC per year in their study. The most widely referenced publications are shown in Table 2 along with author, total number of citations, and TC per year.

As can be seen in Table 2, five manuscripts have 14 or more total citations, with the most frequently referenced document, written by Bec et al., that was published in 2019. This paper has reached more than 16 citations per year. A short description of these studies is summarized in Table 3.

Table 2. Most globally cited documents

Paper/author	Total Citation	TC per year
Bec et al. (2019)	82	16.40
Bae et al. (2020)	29	7.25
Gonzales-Rodriguez et al. (2020)	26	6.50
Trunfio et al. (2022)	26	6.50
Castagnetti et al. (2017)	14	2.00

Source: Authors

Table 3. Description of the most trending papers in the research field

Paper/author	Research description
Bec et al. (2019)	The authors proposed a heritage preservation conceptual model for managing heritage in digital tourism experiences. The model includes four stages, namely, presentation of historical facts, contested heritage, integration of historical facts and contested heritage, and/or an alternate scenario.
Bae et al. (2020)	The authors proposed and tested a research model representing the relationships between the characteristics of mixed reality, perceived immersion, perceived enjoyment, visitor satisfaction, and brand equity theory components. According to the results, the mixed reality characteristics (interactivity and vividness) influence visitors' perceived immersion and perceived enjoyment, as well as brand equity theory components (brand awareness, brand association and brand loyalty).
Gonzales-Rodriguez et al. (2020)	The authors studied the quality of tourist experience when visiting a cultural heritage destination. Online comments on the virtual tour experience were analysed. The findings reveal the potential influence of immersive virtual reality technologies on tourist quality experience. The most frequently commented topics were related to service quality, quality of experience, IVR technology (smart glasses), and staff.
Trunfio et al. (2022)	The authors explored how and to what extent functional elements of the mixed reality devices affect experiences and drive post-experience behaviours. The results confirmed that heritage valorisation and education in museums are enhanced by mixed reality developments, which create new immersive experiences and behaviours.
Castagnetti et al. (2017)	The authors present a research project VisualVersilia 3D that was conducted on an archaeological site as a case study. The aim was to combine the traditional reading of the documents and the potential use of modern communication technology in the context of cultural tourism. The result is the development of a methodology for documenting current and past historical ages and integrating their 3D visualization to provide immersive virtual reality for a successful enhancement of the heritage.

Source: Authors

According to the description of the most cited papers in the field of immersion technology application in heritage tourism (Table 3), papers differ in research focus, reporting conceptual, empirical, and case study findings.

3.3. Keywords Co-occurrence Analysis

The list of keywords contains an outline of the paper's main concepts of interest. Thus, the results of keyword analysis present the paper's main topics are presented understandably and straightforwardly. In this stage of the study, a co-occurrence analysis of keywords is conducted using the most commonly used keywords to show how frequently certain keywords have been used together in the literature. Data mining and statistical analysis are done on the keywords that appear often in research papers using the biblioshiny software package. The size of the particular frame indicates the frequency of certain terms in the literature.

Figure 1 and Figure 2 show the results of the word cloud analysis of analysed literature and co-occurrence analysis of keywords. According to the analysis from biblioshiny, the main keywords that are used frequently in the field of immersive technology in heritage and cultural tourism are "virtual reality", "technology", "management", "cultural heritage tourism", "destination" and "heritage" (Figure 1). As shown in Figure 2, they are grouped in two clusters, referring to virtual and augmented reality.

Figure 1. Word-Cloud Analysis of Literature Review

Source: Authors

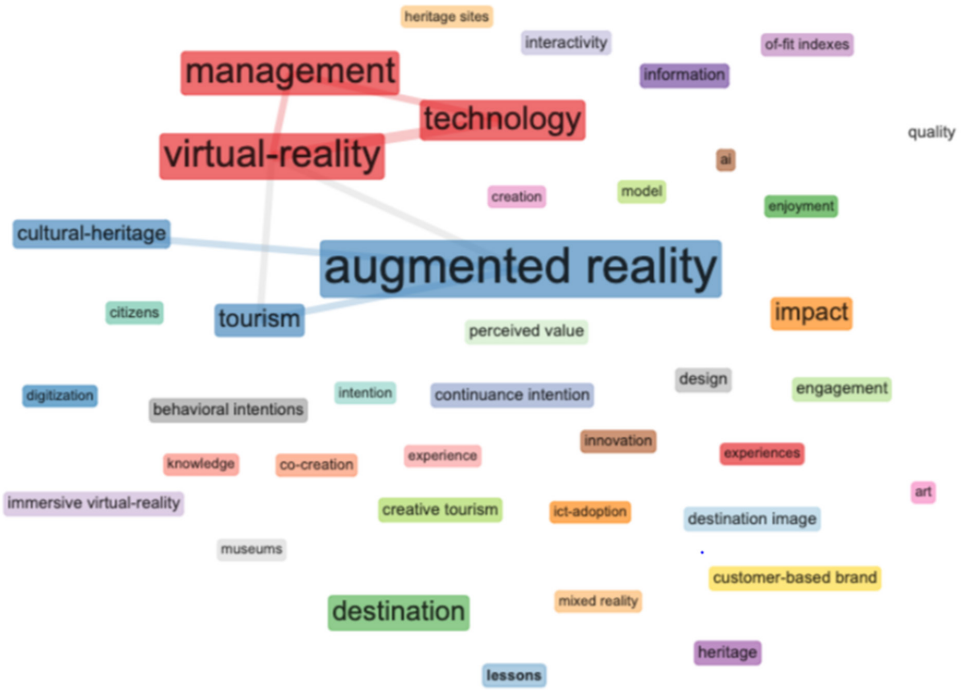

Figure 2. Co-occurrence of keywords

Source: Authors

3.4. Country Collaboration Analysis

The following section analyses the geographical development of publishing (Table 4). Results show that 75 authors from 12 countries (Italy, South Korea, Greece, Cyprus, UK, Australia, Egypt, Portugal, France, Spain, China, and Jordan) have contributed to the application of immersive technologies in cultural heritage tourism research. In terms of publication number, Italy has published 22 documents on this topic, followed by South Korea with 13 papers and Greece with 9 publications. Half of the research was conducted in European countries (Italy, Greece, Cyprus, the UK, Portugal, France, and Spain).

Table 4. Country Scientific Production

Region	Frequency
Italy	22
South Korea	13
Greece	9
Cyprus	6
UK	6
Australia	4
Egypt	3
Portugal	3
France	2
Spain	2
China	1
Jordan	1

Source: Authors

Furthermore, the country collaboration map is shown in Figure 3. According to Baker, et al. (2021), science mapping explores the associations between research continents. Figure 3 shows that intercountry collaboration exists in the blue colour of the map, representing the existence of research networks with other nations. The bibliometric analysis indicates that Italy (22) and South Korea (13) are some of the highest-contributing countries.

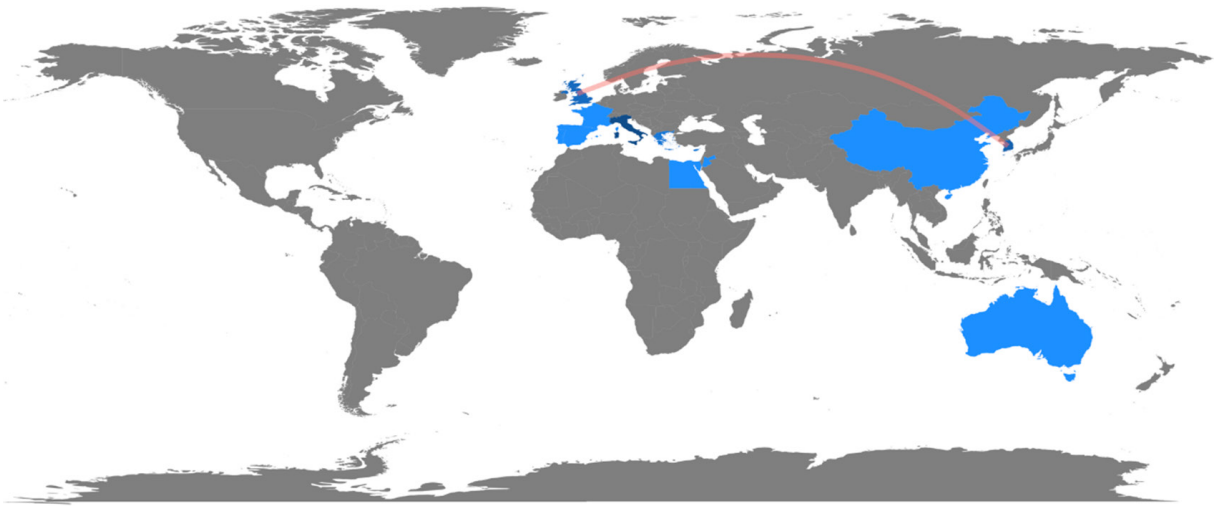

Figure 3. Collaboration of Countries

Source: Authors

4. DISCUSSION AND CONCLUSION

The use of augmented reality and virtual reality has become widely available due to quick technological progress, as well as large investments in immersive technologies. Applications have spread to several industries, and the tourist sector is receiving increasing scholarly interest. Technology has been used more and more in the sector of cultural heritage tourism, as well. What is more, recent developments in digital technologies have made them one of the focal points of any heritage tourist experience. Virtual and augmented reality can improve the visitor experience by delivering a new level of visit that is more immersive, customized, and content-rich. There is potential for augmented and virtual reality to support the preservation of heritage destinations and attractions. However, even though technology is developing quickly, it seems that cultural heritage components are being digitalized more slowly.

Today, an extensive number of studies examine technological advancements that can improve visitor experiences in cultural heritage sites, including the application of augmented reality, virtual reality, electronic guides, QR codes, and mobile phone applications. The number of academic research will undoubtedly increase as immersive technologies continue to play a significant role in heritage tourism and heritage tourism experiences.

Research on the consequences, opportunities, and problems of contemporary technology is also a strong sign of the importance of heritage tourism in the scientific community. In addition, researchers continue to give more critical evaluation of immersive technologies in heritage tourism. This enormous field of tourist studies is one that we are only now starting to fully comprehend. Heritage and cultural tourism will advance as the travel industry expands and more people look to the past to understand the present and the future (Lowenthal, 2015).

This study's literature review and bibliometric analysis show a shift of focus within area of the heritage tourism and immersive technology, as this topic has received increasing attention in recent years. This paper is the first literature review and bibliometric analysis on this topic from the Web of Science database. This study used a comprehensive bibliometric method such as citations and keyword analysis.

Based on the findings of the literature search in the Web of Science (WoS) database, a total of 20 publications between 2017 and 2022 were reached. Analysis of the publication type of the studies on this topic determined that most publications are conference papers written in English. Italy and South Korea are the countries with the most scientific publications on this topic. The most used keywords are "virtual reality", "technology", "management", "cultural-heritage tourism", "destination" and "heritage". Furthermore, it has been found that Italy and South Korea lead the research in the relevant subject based on the outcomes of international collaboration analysis. Therefore, it is believed that by presenting the current status of research regarding literature review analysis about this issue, this study will contribute to the growth of scientific knowledge in the field.

This paper is a rare attempt to give a literature review and bibliometric analysis on this topic. Despite the significance and purpose of this study, there are several limitations. The study attempted to provide a view of immersive technology in heritage tourism between 2017 and 2022. Future research may compare the contribution of regions and researchers over longitudinal studies. The current research is limited to the Web of Science (WoS) database and reviewed

only articles in English. Therefore, other databases such as Scopus, Emerald, ScienceDirect as well as publications from major conferences and books should be explored, as well. The selected criteria may have contributed to identifying the final sample of analysed papers in ways that other keywords and/or other researchers may not have.

Although there has been research progress in this field, several issues emerged that provide potential for further research. In order to gain additional insight into this subject, it is recommended that future research studies use different bibliometric techniques to examine present perspectives and attitudes about the implementation of immersive technology in heritage tourism as well as anticipated future developments. Additionally, this bibliometric study showed that other technologies, such as holograms and 360-degree movies, have not yet been investigated in this context. In order to help visitors and business professionals make the best use of what the virtual world has to offer, it is crucial to understand the potential and difficulties that lie ahead, as immersive technologies develop and research expands. Consequently, ongoing research regarding immersive technology usage in the field of heritage tourism should be performed using bibliometric analysis.

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Exploring the Impact of Event Experience on Visitors' Behavioural Intentions

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Keywords:
Event tourism;
Event experience;
Visitors' behavioural intentions;
Event experience outcomes;
Quantitative analysis

Abstract: *The purpose of this paper is to examine the relationship between visitors' event experience and their behavioural intentions. Constructs in the measurement model were operationalized using items derived from related previous research. Data was gathered using questionnaires distributed online. Hypotheses were tested using regression analyses, based on data gathered from 144 event visitors. The results of this study indicate a significant role of event attributes and event experience on visitors' behavioural intentions. Thus, these findings explain to what extent experiencing the event environment as a whole can generate visitors' positive behavioural intentions in terms of repeat visits, positive word-of-mouth, and willingness to pay more. Therefore, this study contributes to the existing literature on experience measurement, adding to the knowledge of event experience and event experience outcomes, by introducing event experience as a moderator variable.*

1. INTRODUCTION

Event tourism is a growing segment that has a positive impact on the local economy in general, as well as on tourist destinations in particular. Events enrich tourism offers, are considered tourist attractions in the destination, and cater to both domestic and foreign visitors. According to Getz (2008), events are not beneficial only for tourism but positively influence community-building, urban renewal, cultural development, and national identity, as well.

In order to organize successful and attractive events, event managers should know visitors' preferences and attitudes. Therefore, exploring event visitors' perceptions and experiences, as well as the consequences of event participation is of great importance for event tourism development. Building on the literature review, studies aiming to determine the direct effect of event attributes on visitors' behavioural intentions are limited (e.g. Dalgic & Birdir, 2020).

Recently, researchers examined the indirect association between event attributes and behavioural intentions (e.g. Molina-Gomez et al., 2021). Moreover, past research focused on determining the direct effect of event experience construct on behavioural intentions (e.g. Sorrentino et al., 2020). However, as argued by Sharma et al. (2022) tourism experience may influence behavioural intentions indirectly, as well. In this vein, Dalgic and Birdir (2020) demonstrated that festival experience fully mediated the effect of key success factors on festival loyalty. However, little is known about the moderator role of event experience concerning event loyalty.

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In this regard, to fill previously described gaps in event experience literature, this study tries to address the following research questions: (a) what is the effect of event attributes on behavioural intentions, and (b) what is the role of event experience as moderator variable? In particular, the study is focused on determining the effect of experiencing event attributes on visitors' behavioural intentions. What is more, it assesses event experience and its moderating impact on behavioural intentions.

2. CONCEPTUAL MODEL

Events are characterized by services, products and activities that can attract visitors and create a unique and authentic atmosphere. According to Dalgic and Birdir (2020), an event's key success factors can change the perceptions and behaviours of participants and provide them with unique experiences. Based on an extensive literature review, Molina-Gomez et al. (2021) proposed activity programme, authenticity, concession, and environment as tangible, and socialisation and enjoyment as intangible festival attributes. Dalgic and Birdir (2020) concluded that event factors vary according to the festival themes and locations, and introduced the following key attributes across the range of festivals: programme, facilities, convenience, food, accessibility, information about the festival, festival area, souvenirs, employees, and security.

Geus et al. (2016) defined event experience as an interaction between an individual and the event environment (both physical and social), modified by the level of engagement or involvement, involving multiple experiential elements and outputs (such as satisfaction, emotions, behaviours, cognition, memories and learning), that can happen at any point in the event journey.

The literature review reveals several event experience outcomes that can be viewed as desired and undesired event consequences and can generate positive or negative impacts. Getz (2008) introduced a series of event experience outcomes: personal, social and political, cultural, economic, and environmental. Moreover, Geus et al. (2016) stated that experiences produce outcomes such as satisfaction, emotions, cognition, and behaviour. Similarly, Suhartanto et al. (2020) suggested that experiences result in attitudinal and behavioural outcomes.

In terms of this paper, the focus is on behavioural intentions as one of the experience outcomes. Past research in the context of event experience mostly measured visitors' loyalty as their revisit intention, and positive word of mouth (Dalgic & Birdir, 2020; Hermann et al., 2021; Sorrentino et al., 2020; Tsai, 2021).

According to the service literature in general, and tourism and event literature in particular, the association between service/product attributes and behavioural intentions is confirmed in several studies (e.g. Dalgic & Birdir, 2020; Molina-Gomez et al., 2021; Salem & Kiss, 2022; Sharma et al., 2022). In addition, previous research in the event experience context supported the association between event experience and behavioural intentions (Dalgic & Birdir, 2020; Sorrentino et al., 2020; Tsai, 2021).

Therefore, the research hypotheses are formulated as follows:

Hypothesis One: Event attributes have a positive and significant effect on behavioural intentions.

Hypothesis Two: Event experience moderates the effect of the event attributes on behavioural intentions.

The conceptual model is illustrated in Figure 1.

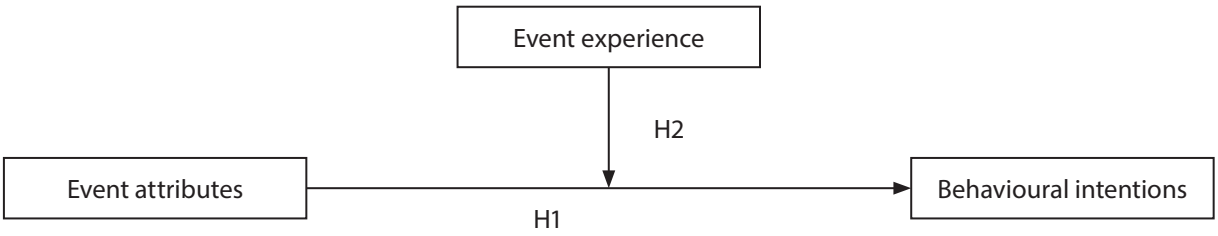

Figure 1. Conceptual model
Source: Authors

As depicted in Figure 1, this study proposes the conceptual model with two research hypotheses and three constructs that represent independent, dependent and moderator variables.

3. METHODOLOGY

As illustrated in Figure 1, this study aims to examine the relationship between experiencing event attributes and visitors' behavioural intentions, as well as the role of event experience as a moderator variable. Constructs in the measurement model were operationalized using items derived from related previous research. Adapting measures from Bitner (1992), Baker and Crompton (2000), Lee et al. (2008), and Marković et al. (2018), event attributes construct was measured using three dimensions (ambience, service encounter, and layout and design) that were assessed on a scale from "very poor" (score 1) to "excellent" (score 7). The event experience construct was measured with seven dimensions (hedonism, novelty, local culture, refreshment, meaningfulness, involvement, and knowledge) adopted from Kim et al. (2012), while behavioural intentions construct contains four dimensions (repurchase intention, positive word of mouth, willingness to pay more, and strength of preference) from Jones and Taylor (2007) and Marković et al. (2018). Both, event experience and behavioural intentions were assessed on a scale from "strongly disagree" (score 1) to "strongly agree" (score 7).

All the visitors of the Dubrovnik Winter Festival 2022 (Croatia) were deemed as population in this study. The sample was obtained using the snowball sampling technique, with an online questionnaire. Data gathering resulted in 144 fully completed questionnaires that were used for further analysis. Data was described with descriptive statistical analysis. In addition, Cronbach's alpha coefficients were calculated to assess the reliability of measurement scales. For testing the main study hypotheses, multiple regression analysis and hierarchical multiple regression analysis were performed.

4. RESULTS

This section provides findings generated from quantitative analysis, presenting sample description, reliability scores for measurement constructs, perceived experience and behavioural intentions mean scores, and hypotheses testing results. Analysis was performed on 144 valid questionnaires.

The sample structure consisted of predominantly female respondents (71.5 per cent). On average, respondents were 34 years of age, mostly married or in a relationship (63.2 per cent). Most of them completed college or a higher level of education (81.9 per cent), and reported a middle or higher level of average monthly income (88.8 per cent).

In terms of event visit characteristics, the sample consisted of predominantly repeated visitors who visited the event two or more times (89.5 per cent). They were usually accompanied by 3 or more persons (64.6 per cent), with approximately one child. As the major source of information regarding the event, respondents reported internet and social media (34.0 per cent).

Mean scores and reliability values for measurement constructs in the research model are described in Table 1.

Table 1. Descriptive and reliability analyses for measurement constructs

Constructs and dimensions	Mean	Standard dev.	Cronbach alpha	Number of items
Event attributes	***4.34***	***0.921***	***0.932***	***22***
Ambience	4.03	1.125	0.887	8
Layout and design	4.07	1.014	0.848	8
Service encounter	5.11	1.135	0.918	6
Event experience	***3.39***	***1.401***	***0.973***	***24***
Hedonism	3.31	1.526	0.927	4
Novelty	2.78	1.611	0.940	4
Local culture	3.88	1.391	0.690	3
Refreshment	4.16	1.604	0.904	4
Meaningfulness	2.91	1.650	0.939	3
Involvement	3.75	1.659	0.836	3
Knowledge	2.94	1.598	0.940	3
Behavioural intentions	***4.10***	***1.632***	***0.956***	***12***
Repurchase intention	5.08	1.787	0.936	3
Positive word of mouth	4.38	2.002	0.984	3
Willingness to pay more	3.75	1.790	0.862	3
Strength of preference	3.17	1.808	0.925	3

Note: numbers in italics represent overall values for each construct

Source: Authors

In terms of reliability, Cronbach's alpha values range between 0.932 and 0.973 and are above the cut-off value recommended by Hair et al. (2010). These results imply adequate internal consistency and reliability of the measurement scale.

Next, according to the results reported in Table 1, constructs' mean scores range between 3.39 and 4.34, implying positive perceptions of event attributes, positive behavioural intentions, and moderate event experience. The most dominant event attributes dimension was "service encounter" (mean = 5.11), while "refreshment" was the best-perceived event experience dimension (mean = 4.16). Additionally, the highest level of behavioural intention dimensions was given to "repurchase intention" (mean = 5.08).

Several regression analyses were performed to quantify the effect of the independent variable on the dependent variable in the proposed conceptual model and to test the main research hypotheses. Namely, H1 was tested using multiple regression analysis, while hierarchical multiple regression analysis was used to test H2.

Firstly, the effects of event attributes on behavioural intentions (H1) were examined. Thus, dimensions "ambience", "service encounter", and "layout and design" were deemed as independent variables, while behavioural intentions construct served as dependent variable. Correlation coefficients were calculated between these variables, aiming to test possible multicollinearity in the regression model. The results are shown in Table 2.

Table 2. Correlation matrix for event attributes and behavioural intentions constructs

Variables	1	2	3	4
1. Ambience	1.000			
2. Service encounter	0.431	1.000		
3. Layout and design	0.697	0.566	1.000	
4. Behavioural intentions	0.710	0.381	0.516	1.000

Note: all correlation coefficients are significant at a 0.01 level

Source: Authors

As shown in Table 2, all correlation coefficient values do not exceed 0.80. According to Bryman and Cramer (2009), this is a cut-off value for assessing possible multicollinearity. Thus, the multicollinearity problem does not exist in the present regression model.

Table 3 summarises the results of multiple regression analysis and testing hypothesis H1.

Table 3. Multiple regression results

Independent variable	b	Beta	t	Sig.
Constant	-0.505		-1.031	0.305
Ambience	0.988	0.674	8.072	0.000*
Service encounter	0.135	0.094	1.300	0.196
Layout and design	0.011	0.007	0.072	0.943
$F(3, 137) = 47.711$, $p < 0.01$; $R = 0.715$, $R^2 = 0.511$				

Note: Dependent variable: behavioural intentions; * - significant at 0.01 level

Source: Authors

As displayed in Table 3, results show a significant, positive and strong relationship between event attributes dimensions and behavioural intentions ($R = 0.715$, $p < 0.01$). According to significant F-statistics, the independent variables in the model are significant predictors of the dependent variable. What is more, event attributes dimensions explained 51.1 per cent of the variance in behavioural intentions, and dimension "ambience" had the strongest significant individual effect on behavioural intentions ($\beta = 0.674$, $p < 0.01$).

Therefore, the results of multiple regression analysis imply that event ambience, service encounter, and event layout and design significantly predict event visitors' behavioural intentions, accepting hypothesis H1.

Next, the moderation effect of event experience on the relationship between event attributes and behavioural intentions was assessed (H2). Generally, a moderator is a variable that affects the direction and/or strength of the relation between an independent and a dependent variable (Baron & Kenny, 1986). Thus, as seen in Figure 1, the moderator variable was the event experience construct, while the event attributes construct and behavioural intentions construct served as independent and dependent variables, respectively.

To avoid multicollinearity problems, independent and moderator variables were centered. In addition, following Baron and Kenny (1986), an interaction term (a product of independent and moderator variables) was created, and added to the regression model.

The results of hierarchical multiple regression analysis and testing hypothesis H2 are captured in Table 4.

Table 4. Moderator analysis results

Independent variable	b	Beta	t	Sig.
Model 1				
Constant	4.113		46.041	0.000*
Event attributes (centered)	0.286	0.166	1.971	0.050**
Event experience (centered)	0.731	0.630	7.470	0.000*
$F(2, 138) = 96.768$, $p < 0.01$; $R = 0.764$, $R^2 = 0.584$, R^2 change = 0.584, F change Sig. = 0.000				
Model 2				
Constant	4.241		41.197	0.000*
Event attributes (centered)	0.283	0.164	1.977	0.050**
Event experience (centered	0.809	0.698	7.960	0.000*
Interaction term	0.126	0.145	2.387	0.018**
$F(3, 137) = 68.608$, $p < 0.01$; $R = 0.775$, $R^2 = 0.600$, R^2 change = 0.017, F change Sig. = 0.018				

Note: Interaction term: product of event attributes (centered) and event experience (centered); dependent variable: behavioural intentions; * - significant at 0.01 level, ** - significant at 0.05 level

Source: Authors

Results presented in Table 4 demonstrate that both models (with and without interaction terms) are statistically significant. What is more, model 2 (that includes an interaction term between event attributes and event experience) explains 1,7 per cent more variance in behavioural intentions than model 1 (without interaction term) (R^2 change = 0.017). This percentage increase in the variance explained is statistically significant (F change Sig. = 0.018). Therefore, event experience does moderate the relationship between event attributes and behavioural intentions.

In addition, standardized coefficients in the moderator model (Table 4) show significant individual effects of event attributes and event experience on behavioural intentions ($\beta = 0.164$, $p < 0.05$; $\beta = 0.698$, $p < 0.01$, respectively). Adding the interaction term in the model shows a significant individual effect as well ($\beta = 0.145$, $p < 0.05$).

Therefore, reported results of moderator analysis demonstrate that event experience significantly affects the relationship between event attributes and behavioural intentions. Thus, hypothesis H2 is accepted.

5. CONCLUSION

This study tested the association between event attributes and behavioural intentions in the context of the event environment and introduced event experience as a moderator variable. The results revealed that event attributes positively and significantly predict behavioural intentions, suggesting that highly perceived ambience, service encounter, and layout and design lead to more positive behavioural intentions of event visitors. Hence, hypothesis H1 is accepted. What is more, this is in line with similar past research. A significant positive relationship between key success factors (festival programme, festival area and accessibility, informational adequacy, festival staff and volunteers, souvenir and convenience, security, and food) and festival loyalty was shown by Dalgic & Birdir, 2020). Additionally, Molina-Gomez et al. (2021), demonstrated the positive impact of tangible and intangible event attributes on loyalty through satisfaction, where tangible attributes generated greater influence.

Additionally, ambience appeared to be the most important individual event attribute in this study, with the strongest individual effect on visitors' behavioural intentions. This implies that the variety of programmes and entertainment, quality and variety of food and beverage, various

souvenirs and other products availability, as well as a feeling of safety and affordable prices, are the most vital elements that predict visitors' behavioural intentions. Thus, these findings explain to what extent experiencing event attributes can generate visitors' positive behavioural intentions in terms of repurchase intention, positive word of mouth, willingness to pay more, and strength of preference.

Moreover, event experience emerged as a significant moderator factor in the relationship between event attributes and behavioural intentions, supporting hypothesis H2. This indicates that experiencing hedonism, novelty, local culture, refreshment, meaningfulness, involvement, and knowledge acts as a key event component that successfully intervenes in the relationship event attribute - behavioural intentions. Thus, to enhance the positive behavioural intentions of event visitors, one should take into account event attributes and event experience as important combinations of event elements.

Therefore, this study contributes to the existing literature on experience measurement, adding to the knowledge of event experience, by focusing on factors affecting visitors' behavioural intentions as one of the event experience outcomes. It emphasizes the role of event attributes and event experience for positive visitors' behavioural intentions. What is more, it provides moderator analysis with new insights regarding the role of event experience construct. Specifically, the event experience construct is introduced as the variable that affects behavioural intents indirectly, thus improving our understanding of the event experience role. As shown in this study, event experience can indirectly enhance visitors' behavioural intentions by contributing to the visitors' positive perceptions of event attributes.

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