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CONTENTS

IE-2022:1 EDITORIAL

New approaches in the social sciences, mostly following the development of new technologies, are seizing more and more attention within leading scientific periodicals. As an example of this line of inquiry: What social and economic consequences can we expect of the metaverse, which promises to bring a new level of social connectedness, mobility, and collaboration to the world of virtual work? The metaverse draws on a vast ensemble of different technologies, including virtual reality platforms, gaming, machine learning, blockchain, 3-D graphics, digital currencies, sensors, etc. How can the metaverse, AI, and machine learning facilitate the achievement of the UN universal sustainable development goals?

"The metaverse is poised to reshape the world of work in at least four major ways: new immersive forms of team collaboration; the emergence of new digital, AI-enabled colleagues; the acceleration of learning and skills acquisition through virtualization and gamified technologies; and the eventual rise of a metaverse economy with completely new enterprises and work roles… While still in its early stages, the emergent metaverse provides an opportunity for enterprises to reset the balance in hybrid and remote work, to recapture the spontaneity, interactivity, and fun of team-based working and learning, while maintaining the flexibility, productivity, and convenience of working from home" (M. Purdy, in: *Harvard Business Review*, April 5, 2022).

All of these and other new approaches are especially welcome in this and future issues of *Intellectual Economics*. A similarly important field involves determining and evaluating the criteria for the most efficient blockchain-based secure authentication method, and suggests solutions to other similar problems.

Below is the traditional short presentation of the contents of the current issue of *Intellectual Economics* (IE-2022:1). The prevailing financial constructs and processes are researched in the article of D. Th. Phan et al. (Hungary); and R. Vorobei explores the determinants of stock price indices in Ukrainian agro-industrial companies. P. Pavon et al. (Spain) analyze comparable data on efficiency aspects of software piracy in the OECD Countries.

Another group of articles is dedicated to the environmental, social, and governance problems of corporate management and leadership: I. Zumene et al., from Latvia, on policy integration and implementation from the corporation perspective; and S. Angelis and P. Polycronidou, from Greece, on leadership and motivation in the Greek pharmaceutical industry. Interesting changes in the misery index of the Visegrad States in 2009 and 2020 (partly during the COVID-19 pandemic) are reviewed by J. Masarova et al. (Slovakia). V. Andriulis et al. (Lithuania) conclude that the aging population is a significant factor negatively affecting productivity measured by GDP per person but not by TFP, and stress its importance while identifying the factors that can reduce its negative impact.

The digital transformation of educational systems and the impact of ICT under the pandemic surge are detailed by an international group of researchers from the US and Russia (W. Strielkowski et al.). One article is dedicated to perspectives on the implementation of machine learning (O. Zyma et al., Ukraine), and another to Facebook (Nguyen Thi Loc et al., Vietnam), the latter being applied in developing the tourism industry.

Antanas Buracas

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BUILDING A CONCEPTUAL FRAMEWORK FOR USING BIG DATA ANALYTICS IN THE BANKING SECTOR

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Abstract. *Big Data and Big Data Analytics (BDA) are becoming trending technologies of the future. This topic has garnered considerable interest from researchers and businesses. However, BDA research in the banking sector has proven to be extremely limited and mixed. Addressing the challenges of BDA application and laying the foundation for BDA to improve banking efficiency raises significant questions about strategic management in the banking sector. Through a systematic review of the literature and a case study in Hungarian banks, this study intends to address the major inconsistencies in existing ideas about BDA applications. This study also proposes a conceptual model to evaluate the impact of factors influencing the use of BDA in the banking sector and investigates whether BDA affects the performance of banks. Our study finds that the use of BDA in the banking sector has to be aligned with the creation of dynamic capabilities that positively and directly affect banking in terms of the market and operational performance. Meanwhile, the dynamic capabilities created by BDA usage have a moderating impact on bank performance through improved risk management performance. Furthermore, this research helps managers focus on key factors, namely technological infrastructures, Big Data skills, data quality, and top management support, to boost the efficiency of using BDA.*

Keywords: *Big Data analytics; banking efficiency; risk management*

JEL index*: G21; O33*

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1. Introduction

Big Data is among the emerging technologies that national digital strategies target (OECD, 2015). For example, France invested EUR 150 million to support R&D in BDA and four other strategic digital technologies. Meanwhile, Germany has established two Big Data solution centers to boost Big Data applications in industrial applications, life sciences, and the healthcare sector (OECD, 2015). As one of the growing trends in the Industry 4.0 era that has revolutionized business management (Raguseo & Vitari, 2018), Big Data is becoming an increasingly prominent topic of research and is considered a revolutionary change in many industries (Wamba et al., 2017). Big Data is an important driving force for supply chain management and directly influences firms' business growth, especially in highly dynamic markets (Chen et al., 2015). Big Data can offer endless insights and valuable information to enhance the transformation process of firms that adopt it (Mikalef & Krogstie, 2020). Small and medium-sized enterprises (SMEs) use BDA to create business value in terms of strategic value, transactional value, transformational value, and informational value, which have a positive impact on the company's market performance and financial performance (Maroufkhani, Tseng et al., 2020).

The Big Data story far exceeds the limits of information technology (Braganza et al., 2017). Implementing Big Data initiatives would inevitably entail factors that are required to achieve its benefits; not simply buying a computer device. Successful businesses rarely improve their performance solely through the use of new technologies (Popovič et al., 2018). To be successful with BDA solutions, organizations must carefully consider technical factors and all relevant aspects related to strategic management, human resources, corporate culture, and government policies (Raguseo & Vitari, 2018). According to Maroufkhani and Tseng et al. (2020), SMEs need to focus on technological, organizational, and external support issues to successfully implement BDA. Meanwhile, for logistics firms, perceptions of the benefits of BDA and top-level management support greatly influence whether or not BDA is used (Lai, Sun & Ren, 2018). Consequently, to provide organizations with the effectiveness and competitive advantage of Big Data solutions, the planning and development of Big Data initiatives must provide business value such as strategic value, transactional value, transformational value, and informational value. Additionally, investing in BDA solutions is considered risky and expensive (Mikalef & Krogstie, 2020; Raguseo & Vitari, 2018); it also comes up against barriers during implementation. Alharthi, Krotov, and Bowman (2020) recognized the importance of removing barriers to achieve optimal results when using BDA. These barriers arise from technical barriers such as infrastructure readiness, data complexity, human barriers such as lack of skills, and organizational barriers such as confidentiality and organizational culture.

From an academic point of view, most of the research on BDA has been done in the fields of marketing (Erevelles et al., 2016), tourism (Miah et al., 2017), transportation (Zhu et al., 2018), smart cities (Ghani et al., 2019), healthcare (Wang & Hajli, 2017), and social media (Ghani et al., 2019). Unfortunately, research on the banking industry has been mostly restricted to BDA benefits by analyzing the best practices of BDAs among banks (Hung, He & Shen, 2020; Shakya & Smys, 2021; Srivastava & Gopalkrishnan, 2015; Sun et al., 2014) and literature reviews (Nobanee et al., 2021). Despite the importance of BDA in the banking industry and the high cost of infrastructure investment for BDA (Mikalef & Krogstie, 2020), there remains a paucity of evidence on the significant factors influencing the successful use of BDA. Moreover, although commercial

reports say a lot about the applications and effectiveness of BDA, little detailed investigation into how to build an implementation framework which leads to effective and efficient results from the use of BDA at banking institutions exists.

This research aims to answer the following research question: How can the benefits of BDA usage in the banking sector be boosted?

In order to answer the study question, a systematic literature review is utilized, integrating practical evidence from the banking sector to establish a conceptual model of the usage of BDA. This study aims to contribute to this growing area of research by clarifying the current contentions among researchers regarding Big Data resources and building a conceptual framework for using BDA in banking sectors through a combination of dynamic capability and the Technology-Organization-Environment (TOE) framework. Furthermore, this study describes the current situation of BDA in a European country.

This study is organized in the following way. The second part presents an overview of Big Data and BDA, practical applications of BDA in various industries, and related theories and research on the use of BDA at the organizational level. The third part is concerned with the systematic literature review method used for this study. Part four presents the conceptual framework, focusing on the combination of the TOE framework and dynamic capabilities theory. The final part is the conclusion, which provides the theoretical and practical contribution, limitations, and future directions.

2. Literature review

2.1. Big Data and BDA

Every day, a huge amount of data is created around the world. For example, Facebook creates around 500 terabytes of log data every day, Walmart uploads one million new customer transactions per hour, and Youtube uploads around 100 hours of video each minute (Kambatla et al., 2014). These figures reveal that larger and more diverse datasets, such as structural data (text, numeric), semi-structural data (voice, video, image), or nonstructural data (social tweets, comments), will be increasingly generated. There is no generally established definition of Big Data, but Big Data has become an attractive term in academia (Zhou et al., 2014). Therefore, researchers quite often come across new definitions of Big Data. Most studies acknowledge that the first definition of Big Data is from Laney (2001), who observed that Big Data implies data sets with the "3V" characteristics: volume, velocity, and variety. These characteristics make data governance exceed the limits of existing technology (Dumbill, 2013). Under a working definition from HMG (2014), Big Data refers to a large amount of complex data which requires more advanced analytical techniques to obtain meaningful insights from in real-time (HMG 2014). Likewise, the European Commission (2018) considers data to be Big Data if it has four characteristics: a large amount, different types, high velocity, and various sources. Over time, the 3V concept was gradually added to with another V, depending on each author's point of view (Wang, 2012). For instance, besides the generally accepted 3V characteristics of Big Data – volume, velocity, and variety – Zhou et al. (2014) added a new characteristic: veracity. Through a literature review, Sivarajah et al. (2017) even identified the 7V characteristics of Big Data: volume, variety, veracity, value, velocity, visualization, and variability.

From a managerial point of view, Big Data is increasingly being recognized as raw material in business operations. According to Fosso et al. (2015), Big Data's ultimate goal is to deliver business value and create a competitive advantage. For managers in large firms, the most impressive thing about Big Data is the opportunities and benefits that Big Data brings, and the infrastructure requirements (Schultz, 2013). This idea suggests an urgent need for a more in-depth understanding of how to use BDA effectively and what factors would play a key role in this process.

2.2. Studies in BDA at the firm level

Factors affecting BDA adoption/usage.

Previous research has established that different variables are related to the adoption/usage of BDA at the firm level (Table 1). By adopting the TOE framework, many recent studies (e.g., Chen et al., 2015; Maroufkhani, Wan Ismail & Ghobakhloo, 2020) have shown that technological, organizational, and environmental factors can play a key role in affecting the adoption of BDA at large or SME enterprises. However, these factors can vary depending on the type of industry or organization (Sun et al., 2018). Moreover, Verma and Chaurasia (2019) found considerable differences among adopters and non-adopters regarding how firms decide to use BDA. For adopters, technological factors (relative advantage, complexity), organizational factors (top-level management support, technology readiness, organizational data environment), and the environmental factor (competitive pressure) become more important in adopting BDA; meanwhile, for non-adopters, the significant factors are relative advantage, complexity, and competitive pressure. The factors affecting BDA usage/adoption require more research, as differences exist between sectors and countries (Maroufkhani, Wan Ismail & Ghobakhloo, 2020; Raguseo & Vitari, 2018; Sun et al., 2018).

Table 1: *Recent studies in factors influencing the use of BDA*

Authors	Country	Direct Factors (adoption intention/ actual usage)
(Chen et al., 2015)	161 firms worldwide	Expected benefits, technological compatibility, top-level management support
(Sun et al., 2018)	Not given	Twenty-six identified factors influence the adoption of business intelligence and analytics
(Gangwar, 2018)	478 firms India	Relative advantage, compatibility, complexity, top-level management support, organizational size, competitive pressure, vendor support, data management, data privacy
(Lai, Sun & Ren, 2018)	210 firms in China	Perceived benefits, top-level management support
(Park & Kim, 2019)	Korean firms	The strongest determinants of adoption are: the benefits from Big Data, technological capabilities, financial investment competence, and data quality and integration

(Verma & Chaurasia, 2019)	Indian firms	The relative advantage, complexity, compatibility, top-level management support, technology readiness, organizational data environment, and competitive pressure (for adopters)
(Maroufkhani, Wan Ismail & Ghobakhloo, 2020)	112 SMEs in Iran in the manufacturing sector.	Technology and organizational factors are the most influential in BDA adoption

The use of BDA in firms

The benefits brought from BDA have been witnessed in many areas, such as the finance and banking sector, supply chain, health care, and sport (Ali et al., 2020; Hung, He & Shen, 2020; Troilo et al., 2016). BDA benefits both incumbent firms and start-up firms. While traditional firms could use BDA to capture new opportunities, improve products and services, and enhance operations, they could also deliver new products and services, creating new business models through BDA (Hung, He & Shen, 2020). In addition, BDA could bring SMEs comprehensive insights, enable faster and more accurately decision-making, and reduce operational cost (Maroufkhani, Tseng, et al., 2020). The applications and features that BDA offers vary from sector to sector. For example, administrators can improve public transit efficiency in the transportation sector in terms of traffic scheduling, planning, or scheduling optimization based on data analysis obtained from Taxi trip data, GPS, GIS and mobile phone data, sensors, and web data (Welch and Widita, 2019). For the healthcare sector, data can come from clinical data, biometric data, financial data, or data from social media, which are then processed and analyzed for diagnostics, telemedicine, patient treatment, or personalized medicine (Batko and Ślęzak, 2022).

BDA and banking research

Banks are one of the domains that are valued as early IT adopters in data-driven decision-making (Hung, He & Shen, 2020). Storing large amounts of customer data about interaction channels is a major competitive advantage for banks (Hung, He & Shen, 2020). In the age of Big Data, there are three recognizable trends in the application of BDA in banks. Firstly, by using large volumes of data on demographics, financial situations, transaction behaviors based on over-the-counter transaction channels, ATMs, mobile apps, internet channels, and social media, banks can better understand customer behavior, thereby improving the effectiveness of marketing activities (Ali, 2020; Hung, He & Shen, 2020). From a customer perspective, Giebe, Hammerström, and Zwerenz (2019) suggest that using BDA can increase customer loyalty through customer advisory services. Second, banks are using Big Data in volume, velocity, and variety to detect fraud and manage risk more accurately (Shakya & Smys, 2021; Srivastava & Gopalkrishnan, 2015). Third, compared to traditional data analysis, BDA allows banks to process large amounts of data faster (Sun et al., 2014), which contributes to improving their efficiency. Unfortunately, however, research on Big Data in the banking sector is still rather modest.

BDA is among the leading future technologies (Morabito, 2014); however, the popularity of BDA in Hungary is still lagging behind other countries (Kő, Fehér & Szabó, 2019). For an in-depth understanding of the usage of BDA in the Hungarian banking sector, we conducted a survey in December 2021 with the assistance of the Hungarian Banking Association. Primary inclusion criteria for selecting participants were at least five years of experience in digital trans-

formation and Big Data projects related to banking sectors. Among these fourteen experts, there were three researchers from universities and fintech centers, one data analytics consultant, one manager at the Hungarian central bank, and nine high and medium-level managers at banks in Hungary. As a result, opinions from these experts provided us with high reliability and validity of evidence. The first question elicited information on the importance of BDA, and this survey among experts in the Hungarian Banking sector confirms that BDA plays a particularly significant role in the banking industry. Almost 50% of respondents agreed that banks might use BDA in the future; meanwhile, more than 40% said that banks are using BDA in some functional departments, while just one bank manager said they were testing BDA projects. In terms of the cost benefits, half of the respondents indicated that there is no cost reduction, or none that may be demonstrated yet, with BDA projects. However, more than 30% agreed that banks could achieve up to 10% cost reduction. Notably, one respondent who works on the board of directors in a large bank agreed that their bank could achieve around 40% cost reduction with BDA solutions. More than 50% of respondents indicated that risk management, fraud and crime prevention, sales and marketing, customer relations, and customer experiences are the most adopted departments in banks. Data quality, top-level management support, and BDA skills are the most critical factors influencing the success of BDA implementation (Figure 1). All respondents agreed that BDA skills combine IT skills, data science skills, and business skills. Among them, programming and problem-solving skills are the most important skills for BDA.

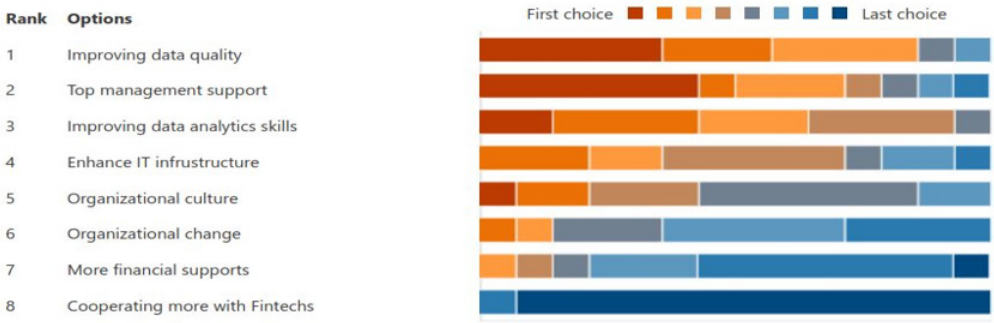

Figure 1: *The ranking of significant factors in the successful use of BDA at banks*
Source: *Authors' elaboration*

3. Methodology

This study uses a systematic literature review to gain insights into the adoption and use of BDA among enterprises. Firstly, the authors searched for relevant studies using Scopus and Web of Science, two of the most comprehensive databases in this field. Next, keywords related to our topic were applied, such as Big Data and BDA, combined with use, usage, adopt, and adoption in the field of banking or finance. Criteria for selecting publications were as follows: (1) publication in journals; (2) language in English.

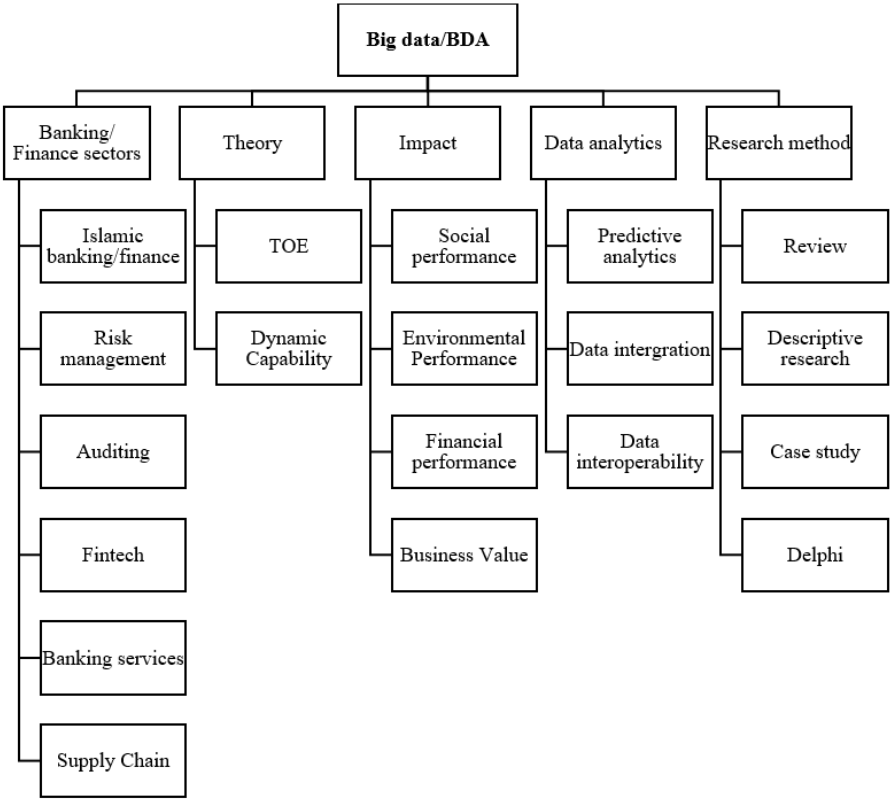

Figure 2: *The main themes from BDA studies in the banking sector*
Source: *Keywords collected from Scopus/ the Web of Science*

The authors found 20 studies in SCOPUS and 20 studies from the Web of Science database. For the purpose of analysis, abstract reviews were conducted, after which only 12 studies were included in the following part. Figure 2 demonstrates that previous studies mostly use the case study and review method to describe the application of BDA in the banking sector. Among the most common functions mentioned in previous studies are risk management, Islamic banking, banking services, and supply chain finance. Research regarding the use of BDA in banks is very limited. Therefore, article references were searched further for additional relevant publications on Google Scholar.

4. Conceptual framework

The development of the research model

A conceptual framework was created to explain how classic theory has advanced current research. Ravitch and Riggan (2016) suggest that conceptual frameworks should explain why and how important topics should be studied. An effective conceptual framework should convince future researchers of the importance of research by suggesting and highlighting the most important features of relationships and data (Ravitch & Riggan, 2016). Jabareen (2009) argues that conceptual frameworks should generate coherent new interpretations within a particular field of study.

This part of the study aims to explain how the conceptual framework has evolved. The resource-based view (RBV) is among the most common and effective theories for studying the impact of information technology on performance. Barney (2014) explained that the firm's performance depends on the characteristics/quality of its resources and capabilities. Barney (1991) also presented a classification of firms' resources, including physical capital resources, human capital resources, and organizational capital resources. Theoretically, firms use strategic resources that are valuable, rare, inimitable, and non-substitutable (VRIN) to create sustainable competitive advantage (Barney, 1991; Eisenhardt & Martin, 2000). To evaluate the impact of BDA on firm performance, some authors have relied on the resource-based view theory. According to Gunasekaran et al. (2017), BDA assimilation is considered a capability that provides a competitive advantage for organizations in terms of operating performance and supply chain performance. This view is supported by Maroufkhani, Wan Ismail, and Ghobakhloo (2020), who found that BDA adoption functions as a form of knowledge capability and an intangible resource for firms to enhance their performance. In terms of creating business value from BDA, Raguseo and Vitari (2018) acknowledge that a BDA solution brings higher business value and higher competitive advantage. Meanwhile, Müller, Fay and vom Brocke (2018) suggest that by using BDA as an asset, firms can improve their productivity by around 3–7%. Drawing on RBV, Wamba et al. (2017) confirm that BDA capability is the critical organizational capability to provide a sustainable competitive advantage. Built from three sub-IT capabilities, BDA capability delivers a direct positive impact on business processes and firm performance.

However, researchers also pointed out the two biggest limitations when applying RBV in research on Big Data initiatives. First, RBV fails to address the influence of market dynamism and firm evolution over time (Wang & Ahmed, 2007). Second, data is considered the core resource in Big Data solutions, but data access and use by many parties is now possible (Braganza et al., 2017). Braganza et al. (2017) concluded that under the analytical lens of RBV, the core resource in Big Data initiatives is data, which does not satisfy the rarity characteristic. The authors argue that, in Big Data initiatives and projects, data can be obtained by third parties, vendors are also ready to provide Big Data solutions to buyers when a business uses BDA, and competitors also have BDA implementation capabilities. Therefore, the influence of BDA as a core resource on sustainable competitive advantage will be reduced.

Recognizing some drawbacks of RBV, Braganza et al. (2017) called for further research on Big Data with more of a focus on dynamic capabilities theory. Dynamic capabilities theory has been extended from RBV, and has attempted to explain how firms achieve competitive advantage in dynamic markets (Eisenhardt & Martin, 2000). Dynamic capabilities are viewed as an emerging and potentially integrative approach to understanding new sources of competitive advantage

(Teece, Pisano & Shuen, 1997). RBV pays attention to resources, while dynamic capabilities emphasize organizational and strategic routines (Eisenhardt & Martin, 2000).

Wang and Ahmed (2007) refer to resources as the firm's foundation, and capabilities can deploy these resources to attain the desired goal. These resources and capabilities cannot retain or satisfy VRIN characteristics, and they cannot create competitive advantages for firms in a dynamic market environment. Wang and Ahmed (2007) noted that "dynamic capabilities emphasize a firm's constant pursuit of the renewal, reconfiguration and re-creation of resources, capabilities and core capabilities to address the environmental change." They also identified the three most important factors contributing to dynamic capabilities: adaptive capability, absorptive capability, and innovative capability; through these capabilities, a firm can "integrate, reconfigure, renew and recreate its resources and capabilities" to gather changes from external factors (Wang & Ahmed, 2007). Following this line of thought, by collecting relevant data from internal and external sources, BDA allows banks to understand their customers more deeply, therefore helping banks to follow up and perceive market/customer changes better, even in real-time. In addition, banks can make changes and upgrade their products/services to meet new customer needs while helping to improve and create more effective marketing campaigns (Mikalef & Krogstie, 2020). This means that using BDA is closely aligned with creating adaptive capability. For example, Disney uses Big Data obtained through RFID mounted on bracelets to analyze customer behavior, provide better experiences for park visitors, and improve its marketing effectiveness (Van Rijmenam, 2014). Some authors have applied dynamic capabilities theory as a foundation for Big Data research (Ali et al., 2021; Ghasemaghaei et al., 2017). By employing dynamic capabilities theory, Ghasemaghaei et al. (2017) found that data analytics work as a dynamic capability that influences the agility of enterprises.

This study uses dynamic capabilities theory as the foundation for BDA usage on firm performance, where BDA usage is conceptualized as a dynamic capability of a firm. Using BDA is considered an organizational capability because this new technology allows businesses to process and exploit their Big Data resources to sustain competitiveness, such as market performance and operational performance (Gupta et al., 2019). Some tools from using BDA among firms are considered replaceable, homogeneous, or, as far as Eisenhardt and Martin (2000) observe, as commonality. Therefore, the use of BDA across firms reflects the key characteristics of dynamic capabilities suggested by the literature: commonalities in key features, coupled with idiosyncrasy in detail (Eisenhardt & Martin, 2000; Wang & Ahmed, 2007). The common feature in using BDA across firms, for example, is successful customer intelligence. By integrating data types from structured to unstructured or using analytical tools such as data mining, firms can understand customer behavior based on customers' activity on their website and mobile apps. However, idiosyncrasy characteristics in dynamic capabilities such as BDA usage are expressed in the differences between firms in the service/product development process, the business process, and customer service. For example, even using the same BDA, each bank utilizes BDA to provide different products. Therefore, the concept of dynamic capabilities has now been greatly expanded compared to the original one. Helfat et al. (2007) emphasized dynamic capabilities associated with changes to differentiate from normal operational capabilities. Dynamic capabilities refer to "the capacity of an organization to create, extend, or modify its resource base purposefully" (Helfat et al., 2007, p. 1). The capacity to change resource bases creates many advantages for firms, such as:

creating new products, models, and production processes. Therefore, to maximize the benefits of dynamic capabilities, firms need to fully evaluate their internal and external factors (Mikalef & Krogstie, 2020). Regarding IT capabilities, Kohli and Grover (2008) advocate that IT capabilities are frequently built via means of combining specific physical/IT infrastructure with both human and organizational resources. Therefore, we assert that the dynamic capabilities resulting from the use of BDA are shaped by the combination of core resources/capabilities. Therefore, this study conceptualizes BDA usage as a competitive capability facilitated by four core resources/capabilities, such as data quality, technical infrastructure resources, management support, and data analytics skills. For these reasons, it is necessary to combine the TOE framework with dynamic capabilities when studying BDA.

Few previously published studies have combined dynamic capabilities and the TOE framework. The TOE framework was introduced in 1990 by Tornatzky and Fleischer, and has become a prominent theory in adopting information technology to explain IT adoption at the firm level (Lai, Sun & Ren, 2018). According to Tornatzky and Fleischer (1990), many factors that impact innovation adoption in firms can be grouped into three main contexts: technological, organizational, and environmental. The biggest advantage of the TOE framework is that it offers flexibility in research; researchers can remove or add related variables into their studied model depending on the specific type of technology or subject. Gupta et al. (2019) evaluated how ERP and Big Data predictive analytics impact firm performance by applying dynamic capability. Research suggests that building BDPA is influenced by three factors: data, managerial, and technical skills. Of the many factors influencing BDA use, top management support is found in most previous studies. Meanwhile, managerial and technical skills factors were suggested from studies in the banking sector (Ali et al., 2021). Our study aims to combine this key factor from previous studies with three other factors that affect BDA use: IT infrastructure readiness, BDA skills, and data quality.

Proposed research model

Based on the above argument, this part of the study explains and presents a proposed research model for BDA in the banking sector. Our model combines four important factors from the TOE framework and dynamic capabilities (Figure 3).

Prior research indicated that technological readiness, technological competence, or organizational readiness is the state of being prepared, both in terms of facilities and skills, to ensure that firms qualify when using new technologies (Maroufkhani, Wan Ismail & Ghobakhloo, 2020; Wang, Wang & Yang, 2010). In addition, for BDA, IT infrastructure provides the technical basis for the smooth implementation of Big Data initiatives (Lai, Sun & Ren, 2018; Park & Kim, 2019). Therefore, small and medium-sized enterprises need adequate technical resources, and enterprises cannot implement BDA without adequate technical resources (Maroufkhani, Wan Ismail & Ghobakhloo, 2020). Therefore, in Figure 3, our research supports the idea that IT infrastructure readiness will have a positive impact on the usage of BDA.

Data characteristics imply the size of data in terms of volume, velocity, and variety. When banks face the characteristics of Big Data, they tend to use BDA to optimize what data brings (Ghasemaghaei, 2018). In the modern world, the internet and mobile phones allow banks to interact more frequently with customers and to collect more data. These data increase volume, velocity, and variety in structural/semi-structural or unstructured formats. In addition, the de-

velopment of technology and collaboration with third parties will enable banks to retrieve more data from diverse sources with different data types. Research from Lai, Sun, and Ren (2018) shows that when data becomes larger in volume, is created at higher speed, and is stored in a more diversified way, more enterprises tend to adopt BDA. However, enterprises are more concerned with data quality and Big Data integration into BDA usage (Park & Kim, 2019). Data quality refers to the consistency and integrity of the collected data (Kwon, Lee & Shin, 2014). This means that banks with higher data quality will increase their use of BDA. As a result, this study supports the idea that data quality will positively influence the usage of BDA at banks.

Implementing and maintaining complex BDA projects requires staff knowledge and skills (Ali et al., 2021; Gangwar, 2018). Grossman and Siegel (2014) observed that BDA techniques combine data analysis, business knowledge, and IT skills. BDA personnel should be capable of dealing with emerging technologies such as natural language processing, text mining, video/voice/image analytics, and visual analytics (Schultz, 2013). Park and Kim (2019) suggested that the relevant Big Data management and analytic competency can be achieved through training and external experts. Verma and Chaurasia (2019) agreed that employees or data scientists should use high-level data science practices to understand the business domain in order to comply with BDA requirements and provide actionable business outcomes. Therefore, BDA technology is one of the main factors driving enterprises to implement BDA solutions (Verma & Chaurasia, 2019). Maroufkhani, Tseng et al. (2020) also found that BDA skills play the most significant role in using BDA. Therefore, it is highly likely that BDA skills have a positive impact on the usage of BDA in the banking sector.

Liang et al. (2007) explain that the commitment of top-level management includes both the beliefs and participation of top-level managers. Top-level management's beliefs show managers' beliefs about the business benefits of IT innovation, while top-level management participation demonstrates managers' support by creating visions, strategies, goals, and standards for IT innovation. The beliefs and participation of top-level management have a significant impact on how organizations embrace IT transformations. Mikalef and Krogstie (2020) argued that it is difficult for firms to achieve higher levels of innovation capability without the support of management. Another study also confirmed the strategic importance of top-level management support for BDA use (Chen et al., 2015). When top-level managers understand the benefits of BDA, they will support the use of BDA in many forms, such as by: building infrastructure, upgrading BDA skills, and providing financial support (Lai, Sun & Ren, 2018). Using BDA requires gathering, analyzing, and understanding data from many different enterprise functions so that top-level management support will promote and solve communication and coordination problems (Chen et al., 2015; Verma & Chaurasia, 2019), reducing conflict/resistance (Gangwar, 2018). Ali et al. (2020) found that banks' commitment to Big Data had significant positive impacts on their environmental and financial performance. Meanwhile, managerial skills play a significant role in creating BDA capability at banks (Ali et al., 2021). Therefore, our study recognizes that BDA usage will be more beneficial with stronger top-level manager support.

Ghasemaghaei's (2018) study identified the benefits of BDA in providing better products/services and improving customer experience. Many large banks are using Big Data to understand customers' awareness, perceptions, and satisfaction (Schultz, 2013). For example, banks can analyze unstructured or semi-structured data and identify customer needs or concerns through

website clicks or voice recordings from call centers (Schultz, 2013). A major purpose of using Big Data at the Bank of America is to improve the quality of customer information (Schultz, 2013). Through understanding more about customers, banks would be able to explore new markets more quickly, introduce new products or services into the market faster, achieve a higher success rate of new products or services, and gain more market share than their competitors. Using large volume, real-time data and different data types could help firms provide better products/services and enhance their efficiency above that of their competitors (Q. Ali et al., 2020; Ghasemaghaei, 2018). Process-level performance in the Ghasemaghaei (2018) study is consistent with the previous study from Ramanathan et al. (2017), who concluded that it is likely that business analytics has a significant impact on business performance, which is most noticeable at the process level. Like other IT solutions, Big Data can produce valuable advances in the time required to complete a computing task. For example, it is easy to see that business analytics provides more insight into customers, thereby performing more effective marketing campaigns. Likewise, a recent report from the Magyar Nemzeti Bank also points out that most financial institutions expect AI, Big Data, and cloud technology to have the most significant impact on business processes (Magyar Nemzeti Bank, 2020). Belhadi et al. (2019) argued that using BDA helps improve intra-and inter-organizational transparency and accountability, helps managers make decisions more quickly and accurately, and improves employees' efficiency. Similarly, a positive relationship between BDA usage and operational performance was found from a previous study by Gupta et al. (2019).

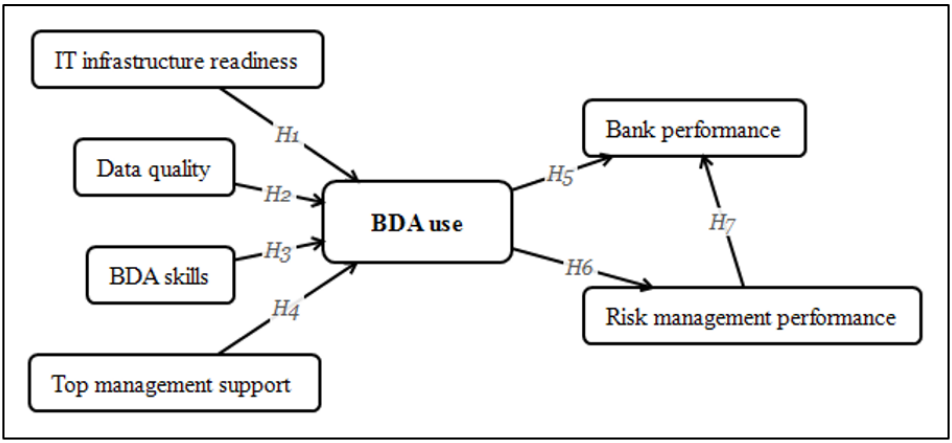

Figure 3: *Conceptual framework*
Source: *Authors' elaboration*

Risk management is one of the key functional differences between the banking industry and non-financial firms (Aebi, Sabato & Schmid, 2012). Therefore, technological innovations will influence the risk management sector in banking operations. In particular, the wave of applications for BDA technologies will benefit risk managers at banks to make smarter decisions at lower

costs (Härle, Havas & Samandari, 2016). For instance, BDA analyzes customers' information to help banks make accurate decisions about the provision of services such as retail lending and financial crime detection.

Figure 3 shows that IT infrastructure readiness, BDA skills, data quality, and top-level management support are the main factors influencing BDA usage in banks (H1, H2, H3, H4). Furthermore, the usage of BDA in this model refers to the ability to create dynamic capabilities such as adaptive, absorptive, and innovative capabilities. Accordingly, the use of BDA at banks can improve banking performance in two ways. Firstly, it directly enhances the bank's performance in terms of market and operational performance (H5). Secondly, the usage of BDA at banks can improve risk management performance and subsequently help improve the bank's performance (H6, H7).

4. Conclusion

4.1. Theoretical contributions

This article aimed to theoretically study the impact of BDA on bank performance. Building on the arguments and analysis of previous studies, this study provided a deeper understanding of the factors influencing the successful use of BDA and the impact of the use of BDA on firm performance. Moreover, this study is one of the first papers to attempt to review the implementation of BDA in the banking industry. The combination of the TOE framework and dynamic capabilities is used to explain the relationship between TOE factors, the data dimension, BDA dynamic capabilities, risk management, and bank performance. Several factors from the TOE framework can be indicators of success when using BDA solutions: IT infrastructure readiness, BDA skills, data quality, and top-level management support. Therefore, the use of BDA is highly likely to increase the effectiveness of banks' risk management. In addition, many theoretical studies have shown methods to enhance BDA capability, mainly based on the resource-based view and dynamic capabilities theories. This study showed that BDA usage is inconsistent with four assumptions of VRIN in RBV theory, but is consistent with the three capabilities in dynamic capability: adaptive capability, absorptive capability, and innovative capability. Therefore, we suggest that banks should carefully consider these capabilities when planning to use BDA. This means that the practical use of BDA should be directed towards creating adaptive, absorptive, and innovative capability. According to our conceptual framework, the use of BDA to create these dynamic capabilities will affect bank performance. This study proposes a model for assessing business-influencing factors, especially in the banking sector, based on the perspective of the banking industry combined with dynamic capability and the TOE framework. Arguments and evaluations from the built framework will help future researchers to reduce research time when building research models.

4.2. Practical contributions

This study provides a more realistic view of BDA in the banking sector. Whether BDA solutions will become a trend or something practical for business – particularly in the banking and finance sectors, where competition between established banks and new entrants such as tech giants is intensifying – remains to be seen. This study is the first report on the practical use of BDA

in the banking sector. The opinions of bank managers and experts confirmed that BDA plays a particularly important role in the operations of banks. BDA is used in functional areas such as risk management, fraud, crime detection, sales and marketing, and customer relationships. This means that there is a lot of room for banks or Big Data solution providers to advance BDA to improve other areas. The influencing factors presented in this study will help bank managers to comprehensively evaluate the projects of Big Data initiatives. The results of this paper also suggest that bank executives should pay more attention to the organizational aspects of BDA, such as developing analytics skills and improving current IT infrastructure/data quality. In particular, dedicated support from top-level management through commitment and a focus on Big Data initiatives will ensure the effective use of BDA.

4.3. Limitations and future directions

A limitation of this study is that its scope is limited in terms of the banking industry. Further research is needed to investigate how BDA use affects other sectors. Another limitation is that our article proposes a framework based on sound expert opinion and literature review. We suggest that more quantitative studies are required to estimate the relationship of significant factors, the use of BDA, and its impact on banking.

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DETERMINANTS OF UKRAINIAN AGRO-INDUSTRIAL COMPANIES' STOCK PRICE MOVEMENTS

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Abstract. *Economic activity in the sphere of agriculture generated from 7.5% to 12.4% of Ukrainian GDP during 2010–2020. The financial health and stability of system-forming agro-industrial companies strongly influence socio-economic outcomes at the current stage of Ukrainian development. The market capitalization of agro-industrial enterprises, as well as the evolution of their stock prices, reflects the efficiency of economic activity and management decisions. The constant evaluation of Ukrainian agro-industrial companies' stock price movements, along with the determinants that cause their change, allows a clear understanding to be obtained for strategic management of the current market position of the company as well as when forming a vision for the next steps of development. Consequently, the aim of this article is to review the evolution of the largest Ukrainian agro-industrial companies' stock prices, to empirically evaluate the interconnection of selected determinants with stock price changes, and to formulate conclusions based on the analysis conducted. To achieve the research aims, statistical methods such as correlation and multiple regression analysis were used, as well as comparative economic analysis.*

Based on the study results, it is possible to conclude that during 2010–2020 the stock prices of selected agro-industrial companies had uneven paths of evolution, but there was an overall downward shift in 2014 during the economic crisis in Ukraine. With selected multiple regression independent variables, it is possible to explain more than 70% of stock price variation and to closely capture the general trend of 2010–2020 stock price movements. The study results can be used by the management of agro-industrial companies to make data-based strategic decisions.

Keywords: *capital, market capitalization, stock prices, share capital, financial resources.*

JEL Code: G12, Q13, Q14

Introduction

The agriculture sector is one of the most important parts of the modern Ukrainian economy. Economic activity in sphere of agriculture generated from 7.5% to 12.4% of GDP during 2010–2020, and at the current stage this sector is one of the most important for the national economy. Considering the continuous development of the Ukrainian economy based on market principles and taking into account the globalization of trade, it is important to have sustainably growing domestic agro-industrial companies with competitive products in internal as well as external markets. The largest agro-industrial companies in Ukraine have public status. Their public company statuses and IPOs have already allowed them to raise long-term resources and increase their equity, and have had a positive reputational effect due to the transparency in their actions and the availability of financial information. Market capitalization and stock prices are indicators that reflect the financial health of the enterprise, and their sustainable growth can allow them to raise additional equity or debt financing at lower cost, as well as having more benefits for shareholders.

The concept of companies' valuation and its connection with stock prices has been described in the scientific works of Collins (1957), King (1966), Rappaport (1987), Chen, Roll, and Ross (1986), and others. The writings of these authors contain the fundamental basis of these scientific subjects, the estimation of determinants affecting stock prices and the developed methodology of the impact of its valuation, and theoretical and practical aspects of the dependencies of stock price on financial performance. Collins (1957) considered net profit, dividend, and book value as factors affecting the stock prices of American banks, while Chen, Roll, and Ross (1986) evaluated the effect of industrial production, inflation, risk premium, market index, consumption, and oil prices on stock returns. Further development of research on stock price impactors and empirical evidence for specific countries was provided in the works of Gill, Biger, and Mathur (2012), who considered, among others, earnings per share, book value, and dividend coverage as stock price determinants for American firms. Narayan and Narayan (2010) tested the relationship of oil prices and the exchange rate with the stock price movements of Vietnamese companies, while Sharma (2011) examined earning per share, book value per share, price earnings ratio, dividend per share, dividend payout, dividend yield, size in terms of sale, and net worth as predictor variables for stock price movements. Yee and Thaker (2018) estimated earnings per share and dividend per share as being significantly related to Malaysian manufacturing companies' stock prices.

Different aspects of Ukrainian agro-industrial companies' financial stability, performance and competitiveness were considered in the scientific works of Davydenko (2015), Ilchuk et al. (2019), Dibrova et al. (2020), and others. The writings of these authors contain the basis for research into the Ukrainian agro-industrial sector.

There is no consensus on the scope of determinants that fully reflect stock price movements, and such a consensus could not exist as informational and political factors as well as emotional aspects of traders, their personal goals, and strategy are hard to measure with figures. However, according to previous studies it is possible to explain general trends and correlations between stock price movements and certain determinants which are relevant for a specific market, industry, or company.

This research is based on three Ukrainian agro-industrial producers with different produc-

tion specializations and market capitalization, as stated in Table 1.

Table 1. *Information about the companies in this study*

Company	Stock exchange	Stock-exchange ticker	Market capitalization as of beginning of 2022, USD	Production specialization
Astarta	Warsaw Stock Exchange	AST	~ 250 million	Agriculture and sugar
Kernel	Warsaw Stock Exchange	KER	~ 1,100 million	Agriculture and sunflower oil
MHP	London Stock Exchange	MHPC	~ 700 million	Agriculture and poultry

For this study it was decided to select four factors: book value per share; trailing 12-month earnings per share; exchange rate; and the commodity price that is relevant for company operations. The main research objective is to answer the question of if it is possible to explain the stock price movement of Ukrainian agricultural producers using a multi-regression model with selected factors, and to which degree the factors correlate with stock price changes.

This paper is organized in the form of case study with the following objectives:

- to analyze the movements dynamics of selected Ukrainian agro-industrial companies' stock prices during 2010–2020;
- to select financial performance and macroeconomic variables in order to create an econometric model aimed at explaining the stock price movements of selected Ukrainian agro-industrial companies;
- to present, examine, and evaluate the results of the created models;
- to provide conclusions and proposals based on the obtained results.

Information sources for the case study were: quarterly and annual financial statements of selected Ukrainian agro-industrial companies; State Service of Statistics data; Federal Reserve Economic Data; data on historical share prices from Stock exchange websites; and scientific articles from international publications.

The achievement of the research objectives was based on the creation of models to evaluate the impact of selected determinants on stock price movements by applying correlation analysis, the multiple regression technique, and a comparative economic analysis.

Consequently, the aims of this research are: to review the evolution of the stock prices of the largest Ukrainian agro-industrial companies; to empirically evaluate the interconnection of selected determinants with stock price changes; and to formulate conclusions based on conducted analysis.

Literature review

Many researchers have attempted to empirically explain and predict price movements in stock markets using various research methods with different sets of determinants and factors.

Chen, Roll, and Ross (1986) used a time series of industrial production, inflation, con-

sumption, risk premium, and oil prices as factors to explain stock returns. As a result, it was found that industrial production, changes in risk premium, and inflation are significant in explaining stock returns.

Ma and Kao (1990) analyzed the impact of exchange rate change on stock price movements. It was concluded that stock prices generally benefit from domestic currency appreciation.

Abdullah and Hayworth (1993) used VAR model to analyze price fluctuations on stock market. They discovered that such factors as budget deficits, long-term interest rates and money growth are causal factors of stock price movements.

Bilson, Brailsford, and Hooper (2000) investigated the impact of macroeconomic variables to explain equity returns in 20 emerging stock markets. Such variables as value-weighted world market index, money supply, goods price, real activity, and exchange rate were used within a multifactor model. Some evidence was found that the mentioned variables were significant with emerging market stock returns; however, the degree of significance of each factor varied from country to country. In terms of degree of significance, exchange rate was considered the most common factor for selected emerging markets.

Chan and Hameed (2006) estimated if earnings forecast from analysts affect stock prices in emerging markets. According to their research, firms' earnings forecasts in markets with wide analyst coverage significantly affect stock price movements.

Chen and Zhang (2007) provided empirical evidence that stock price movements are related to movements in profitability, capital investment, growth opportunities, discount rate and earnings yield.

Ghosh et al. (2010) analyzed, with multiple regression, the interconnection between share price changes on the Bombay Stock Exchange in India and a set of factors: exchange rate, oil price, gold price, call money rate, cash reserve ratio, and foreign direct investment. According to their research, exchange rate and call money rate are the factors that have the most significant impact on stock price changes, while other factors have insufficient influence.

Benaković and Posedel (2010) investigated the relationship between macroeconomic factors and stock return in the Croatian market. They used a multiple regression model with 5 macroeconomic determinants: inflation, interest rate, market index, industrial production, and oil prices. As a result of their analysis, it was concluded that the market index of the Zagreb stock exchange was the common, statistically significant factor for all 14 selected Croatian companies. Inflation and interest rate were also statistically significant for 6 and 7 companies, respectively, while other factors were considered statistically non-significant.

Sharma (2011) empirically evaluated the relationship between stock prices and company performance indicators such as: earning per share, book value per share, price earnings ratio, dividend per share, dividend payout, dividend yield, size in terms of sale, and net worth for 1993/94–2008/09. As a result of their research, it was found that earning per share, book value per share, and dividend per share have a significant influence on stock price movements.

Gill, Biger, and Mathur (2012) also used multiple regression to analyze the interconnection between the share prices of American firms and selected explanatory variables: book value per share, earnings per share, dividend coverage ratio, dividend per share, dividend payout ratio, price-earnings ratio, firm size, CEO duality, internationality, and firm industry. They established that earnings per share, price-earnings ratio, book value per share, dividend per share, interna-

tionality of the firm, and CEO duality have an impact on the equity share prices of American firms.

Rajhans (2013) used multiple regression to identify factors affecting the stock prices of Indian firms. It was concluded that profit, fixed assets, net sales, and WACC have a significant impact on firms' market capitalization.

Avdalovic and Milenković (2017) performed research with data from 2010–2014 using a multiple regression model with stock price as a dependent variable, and selected independent variables such as: total assets of the company, return on equity, return on assets, earnings per share, book value, leverage, price-earnings ratio, and price to book ratio. They concluded that in the observed model, assets, return on assets, earnings per share, book value, price-to-book ratio, and leverage were considered to be statistically significant predictors of stock price movements.

Yee and Thaker (2018) investigated the stock price movements of 30 companies from the manufacturing industry in Malaysia. They used separate multiple regression models with firm-specific variables and macroeconomic variables as predictors. In the firm-specific model, the following were included: earnings per share, dividend per share, and return on equity as independent variables; in the macroeconomic model – interest rate, exchange rate, money supply, and GDP. As a result, it was concluded that all firm-specific determinants have a significant impact on stock prices, while macroeconomic indicators were considered insignificant in their research.

Considering the research results of the reviewed literature, it can be concluded that there is no consensus in the set of determinants that can universally explain the stock price movements of any company; however, many empirical findings were obtained relating to firm-specific and macroeconomic factors that influence stock prices.

For this paper it was decided to use a combination of firm-specific (book value per share, earnings per share, and firm-specific commodity price) and macroeconomic (exchange rate) factors to evaluate their influence on the stock price movements of selected Ukrainian agricultural companies.

Methodology

In the case study, a multiple-regression model was used to evaluate the impact of a selected series of indicators that affect share price: book value per share, trailing 12-month earnings per share, exchange rate, and main company operations' commodity price. Multiple regression can establish the level of significance and the relative predictive importance of independent variables (R^2). Due to the small data sample, the statistical significance of the variables is considered at $p < 0.2$.

Considering the fact that the publication of financial reports has a delayed impact on share price (Callen et al., 2013), it was decided to derive weighted average stock price from the series over the quarter after the reporting period. All other series of variables for the multiple-regression model represent companies' quarterly reporting periods. The time series is 1 quarter.

The following equation represents the model that was used in the case study research:

The definitions of selected variables and the data sources from which they were collected are stated in the Table 2.

Table 2. *Definitions of variables*

Variable	Abbreviated variable	Definition	Data sources
Basic Series			
Stock price	SP	Daily stock price during the quarter after reporting period, translated to USD	Warsaw Stock Exchange – *gpw.pl*
Volume	VOL	Daily stock trade volumes during the quarter after the reporting period	Yahoo! Finance – *finance.yahoo.com*
Book value	BV	Equity available to common shareholders	Financial reports from official websites: *astartaholding.com* *kernel.ua* *mhp.com.ua*
Net profit	NP	Net profit over the reporting period (quarter)	
Average shares outstanding	ASO	The average number of current shares in the company's stock outstanding over the reporting period	
Exchange rate	ER	Time series of USD/UAH exchange rate	Yahoo! Finance – *finance.yahoo.com*
Main company operations' commodity price	MCOCP	Time series of main company operations' commodity price	Federal Reserve Economic Data: *fred.stlouisfed.org/series*
Derived Series			
Daily average stock price	DASP	A figure that represents the daily average price of a stock	
Weighted average stock price	WASP	A figure that represents the average price of a stock, adjusted for its trade volume	
Book value per share	BVPS	A figure that represents the value of a company's equity on a per-share basis	
Trailing 12-month earnings per share	EPS (TTM)	A figure that represents the total earnings of a company over the last 4 quarters on a per-share basis	

Alongside multiple regression, correlation analysis was performed. With correlation analysis, it is possible to examine the strength of the linear relationship between variables and establish their interrelation. The theoretical correlation impacts of the determinants on stock price movements are summarized in Table 3, based on previous research.

Table 3. *Summary of expected signs of each determinant*

Determinant	Author	Country or market	Expected impact on stock price*
Book value per share	Sharma (2011)	India	+
	Gill, Biger & Mathur (2012)	USA	+
	Srinivasan (2012)	India	+
	Tandon & Malhotra (2013)	India	+
	Avdalovic & Milenković (2017)	Serbia	+
Earnings per share	Patell (1976)	USA	+
	Sharma (2011)	India	+
	Gill, Biger & Mathur (2012)	USA	+
	Srinivasan (2012)	India	+
	Tandon & Malhotra (2013)	India	+
	Enow & Brijlal (2016)	South Africa	+
Earnings per share (continued)	Avdalovic & Milenković (2017)	Serbia	+
	Yee & Thaker (2018)	Malaysia	+
Exchange rate	Bilson, Brailsford & Hooper (2000)	Emerging markets	-
	Ghosh et al. (2010)	India	-
	Yee & Thaker (2018)	Malaysia	+
Main company operations' commodity price	---	---	+

**"+" means increase of stock price with determinant value increase, "-" means decrease of stock price with determinant value increase.*

According to previous research, selected determinants such as book value per share and earnings per share should have a positive effect on share prices, and exchange rate in general should have negative effect, however in one research paper a slight positive effect was observed. In theory, main company operations' commodity price should have a positive effect on share prices, which is connected to expectations on the increase of future earnings.

Results

Astarta company held an IPO and started listing shares on the Warsaw Stock Exchange in 2006; as of the beginning of 2022, the company's market capitalization was around 250 million USD. The data in Figure 1 gives a summary of the stock price movements of Astarta by quarter during 2010–2020.

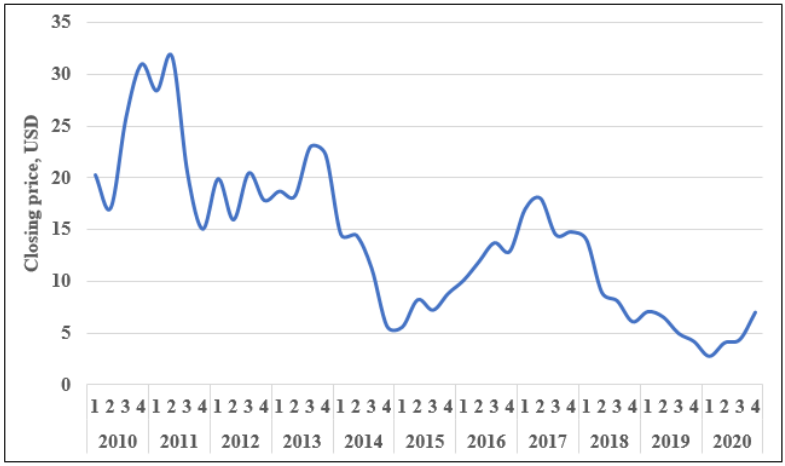

Figure 1. The dynamics of Astarta's stock price movements during 2010–2020.
Source: author's calculations based on data from Yahoo Finance website.

During 2010–2020, the stock prices of Astarta experienced several major shifts and an overall unequal evolution. The highest price during the period was observed in 2011 Q2: 31.72 USD, which was 55.5% higher than in 2010 Q1. This was mostly due to favorable commodity prices and a stable UAH exchange rate, alongside good profitability. The Ukrainian hryvnia devalued from 8.24 USD/UAH in 2013 Q4 to 15.82 USD/UAH in 2014 Q4, and continued to decline in 2015, ending 2015 Q4 at 24.03 USD/UAH, which was the main influence of the downward trend in stock price changes in 2014–2015.

Table 4. *Correlation analysis for Astarta*

	WASP
BVPS	–0.07
TTM EPS	0.78
ER	–0.72
MCOCP: Sugar	0.82

Source: author's calculations using MS Excel based on aggregated data.

Correlation analysis for Astarta shows a strong positive relation between stock prices and such determinants as earnings per share and prices of sugar, but there is also a strong negative impact of exchange rate on stock prices. Book value per share demonstrated a minor negative relation with stock prices during 2010–2020.

Table 5. *Outcomes of the specified multiple regression model for Astarta*

	Intercept	**BVPS, USD**	**TTM EPS, USD**	**ER, USD/ UAH**	**MCOCP: US Cents per pound – Sugar**
Coefficients	17.915	–0.136	1.663	–0.363	0.135
Standard error	5.320	0.125	0.293	0.081	0.212
***t*-stat**	3.368	–1.087	5.686	–4.496	0.638
***p*-value**	0.002	0.284	0.000	0.000	0.527
***R*-square**	0.84				
Dependent variable	Weighted Average Stock Price of the quarter after reporting period				

Source: author's calculations using MS Excel based on aggregated data.

The model for Astarta has an R^2 value of 0.84, which indicates that 84% of stock price movements can be explained with the defined independent variables; however, only 2 determinants – TTM earnings per share and exchange rate – were statistically significant, with $p < 0.2$. The intercept of regression indicates that with defined independent variables equal to 0, stock price will have a value of 17.91 USD. The coefficients of independent variables indicate change in the weighted average stock price of the quarter after the reporting period if the variables increase by 1 conditional unit. According to the model, an increase of TTM EPS by 1 USD or of world prices of sugar by 1 US cent per pound causes an increase in stock price of 1.66 USD or 0.13 USD, respectively. An increase of book value per share by 1 USD or of exchange rate by 1 USD/UAH causes a decrease in stock price of 0.14 USD or 0.36 USD, respectively.

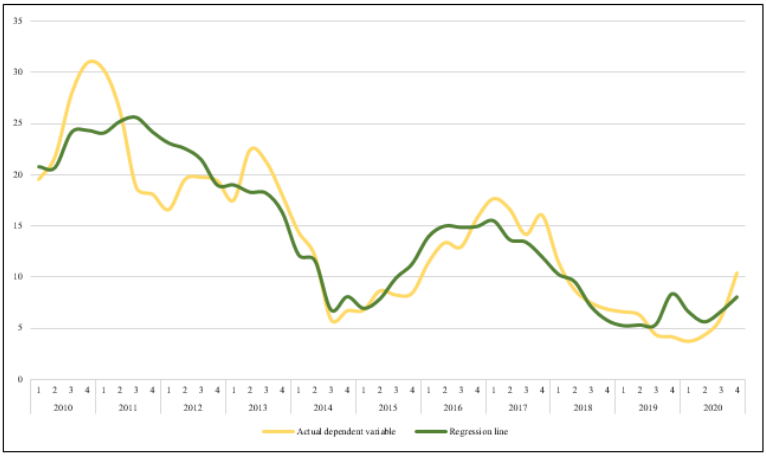

Figure 2. Visual representation of model outcome and actual stock prices of Astarta.
Source: author's calculations using MS Excel based on aggregated data.

The Kernel company held an IPO and started listing shares on the Warsaw Stock Exchange in 2007; as of the beginning of 2022, the company's market capitalization was around 1,177 million USD. The data presented in Figure 3 gives a summary of the stock price movements of Kernel by quarter during 2010–2020.

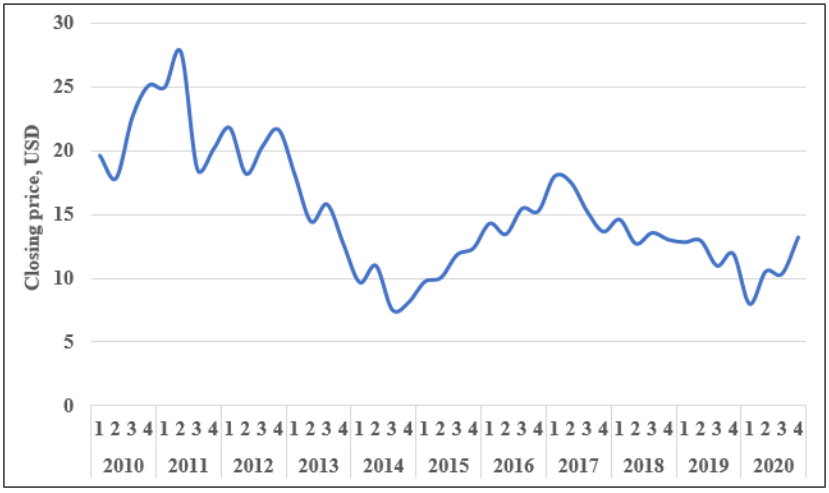

Figure 3. The dynamics of Kernel's stock price movements during 2010–2020.
Source: author's calculations based on data from Investing.com website.

Table 6. *Correlation analysis for Kernel*

	WASP
BVPS	–0.39
TTM EPS	0.57
ER	–0.53
MCOCP: *Sunflower Oil*	0.68

Source: author's calculations using MS Excel based on aggregated data.

Correlation analysis for Kernel shows a positive relation between stock prices and such determinants as earnings per share and prices on sunflower oil; there is also a negative impact of exchange rate on stock prices. Book value per share demonstrated a moderate negative relation with stock prices during 2010–2020.

Table 7. *Outcomes of the specified multiple regression model for Kernel*

	Intercept	**BVPS, USD**	**TTM EPS, USD**	**ER, USD/ UAH**	**MCOCP: USD per ton – Sunflower Oil**
Coefficients	15.507	–0.528	2.274	–0.151	0.005
Standard Error	4.612	0.166	0.500	0.104	0.004
***t* stat**	3.362	–3.182	4.547	–1.458	1.452
P-value	0.002	0.003	0.000	0.153	0.154
R Square	0.74				
Dependent Variable	Weighted Average Stock Price of the quarter after reporting period				

Source: author's calculations using MS Excel based on aggregated data.

The model for Kernel has an R^2 value of 0.74, which indicates that 74% of stock price movements can be explained by the defined independent variables. All determinants – book value per share, TTM earnings per share, exchange rate, and sunflower oil prices – were statistically significant, with $p < 0.2$. The intercept of regression indicates that with the defined independent variables equal to 0, stock price will have value of 15.51 USD. The coefficients of the independent variables indicate a change in the weighted average stock price of the next quarter after the reporting period if the variables increase by 1 conditional unit. According to the model, an increase of TTM earnings per share or of world prices of sunflower oil by 1 USD per kg cause an increase

in stock price of 2.27 USD or 5 USD, respectively. An increase of book value per share by 1 USD or of exchange rate by 1 USD/UAH causes a decrease in stock price of 0.53 USD or 0.15 USD, respectively.

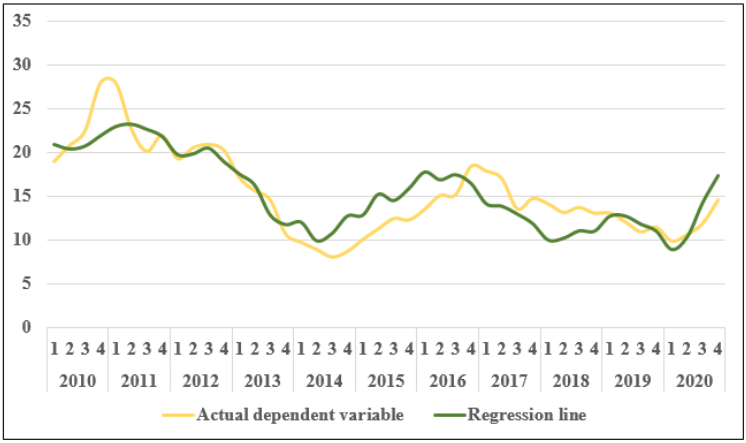

Figure 4. Visual representation of model outcome and actual stock prices of Kernel

Source: author's calculations using MS Excel based on aggregated data.

The MHP company held an IPO and started listing global depositary receipts on the London Stock Exchange in 2008; as of the beginning of 2022, the company's market capitalization was around 700 million USD. The data in Figure 5 gives a summary of the stock price movements of MHP by quarter during 2010–2020.

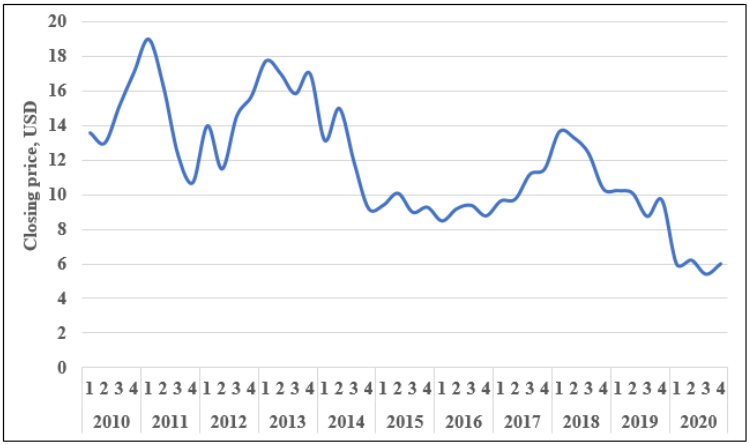

Figure 5. Dynamics of MHP's stock price movements during 2010–2020.

Source: author's calculations based on data from London Stock Exchange website.

Table 8. *Correlation analysis for MHP*

	WASP
BVPS	–0.22
TTM EPS	0.48
ER	–0.76
MCOCP: Poultry	–0.32

Source: author's calculations using MS Excel based on aggregated data.

Correlation analysis for MHP has shown a positive relation between stock prices and earnings per share; also, there is strong negative impact of exchange rate on stock prices. Book value per share and prices of poultry demonstrated moderate negative relations with stock prices during 2010–2020.

Table 9. *Outcomes of the specified multiple regression model for MHP*

	Intercept	**BVPS, USD**	**TTM EPS, USD**	**ER, USD/ UAH**	**MCOCP: US Cents per Pound – Poultry**
Coefficients	12.847	–0.284	0.770	–0.316	0.061
Standard Error	2.175	0.118	0.179	0.046	0.023
***t* stat**	5.908	–2.412	4.301	–6.866	2.674
P-value	0.000	0.021	0.000	0.000	0.011
R Square	0.75				
Dependent Variable	Weighted Average Stock Price of the quarter after reporting period				

Source: author's calculations using MS Excel based on aggregated data.

The model for MHP has an R^2 value of 0.75, which indicates that 75% of stock price movements can be explained with the defined independent variables. All independent variables were statistically significant, with $p < 0.2$. The intercept of regression indicates that with the defined independent variables equal to 0, stock price will have a value of 12.85 USD. The coefficients of independent variables indicate the change in the weighted average stock price of the next quarter after the reporting period if the variables increase by 1 conditional unit. According to the model, an increase of TTM earnings per share or of world prices of poultry by 1 US Cent per pound causes an increase in stock price of 0.77 USD or 0.06 USD, respectively. An increase of book value per share by 1 USD or of exchange rate by 1 USD/UAH causes a decrease in stock price of 0.28 USD or 0.32 USD, respectively.

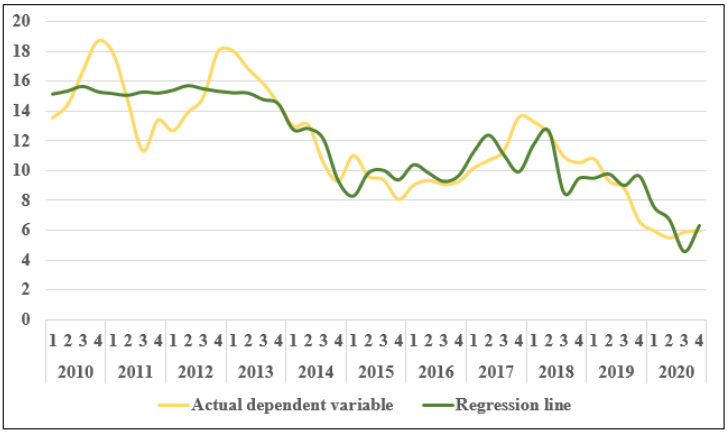

Figure 6. Visual representation of model outcome and actual stock prices of MHP.
Source: author's calculations using MS Excel based on aggregated data.

Table 10 summarizes the outcomes of regression models and correlation analyses. Statistical significance was considered at the level of $p < 0.2$, and the correlation direction indicates the direction of stock price change with the increase of the specific determinant. According to the summary, the profitability of each company reflected through a trailing 12-month earnings per share indicator significantly impacts stock price movements with a positive correlation. Exchange rate also significantly impacts the stock prices of all selected companies, and this correlation is negative. Book value per share impacts stock price movements significantly in 2 of 3 cases, and this correlation is negative. The main company-specific commodity price also impacts stock price movements significantly in 2 of 3 cases, however this correlation direction is inconsistent.

Table 10. *Summary of correlation and regression analysis outcomes*

	Statistical significance				Correlation direction			
	BVPS	TTM EPS	ER	MCOCP	BVPS	TTM EPS	ER	MCOCP
Astarta	N	Y	Y	N	-	+	-	+
Kernel	Y	Y	Y	Y	-	+	-	+
MHP	Y	Y	Y	Y	-	+	-	-

Source: author's aggregation from previous tables.

Conclusion and discussion of the perspectives for future research

The conducted research investigated the impact of selected determinants – book value per share, trailing 12-month earnings per share, company-specific commodity price, and exchange rate – on the stock price movements of the three largest agriculture producers in Ukraine. R^2 values of created and examined multiple regression models indicated that, based on the selected determinants, it is possible to explain between 74% and 84% of the chosen companies' stock price variations during 2010–2020.

The directions of the correlation coefficients of selected determinants, except commodity prices, were consistent. The direction of the correlation between stock prices and book value per share was negative, which is the opposite to the expected result and could be the basis for further investigation considering the political and economic context in Ukraine during 2010–2020.

Determinants that were statistically significant for all companies from the sample were: trailing 12-month earnings per share, which reflects companies' performance and ability to generate profit; and exchange rate, which represents the macroeconomic situation in Ukraine.

Main commodity price, which is the company-specific determinant of stock price movements, demonstrated an uneven level of statistical significance among the sample of companies. Taking into consideration a significance level of $p = 0.2$, the significance levels were met for poultry price for MHP and sunflower oil price for Kernel; however, sugar price was not statistically significant for the stock price movement of Astarta, since $p = 0.527$, which is higher than 0.2.

This research provides some evidence that earnings per share and exchange rate have a significant impact on the stock price movements of selected Ukrainian agro-industrial companies, while book value per share and commodity price impacted stock prices significantly for 2 of the 3 selected firms.

Based on models created within this research it is possible to estimate the trend of the stock price movements of Ukrainian agriculture companies in the short term; however, from 16% to 26% of stock price variation remains unexplained, which is grounds for further research.

Understanding the impact of specific determinants on stock price movement based on historical data can help to allocate resources in the management decision-making process in order to achieve financial performance and capitalization in the short term.

In the context of the impact of exchange rate and earnings per share on share prices, this paper supports the findings of: Bilson, Brailsford, & Hooper (2000); Ghosh et al. (2010); Sharma (2011); Gill, Biger, and Mathur (2012); Enow and Brijlal (2016); Avdalovic and Milenković (2017); and Yee and Thaker (2018).

This study is limited to the sample of Ukrainian agro-industrial companies. The findings of this paper could be relevant only to firms similar to those that were included in this research. Additionally, the determinant of commodity price is based on the main production commodity that is relevant for the operations of each separate firm.

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ENVIRONMENTAL, SOCIAL, AND GOVERNANCE POLICY INTEGRATION AND IMPLEMENTATION FROM THE PERSPECTIVE OF CORPORATIONS

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Abstract. *Sustainability has taken over the corporate world as wider disclosure and increased commitment is expected around environmental, social, and governance (ESG) matters from companies globally. Firms operating across emerging economies such as Latvia are no exception, and several studies have recently pointed towards increasing ESG consciousness in the Baltics and in the overall Central and Eastern European region – both in stock listed companies as well as financiers.*

Evidence on self-evaluation, motivation, and challenges from the perspectives of these companies themselves in an overall aggregated form is currently still missing. This study, therefore, aims to capture the ESG adoption and implementation practices of companies operating in Latvia.

By analyzing the survey data of 74 medium to large enterprises of various industries and ownership structures, the results indicate an average degree of ESG factor implementation of 5.45 out of 10. Higher scores were attributed to stock-listed, foreign corporation-owned, and state-owned companies, as well as companies with gender-diverse management boards and supervisory boards in place. Sustainability disclosure, especially according to recognized standards, is performed by only 11% of respondents, signaling inconsistencies in materiality assessments and free preference regarding the factors of disclosure, leading to greenwashing concerns.

Keywords: *CEE, ESG, sustainability reporting*

JEL Classification*: G30, G32, Q56*

1. Introduction

Ever since the responsibility for achieving the Sustainable Development Goals (SDG) has been equally delegated to companies, the motivation of companies to consider, implement, and report on their achievements in sustainability has been multiplied. Especially recently, this trend has taken over the corporate world – companies worldwide increasingly pay attention to the evaluation, implementation, and reporting of their sustainability achievements given the ever-rising demand for sustainable investments and increasing regulatory requirements (OECD,

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2020).

The environmental, social, and governance (ESG) factors are increasingly used by companies worldwide as a measure for the various facets of sustainability (EY, 2021). All in all, however, the trend and focus on sustainability matters to such an extent is a relatively recent phenomenon, with a large majority of corporations initiating their sustainability strategies in the last decade, introducing new C-level executives to guide those efforts, setting sustainability targets, and disclosing their results (Ioannou et al., 2016). As such, the level of ESG adoption across corporations is also still far from being unified – there are differences across stock listed and privately held companies, and across companies of various geographies, sizes, and financial strengths (Yu & Luu, 2021). While the European Union is generally in pole position in terms of existing regulations and efforts in corporate sustainability encouragement, Latvia, like other Central and Eastern European (CEE) countries, is still a developing economy in terms of ESG. Although there is evidence that a share of companies are already actively pursuing endeavors in strengthening their sustainability behavior, the degree of ESG compliance and reporting relative to Western Europe and Scandinavia, in particular, is assumingly lower (Deloitte, 2020)

Academic research helping to deeper understand implementation practices and potential challenges is scarce and fragmented. While there is recent previous evidence on the ESG disclosure levels of Baltic stock-listed companies (Zumente et al., 2020), stock-listed companies only constitute an insignificant share of the overall Latvian corporation universe. As of 2021, of the hundred largest companies as measured by revenue, only five were stock market listed and therefore had implied motivation towards ESG disclosure (Prudentia, 2021). The remaining share consisted of large state-owned companies, branches of international company groups, or privately held companies, the sustainability assessment of which has so far not been academically analyzed.

To bridge the identified gap in the academic literature, this study seeks to assess the current status quo of ESG implementation. Contrary to the analysis of secondary sources, this research seeks to understand and explore the views and assessments of these companies themselves. This approach, differing from secondary source analysis, allows for a deeper exploration of the drivers, challenges, and motivation for the adoption of sustainability principles.

The chosen methodology was based on a dataset gathered from a survey. A questionnaire consisting of 20 multiple-choice and closed-ended questions was distributed to 200 medium and large companies operating in Latvia, as measured by revenue in 2019. An opinion poll addressed the assessment of ESG familiarity, the degree of specific ESG implementation steps, the identification of the key drivers of sustainability factors, as well as the detection of the challenges that companies might experience. In total, 74 responses were received for the survey – a response rate of around 37%. When measuring the total revenue of the companies included in the final sample, this amounts to more than 12bn EUR, representing around 20% of the total revenue generated by all of the companies registered in the country (Central Statistics Bureau, 2021). To aid the interpretation of these results, three in-depth interviews were conducted with respondents representing various company ownership types.

This paper provides multiple contributions to the academic literature. Firstly, it contributes to the existing scholarly research which aims at describing ESG implementation practices – in this case, with respect to a specific CEE country. Secondly, by addressing the shortcomings and

challenges highlighted by this research, policymakers and business practitioners can explore ways in which to foster wider adoption of ESG policies across companies in CEE countries by using the example of Latvia. Furthermore, these study results might be beneficial for the top-level management of companies to understand the pros and cons of ESG implementation, and may therefore further drive ESG implementation across corporations. In addition, the conclusions of this study can aid financiers and investors in better understanding the status quo of the companies they may potentially invest in.

The remainder of this paper is organized as follows: section 2 summarizes the relevant literature regarding ESG drivers and provides regional background information; section 3 sets forth the methodology employed in this study; section 4 describes and discusses the results; and, finally, section 5 concludes.

2. Literature review

2.1. Firm characteristics and ESG implementation

ESG adoption across corporations globally has surged during the last decade. The KPMG Survey of Sustainability Reporting in 2020 revealed that sustainability reporting by the largest 100 firms across 52 countries has rapidly amplified, from 18% in 2002 to 75% in the 2017 survey, up to 80% in 2020 (KPMG, 2020). Evidence points towards the consideration that sustainability aspects have taken a more important role for managerial decision making (Koval et al., 2021). While earlier research by Ioannou and Serafeim (2012) suggested that political, legal, and labor market institutions are significant factors affecting variations in corporate social performance, more recent evidence by Yu and Luu (2021) – who performed a study of over 1,963 large-cap companies headquartered in 49 countries – found that firm characteristics explain most of the variation in firm ESG disclosure, while differences in country factors such as corruption and political rights explain less. It can be argued that with a wider roll-out of ESG requirements globally, national characteristics become secondary to actual company features. In this case, as this study concentrates on companies operating in a single country, it is more relevant to explore firm-level differences.

One of the key differentiators is firm ownership. As different owners might have various objectives and decision-making horizons concerning sustainability, academic research has confirmed ownership type to be a key differentiating factor (Barnea & Rubin, 2010). A study by Li and Wu (2018) showed that the ownership structure of the company can materially impact the ESG score, finding that private businesses focus significantly more on material ESG aspects and therefore are able to reduce negative incidents. Soliman et al. (2013) indicated a significant, positive connection between sustainability ratings and ownership by institutions and foreign investors, while ownership by managers is negatively associated with companies' social performance ratings. Siew and Balatbat (2016), when evaluating up to 700 NYSE listed companies, also found that institutional ownership has a negative impact on the level of information asymmetry in terms of ESG on stock-exchange listed companies. Overall, stock exchanges are in a unique position to spread the sustainability message and provide additional motivation to companies to disclose their ESG results. As summarized by Bizoumi et al. (2019), in the case of the Athens Stock Exchange, ESG guidelines have been created for listed companies that especially

focus on the degree of sectoral specificity and emphasis on materiality endorsed by international sustainability standards like the SASB's industry standards. In addition, Rees and Rodionova (2015) examined the influence of family ownership on ESG rankings. By using a sample of almost 4,000 companies from 46 countries, the authors found that family ownership as well as closely held equity are associated with worse ESG performance. These results hold true across the liberal markets examined by the authors, as well in coordinated market economies. Finally, a report conducted by PwC revealed that state ownership is correlated with better reporting on sustainability targets, showing a significant difference in average ESG scores between state-owned companies (SOEs) and companies without state ownership (PwC, 2015). As summarized by the OECD, around 25% of the largest global companies are state-owned, and thus it should be expected that SOEs themselves are held accountable and run according to exemplary standards of transparency and disclosure in areas relevant to ESG (OECD, 2020).

Ownership board composition is discussed in academic research as a factor impacting the quality of non-financial disclosures (Rao & Tilt, 2016). Cuadrado-Ballesteros and Rodríguez-Ariza (2015) found that the proportion of independent directors at the company's decision-making level positively correlates with the ESG disclosure level. Tamimi and Sebastianelli (2017) found that companies with larger and more diverse boards have more sophisticated sustainability reporting, and they disclose a larger amount of ESG data. Kamarudin et al. (2022), using international data extracted from a global ESG dataset from the Refinitiv database on over 23,000 companies from 37 countries, also found that firms with a better board gender diversity exhibit higher corporate sustainability performance. Interestingly, it was observed that in highly competitive industries the positive relationship between board gender diversity and corporate sustainability performance is weakened. Previous results on the Baltic countries by Zumente and Lāce (2020) indicated that companies with larger boards and companies that have female representatives on their supervisory boards have, on average, higher non-financial disclosures scores, while no correlation was found for gender diversity on management boards.

The importance of the board and its alignment to ESG goals was studied by Crifo et al. (2019). While analyzing the 120 largest French companies by capitalization for the year 2013, they found that corporate sustainability appears to be positively related to internal forces (inside directors).

Finally, the literature suggests a correlation between ESG performance and company size and age. While research on organizational legitimacy implies that larger and more visible organizations experience more pressure to conform to societal expectations (Powell & Bromley, 2015), larger companies are also the most visible to the public (Suchman, 1995) and are likely to be under the most scrutiny. According to Moore (2001), there is a positive relationship between social performance and both the age and size of the company. As Artiach et al. (2010) explain it: larger and more profitable companies are more likely to have the financial resources necessary to optimize the sustainability facets of their operations. To mitigate this effect, the largest companies in terms of revenue were chosen for analysis in this study.

Concerning the company's views and motivation on the subject of sustainability, a recent global board member survey indicated that next to the belief that it is the right thing to do, 78% of respondents also believe that ESG is a key contributor to strong financial performance. With respect to the implementation stage, only 48% of respondents had incorporated ESG standards

across all aspects of the organization (Willis Tower Watson, 2020). When discussing the relative importance of ESG for today and the future, the ESG survey by Deutsche Bank highlighted strong growth in importance indices across all ESG dimensions in both US and European markets. The strongest focus was placed on the environmental factors in Europe, while US firms were relatively more focused on social factors (Deutsche Bank, 2021).

2.2. Regional background

Latvia has been a European Union member since 2004 and an OECD member since 2016. While the economy has grown and developed significantly over the years since regaining its independence in 1990, GDP per capita is still one of the five lowest among the EU Member States (Eurostat, 2021). Consequently, several global tendencies in terms of business development, stock exchange expansion, and corporate governance – similarly to other CEE countries – have also been slower than in Western Europe (Bistrova & Lace, 2016). In response to the UN SDG, Latvia has come up with the Sustainable Development Strategy 2030. According to the implementing body, this is a long-term planning document at the highest national level, encompassing the main tasks of the state and society to achieve balanced and sustainable development outlining, among others, such development priorities as: investment in human capital; innovative and eco-efficient economy; and nature as future capital. It also outlines strategic indicators such as: GDP per capita; the ecological footprint; the Human Development Index; and the Global Competitiveness Index (Cross-Sectoral Coordination Centre, 2021).

Although the amount of academic literature on topics around ESG is rising, there is still a lack of a comprehensive overview of implementation practices with respect to the CEE – and, more specifically, the Baltic – region. One piece of research on ESG at the Baltic level which analyzed the survey data of 37 financial market players revealed that around 81% of respondents already use ESG data when evaluating their investments, thus the implied interest or pressure from the side of financiers is already present in this market (Zumente & Bistrova, 2021). From the corporate side, a study performed by Sustinere, a sustainability advisory agency, analyzed the annual reports of the 100 largest companies in Latvia to assess their ESG reporting practices. The results, based on the analysis of 2019 and 2020 reports, suggest that 20% of companies provide systematic ESG reports. Analyzing the quality of ESG reports, the leading companies when differentiated by type of ownership are stock listed companies (62%), which can be explained by stock exchange requirements and pressure from capital providers, as well as state-owned enterprises (50%). Companies of foreign capital (14%) and local capital (5%) show lower results. Latvia's 100 largest companies received an average evaluation score of 20% (Sustinere, 2020).

Further evidence can be found in the Foreign Investor Council in Latvia (FICIL) and KPMG's 2021 joint study on sustainability practices in Latvian companies, in which 12 in-depth interviews were conducted representing IT, real estate management, the production of construction materials, food, retail, and other industries. The sample, however, was limited to multinational groups, for which sustainability strategies have mostly been developed at the group level and therefore the driver of ESG implementation often also lies outside of Latvian borders. The second part of the study included a survey responded to by 51 FICIL members. The outcome revealed that the key areas of focus are employee welfare and safety, the efficient use of natural resources, and the reduction of harmful effects on nature. The greatest challenges faced

by companies when preparing a sustainability report included the complicated data gathering process, the effort that is necessary to prepare the report, as well as difficulties in materiality assessments (KPMG & FICIL, 2021).

Research objective and methodology

To obtain an assessment and gather opinions on ESG implementation practices, motivations, and challenges, a questionnaire was distributed to 200 medium and large companies operating in Latvia including the hundred largest companies in terms of revenue. The self-evaluation approach, as used in a previous study of the ESG assessments of Baltic listed companies by Zumente & Lāce (2020), is contradictory to an independent review of ESG disclosures or publicly shared information. However, this approach allows the drivers and barriers behind the decisions that companies make in relation to their sustainability policies to be explored in more depth. The self-assessed views of companies are crucial to explore, as corporations are key players in the economy and thus have a direct impact on the economic climate and the social environment. While it might be argued that companies may tend to exaggerate their successes and achievements, the aggregation of the data can aid in limiting such effects. To obtain less biased answers, survey responses were collected anonymously, and questions were sent via e-mail or Linked-in either to board members or a designated sustainability officer if the company had a publicly assigned one.

First, the questionnaire asked respondents to disclose the demographic data of company size, ownership type, gender diversity in management and supervisory board, and year of establishment. Obtaining this data was important in order to conclude on the potential different impacts that these factors might have on ESG adoption practices. The core part of the questionnaire consisted of twenty multiple-choice and closed-ended questions focusing on: (1) the degree of ESG awareness, implementation status, and disclosure; (2) reasons and responsibilities with respect to the sustainability of operations; and (3) observed obstacles in the ESG implementation journey. In addition, this study sought to capture the estimated degree of importance of ESG in the company's agenda as of now, which might consequently allow for the repeat of such studies to measure this score over time or geographies.

To better explain these results as well as capture any remaining opinions and sentiments, three in-depth interviews with companies of differing ownership types (a state-owned company – SOE – a subsidiary of a wider international group, and a privately held local company) were organized. The interviews were semi-structured, following a set of pre-defined questions in line with the questionnaire but also allowing for more open-ended questions. In the survey, 74 responses were received, revealing a response rate of around 30%. The sum of the total revenue of the companies included in the data set amounted to 12bn EUR, while the total employee number was over 68 thousand. This allows us to conclude that the sample represents a considerable share of the medium-large enterprise universe of the economy, and around 20% of the revenue attained by all corporations operating in Latvia in 2020 (Central Statistics Bureau, 2021).

The descriptive statistics of the final data set, compiled based on the survey results, are presented in Table 1.

Table 1. *Sample statistics*

	Min	Max	Average
Revenue (million EUR)	10	2,800	162
No. of employees	21	12,200	919
Year of establishment	1918	2020	n/a

This sample represents a well-balanced mix of companies operating across all of the largest economic sectors of the economy (see Figure 1). The most-represented sectors include retail and wholesale, transport, and logistics services, as well as manufacturing.

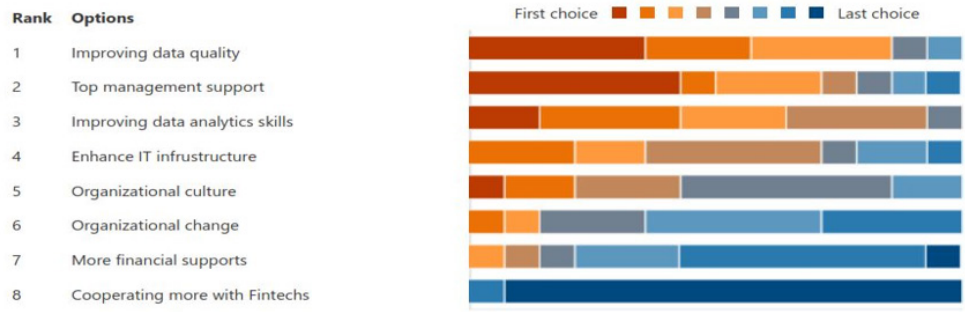

Figure 1. *Dataset by industry (number of companies).*

The companies surveyed also had varying types of ownership. The largest share, or 32% of the companies in the sample, were owned by local private persons, 23% were state-owned companies, 15% represented foreign capital ownership in the form of a multinational company's branch in Latvia, and 12% direct ownership by foreign individuals. Given the low degree of stock traded companies in the region, the sample was composed of only 5% publicly-owned firms. Finally, 12% of the companies had a mixed ownership structure – either combining several of the previous proprietorship types or also involving financial investor presence.

4. Results

Diversity and inclusion are important elements of proper corporate governance guidelines, as recently summarized by the Latvian Corporate Governance Code (Advisory Board for Corporate Governance, 2020). In addition, according to academic research (see Rao & Tilt, 2016), board member gender diversity can have a material impact on non-financial disclosure level and quality. The statistics on board structure show that slightly below half, or 45%, of these companies have no female representatives on their management boards. Of the remainder, the average proportion of women in the decision-making body is 43%. All in all, it can be concluded that a significant share of Latvian companies are still missing out on the proper implementation of this factor.

While the establishment of supervisory boards is not a mandatory requirement for limited liability companies according to local law, the majority (58%) of the surveyed companies have a supervisory board in place.

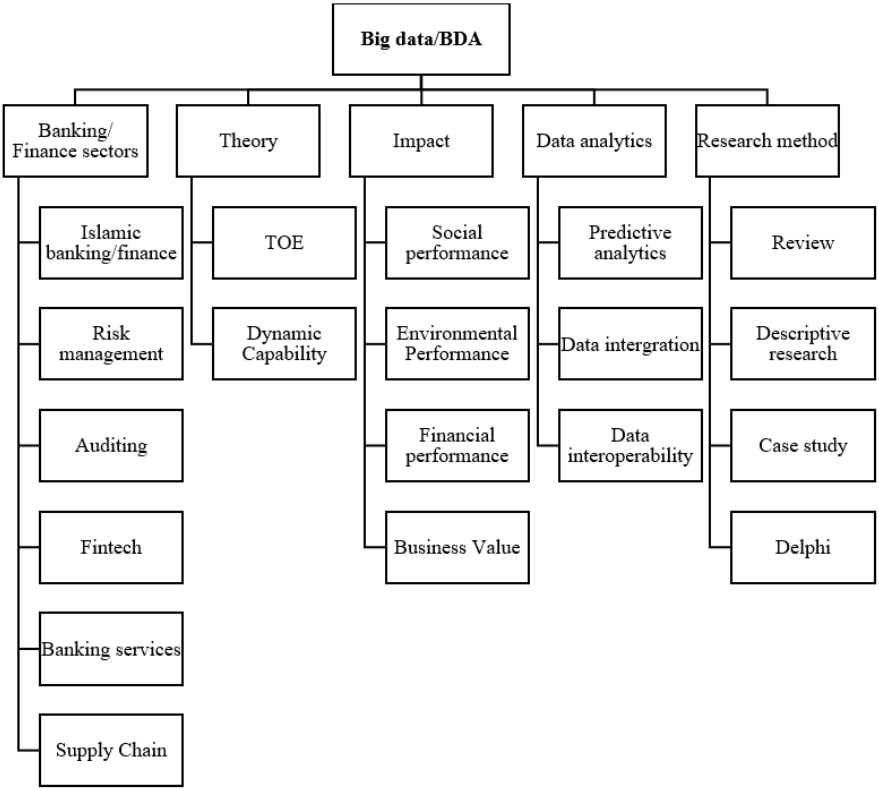

Figure 2. *Supervisory board composition (% of sample).*

Based on Principle #9 of the Latvian Corporate Governance Code, it is suggested that at least half of board members should be independent. Based on the results, 28% of the sample companies have ensured that this is the case, which is a relatively positive result. Only 15% of the companies have no independent members on their advisory boards, indicating that the full potential benefits of having this type of decision-making body in place are not fully realized. Of the 43 companies that have a supervisory board, around half, or 19 companies, have no female representatives.

The average proportion of females in the supervisory boards across the companies that have one in place is 22% (around one female per four men). In relevant previous research

regarding Baltic stock listed companies, it was found that 12% of the supervisory board members were women, signaling that the present sample of the largest Latvian companies scores better. As previously found for public Baltic companies, female presence on the supervisory board has a positive impact on ESG disclosure level (Zumente & Lāce, 2020)

Of all the companies questioned, the vast majority, or 82%, indicated that the company's leadership is aware of the ESG concept in general. When asked to evaluate the current degree of ESG factor implementation in the company's operations, the average score on a scale of 1 to 10 was 5.45 (with a median of 6). The indicated score, above the midpoint of 5, shows that generally the cohort of mid to large-size companies operating in Latvia are in the course of sustainability implementation and follow the global trend in this aspect. Only 56% of respondents reported that the ESG topic is within the direct responsibility or oversight of management. This potentially signals that the topic of ESG is still not among the top priorities of company executives. Contrary to the Latvian data, there is a growing international trend of including ESG measures in annual management incentive plans. Based on global data for overall performance assessments, 63% have already factored ESG into annual incentives and 41% have done so for long-term incentives (Willis Tower Watson, 2020).

Interestingly, while the differences in ESG score based on industry classification are not significant, the results differ substantially based on ownership type (see Figure 3). Stock-listed companies, potentially as a result of stock exchange requirements, have the highest level of ESG implementation (average score 8), followed by international company branches (score of 6.7) – where sustainability strategies usually cascade down from global HQ – and state-owned companies (6.3). The poorest performance is assessed in companies owned by local private persons (3.6).

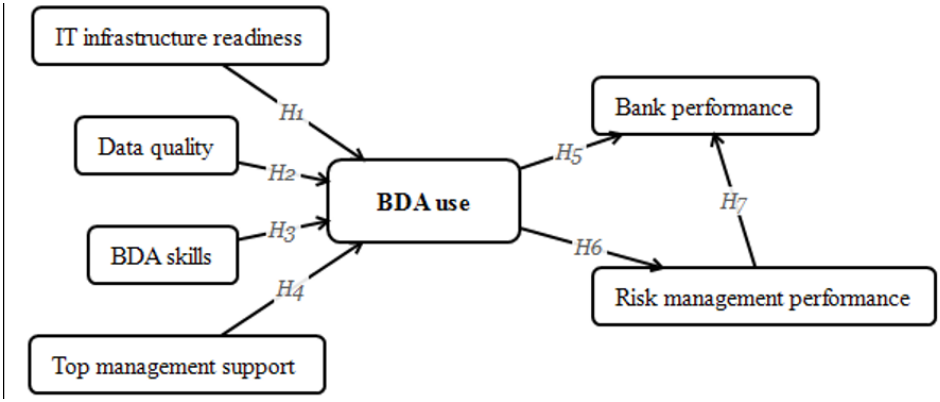

Figure 3. *ESG self-assessment of corporations across ownership types (average score out of 10).*

Consequently, it would appear that ownership is one of the key drivers that can have a material impact on ESG adoption across companies in emerging countries like Latvia, where the global trend is potentially still not so pronounced. This result is also in line with previous studies such as Barnea and Rubin (2010) and Soliman et al. (2013). When asked about the matter,

companies themselves confirm this assumption. While the global tendency towards sustainability is mentioned as the main driver (selected by 52% of the respondents), owners' requirements come a close second (40%). Other often-mentioned motivators include management board initiatives and attempts at risk reduction practices (each mentioned by 30% of respondents). Qualitative interviews confirmed that pressure from owners often accelerates the speed of ESG adaption, while disbelief in the value of ESG by owners hinders proper sustainability policy development.

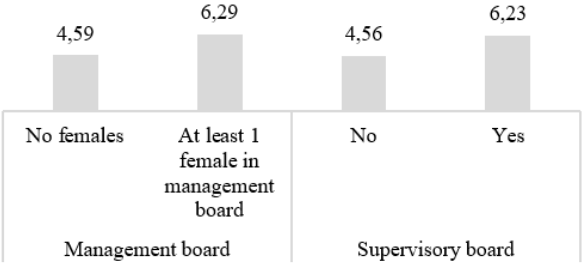

Figure 4. *Average ESG implementation score (out of 10) based on the gender diversity of the management board and the existence of a supervisory board.*

The diversity of the management board and the existence of a supervisory board seem to create a difference in the self-assessed ESG level. As depicted in Figure 4, companies that have no females on their management board seem to rank themselves lower (on average 4.59), while companies that have at least one female on the management board score 6.29. A similar positive effect on ESG assessment of 4.56 versus 6.23 is implied from the existence of a supervisory board.

Practices concerning ESG disclosure are still developing and are behind Western European and US large corporations as more than half, or 52%, of companies make no disclosures on their sustainability progress. Only around one in ten companies (11%) choose to use internationally recognized reporting formats or principles (i.e., Global Reporting Initiative, SDG, etc.), while a wider share of respondents (37%) report their sustainability results in an informal manner – as a section in the annual report or as disclosures on their website. The main motivators behind disclosures are global tendencies and peer pressure from competitors (22%), the requests of owners (16%), and the decision to perform sustainability reporting due to management preferences (9%). As suggested in one of the follow-up interviews, companies might choose to present selected data which are more easily traceable or show more favorable results in order to have reporting formally in place. However, as long as there are no mandatory requirements this approach might lead to a lack of focus on material areas, selective reporting leading to greenwashing concerns, as well as difficulties in data comparison

According to the results (see Figure 5), most companies have more established policies for social and governance factors – especially focusing on the safety and satisfaction of employees, donations, and corporate governance principles. In addition, for several of the most popular S and G metrics there is a gap between the number of companies that have a formal policy in place and the number of companies that actually measure and disclose the respective data.

Interestingly, the environmental factor is approached differently – while only less than one third of the sample pay attention to environmental impact, almost all companies have a formal policy in place and measure the actual data.

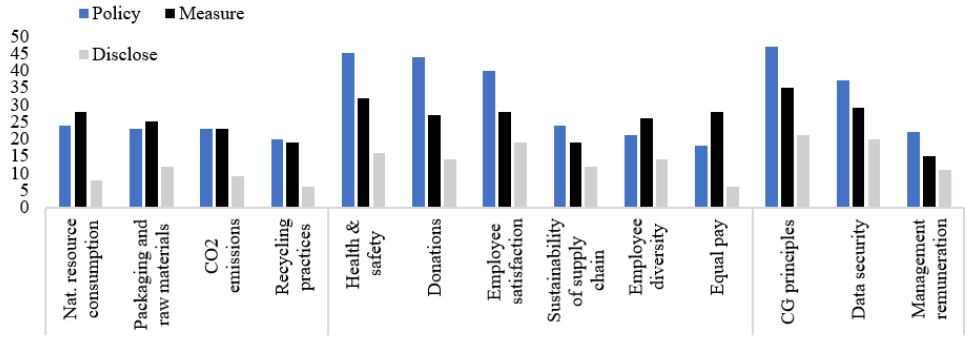

Figure 5. *Approach to specific ESG factors (number of companies).*

Given the pronounced focus on specific S and G metrics as well as the relatively low application of internationally accepted reporting standards, it can be concluded that, for the vast majority, several important steps (i.e., setting material sustainability focus areas, involving stakeholders in prioritization, etc.) have been left out and companies more or less choose to disclose information that is easily reportable or measurable, avoiding areas which are more complex or where favorable results have not yet been achieved.

The results of the study confirm this concern. Materiality assessment helps to understand the key aspects of ESG that are critical for companies operating in various industries and geographies (SASB, 2021). A focus on the material aspects of ESG aids companies in setting the right focus and concentrating on performing towards those factors which can be substantively impacted by the specific company. In a period in which corporations and investors are spending more resources on sustainability issues, the question of which sustainability issues are financially material has become crucial in understanding whether companies are managing their resources efficiently (Rogers & Serafeim, 2019). Several academic papers have reported that only an industry-specific approach to materiality yields economically significant results, meaning that businesses improving their performance on material sustainability issues outperform competitors with declining performance on material sustainability issues (Khan et al., 2016). The results of the survey show that 72% of the respondent companies have not performed a materiality assessment, leading to an overall situation where sustainability priorities can be unclear.

A related concept that is emphasized by internationally recognized reporting standards is stakeholder dialogue – a formal process of understanding the facets of corporate social performance that are important for the company's stakeholders. It can be argued that only then – when a corporation is focusing its attention on the factors that are significant for its stakeholders

and that are of material impact for the specific industry in which the corporation operates – can the optimal level of sustainability be achieved. In the Latvian survey, 60% of the respondents admit that they have not performed a stakeholder dialogue to understand the ESG matters that are important for their stakeholders. While stock-listed companies show better results on the completion of these steps (75%), privately held companies perform significantly worse (see Figure 6).

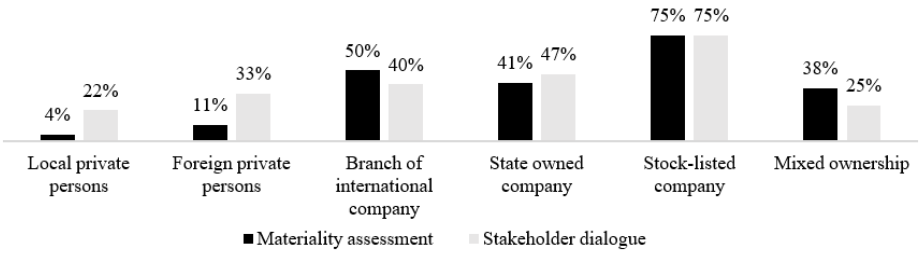

Figure 6. *Share of companies in the sample having performed materiality assessment and stakeholder dialogue.*

Overall, given that the majority of the questionnaire respondents so far have not focused their attention on these two important steps in the sustainability path, appropriate educational measures should be suggested. Based on the additional explanation gained in the in-depth interviews, companies struggle to understand the value of these assessments or do not have a clear view on what would be the best way to practically organize stakeholder dialogue. With respect to further challenges or reasons that hinder proper sustainability practice implementation (see Figure 7), 46.3% mention lack of motivation. In combination with difficulties in measuring ESG factors (mentioned by 31.3%) as well as the costs associated with more sustainable actions and operations (29.9%), these obstacles do not seem to be unresolvable.

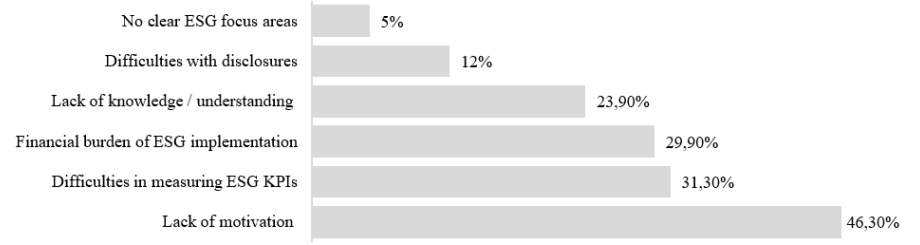

Figure 7. *Challenges in ESG implementation (% of companies that selected each answer).*

While the previously suggested educational measures could tackle the shortcomings in

knowledge and understanding (23.9%) and difficulties with disclosures (12%), the lack of motivation calls for broader measures along the lines of certain regulations, positive enforcements, or incentives (i.e., certain tax benefits, lower interest rates from banks, discounts for participation in associations, etc.) for companies that act on sustainability initiatives. Polishing sustainability practice for SOEs could also serve as a positive benchmark and a role model, as suggested by OECD (2020).

Finally, when comparing ESG self-assessment with future estimated sustainability importance, the results once more confirm the perceived lack of motivation (see Figure 8).

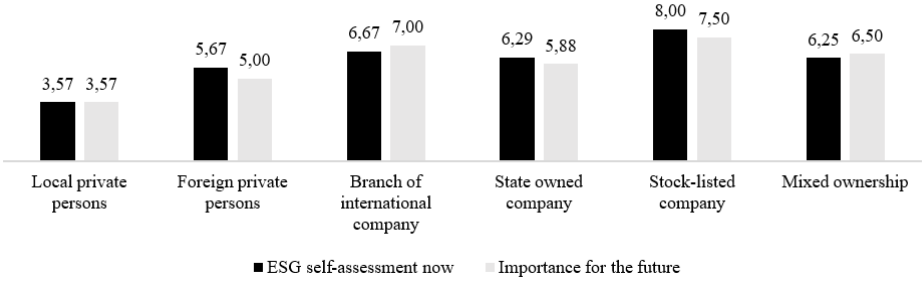

Figure 8. *ESG self-assessment today vs estimated importance in the future (average on a scale out of 10).*

The average estimated future ESG importance score of 5.3 (out of 10) is even lower than the average estimated ESG implementation score as of today (5.45), signaling that the majority of companies estimate that their focus on sustainability matters will even slightly decrease. This result is the direct opposite to most global data (i.e., Deutsche Bank, 2021), which suggests that companies tend to expect a higher focus on ESG elements in the future. Overall, this finding supports the recommendation for proper national or international sustainability incentive policies which would enforce corporations to increase the prioritization of aspects of sustainability in the future and therefore achieve a greater contribution to the SDG.

5. Conclusions

The main aim of this study was to explore the corporate viewpoint of ESG implementation by analyzing the case of an emerging economy – Latvia. The survey response data for 74 medium and large companies operating in Latvia were analyzed.

The results reveal that 82% of corporate leaders are aware of the ESG concept. On average, the current degree of ESG factor implementation is evaluated at 5.45 out of 10, indicating that, generally, the cohort of mid to large size companies operating in Latvia are on the course of sustainability implementation and follow the global trend in this regard. Nevertheless, only 56% of respondents report that the ESG topic is within the direct responsibility or oversight of management, signaling that ESG might not be highest on the agenda yet, which is contrary to the international trend of including ESG measures in annual management incentive plans.

This paper provides insights into ESG drivers for Latvian companies, contributing to

the growing body of literature exploring the determinants of the sustainability orientation of corporations. This study confirms previous academic evidence of ownership being a key sustainability driver. Stock-listed companies, likely as a result of stock exchange requirements, have the highest level of ESG implementation (an average score of 8), followed by international company branches (6.7) – where sustainability strategies are usually cascaded down from global HQs – as well as state-owned companies (6.3). The poorest performance is demonstrated by companies owned by local private persons (3.6). These self-assessed results are largely in line with the previous external evaluation conducted by Sustinere (2020). Corporations themselves confirm the importance of ownership in their ESG decisions – while the global tendency towards sustainability is mentioned as the main ESG driver (selected by 52% of the respondents), the requirements of owners come a close second (40%).

The present study also points towards board characteristics as being a further important ESG driver. In the case of this study, 45% of the surveyed companies have no female representatives on their management boards. In addition, as it is not a mandatory requirement, 42% of firms have not established supervisory boards. The diversity of the management board and the existence of a supervisory board appear to create a difference in self-assessed ESG level – companies that have no females on their management board seem to rank themselves lower (on average 4.59), while companies that have at least one female on their management board score 6.29. A similar positive effect on the ESG assessment of 4.56 versus 6.23 is implied from the existence of a supervisory board.

This study also sheds some light on local non-financial disclosure practices, indicating that 52% of companies make no disclosures on their sustainability progress. As only 11% of respondents report according to internationally recognized reporting principles, the remaining companies choose to favor disclosure across the easier-reportable or measurable factors for Social and Governance domains, avoiding areas such as Environmental data which are more complex and expensive to measure, or where positive results have not yet been achieved. In addition, these results show that 72% of the respondent companies have not performed a materiality assessment and 60% lack stakeholder dialogue, leading to a frequent situation when sustainability priorities are unclear and selective reporting might be preferred. Without unified reporting requirements, companies can decide themselves on materiality areas and the volume of non-financial information disclosed, leading to significant differences in ESG adoption.

Finally, with respect to challenges which hinder proper sustainability practice implementation, lack of motivation is mentioned most frequently (46.3%), followed by difficulties in measuring ESG factors (31.3%), and the costs associated with more sustainable actions and operations (29.9%). Policy-makers should, therefore, consider that the lack of motivation could call for broader measures along the lines of certain regulations, positive enforcements, or incentives (i.e., certain tax benefits, lower interest rates from banks, discounts for participation in associations, etc.) for companies that act on sustainability initiatives.

It should be noted that the research conducted was solely based on responses received during the survey and subsequent interview process, and that the companies were not externally evaluated in terms of their ESG performance, the combination of which could be suggested for future research. The results of this study could also be interpreted in terms of more specific managerial implications, providing a baseline for companies still embarking on the sustainability journey that are willing to overcome the obstacles that are currently encountered by companies operating in Latvia.

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EFFICIENCY ANALYSIS ON THE CONSUMPTION OF SOFTWARE PIRACY IN OECD COUNTRIES

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Abstract. *This paper focuses on one of the topics of copyright economics: the study of software piracy and its determinants. The efficiency of OECD countries regarding the consumption of illegal software is analyzed. In this vein, efficiency is associated with the minimal consumption of software piracy according to the socioeconomic characteristics of a nation. Data Envelopment Analysis is the methodology employed, which assigns an efficiency score to the countries in order to establish a ranking of efficiency. Additionally, a relationship is established between the legal origin of the copyright law of a country and its efficiency level. The results of the efficiency analysis show that the efficient countries are Austria, Hungary, Japan, Korea, Mexico and Slovakia; this leads to the affirmation that the countries with lower levels of piracy are not always efficient. According to the legal origin of copyright law, countries with a German origin are the most efficient. Consequently, the efficiency score is not related to the level of software piracy but to the legal origin.*

Keywords: *software piracy, copyright economics, efficiency assessment, data envelopment analysis, efficiency ranking.*

JEL Classification: *C14; O34; Z10.*

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1. Introduction

In 2017, unlicensed software accounted for 37% of the software installed on computers worldwide, resulting in losses of around US$46 billion according to the Business Software Alliance (BSA). This data depends on the region: countries with a lower piracy rate are in North America and Western Europe (their piracy rates are 16% and 26%, respectively), while in the other regions more than half of the software used is illegal (BSA, 2018).

Software[2] piracy has become a global phenomenon driven by the emergence of digital technologies, which reduce copying costs and facilitate their distribution and perfection (Andrés, 2006a; Yang et al., 2009). The BSA defines software piracy as "the illegal use and/or distribution of software protected under intellectual property laws."

The study of software piracy forms part of the economics of copying[3] (Landes & Posner, 1989), where one of the main (and most commonly studied) topics is the analysis of the determinants of piracy (Banerjee et al., 2005; Yang et al., 2004). According to existing studies, the level of piracy depends on multiple elements, such as wealth, education, culture, and regulation.

These determinants explain that, for example, pirated software in Mexico constitutes 49% of use, (Mexico ranks top in the world piracy ranking) against 15% in the USA – the latter being the country with the lowest software piracy rate.

We raise the following questions: Given the determinant factors of illegal software of a country, could the rates of piracy software be reduced? In other words, are resources/policy being used efficiently by governments/countries in order to reduce the consumption of illegal software?

Scholars have focused on determinants and consequences of the consumption of illegal software (Proserpio et al., 2005; Goel & Nelson, 2009; Andrés & Goel, 2011; Dias Gomes et al., 2018), but no studies have analyzed the consumption of software piracy using the efficiency approach. In this context, efficiency is associated with the minimal consumption of software piracy according to the socioeconomic characteristics of a nation. Striving to address this gap, this paper analyses efficiency in terms of reducing consumption levels of software piracy in several countries. To this end, a methodology employed in studies of efficiency measurement is applied, which uses a non-parametric method based on mathematical programming, known as Data Envelopment Analysis (DEA). Through efficiency scores, the methodology of DEA evaluates the relative efficiency of a set of units (countries in our case) that are comparable, while the resources they consume (determinants of software piracy) and the productions they generate (variable on the level of piracy) are similar (the variables for all the countries are the same in our case).

The DEA methodology was developed by Farrell (1957), who defined a frontier of the best practices composed of the most efficient units of the sample in order to obtain efficiency measures for each unit. Since the relative efficiency scores are obtained by comparing the data of each

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[2] Software forms part of the information or knowledge goods, their characteristics are (Shapiro & Varian, 1999): a) high production costs versus very low reproduction costs; b) experience goods; c) decreasing marginal utility; d) technological dependence (lock-in); e) network effects (feedback); f) intellectual property. Copyright goods can be found within knowledge goods: the main difference between them is the perception of copyright goods as public goods (Watt, 2009). Software belongs to information and copyright goods.

[3] Copying economics is an area of copyright economics (Plant, 1934); while the first "analyzes the effects of new technologies on the process of copying and reproduction", the economics of copyright "focuses on the impacts of the legal framework" (Towse et al., 2011, p. 31).

unit with those of the rest, specifically with "best practices," once the methodology has been applied to the set of units, these units can be ordered to establish a ranking of efficiency. As regards the literature on ranking Decision Making Units (DMUs) in DEA, several reviews exist, such as those by Adler et al. (2002), Jahanshahloo et al. (2008), and Hosseinzadeh Lofti et al. (2013).

The main contribution of this paper is the application of the DEA methodology as a tool that can promote the design of effective copyright policies. Specifically, DEA is applied to the 36 member nations of the Organization for Economic Co-operation and Development (OECD) for the years 2009, 2013, 2015, and 2017. This methodology will identify which countries are not efficient (a high consumption of illegal software compared with the socioeconomic structure) and which must modify the copyright protection framework in order to improve the efficiency score.[4] So, the results of this study will shed light on the quality of the management of copyright policy. Additionally, it will be studied whether the efficiency level of a country is associated with the legal origin of its copyright protection system.

The structure of this paper is as follows. Section 2 presents the formalization of the methodology proposed, the sample, and a literature review of software piracy in order to select the study variables. Section 3 reports the results of datasets from different years. Finally, the last section provides a summary and the conclusions.

2. Methodology, selection of sample, and variables

2.1. Methodology

DEA is a well-known non-parametric methodology for the assessment of the relative efficiency of a sample of homogeneous DMUs on the basis of data regarding the input consumption and the output production. DEA models typically assign a normalized efficiency score to each DMU in order to distinguish between efficient and inefficient units.

The standard input-oriented CCR DEA model (Charnes et al., 1978) is defined as follows.

Suppose there are m independent DMUs, j in $M=\{1, 2,\ldots,m\}$, each of which consume k different inputs, i in $I=\{1,2,\ldots,k\}$, in quantities x_{ij}, to generate h different outputs in quantities y_{rj} (r in $H=\{1,2,\ldots,h\}$).

The efficiency of a given DMU, j_0 in M, can be computed as follows:

$$
\begin{aligned}
E(j_0) = \quad & \min \theta_{j_0} \\
& s.t. \quad \sum_{j \in M} \lambda_j x_{ij} \leq \theta_{j_0} x_{ij_0} \qquad \forall i \in I \\
& \sum_{j \in M} \lambda_j y_{rj} \geq y_{rj_0} \qquad \forall r \in H \\
& \lambda_j \geq 0 \qquad \forall j \in M \\
& \theta_{j_0} \quad free
\end{aligned}
$$

[4] There are two ways to improve efficiency scores: increasing the output and/or reducing the input. The second option is not considered in this paper because the inputs used are positively linked to the development level of a country, and, therefore, efficiency scores can only be improved by increasing the output – that is, increasing the legal consumption of software (or reducing the consumption of software piracy).

DMU j_0 in M is efficient if $E_{j0} = 1$ and the deviation variables in the reformulated model below, s^-_{ij0}, i in I, and s^+_{rj0}, r in H, are both zero:

$$\min \theta_{j_0} - \varepsilon \left(\sum_{i \epsilon I} s^-_{ij0} + \sum_{r \in H} s^+_{rj0}\right)$$

$$s.t. \quad \sum_{j \in M} \lambda_j x_{ij} = \theta_{j_0} x_{ij_0} - s^-_{ij0} \qquad \forall i \in I$$

$$\sum_{j \in M} \lambda_j y_{rj} \geq y_{rj_0} + s^+_{rj0} \qquad \forall r \in H$$

$$\lambda_j \geq 0 \qquad \forall j \in M$$

$$s^-_{ij0} \geq 0 \qquad \forall i \in I$$

$$s^+_{rj0} \geq 0 \qquad \forall r \in H$$

$$\theta_{j_0} \quad free,$$

Efficient units are assigned a score of 1, whereas inefficient units obtain a score which reflects their degree of inefficiency (a value less than 1 and greater than 0). These efficiency scores can be used to establish a ranking of DMUs. The ranking is incomplete, however, since efficient DMUs cannot be differentiated in these terms. Various approaches exist to rank all the DMUs and not only the efficient DMUs: in general, three major categories of approaches can be distinguished. These are outlined below, but this list is not exhaustive.

One category corresponds to methods based on cross-efficiency (XE). In this type of method, the conventional CCR DEA model is first solved to compute the efficiency score of each DMU, which is then imposed as a constraint in a secondary-goal DEA model.

A second important category of DEA ranking methods is formed of those based on the computation of a Common Set of Weights (CSW) for all DMUs, which can then be used to rank all DMUs. Different criteria can be used to choose the CSW (e.g. compromise programming, regression analysis and deviation from weight profiles of efficient DMUs).

A third major category of DEA ranking methods are those based on super-efficiency (SE). Such methods generally use DEA models, and the key feature of this approach is that the DMU being ranked is dropped from the set of DMUs that define the technology. This can lead, in the case of extremely efficient DMUs, to SE scores larger than unity, which can be used to rank those DMUs. Since for inefficient units these SE scores coincide with conventional efficiency scores, this method is applied only to rank efficient DMUs. A variety of metrics can be used to measure the distance of an efficient DMU to the corresponding SE frontier (obtained when the DMU is dropped from the set of DMUs that define the technology), such as radial, the slacks-based measure, the L1 norm, and the Tchebycheff norm.

In order to differentiate between the performance of efficient DMUs, we use the super-efficiency method because in XE methods it may occur that an efficient DMU is ranked below an inefficient DMU, and in CSW methods a previous criterion must be defined to choose the weights. Moreover, the most common metric is employed here: the radial metric.

For the standard input-oriented CCR DEA model, the super-efficiency of a given DMU, j_0 in M, can be computed as follows:

$$
\begin{aligned}
E^{super}(j_0) = \quad & \min \theta_{j_0} \\
& s.t. \quad \sum_{j \in M \setminus \{j_0\}} \lambda_j x_{ij} \leq \theta_{j_0} x_{ij_0} \quad \forall\, i \in I \\
& \sum_{j \in M \setminus \{j_0\}} \lambda_j y_{rj} \geq y_{rj_0} \quad \forall\, r \in H \\
& \lambda_j \geq 0 \qquad\qquad \forall\, j \in M \setminus \{j_0\} \\
& \theta_{j_0} \quad free
\end{aligned}
$$

Our CCR DEA model assumes constant returns to scale (CRS). Models assuming variable returns to scale (VRS) can be obtained by adding to the CRS model (1) and (3) the following constraints: and , respectively. However, in this paper, the CCR model where CRS are assumed is used because the CRS super-efficiency DEA model is usually feasible, while the VRS super-efficiency DEA model can be infeasible. Seiford & Zhu (1999) show the condition under which the VRS model is infeasible.

2.2. Selection of sample

The sample includes the 36 member nations of the OECD[5] in order to supply an international framework for the study.

Furthermore, the research time covers the years 2009, 2013, 2015, and 2017.[6] This will enable intertemporal comparisons to be made.

2.3. Selection of variables

DEA is a non-parametric method which enables multiple variables, inputs, and outputs measured in different units to be integrated. Furthermore, since it is a non-parametric method, it is not necessary to define or justify the functional form of the production between inputs and outputs. However, the selection of the variables has been made through a meticulous study of the determinants of software piracy to ensure that the analysis has a solid foundation.

2.3.1. Output variable

As noted earlier, the efficiency of the use of resources to combat piracy, given the determining factors, is studied in this paper. Therefore, an efficient protection is that which minimizes the volume of pirated product according to its determinants.

With the aim of gauging the piracy of software in a nation, statistical data provided by the BSA is used; this is the reference database of the main work related to software piracy. The BSA

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[5] Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

[6] The selection of these years is explained by the availability of data on software piracy which is offered by the BSA (2012, 2014)

is an American organization that measures the rate of pirated software (SPR).[7] This rate varies between 0% and 100%; where 0% reflects the non-existence of piracy, while 100% indicates all the consumed software has been pirated.

According to the properties of the DEA analysis, in this paper, instead of SPR, we will use the rate of legal software (LSR).[8] Therefore, when the value of the LSR is 0%, this means that all software is pirated; an LSR of 100% indicates the total absence of piracy.

2.3.2. Input variables

In line with some of the most representative work in the piracy framework (Proserpio et al., 2005; Goel & Nelson, 2009; Andrés & Goel, 2011; Dias Gomes et al., 2018), determinants of software piracy can be classified into four dimensions or categories[9]: economic, institutional, educational, and cultural.

Table 1 compiles the bibliographic references of software piracy determinants, which explain the selection of input variables.

- Economic dimension

Most studies regarding software piracy agree that the wealth of a nation is negatively related to the level of software piracy. This can be explained because intellectual property rights (IPR) are more protected, and have lower piracy rates, in nations with higher per capita incomes (Rapp & Rozek, 1990; Park & Ginarte, 1997).

This research will use GDP per capita in constant dollars 2011 (GDPpc). Data has been collected from the World Bank online database.

Reviews of most relevant work that studies the connection between this dimension and software piracy are shown in Table 1. As can be observed, there is a negative relationship between SPR and GDPpc, so it can be said that the link between GDPpc and LSR is positive.

- Institutional dimension

According to Knack and Keefer (1995) and Hall and Jones (1996), nations with stronger institutions are those which provide a greater protection of the IPR. Therefore, countries with weaker institutions have greater piracy rates, and vice versa (Marron & Steel, 2000).

In this context, corruption is a way of gauging the quality of the institutional framework. Nations with the highest corruption are those that encourage piracy more, because in these nations, hackers enjoy greater opportunities for operating outside the law.

In line with the reviews shown in Table 1, this paper will use the Corruption Perceptions Index (CPI). This is an indicator built by Transparency International (n.d.), which reflects levels of corruption perceived in each nation according to valuations and opinion polls of experts in the field. The range of this indicator varies between 0 and 100; a value of 100 indicates the absence of corruption, and vice versa.

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[7] Software Piracy Rate (SPR) = Unlicensed software units \ Total software units installed, where Total software units installed = PC receiving software x Software units per PC.

[8] Legal Software Rate (LSR) = 100 − SPR.

[9] Technology is usually considered as another dimension. Since the results of studies are not concise with respect to this factor, this factor is excluded from this paper.

Table 1: *References of software piracy determinants*

Reference	Study	Output	Dimension/Input	Link output-input
Husted (2000)	Software piracy, cross-section analysis for 37 nations in 1996	SPR	Economic: GDP pc	(-)
			Cultural: Individualism	(-)
Marron & Steel (2000)	Software piracy, cross-section analysis for 77 nations with averages from 1994–1997	SPR	Economic: GDP pc	(-)
			Educational: Average years of schooling in population >25 years	(-)
			Cultural: Individualism	(-)
Ronkainen & Guerrero-Cusumano (2001)	Software piracy, cross-section analysis for 50 nations in 1997 and 1998	SPR	Economic: GDP pc	(-)
			Institutional: CPI	(-)
Depken & Simmons (2004)	Software piracy, cross-section analysis for 65 nations in 1994	SPR	Economic: GDP pc	(-)
			Educational: Literacy rate	(+)/(-)
			Cultural: Individualism	(-)
Banerjee et al. (2005)	Software piracy, panel data analysis for 53 nations from 1994–1999	SPR	Economic: GDP pc	(-)
			Institutional: CPI	(-)
Proserpio et al. (2005)	Software, movies and music piracy; cross-section analysis for 76 nations with averages from 1999–2002	SPR	Economic: GDP pc	(-)
			Institutional: CPI	(-)
			Educational: Average years of schooling in population >25 years	(-)
			Cultural: Individualism	(-)
Shadlen et al. (2005)	Software piracy; panel data analysis for 80 nations from 1994–2002	SPR	Economic: GDPpc	(-)
			Educational: Combined primary, secondary, and tertiary gross enrollment ratio	(-)
Andrés (2006a)	Software piracy; panel data analysis for 23 nations in 1994, 1997 and 2000	SPR	Economic: GDP pc	(-)
Andrés (2006b)	Software piracy; cross-section analysis for 34 nations in 1995	SPR	Economic: GDP pc	(-)
Moores (2008)	Software piracy; cross-section analysis for 57 nations with averages from 1994–2002	SPR	Economic: GDP pc	(-)
			Cultural: Individualism	(-)

Robertson et al. (2008)	Software piracy; cross-section analysis for 88 nations in 1999	SPR	Economic: GNP pc	(-)
			Institutional: CPI	(-)
Goel & Nelson (2009)	Software piracy; cross-section analysis for 80 nations in 2004	SPR	Economic: GDP pc	(-)
			Institutional: CPI	(-)
			Educational: Literacy rate	(+)
Yang et al. (2009)	Software piracy; panel data analysis for 59 nations from 2000–2005	SPR	Economic: GDP pc	(-)
			Cultural: Individualism	(-)
Andrés & Goel (2011)	Software piracy; cross-section analysis for 100 nations in 2007	SPR	Economic: GDP pc	(-)
			Institutional: CPI	(-)
Dias Gomes et al. (2018)	Software piracy; panel data analysis for 81 nations from 1995–2010	SPR	Economic: GDP pc	(-)
			Institutional: CPI	(-)
			Educational: Duration of primary education (years)	(-)

Source: *Author's own*

Regarding the results of the references in Table 1, it can be stated that there is a negative relationship between SPR and CPI; in other words, the connection between LSR and CPI is positive.

- Educational dimension

The majority of studies on software piracy that analyze this dimension found the relationship between educational level and software piracy to be negative (Marron & Steel, 2000; Depken & Simmons, 2004; Proserpio et al., 2005; Shadlen et al., 2005; Goel & Nelson, 2009; Dias Gomes et al., 2018).

A population with a higher educational level becomes more aware of the need to protect IPR, and hence demand major protection.

Research, such as that by Marron and Steel (2000), Proserpio et al. (2005), and Andrés (2006b), uses the average years of schooling in populations over 25 years of age as their study variable. However, in line with Dias Gomes et al. (2018), this paper will use the duration in primary education (DPE).[10] Data is provided by the World Bank online database.

Since the link between DPE and SPR is negative, then the relationship between DPE and LSR is positive.

- Cultural dimension

Features of a culture provide information on the customs and practices of a society. In this respect, there are studies which conclude that culture affects attitudes towards software piracy.

According to Hofstede (1997), there are five dimensions that explain the attitude of a society in economic and social aspects: 1) power distance, 2) individualism, 3) masculinity, 4) un-

[10] Dias Gomes et al. (2018) did not apply the average years of schooling in the population aged over 25 due to the non-availability of data in recent years (this is a variable obtained by Barro and Lee in 1996), hence they used DPE.

certainty avoidance, and 5) long-term orientation. A number of studies have linked Hofstede's dimensions with piracy. Individualism[11] (IND) is the single dimension that is significantly connected with software piracy.

In line with the results of references shown in Table 1, there is a negative connection between individualism and software piracy. Consequently, nations of a more individualistic nature have a lower level of software piracy since collectivist nations are more concerned about social harmony and group welfare. This greater emphasis based on sharing also occurs in software frameworks, and hence illegal products circulate more readily in a collectivist society. Therefore, there is a positive link between IND and LSR. Table 2 reflects the connection between the output (LSR) and input variables.

Table 2: *Links between output and input variables*

Output	Input	Link
LSR (Legal Software Rate)	GDPpc (GDP per capita)	Positive (+)
	CPI (Corruption Perceptions Index)	Positive (+)
	DPE (Duration of primary education)	Positive (+)
	IND (Individualism)	Positive (+)

Results and discussion

In this paper, the ranking of the 36 member nations of the OECD is applied across several years in order to consolidate the results, since the variables analyzed do not change abruptly for each nation over short periods.

As previously stated, the CRS super-efficiency model has been used since it is always feasible. The VRS super-efficiency model cannot be used in our case because the model is infeasible for certain countries.

Table 3 shows the efficiency scores and the ranking of countries for the period studied.

As can be observed, for 2017 there were six efficient nations (Austria, Hungary, Japan, Korea, Mexico and Slovakia), which are ordered according to the super-efficiency score as follows: Korea, Mexico, Austria, Hungary, Japan, and Slovakia. These countries and Portugal were also efficient in 2015, where the ranking is the following: Korea, Mexico, Austria, Slovakia, Hungary, Japan, and Portugal. For 2013, the efficient nations were the same as in 2015, but Hungary and Portugal moved up one position and Slovakia and Japan moved down one position. Finally, in 2009, there were also eight efficient nations (Austria, the Czech Republic, Hungary, Japan, Korea, Mexico, Portugal, and Slovakia), which coincide with the efficient nations of 2013. These efficient nations are ordered according to the super-efficiency score as follows: Korea, Austria, Hungary, Mexico, Japan, Slovakia, Portugal, and the Czech Republic. Note that the same order is maintained as in 2013 for these countries, except for Mexico and Japan, which are in 4th and 5th place for 2009 and in 2nd and 7th place for 2013, respectively.

[11] Individualism refers to the level of individuality valued over group ideals. Data of this variable has been extracted from Hofstede (1997).

Table 3: *Efficiency scores and positions of the nations in different years*

OECD countries	2017		2015		2013		2009	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Australia	0.8043	24	0.7988	24	0.7611	29	0.7593	33
Austria	1.1182	3	1.1216	3	1.1348	3	1.1430	2
Belgium	0.8280	18	0.8160	22	0.8072	19	0.8697	19
Canada	0.8131	23	0.7863	27	0.7759	24	0.7929	30
Chile	0.8691	13	0.8294	19	0.7990	20	0.8289	25
Czech Republic	0.9327	11	0.9442	11	1.0238	8	1.0150	8
Denmark	0.7693	29	0.7620	31	0.7519	31	0.8050	27
Estonia	0.8161	22	0.8383	18	0.7823	22	0.8573	21
Finland	0.8660	14	0.8671	16	0.8555	14	0.8727	18
France	0.8181	20	0.7994	23	0.7760	23	0.7705	31
Germany	0.9880	9	0.9906	8	0.9870	9	0.9984	9
Greece	0.6348	35	0.6284	35	0.7156	34	0.9057	14
Hungary	1.0699	4	1.0743	5	1.0958	4	1.1108	3
Iceland	0.5680	36	0.5747	36	0.5606	36	0.5486	36
Ireland	0.6945	34	0.7068	34	0.7035	35	0.6744	35
Israel	0.9530	10	0.9404	12	0.9284	11	0.9707	11
Italy	0.7967	26	0.9623	10	0.8964	13	0.9225	12
Japan	1.0465	5	1.0343	6	1.0373	7	1.0756	5
Korea	1.6452	1	1.5984	1	1.5500	1	1.4750	1
Latvia	0.8031	25	0.8230	20	0.7940	21	0.8862	16
Lithuania	0.7669	31	0.7786	29	0.7617	27	0.8768	17
Luxembourg	0.8582	17	0.8740	14	0.8541	15	0.9115	13
Mexico	1.3317	2	1.2358	2	1.1759	2	1.1093	4
Netherlands	0.7687	30	0.7614	32	0.7570	30	0.7620	32
New Zealand	0.9984	7	0.9817	9	0.9513	10	0.9737	10
Norway	0.7447	33	0.7433	33	0.7192	33	0.7400	34
Poland	0.7846	27	0.7893	26	0.7752	25	0.8226	26
Portugal	0.9929	8	1.0294	7	1.0526	6	1.0163	7
Slovakia	1.0441	6	1.0837	4	1.0767	5	1.0553	6

Slovenia	0.8886	12	0.8989	13	0.9030	12	0.8641	20
Spain	0.7549	32	0.7621	30	0.7517	32	0.7968	29
Sweden	0.8260	19	0.8179	21	0.8116	18	0.8420	23
Switzerland	0.7840	28	0.7851	28	0.7612	28	0.8033	28
Turkey	0.8163	21	0.7974	25	0.7741	26	0.8543	22
United Kingdom	0.8621	16	0.8562	17	0.8318	17	0.8407	24
United States	0.8629	15	0.8698	15	0.8524	16	0.8941	15

Certain comments should be made regarding the results shown. Firstly, efficient nations, with the exception of Austria and Japan, have high software piracy rates (although all nations reduced software piracy throughout the study period); on the other hand, nations with the lowest software piracy rates have been classified as inefficient nations (the USA, Australia, Luxembourg, and Germany, for example). Therefore, using the same example as that in the introduction of this paper, Mexico uses its resources and/or applies its policies more efficiently than the USA.

Regarding the results during the study period, it can be stated that there were no major changes in the position of nations in the different efficiency rankings. However, Greece, Italy, and Lithuania suffered major variations in their positions. Tables 4–7 of the Appendix to this paper offer a dataset for the period studied. Greece dropped in the ranking, from 14th place for 2009 to 34th place for 2013; these changes could be explained by the fall of the GDPpc (it can be observed that the other input variables have no significant fluctuations). Italy also underwent significant variation in its positions, ranking 10th for 2015 and 26th for 2017; in this case, the CPI was the input variable that experienced a major variation (while the CPI was 44 in 2015, the CPI of 2017 was 50). The drop of Lithuania in the ranking, from 17th place for 2009 to 27th place for 2013, could be explained by the variation of both the GDP and the CPI (GDP and CPI grows while the output variable has no major increase).

Therefore, according to the results offered by this study, the most efficient nation in the consumption of legal software throughout the 2009–2017 period was Korea.

However, to illustrate that, in general, there were no abrupt changes in the ranking over the different years, the strength and association between the different rankings are analyzed. To do this, Spearman's correlation between each pair of years will be used.

Spearman's correlation coefficient is a non-parametric measure of rank correlation, that is, of the statistical dependence of ranking between two different years. Spearman's correlation coefficient can take a value between +1 and −1. If Spearman's coefficient is close to 0, then the association between the two rankings is weak or null, and if it is close to +1 (or −1), then the association between the two rankings is almost perfectly positive (or negative).

Table 8 shows Spearman's correlation coefficients between the rankings of all the years.

Since all the Spearman's correlation coefficients shown in Table 8 are close to +1, the associations between the rankings of the different years are almost perfect. In this way, this analysis of the efficiency of member nations of the OECD shows consistency over the years.

Table 8: *Spearman's correlations coefficients*

	Ranking 2017	**Ranking 2015**	**Ranking 2013**	**Ranking 2009**
Ranking 2017		0.94311454	0.95418275	0.802574
Ranking 2015	0.94311454		0.98481338	0.87464607
Ranking 2013	0.95418275	0.98481338		0.88597169
Ranking 2009	0.802574	0.87464607	0.88597169	

Goel and Nelson (2009) and Andrés and Goel (2011) found that the legal origin of copyright protection systems could explain the level of software piracy in a country (in line with La Porta et al.,1999, there are four legal origins: English, French, German, and Scandinavian). This association motivates the research hypothesis of this work, from which it is studied whether the efficiency scores of countries are associated with their legal origins.

For this analysis, the Kruskal–Wallis test is used (Kruskal & Wallis, 1952; Brockett & Golany, 1996). This involves determining whether or not there are significant differences in the average values obtained in the efficiency scores between the various groups into which the sample of countries has been divided, in terms of their legal origin.

Table 9 shows the p-value obtained from the Kruskal–Wallis test and the average efficiency score of each group of legal origin, for each year considered.

Taking Table 9 as a reference, the Kruskal–Wallis test (with a significance level of 5\%) leads to the rejection, for every year considered, of the hypothesis of equality of means for efficiency scores in the four groups of countries proposed according to their legal origin. Through examining the average values of each group for every year considered, countries of German origin are the most efficient while countries of Scandinavian origin are the least efficient. There are hardly any significant differences between the means of the countries of English origin and the countries of French origin.

Table 9: *Legal origin – Kruskal–Wallis tests*

Year	***p*-value**	**Average efficiency score**			
		English Origin	**French Origin**	**German Origin**	**Scandinavian Origin**
2017	0.016	0.85547	0.84456	1.03331	0.75479
2015	0.010	0.84857	0.84904	1.03693	0.75300
2013	0.015	0.82919	0.83502	1.03519	0.73977
2009	0.012	0.84368	0.88093	1.03979	0.76167

On the other hand, these results lead us to study whether the regional proximity of a country is also related to its efficiency level. To this end, the countries have been divided into six groups: (1) Asia Pacific; (2) Central and Eastern Europe; (3) Latin America; (4) Middle East and America; (5) North America; and (6) Western Europe.

Taking Table 10 as a reference, the Kruskal–Wallis test (with a significance level of up to

10\%) leads to the acceptance, for every year considered, of the hypothesis of the equality of means for efficiency scores in the six groups of countries proposed according to their regional proximity.

Table 10: *Regional proximity – Kruskal–Wallis tests*

Year	2017	2015	2013	2009
p-value	0.141	0.247	0.377	0.423

4. Conclusions

Numerous articles analyze software piracy and its determinant factors. This paper is based on these factors, for which a historical, well-researched, and methodologically useful review is provided. According to this review, the determinants of software piracy can be classified into four dimensions: economic, institutional, educational, and cultural.

The question that arises is whether countries make efficient use of their resources to combat piracy, given the determining factors, or whether they have room for improvement. In this paper, the DEA methodology has been used in order to analyze how efficient a country is compared to the rest of the countries in the sample. Each country is assigned a relative efficiency score, which has allowed us to establish an efficiency ranking for all the countries considered.

The analysis applied indicates that, for every year included in the sample, the efficient countries were Austria, Hungary, Japan, Korea, Mexico, and Slovakia (Portugal was efficient every year ,with the exception of 2017, and the Czech Republic was efficient in 2009 and 2013). These countries (except Austria and Japan) have a high consumption of illegal software. On the other hand, Denmark, Ireland, the Netherlands, and Norway are placed at the bottom of the ranking; these are some of the countries with the lowest levels of software piracy. Therefore, the efficiency analysis leads us to affirm that the countries with lower levels of piracy are not always efficient; however, it can happen that a country which displays high levels of piracy obtains a high score of efficiency since this country is doing everything possible to reduce the volume of piracy, given its circumstances. Consequently, the level of software piracy is not related to the efficiency score. The results of the efficiency analysis show that, with the exception of the six efficient countries, the remaining countries could reduce their piracy rates; in these cases, reducing the volume of piracy requires reforming the institutional framework and acting on the input variables.

Although these results are fully applicable to all years of the sample (see Spearman Correlations), it is appropriate to qualify that the positions in the ranking of Greece, Italy, and Slovakia suffer significant changes over the years due to fluctuation of the GDPpc (in case of Greece and Slovakia) and the CPI (in case of Italy and Slovakia). This is one of the advantages of efficiency analysis: it enables the identification of which factors must be improved in order to increase the level of efficiency.

Another relevant result concerns the relationship between efficiency score and legal origin. According to the Kruskal–Wallis test, it can been said that the legal origin of a country is related to the efficiency level. Specifically, countries with a German origin are the most efficient; in contrast, Scandinavian countries have the worst efficiency levels for all years of the sample. Nonetheless, regional proximity does not determine the efficiency level. For example, Germany

and France have regional proximity, but their efficiency scores are very different; France and Chile are not geographically close countries, but they have very similar efficiency scores since they have the same legal origin.

The efficiency analysis applied in this paper enables a reflection to be made on the ability of a country to manage its fight against software piracy; furthermore, it indicates the weaknesses and/or strengths of a country as regards improvements in its efficiency level. When a country is not efficient, this means that this country could reduce its piracy consumption according to the determining factors. Therefore, this paper could serve as a guide for the design of efficient copyright policies or reforms, whose principal items include economic, institutional, educational, and cultural aspects.

Appendix

Table 4: *Dataset, efficiency scores, and ranking 2017*

DMUs j=1,…,36	OECD countries	Inputs				Output LSR	Efficiency Score (E_{j0})	Super-efficiency Score (E^{super}_{j0})	Ranking order
		GDPpc	CPI	DPE	IND				
1	Australia	44781	77	7	90	82	0.8043	0.8043	24
2	Austria	45421	75	4	55	81	1.0000	1.1182	3
3	Belgium	43133	75	6	75	78	0.8280	0.8280	18
4	Canada	43871	82	6	80	78	0.8131	0.8131	23
5	Chile	22297	67	6	23	45	0.8691	0.8691	13
6	Czech Republic	32571	57	5	58	68	0.9327	0.9327	11
7	Denmark	47555	88	7	74	80	0.7693	0.7693	29
8	Estonia	29704	71	6	60	59	0.8161	0.8161	22
9	Finland	41443	85	6	63	78	0.8660	0.8660	14
10	France	38956	70	5	71	68	0.8181	0.8181	20
11	Germany	45393	81	4	67	80	0.9880	0.9880	9
12	Greece	24602	48	6	35	39	0.6348	0.6348	35
13	Hungary	27032	45	4	80	64	1.0000	1.0699	4
14	Iceland	47840	77	7	60	56	0.5680	0.5680	36
15	Ireland	66132	74	8	70	71	0.6945	0.6945	34
16	Israel	33123	62	6	54	73	0.9530	0.9530	10
17	Italy	35491	50	5	76	57	0.7967	0.7967	26
18	Japan	38907	73	6	46	84	1.0000	1.0465	5
19	Korea	35938	54	6	18	68	1.0000	1.6452	1
20	Latvia	24859	58	6	70	52	0.8031	0.8031	25
21	Lithuania	29668	59	4	60	50	0.7669	0.7669	31
22	Luxembourg	95666	82	6	60	83	0.8582	0.8582	17
23	Mexico	17956	29	6	30	51	1.0000	1.3317	2
24	Netherlands	48809	82	6	80	78	0.7687	0.7687	30
25	New Zealand	36046	89	6	79	84	0.9984	0.9984	7
26	Norway	65014	85	7	69	79	0.7447	0.7447	33
27	Poland	27379	60	6	60	54	0.7846	0.7846	27
28	Portugal	28257	63	6	27	62	0.9929	0.9929	8

29	Slovakia	30059	50	4	52	65	1.0000	1.0441	6
30	Slovenia	31449	61	6	27	59	0.8886	0.8886	12
31	Spain	34126	57	6	51	58	0.7549	0.7549	32
32	Sweden	47261	84	6	71	81	0.8260	0.8260	19
33	Switzerland	58171	85	6	68	79	0.7840	0.7840	28
34	Turkey	25031	40	4	37	44	0.8163	0.8163	21
35	United Kingdom	40229	82	6	89	79	0.8621	0.8621	16
36	United States	54471	75	6	91	85	0.8629	0.8629	15

Table 5: *Dataset, efficiency scores, and ranking 2015*

DMUs j=1,…,36	**OECD countries**	**Inputs**				**Output LSR**	**Efficiency Score (E_{j0})**	**Super-efficiency Score (E^{super}_{j0})**	**Ranking order**
		GDPpc	**CPI**	**DPE**	**IND**				
1	Australia	43832.43	79	7	90	80	0.7988	0.7988	24
2	Austria	44074.95	76	4	55	79	1.0000	1.1216	3
3	Belgium	41723.12	77	6	75	77	0.8160	0.8160	22
4	Canada	42983.1	83	6	80	76	0.7863	0.7863	27
5	Chile	22536.62	70	6	23	43	0.8294	0.8294	19
6	Czech Republic	30380.59	56	5	58	67	0.9442	0.9442	11
7	Denmark	45483.76	91	7	74	78	0.7620	0.7620	31
8	Estonia	27328.64	70	6	60	58	0.8383	0.8383	18
9	Finland	38993.67	90	6	63	76	0.8671	0.8671	16
10	France	37765.75	70	5	71	66	0.7994	0.7994	23
11	Germany	43784.15	81	4	67	78	0.9906	0.9906	8
12	Greece	24094.79	46	6	35	37	0.6284	0.6284	35
13	Hungary	24831.35	51	4	80	62	1.0000	1.0743	5
14	Iceland	42674.42	79	7	60	54	0.5747	0.5747	36
15	Ireland	60944.02	75	8	70	68	0.7068	0.7068	34
16	Israel	31970.69	61	6	54	71	0.9404	0.9404	12
17	Italy	34244.71	44	5	76	55	0.9623	0.9623	10

18	Japan	37818.09	75	6	46	82	1.0000	1.0343	6
19	Korea	34177.65	56	6	18	65	1.0000	1.5984	1
20	Latvia	23057.31	55	6	70	51	0.8230	0.8230	20
21	Lithuania	26970.81	61	4	60	49	0.7786	0.7786	29
22	Luxembourg	95311.11	81	6	60	81	0.8740	0.8740	14
23	Mexico	16667.84	35	6	30	48	1.0000	1.2358	2
24	Netherlands	46353.85	87	6	80	76	0.7614	0.7614	32
25	New Zealand	34646.31	88	6	79	82	0.9817	0.9817	9
26	Norway	63669.53	87	7	69	77	0.7433	0.7433	33
27	Poland	25299.05	62	6	60	52	0.7893	0.7893	26
28	Portugal	26548.33	63	6	27	61	1.0000	1.0294	7
29	Slovakia	28254.26	51	4	52	64	1.0000	1.0837	4
30	Slovenia	29097.34	60	6	27	57	0.8989	0.8989	13
31	Spain	32215.97	58	6	51	56	0.7621	0.7621	30
32	Sweden	45488.29	89	6	71	79	0.8179	0.8179	21
33	Switzerland	56510.86	86	6	68	77	0.7851	0.7851	28
34	Turkey	23382.25	42	4	37	42	0.7974	0.7974	25
35	United Kingdom	38509.21	81	6	89	78	0.8562	0.8562	17
36	United States	52789.97	76	6	91	83	0.8698	0.8698	15

Table 6: *Dataset, efficiency scores, and ranking 2013*

DMUs j=1,...,36	**OECD countries**	**Inputs**				**Output LSR**	**Efficiency Score** (E_{j0})	**Super-efficiency Score** (E^{super}_{j0})	**Ranking order**
		GDPpc	**CPI**	**DPE**	**IND**				
1	Australia	42920.1	81	7	90	79	0.7611	0.7611	29
2	Austria	44161.54	69	4	55	78	1.0000	1.1348	3
3	Belgium	40780.87	75	6	75	76	0.8072	0.8072	19
4	Canada	42335.67	81	6	80	75	0.7759	0.7759	24
5	Chile	21998.31	71	6	23	41	0.7990	0.7990	20
6	Czech Republic	28379.75	48	5	58	66	1.0000	1.0238	8
7	Denmark	44564.45	91	7	74	77	0.7519	0.7519	31
8	Estonia	26148.49	68	6	60	53	0.7823	0.7823	22
9	Finland	39428.31	89	6	63	76	0.8555	0.8555	14

10	France	37366.93	71	5	71	64	0.7760	0.7760	23
11	Germany	42914.48	78	4	67	76	0.9870	0.9870	9
12	Greece	23746.08	40	6	35	38	0.7156	0.7156	34
13	Hungary	23020	54	4	80	61	1.0000	1.0958	4
14	Iceland	41096.69	78	7	60	52	0.5606	0.5606	36
15	Ireland	45257.06	72	8	70	67	0.7035	0.7035	35
16	Israel	31434.88	61	6	54	70	0.9284	0.9284	11
17	Italy	34219.83	43	5	76	53	0.8964	0.8964	13
18	Japan	37148.66	74	6	46	81	1.0000	1.0373	7
19	Korea	32548.72	55	6	18	62	1.0000	1.5500	1
20	Latvia	21598.88	53	6	70	47	0.7940	0.7940	21
21	Lithuania	25147.71	57	4	60	47	0.7617	0.7617	27
22	Luxembourg	90950.09	80	6	60	80	0.8541	0.8541	15
23	Mexico	16315.86	34	6	30	46	1.0000	1.1759	2
24	Netherlands	45191.49	83	6	80	75	0.7570	0.7570	30
25	New Zealand	33841.18	91	6	79	80	0.9513	0.9513	10
26	Norway	62799.43	86	7	69	75	0.7192	0.7192	33
27	Poland	23554.79	60	6	60	49	0.7752	0.7752	25
28	Portugal	25654.61	62	6	27	60	1.0000	1.0526	6
29	Slovakia	26580.72	47	4	52	63	1.0000	1.0767	5
30	Slovenia	27629.66	57	6	27	55	0.9030	0.9030	12
31	Spain	30677.17	59	6	51	55	0.7517	0.7517	32
32	Sweden	43475.8	89	6	71	77	0.8116	0.8116	18
33	Switzerland	56252.93	85	6	68	76	0.7612	0.7612	28
34	Turkey	21650.76	50	4	37	40	0.7741	0.7741	26
35	United Kingdom	37130.28	76	6	89	76	0.8318	0.8318	17
36	United States	51008.46	73	6	91	82	0.8524	0.8524	16

Table 7: *Dataset, efficiency scores, and ranking 2009*

DMUs j=1,…,36	**OECD countries**	**Inputs**				**Output LSR**	**Efficiency Score** (E_{j0})	**Super-efficiency Score** (E^{super}_{j0})	**Ranking order**
		GDPpc	**CPI**	**DPE**	**IND**				
1	Australia	41207.13	87	7	90	75	0.7593	0.7593	33

2	Austria	42459.98	79	4	55	75	1.0000	1.1430	2
3	Belgium	40375.49	71	6	75	75	0.8697	0.8697	19
4	Canada	39924.2	87	6	80	71	0.7929	0.7929	30
5	Chile	18547.46	67	6	23	36	0.8289	0.8289	25
6	Czech Republic	27735.87	49	5	58	63	1.0000	1.0150	8
7	Denmark	43382.63	93	6	74	74	0.8050	0.8050	27
8	Estonia	22187.93	66	6	60	50	0.8573	0.8573	21
9	Finland	38867.8	89	6	63	75	0.8727	0.8727	18
10	France	36340.51	69	5	71	60	0.7705	0.7705	31
11	Germany	38784.45	80	4	67	72	0.9984	0.9984	9
12	Greece	30430.42	38	6	35	42	0.9057	0.9057	14
13	Hungary	22077.59	51	4	80	59	1.0000	1.1108	3
14	Iceland	40190.18	87	7	60	51	0.5486	0.5486	36
15	Ireland	44995.94	80	8	70	65	0.6744	0.6744	35
16	Israel	28569.3	61	6	54	67	0.9707	0.9707	11
17	Italy	35710.42	43	5	76	51	0.9225	0.9225	12
18	Japan	34317.5	77	6	46	79	1.0756	1.0756	5
19	Korea	28642.84	55	6	18	59	1.0000	1.4750	1
20	Latvia	18579.91	45	6	70	44	0.8862	0.8862	16
21	Lithuania	20299.2	49	4	60	46	0.8768	0.8768	17
22	Luxembourg	89098.73	82	6	60	79	0.9115	0.9115	13
23	Mexico	15011.75	33	6	30	40	1.0000	1.1093	4
24	Netherlands	45125.81	89	6	80	72	0.7620	0.7620	32
25	New Zealand	32122.84	94	6	79	78	0.9737	0.9737	10
26	Norway	62671.3	86	7	69	71	0.7400	0.7400	34
27	Poland	20952.77	50	6	60	46	0.8226	0.8226	26
28	Portugal	26743.2	58	6	27	60	1.0000	1.0163	7
29	Slovakia	23973.84	45	4	52	57	1.0000	1.0553	6
30	Slovenia	28451.55	66	6	27	54	0.8641	0.8641	20
31	Spain	32651.94	61	6	51	58	0.7968	0.7968	29
32	Sweden	40862.97	92	6	71	75	0.8420	0.8420	23
33	Switzerland	54512.98	90	6	68	75	0.8033	0.8033	28

34	Turkey	16783.44	44	5	37	37	0.8543	0.8543	22
35	United Kingdom	35795.18	77	6	89	73	0.8407	0.8407	24
36	United States	48557.87	75	6	91	80	0.8941	0.8941	15

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LEADERSHIP AND MOTIVATION IN THE GREEK PHARMACEUTICAL INDUSTRY

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Abstract. *In today's rapidly changing environment, leadership style and employee motivation are considered as crucial factors for organizations to operate effectively and achieve their missions and objectives. The pharmaceutical industry makes a major contribution worldwide, and in Greece particularly, not only to public health and welfare but also to the economy and employment. The annual turnover of pharmaceutical production in Greece was estimated over one billion euros for the years 2018–2019 (Tsakanikas et al., 2020), and more than 23,300 employees were employed in the sector in 2020, demonstrating a significant increase (9.8%) compared to the previous year (SFEE-IOBE, 2020). In this study, leadership and motivation in the Greek pharmaceutical industry is studied via an empirical analysis. The primary data, collected via questionnaires answered by pharmaceutical industry employees located in Greece, aimed at identifying the impact that leaders, communication, and motives have on employees' performance in the context of the altered and volatile environment the COVID-19 pandemic – which unavoidably changed people's attitude, needs, and ways of communication – has shaped. A general framework was indeed identified (democratic and transformational leadership); however, characteristics of other distinct leadership styles were also observed. Managers' opinions about themselves regarding their contribution to employees' effectiveness were positive but did not achieve the highest grade. Subordinates were positive in this regard, albeit with more tending to agree than strongly agree. Similar findings were extracted regarding motivation. Communication was affected by the new environment that the COVID-19 pandemic has shaped. Face-to-face communication was considered more effective than distance communication; however, employees had positive feelings when they worked remotely and felt more flexible. Finally, according to the above, the overall outcome was positive, yet still indicates that there is room for improvement or for adaptation to the new situation.*

Keywords: *leadership, motivation, communication, pharmaceutical industry.*

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JEL Classification: *M12; O32; L65.*

1. Introduction

There is no one particular leadership style or method that leads to the maximization of employees' performance. Different leadership styles and different leaders' skills have a different impact on (different) employees' performance. Motives and incentives shall be provided to employees to develop and maximize their performance so that they can consequently effectively serve their organizations' targets. However, what motivates one employee may not motivate another, and vice versa. Communication, the "lifeblood of an organization" (Mihiotis, 2005), is highly connected to leadership and effective performance. As pharmaceutical companies are divided into sectors (quality assurance and control, manufacturing, supply chain, technical operations etc.), clear and effective communication between teams and departments can maximize teams' cross-functional performance. The current study was conducted during the COVID-19 pandemic which, over the last two years, has rapidly changed economies, the working environment, people's attitudes, needs, and perceptions, as well as ways of communication. Thus, the new environment that is formed is expected to lead to more or different conclusions regarding leadership and communication, motivation, engagement, and people's commitment and satisfaction.

The pharmaceutical industry is crucial for public health. This was again underlined recently by the contribution of the sector in the worldwide effort to deal with the COVID-19 pandemic. According to the WHO (2021), as of 6:21pm CET, 26 November 2021, 259,502,031 confirmed cases of COVID-19 had been reported to the organization, including 5,183,003 deaths. As of 24 November 2021, 7,702,859,718 vaccine doses had been administered. Vaccines in general are critical for the prevention and control of infectious disease outbreaks, but they are not the only necessary tool. Consider also what the impact of shortages in drugs that cure, prevent, or control diseases such as asthma, diabetes, Hepatitis, and HIV would be, or consider the contribution of the research and development departments of the big pharmaceutical companies that are focusing on the development of drugs curing cancer. The pharmaceutical industry makes a major contribution worldwide not only to public health and welfare but also to the economy. In 2017, the global pharmaceutical market was valued at 1,135 billion U.S. dollars (Mikulic, 2021).

According to recent research from the Foundation for Economic & Industrial Research (Tsakanikas et al., 2020), pharmaceutical production in Greece was estimated at over one billion euros in recent years. According to SFEE-IOBE (2020), the Gross Value Added (GVA) of the domestic pharmaceutical sector was estimated at €1.2 billion in 2019, amounting to a share of 6.6% of the total manufacturing sector. The number of employees in the industry is consequently high and continuously increasing, having reaching 23,300 (SFEE-IOBE, 2020). The extremely complicated process of leadership and motivation becomes even more challenging if we consider the complicated organizational structure of the industry. A pharmaceutical company in Greece, and worldwide of course, consists of several different departments which need to effectively collaborate and communicate, such as human resources, warehouses, supply chain/planning, production/manufacturing, packaging, quality control, research and development, technical operations, regulatory affairs, pharmacovigilance, etc.

The aim of this study is to identify – through the evaluation of primary data – the impact

that leaders, motives, and incentives have on employees' performance. In this, it is significantly important at present to take into account the fact that the altered environment unavoidably changes peoples' attitudes, needs, and ways of communication. The significant importance of both leadership and management in the Greek pharmaceutical industry, as well as the altered environment that is formed, make this study and its conclusions even more significant and valuable.

A literature review, presented in the second section, reveals a huge number of theories, surveys, and questionnaires regarding both leadership and motivation. There is a significant difference, though, between these previous studies and the current undertaking: the environment, as the current study was conducted during the COVID-19 pandemic, which has irrevocably shaped new attitudes, feelings, and working environments (i.e. remote working), all of which underline the significance of this work. The methodology of the current study is described in the third section, and in the subsequent sections the statistical analysis and the results are presented. In the last section, the results and the conclusions are presented.

2. Literature review

"Leadership is one of the most observed and least understood phenomena on earth" (Stogdill, 1974). Because of the high complexity of leadership, several theories have developed over time. In truth, the high complexity of identification and understanding is key for acknowledging and developing new theories. According to Uhl-Bien, Marion, and McKelvey (2007), "much of leadership thinking has failed to recognize that leadership is not merely the influential act of an individual or individuals but rather is embedded in a complex interplay of numerous interacting forces."

The first researchers referred to the "great man": a hero, a born leader, and exclusively male. Such theories are now considered obsolete. The early "trait and skill theory" (Stogdill, 1948) tried to provide the tools to identify "born" leaders. Later, Stogdill (1974) again, Bass (1981), and other researchers tried to improve these tools, succeeding in connecting some traits to leaders (Bass, 1990; Kirkpatrick & Locke, 1991; Kouzes & Posner, 1990), but still providing minimal value as the majority of these traits cannot be learned. In contradiction to early trait theories, leadership is not only about strengths and skills but is also highly connected to behavior. Behavioral theory indicates that leadership can be taught and further developed, and behavioral theories were mainly studied by two universities: Ohio State University (Fleishman, 1953; Halpin & Winer, 1955) and Michigan University (Katz et al., 1951). The conclusions of these two universities were similar and, although criticized, they provide tools (questionnaires) and descriptions of leadership behavior. Similar conclusions were extracted by Blake and Mouton (1964) who, based on the Ohio and Michigan studies, issued a managerial grid focusing again on two dimensions: people and production. Finally, Bowers and Seashore (1966) summarized the Michigan research, also taking into consideration the Ohio research, concluding with the delimitation of four leadership dimensions: support, interaction facilitation, goal emphasis, and work facilitation.

Rensis Likert (1961, 1967) made a significant contribution to leadership and motivation theories by developing "Likert System Management," a continuum from authoritative to participative that demarcates four leadership classifications: the exploitive authoritative; the benevolent authoritative; the consultive; and the participative team. Similar findings and conclusions were reached by House (1971), who, in his Path-Goal theory, identified that a leader can be

defined as supportive, participative, achievement-oriented, or directive, according to their behavior. Some years later, Bolman and Deal (1984, 1991) suggested that a leader should consider the organization's challenges and their team's attitude and then decide which of the four frames (structural, human resource, political, or symbolic) fits, considering the situational model (first issued by Hersey, Blanchard & Natemeyer, 1979) which is highly connected to follower maturity level. Therefore, a leader can be directive or supportive, participative or achievement-oriented, depending on the situation and considering follower maturity levels (Daft, 2015).

The most recent theories focus on influence and the relational process. Influence is considered crucial to effective leadership (Yukl, 1999). Effective influence can lead to commitment and engagement, whereas ineffective influence can lead to resistance among followers. Relational theories resulted in "servant" (Greanleaf, 1973), transactional (Burns, 1978), and transformational (Bass, 1985) leadership theories, and the idea that a leader that influences subordinates shall be a charismatic leader that articulates a vision. A significant outcome of Burns' study (1978) was the development of the "MLQ" questionnaire (Yukl, 2013), which helped researchers to measure the transformational impact a leader has or to describe this leader.

A successful leader should influence subordinates; as a consequence, leadership is highly affected by and dependent on followership. An interesting categorization of followership was produced by Daft (2010), indicating five followership styles: the alienated; the conformist; the pragmatic; the passive; and the effective follower. As we are talking about influence and the interaction between the leader and the follower, effective communication is a mandatory requirement. The communication process is also a very complicated process, including not only content – the spoken or written words, or the symbols a message includes – but also context and paralanguage, including body language, hand gestures, etc. There are too many barriers to effective communication: environment; bias; smothering; emotions; non-verbal communication; culture; etc. There could perhaps be even more, considering the altered environment shaped by the COVID-19 pandemic, which has affected communication channels, non-verbal communication, and also emotional states. Therefore, an effective leader needs to possess special skills such as active listening, emotional intelligence (further analyzed to include self- and social-awareness, self-management, and relationship management according to Coleman and Boyatzis, 2017), and empathy.

An effective leader shall influence subordinates and have strong communication skills, but there is one more crucial factor: motivation. In leadership, several motivational theories have been developed by many researchers, starting with Frederick W. Taylor (1856–1915), who, according to Daft (2010), developed, among others, the "science of bricklaying" (Taylor, 1911): the breaking down of work cycles and production processes into simple elements ("Walk-rest, walk-rest," Taylor, 1911) in order to eliminate losses and standardize the process. Some years later, Mayo (1933), in his experiment at the Western Electric Company's Hawthorne plant in Chicago, caused a shift in supervisory style and human relations, believing that this science was the most crucial factor for increased performance and productivity (Daft, 2010).

As human beings are at the center of this discussion, human needs shall be considered as well. Abraham Maslow, a practicing psychologist, continued on the same path as Mayo. After observing that his patients' problems were mostly derived from their inability to satisfy their needs, he worked from a human resources perspective and proposed his widely known hierarchical relationship of needs, categorizing needs by level of importance and concluding with "Maslow's

pyramid." In the same direction, another psychologist, Frederick Herzberg (1923–2000), studied the aspects that cause satisfaction or dissatisfaction in employees' working environments, concluding, according to Daft (2010), with two factors: hygiene and motivators. Based on Maslow's study, McGregor (1961) categorized employees into two categories according to his Theory X and Theory Y.

Finally, McClelland (1985) identified three different areas of motivational needs: motivation by the need for power; by the need for affiliation; and by the need of achievement. These different areas of motivational needs explain why there is not one unique motivational "tool" for employees, as what motivates one employee may demotivate another, and vice versa. In the motivation area, intrinsic and extrinsic rewards are tools that are now widely used to motivate employees via their personal need for accomplishment or for those motivated by leadership awards, respectively. Empowerment, engagement, and job satisfaction, areas on which human resource management focuses, are considered as crucial factors for the development of employees and consequently for their effective contribution to the accomplishment of organizations' targets.

Leadership has developed throughout time: from the "great man" theory, to the relational and influence theories, and then to the theory of the transformational and visionary leader – a leader who, through their behavior, encourages openness in sharing information required for decision making, at the same time accepting the opinions and ideas of their followers, or a leader that influences their followers and articulates a vision. As identified, leadership is not static but dynamic. As a consequence, leadership is still developing, or, more correctly, adapting; adapting to the situation, the environment, and considering several factors. Thus, new theories are developed. According to some theories, the development of transformational leadership shaped, or resulted in, authentic leadership (Michie & Gooty, 2005). Luthans and Avolio (2003) defined authentic leadership as "a process that draws from both positive psychological capacities and a highly developed organizational context, which results in both greater self-awareness and self-regulated positive behaviors on the part of leaders and associates, fostering positive self-development." Self-awareness refers to the individual's understanding of their own strengths and weaknesses, and is the key factor for self-development. In the same field, models of leadership cognition have recently been developed. Lord and Hall (2005) issued a leadership development model focusing on the cognitive abilities of the leader: skills-task; emotional; social; meta-monitoring; and value orientation. Mumford et al. (2007) focused on the interactions that occur between employees.

Multinational companies and remote working are relatively new phenomena. This newly shaped environment also brings new concepts, such as virtual or e-leadership, into a diverse environment where the leader must communicate, supervise, and lead people from different departments and countries using communication platforms (Avolio et al., 2001; Weisband, 2008) while experiencing a high risk of ineffective communication due to the loss of face-to-face contact. According to Balthazard et al. (2008), group members in face-to-face teams are more cohesive in general, more accepting of a group's decisions, and exhibit a greater amount of synergy and interaction than virtual teams. This kind of leadership demands higher effort – or a different approach – and new practices to: establish (and maintain) trust through remote communication channels; ensure that diversity is understood and appreciated; effectively manage virtual work-life cycles; monitor team progress using technology; enhance visibility of virtual members within

the team and outside the organization; and let individual team members benefit from the team (Malhotra et al., 2007).

3. Methodology

After the theoretical study of leadership and motivation, a questionnaire was developed considering the literature and targeting pharmaceutical industries located in Greece. The questionnaire included demographics and the areas under study. Specifically, nine questions referred to demographics, twenty to leadership style-oriented questions (equally distributed between democratic, authoritative, transformational, and laissez-faire leadership), and one to the definition of the impact of leadership on subordinates' performance. For the transformational-oriented questions specifically, sample items were based on MLQ (5X) (Bass & Riggio, 2006, p. 29), while for the other three styles, questions were created considering the style characteristics described in the literature. Twelve questions were relevant to motives and incentives covering Maslow's basic needs (or hygiene needs according to Herzberg, 1959) and the impact on employees (intrinsic and extrinsic motivation, development, empowerment, and job satisfaction), and one to the definition of the impact of the provided motives on subordinates' performance. Finally, ten questions were relevant to communication and its frequency, the environment, emotions, communication channels, and verbal communication, as these factors are considered crucial for the effectiveness of communication on the one hand, but are considered to be under risk because of the COVID-19 pandemic. Regarding demographics, the participants answered specific questions regarding their birthplace and hometown, gender, age, level of education, years of experience, activity sector and type, as well as the extent to which they were working remotely. For all other questions, apart from two relevant to communication frequency, multiple choice questions were developed using a (Likert) scale from 1–5 (where 1 is *strongly disagree*, 2 – *disagree*, 3 – *neutral*, 4 – *agree*, 5 – *strongly agree*) as is used successfully in many similar surveys.

The questionnaire was active 13–25 December 2021, and the data were collected and stored on the Google Forms platform. For the distribution of the questionnaires, social network platforms (Facebook messenger, Viber, LinkedIn, Instagram) were used. The only criterion for the selection of the population that participated in the questionnaire was employees working in pharmaceutical industries located in Greece, with no other discrimination. The scope was to collect as many participants as possible. Therefore, the sample is considered random, collecting data from social media from employees working in several different departments in pharmaceutical companies of all sizes. The total population, according to previous year data (SFEE-IOBE, 2021), was 23,300. The sample under evaluation was 259 employees. Thus, the portion of the population in the sample was over 1%.

Data collected from 259 employees from more than 10 pharmaceutical industries located in Greece were evaluated. The software used was Microsoft Excel for Mac, version 16.16.27, as well as IBM SPSS Statistics v. 27. The statistical methods used were descriptive statistics, hypothesis testing, and ANOVA, after verifying homogeneity of variance and assuming randomness and normality, as the sample was large enough (Berenson et al., 2020, p. 291). The results were confirmed with non-parametric tests (Wilcoxon, Kruskal–Wallis and Mann–Whitney for the post hock tests) after Kolmogorov-Smirnov normality evaluation. Chi-square analysis was also performed for the independency test of variables.

4. Results

The descriptive statistics of the demographic questions are depicted below and tabulated in Table 1. The sample of 259 respondents consisted of 134 females, 123 males, and two participants who did not declare their gender, and the majority (54.4%) belonged to the 30–39 age group. It is widely known that the education level in the Greek pharmaceutical industry is high: more than half of respondents possessed a master's degree (55.6%), while 9.7% possessed a PhD. Almost four out of five (78%) of the respondents were born in the Attica region, and almost all respondents (96.5%) lived in the Attica region, as most of the pharmaceutical companies are located there. The high complexity and the multiple-department structure of the pharmaceutical industry is also depicted in the survey results, as the responders worked in many different departments. The sample was almost equally distributed between managers and subordinates. Finally, most of the respondents (64.5%) never worked from home, and the rest (35.5%) had worked from home to some extent since the COVID-19 pandemic shaped a new working environment.

Table 1. *Demographics*

Demographic	Variable	Frequency	Percentage
Place of birth	A European country	3	1.2
	A non-European country	4	1.5
	Attica, Greece	202	78.0
	Other area in Greece	50	19.3
Place of residence	A European country	5	1.9
	A non-European country	1	0.4
	Attica, Greece	250	96.5
	Other area in Greece	3	1.2
Gender	Female	134	51.7
	Male	123	47.5
	Neither female nor male	2	0.8
Age	18–29 years old	29	11.2
	30–39 years old	141	54.4
	40–49 years old	79	30.5
	50–59 years old	10	3.9

Education level	PhD	25	9.7
	Master's	144	55.6
	University degree	37	14.3
	Technological institute degree	27	10.4
	Technical education degree	13	5.0
	Secondary education	11	4.2
	Primary education	1	0.4
	Other	1	0.4
Work experience	0–2 years	21	8.1
	3–5 years	58	22.4
	6–10 years	75	29.0
	More than 10 years	97	37.5
	More than 20 years	8	3.1
Department	Business development	6	2.3
	Human resources	6	2.3
	Packaging	13	5.0
	Production	46	17.8
	Quality assurance	47	18.1
	Quality control	46	17.8
	Regulatory affairs	22	8.5
	R&D	29	11.2
	Supply chain	11	4.2
	Warehouse	1	0.4
	Other	32	12.4
Role	Managerial (supervising ≥ 2 employees)	81	31.3
	Managerial (supervising ≤ 1 employee	43	16.6
	Non-managerial (being supervised)	135	52.1

Remote working frequency	Never	167	64.5
	1–2 days per week	55	21.2
	3–4 days per week	24	9.3
	Always	13	5.0

The summarized results regarding preferred leadership style are depicted in Table 2.

Table 2. *Preferred leadership style – summary*

Role	Democratic	Autocratic	Transformational	Laissez-faire
Managerial (supervising ≥ 2 subordinates)	3.9	2.63	3.94	2.49
Managerial (supervising ≤ 1 subordinate)	3.83	2.62	3.87	2.7
Non-managerial roles	3.81	2.73	3.51	2.89

It can be concluded that the preferred leadership styles are democratic and transformational; however, characteristics coming from other distinct leadership styles were also observed, confirming the initial observation from the literature study that leadership is dynamic and shaped according to the environment. The perception of the participants regarding the impact of leadership on effectiveness and productivity is depicted in Table 3.

Table 3. *The impact of leadership on productivity and effectiveness*

The attitude of my manager/I as a manager contribute(s) to the increased productivity and effectiveness of subordinates			
	Managerial (supervising ≥ 2 subordinates)	Managerial (supervising ≤ 1 subordinate)	Non-managerial roles
Mean	4.02	3.86	3.55
SD	0.74	0.83	1.03
Grand mean	3.97		3.55
Grand SD	0.77		1.03

Managers' opinions about themselves regarding their contribution to employees' effectiveness was positive, but not at the highest grade. Subordinates were also positive, but more tended to agree than strongly agree.

Maslow (1954) is widely known for his "Pyramid of needs". The base of the pyramid consists of physiological and safety needs (hygiene needs, according to Herzberg) – according to

Maslow, the first things, the basics, should be covered in order for new needs to be generated. As expected, the majority of the participants, 7 out of 10, believed that their job was safe.

Table 4. *Maslow's needs*

Role	Job safety	Social & esteem	Self-actualization (creativity)
Managerial (supervising ≥ 2 subordinates)	3.78	4.01	3.73
Managerial (supervising ≤ 1 subordinate)	3.56	3.91	3.73
Non-managerial roles	3.90	4.01	3.35

According to Maslow, after physiological and safety needs, the base of the pyramid, are covered, social and esteem needs shall be covered. Over 80% of respondents felt respected by their colleagues. As observed previously, basic needs (physiological and safety) are covered to a high degree, as are social and esteem needs. Moving up the Maslow pyramid, self-actualization needs seem to be covered for six out of ten employees, with a high percentage of neutrality and employees not attaining self-actualization, something that is depicted in the results of non-managerial roles (see Table 4).

The rest of the results regarding motivational tools are depicted in Table 5. More specifically, intrinsic motivation, challenging tasks that provide a sense of accomplishment, were provided to seven out of ten employees. The high portion of neutral answers indicates that there is room for improvement. This can be considered as an indicator of the need for more frequent and effective communication, feedback, and target-setting in order for managers first to understand what motivates each individual and then to provide more challenging (but attainable) targets to each subordinate, helping and supporting them in reaching a sense of accomplishment according to their specific internal needs.

Extrinsic motivation seemed to be a controversial issue among our sample, as the answers varied and indicated neutrality. The responses relating to motivation and growth gained by training and development (high-level needs/motivators according to Herzberg, 1959) show that half of the employees believed that they did not receive adequate training that helped them develop, and that there were not many opportunities for development and growth. This is a strange result, as the activities of the pharmaceutical industry are performed according to Working Instructions (WIs) and Standard Operating Procedures (SOPs), with a training system (read and understood, webinars, seminars, workshops) in place for employees' assigned curricula. In general, development is a factor that participants seemed to be skeptical about, and thus leadership should consider the re-evaluation of the training system.

Seven out of ten employees were informed about their company's performance and were encouraged to make decisions. The majority of the employees participating the survey were empowered by being part of the company (informed) and by participating in decision making. Regarding the job satisfaction of Greek pharmaceutical industry personnel, only half of the partic-

ipants clearly stated (agreed or strongly agreed) that their daily routine was interesting and that they did not feel burnt out. This indicates that there is again room for improvement regarding job satisfaction, as moderate or low levels in the long run could affect employees' effectiveness and productivity.

Table 5. *Motivation*

Role	Intrinsic	Extrinsic	Development	Empowerment	Job satisfaction
Managerial (supervising ≥ 2 subordinates)	3.94	2.96	3.35	3.98	3.36
Managerial (supervising ≤ 1 subordinate)	3.88	3.42	3.54	3.90	3.59
Non-managerial roles	3.57	2.96	3.29	3.72	3.20

Finally, the perception of the participants regarding the impact of the provided motives and incentives on effectiveness and productivity is depicted in Table 6.

Table 6. *The impact of leadership on productivity and effectiveness*

The provided motives and incentives contribute to the increased productivity and effectiveness of subordinates			
	Managerial (supervising ≥ 2 subordinates)	Managerial (supervising ≤ 1 subordinate)	Non-managerial roles
Mean	3.54	3.44	3.23
SD	0.91	1.01	0.96
Grand mean	3.51		3.23
Grand SD	0.94		0.96

Participants occupying managerial roles tended to agree that the provided motives and incentives contributed to increased productivity and effectiveness. The overall image tended towards neutrality, as also observed above. Managers supervising more than two subordinates tended to marginally agree that the provided motives and incentives contributed to increased productivity and effectiveness, while the other managerial roles supervising one or no subordinates tended towards neutrality. Participants occupying non-managerial roles, subordinates, were more skeptical, and were even closer to neutrality towards the statement indicating that the provided motives and incentives contributed to increased productivity and effectiveness.

After descriptive statistics analysis provided a general figure for our sample, inferential sta-

tistics (refer to Appendix, Tables A1–A4) provided a general view for the population of the Greek pharmaceutical industry. Employees agreed that managers contributed with their attitude and actions to increased productivity and effectiveness. However, subordinates were more neutral than employees occupying managerial roles. The same picture was observed in the motivation field and regarding the relevant question regarding the contribution of the provided motives and incentives to subordinates' productivity and effectiveness.

The preferred leadership style was democratic and transformational. However, subordinates were again more neutral than managers. Both managers and subordinates were neutral regarding managers' adoption of autocratic leadership characteristics. Employees occupying managerial roles did not agree that they adopted laissez-faire characteristics, with subordinates being neutral.

The perception of employees regarding extrinsic motivation was independent from employee role. Burn out levels and job satisfaction were factors that were independent from age. Job satisfaction was independent from gender and age, but did, however, depend on years of experience. Time was a factor that could be considered relevant to development. Training and growth opportunities in general were dependent on the years of experience that an employee has, but were independent from age.

Employees in general tended to agree that their company provided what was necessary to effectively work remotely (high speed internet, laptop, office supplies). Empathy was affected by remote working, as remote working employees and those always working on site differed. The working routine was different for those working from home and those working on site. Remote working personnel, although communicating less effectively compared to face-to-face communication, believed that they remained in touch with their colleagues on site, and they had positive feelings while working from home. They also considered their working routine more interesting than that of personnel always working on site.

5. Conclusions

There is no one specific leadership style or method that leads to the maximization of people's performance. Different leadership styles and different leaders' skills have a different impact on (different) employees' performance. Leadership is not static but dynamic: it must change; it must be flexible, adaptive, and shaped each time according to the environment, the situation, the company's culture, and the maturity level of both the leader and the subordinate. That is the reason why the literature has encompassed several different leadership styles throughout time without concluding on one, unique, effective leadership style. However, as Reichard and Avolio (2005) stated, regardless of the leadership style applied, leadership interventions have a positive impact on productivity and effectiveness, even in cases where these interventions endure less than a day.

The results of this study are considered positive and promising regarding leadership in the Greek pharmaceutical industry. A general framework is clearly identified (democratic and transformational leadership); however, characteristics of other distinct leadership styles were also observed. Participants occupying managerial roles tended to agree that leaders contribute to the increase of subordinates' effectiveness and productivity, while subordinates were also positive, but they believed less strongly than managers that leadership contributes to increased effective-

ness and productivity, tending towards neutrality. According to the above, the conclusions of the literature review were entirely confirmed by this study, which also indicates that there is room for improvement and a need for managers to study leadership more, listen more actively to subordinates' needs, and provide more effective incentives that target each individual.

The risks of the development of negative feelings such as, anxiety, anger, or isolation due to the environment that the COVID-19 pandemic has shaped were not confirmed, as employees working remotely had positive experiences. The perception of employees was that remote communication was not as effective as face-to-face communication, and empathy was negatively affected by remote working. No significant differences in stress and burnout between employees working from home and those on site were identified – in truth, employees working from home found their working routine more interesting than employees working on site. Finally, remote working employees felt that they remained in touch with their colleagues (mostly with peers and much less with the managers). A contributing factor regarding the latter could be the supplies provided by the pharmaceutical companies, such as high-speed internet, laptops, or office supplies, maintaining high levels of communication effectiveness.

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APPENDIX

Table A1. *Hypothesis testing summary*

Null hypothesis	Result	Sig.
H_0: Managers do not contribute with their attitude and actions to increased subordinates' productivity and effectiveness.	H_0 rejected for managers H_0 confirmed for subordinates	<0.001 0.203
H_0: Managers neither adopt nor reject, or do not adopt, democratic leadership characteristics.	H_0 rejected for managers H_0 confirmed for subordinates	<0.001 0.049
H_0: Managers tend not to adopt, or do not adopt, autocratic leadership characteristics.	H_0 rejected for managers H_0 rejected for subordinates	0.006 <0.001
H_0: Managers neither adopt nor reject, or do not adopt, transformational leadership characteristics.	H_0 rejected for managers H_0 confirmed for subordinates	<0.001 0.431
H_0: Managers tend not to adopt or do not adopt laissez-faire leadership characteristics.	H_0 confirmed for managers H_0 rejected for subordinates	0.502 <0.001
H_0: The population is either neutral or disagrees that the provided motives and incentives increase subordinates' productivity and effectiveness.	H_0 rejected for managers H_0 rejected for subordinates	0.417 0.019
H_0: The population either tends towards neutral or agrees that the provided motives and incentives increase subordinates' productivity and effectiveness.	H_0 confirmed for managers H_0 rejected for subordinates	0.465 0.171
H_0: Employees tend to agree or agree that the company provides what is needed to work effectively remotely (high-speed internet, laptop, office supplies)	H_0 confirmed for employees, managerial & non-managerial roles	0.615
H_0: Subordinates' (μ_1) and managers' (μ_2) means in the statement "Managers contribute with their attitude and actions to increased effectiveness and productivity" do not differ significantly.	H_0 rejected	<0.001
H_0: Male and female genders' means in the statement "I do not feel burned out" do not differ significantly.	H_0 confirmed for males vs females	0.468
H_0: Male and female genders' means in the statement "My daily routine at work is interesting" do not differ significantly.	H_0 confirmed for males vs females	0.393
H_0: On-site employees' mean and working-from-home (WFH) employees' mean in the statement "I do not feel burned out" do not differ significantly.	H_0 confirmed for on-site vs WFH employees	0.581
H_0: On-site employees' mean and WFH employees' mean in the statement "My daily routine at work is interesting" do not differ significantly.	H_0 rejected for on-site vs WFH employees	0.063

$H_{0:}$ On-site employees' mean and WFH employees' mean in the statement "Empathy is not impacted by remote working" do not differ significantly.	H_0 confirmed for on-site vs WFH employees	0.568
$H_{0:}$ Empathy is impacted by remote working.	H_0 confirmed for WFH employee	0.092
H_0: The population tends towards neutrality or disagrees on the statement "I feel that I remain in touch with my manager and peers (colleagues) when WFH."	H_0 confirmed for WFH employees	0.017
H_0: Remote-working personnel is either neutral or disagrees on the statement "I have positive feelings when WFH."	H_0 rejected for WFH employees	0.005
H_0: Remote-working personnel tends to disagree or disagree on the statement "I communicate more effectively remotely (via Skype, Teams, email, phone) rather than beig on-site."	H_0 confirmed for WFH employees	0.202

Table A2. *ANOVA summary (level of significance 5%)*

Null hypothesis	Result	Sig
H_0: $\mu_1=\mu_2=\mu_3$, where μ_1, μ_2, μ_3 are the variances of the means of age groups 18–29, 30–39, and 40–49, respectively, in the statement related to job satisfaction: "I do not feel burned out."	H_0 rejected	0.005
H_0: $\mu_1=\mu_2=\mu_3$, where μ_1, μ_2, μ_3 are the variances of the means of age groups 18–29, 30–39, and 40–49, respectively, in the statement related to job satisfaction: "My daily working routine is interesting."	H_0 rejected	0.041
H_0: $\mu_1=\mu_2=\mu_3$ H_0:not all μ_n are equal (n = 1, 2, 3), where μ_1, μ_2, μ_3 are the means of groups of 3–5, 6–10, and 11–20 years of work experience, respectively, in the statement related to job satisfaction: "My daily working routine is interesting."	H_0 rejected	0.033

Null hypothesis	Result	Sig
H_0: $\mu_1=\mu_2=\mu_3$, H_0:not all μ_n are equal (n = 1, 2, 3), where μ_1, μ_2, μ_3 are means of age groups 18–29, 30–39, and 40–49, respectively, in the statement related to development: "I receive adequate training that helps me develop."	H_0 confirmed	0.209
H_0: $\mu_1=\mu_2=\mu_3$, H_0:not all μ_n are equal (n = 1, 2, 3), where μ_1, μ_2, μ_3 are means of age groups 18–29, 30–39, and 40–49, respectively, in the statement related to development: "I feel there are opportunities for personal growth and development."	H_0 confirmed	0.627
H_0: $\mu_1=\mu_2=\mu_3$, and the alternative hypothesis H_0:not all μ_n are equal (n = 1, 2, 3), where μ_1, μ_2, μ_3 are the means of groups of 3–5, 6–10, and 11–20 years of work experience, respectively, in the statement "I receive adequate training that helps me develop."	H_0 confirmed	0.577
H_0: $\mu_1=\mu_2=\mu_3$, H_0:not all μ_n are equal (n = 1, 2, 3), where μ_1, μ_2, μ_3 are the means of groups of 3–5, 6–10, and 11–20 years of work experience, respectively, in the statement "I feel that there are growth and development opportunities."	H_0 confirmed	0.609
H_0: $\mu_1=\mu_2=\mu_3$, H_0:not all μ_n are equal (n = 1, 2, 3), and the alternative hypothesis are equal (n= 1, 2, 3), where μ_1 – non-managerial roles (subordinates), μ_2 – managerial roles (supervising ≥ 2 subordinates), and μ_3 – managerial roles (supervising ≤ 1 subordinate), in the statement "Extra benefits are provided connected to my performance are different across the different roles."	H_0 confirmed	0.540

Table A3. *Chi-square summary*

Variables checked for independence	Result	Sig.
i. Burnout vs age ii. Work routine interest vs age	i. Independent ii. Independent	0.222 0.189
i. Burnout vs work experience ii. Work routine interest vs work experience	i. Dependent ii. Dependent	<0.001 <0.001
i. Development via training vs age ii. Development & growth vs age	i. Independent ii. Independent	0.155 0.599
i. Development via training vs work experience ii. Development & growth vs work experience	i. Dependent ii. Dependent	<0.001 <0.001
i. Extrinsic motivation vs role	i. Independent	0.429

Table A4. *Variables' independence check summary*

Null Hypothesis	Result	Critical value
H_0: $\pi_1 = \pi_2$ H_1: $\pi_1 \neq \pi_2$ π_1 = the proportion of managerial roles in the population that agree that managers contribute to subordinates' productivity and effectiveness. π_2 = the proportion of non-managerial roles in the population that agree that managers contribute to subordinates' productivity and effectiveness.	H_0 rejected	11.42 (>3.841)
H_0: $\pi_1 = \pi_2$ Against the alternative that the two populations are not the same: H_1: $\pi_1 \neq \pi_2$ π_1 = the proportion of managerial roles in the population that agree that the provided motives and incentives contribute to increased subordinates' productivity and effectiveness. π_2 = the proportion of non-managerial roles in the population that agree that the provided motives and incentives contribute to increased subordinates' productivity and effectiveness.	H_0 confirmed	2.27 (<3.841)

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CHANGES IN THE VISEGRAD GROUP ECONOMIES IN LIGHT OF THE MISERY INDEX

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Abstract: *The economic performance of countries depends on the stages of the business cycle and changes due to various factors and influences. While the economic crisis of 2008 was triggered by financial factors, the crisis of 2020 was caused by factors of a non-economic nature – the COVID-19 pandemic. The purpose of this paper is to assess changes in the performance and level of economic activity in the Visegrad Group economies in 2009, 2019 and 2020. This assessment is performed using GDP per capita, magic square and the misery index. In 2009, the best performing country was the Czech Republic and the worst was Hungary. In 2019 and 2020, Poland reached a performance level similar to the Czech Republic, and Slovakia performed the worst.*

Keywords: *performance, Visegrad group, magic square, economic stability index, misery index.*

JEL Codes: *E1, E6*

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1. Introduction

The issue of improving the performance of economies has received much attention in research and practice. Tracking the performance of a particular national economy and analysing the factors of its economic growth and fluctuations are among the primary objectives of economic research. Measuring economic progress has been of great value for both economic theory and economic policy. Economic performance is assessed through the evolution of basic macroeconomic indicators, the most common of which are gross domestic product (GDP) or gross domestic product per capita. Economic performance and the achievement of economic goals can also be assessed through the magic square. In addition, various other alternative indicators, or a combination thereof, can be made use of. The purpose of this paper is to assess changes in the performance and level of economic activity in the Visegrad Group (V4) economies in 2009, 2019 and 2020. This assessment is performed using GDP per capita, magic square and the misery index. In this paper, the economic performance of the Czech Republic, Hungary, Poland, and the Slovak Republic is assessed. V4 is a dynamic regional group of EU Member States, where each shows typical features of supporting competitiveness and economic growth. The V4 countries are interconnected within their history, geographical location, and values. Within this group, space is created to strengthen coordination mechanisms to find common positions in terms of the current issues of foreign and European policy, regional development, and economic cooperation.

2. Literature review

The concept of performance has been frequently used in terms of the economic success of countries. Roguľa (2011) defines economic performance as a certain monetary value generated by a given economy over a certain period, using the system of national accounts.

Economic performance refers to the condition and evolution of the economic situation in respective countries. It deals with trends in the evolution of key macroeconomic indicators, or the results of the functioning of the economy as a whole achieved over a certain period of time and generally recorded and evaluated through selected indicators (Draková, 2012).

Large numbers of authors and institutions deal with performance measurement, assessing the performance of economies either by traditional macroeconomic indicators (GDP, inflation, employment, unemployment, etc.), alternative indicators (Human Development Index, Prosperity Index, Global Competitiveness Index, and others), or a combination thereof. (Masárová & Ivanová, 2017).

Most authors use gross domestic product as the basic macroeconomic variable to measure economic performance and progress. The overall performance of economic activity can be best assessed through the current and historic GDP data of the country concerned. For international comparisons of differently sized economies, per capita gross domestic product – expressed, for instance in USD, EUR, PPP – is used.

Nicholas Kaldor (1908–1986), one of the founders of post-Keynesian economics, considered GDP, employment, inflation, and the balance of trade to be the primary indicators to assess the achievement of economic policy objectives. Karl Schiller, an economist and former Minister for Finance and Economic Matters in Germany, invented a magic square to see how economic objectives are being met. The word magic is used because these four objectives are very hard to

attain in real-life (Hamdini & Gaidi, 2021).

The **magic square** consists of four mutually perpendicular half-lines with a superimposed scale in percentages, each of which records one economic policy objective and its indicator value (Draková, 2012):

- sustainable rate of economic growth (rate of economic growth in % – G);
- low unemployment (unemployment rate in % – U);
- stable price level (inflation rate in % – P);
- external economic balance (balance of payment ratio to GDP in % – B).

Picek (2017) claims that the square typically serves as a teaser for a thorough discussion of the individual goals and their mutual interaction. While some are complementary (high GDP growth and low unemployment), others may be prone to unfavourable trade-offs (unemployment and inflation via the Phillips curve, or high GDP growth and a balanced current account).

A lot of research work has addressed economic performance and its evaluation. Firme and Teixeira (2014) used the magic square to assess the macroeconomic performance of Brazil and other selected countries between 1997 and 2012, and quantified the standardized Index of Economic Welfare (created by Medrano and Teixeira in 2013). Nehme (2014) used the magic square, Hicks' IS-LM model, and Mundell's incompatibility triangle in examining economic efficiency and monetary policy in Lebanon.

Draková (2012) used the magic square to assess the economic performance of the BRICS countries (Brazil, Russia, India, and China), whilst Hamdini and Gaidi (2021) assessed economic performance and stability in Algeria over the period of 1980–2019 and proposed the so-called economic stability index. Similarly, Özkaya and Alhuwesh (2021) made use of the magic square to evaluate the performance of Yemen's economy between 2001 and 2015. Brokešová and Vachálková (2016) used the magic square to investigate changes in the insurance industry depending on the evolution of macroeconomic environment. The magic square was also used by Sivák and Staněk (2011) to examine the effects of the global financial crisis on Slovakia in 2008–2010.

Some researchers use the magic square indicators to calculate other indicators and indices. Inflation and unemployment are the key variables that play a decisive role in determining national welfare. These two variables are part of the **misery index**, which is used to assess the misery felt by average citizens in a country.

The misery index, a combination of inflation and unemployment rates created by economist Arthur Okun, is resurfacing as a measure of interest across developed countries as inflation rates increase and unemployment remains relatively high (Clemens et al., 2022).

Okun arguably made the first attempt to aggregate a range of macroeconomic indicators into a single statistic to track the health of the macroeconomy over the business cycle. The original misery index combined two fundamental targets of macroeconomic policy (unemployment and inflation) in a basic aggregate disutility function. This function gauges the level of economic discomfort as the unweighted sum of unemployment and inflation rates.

The level of misery is undoubtedly one of the factors of crucial importance for the assessment of the economic system's efficiency. If poverty strikes a significant part of the society, this definitively proves that the system lacks in efficiency (Grabia, 2011).

The simplicity of the calculation of this index is claimed to be both an advantage and a disadvantage, and the index has been criticized for its low research relevance. Recently, however, the

misery index has been used extensively by researchers and economists, who have modified and expanded its original version to gauge the overall health of the global economy.

Cohen et al. (2014) consider the index a useful tool as it seems to provide a useful approximation of the influence of macroeconomic conditions on population well-being. Various modifications and extensions to the misery index have been presented in research by Barro, Hanke, and Henderson and others. A Harvard economist, Robert Barro, was the first to augment the index with the indicators of growth rate and interest rate in 1999.

In 2011, Steve Hanke came up with the modified misery index, which was the sum of unemployment, inflation, and bank lending rates minus the change in real GDP per capita. Higher readings of the first three elements are "bad", and make people miserable. These are offset by a "good" GDP per capita growth, which is subtracted from the sum of the "bads". A higher misery index score shows a higher level of misery. Cohen et al. (2014) reformulated the index, focusing on the output gap and cyclical unemployment. The new index allows a distinction between short-run and long-run phenomena, places more emphasis on output and unemployment rather than inflation, is based only on objective variables, and gives more weight to recessions than to expansions.

Henderson (2015) points out that although both Barro and Hanke did the right thing in including economic growth into the examination, they made the mistake of using interest and inflation rates in their calculations. His view is supported by Irving Fisher's contribution, who notes that nominal interest rates already incorporate market expectations of inflation. This would double-count inflation in the calculation. Therefore, Fisher suggests that the misery index should be calculated as the sum of the inflation rate and the unemployment rate, minus the growth rate of real GDP.

3. Methodology

3.1 Goal

The purpose of this paper is to assess the changes in the economic performance of the four Visegrad countries – the Czech Republic, Hungary, Poland, and the Slovak Republic – in 2009, 2019 and 2020. This assessment is performed using GDP per capita, the magic square and the misery index.

In 2009, global economies suffered from the economic crisis that was precipitated by the financial crisis of 2007–2008 in the United States. In 2019, the V4 economies were evolving in a favourable way. In late 2019, however, COVID-19 emerged in China, and spread rapidly and globally. The negative economic effects of the pandemic were felt by these countries, especially in 2020.

3.2 Method

The works of Medrano-B and Teixeira (2013) and Hamdini and Gaidi (2021) were followed to construct the magic square. Minimum and maximum values of each indicator under study (Table 1) were determined based on the recommended values and the actual indicator values in the V4 countries in 2009, 2019 and 2020.

Table 1. *Minimum and maximum indicator values*

	Minimum Value	Maximum Value	Nature of the indicator
Real GDP growth (%) – G	–7	7	Maximising
Unemployment rate (%) – U	2	15	Minimizing
Inflation rate (%) – P	2	6	Minimizing
Current account balance (% of GDP) – B	–5	5	Maximising

As indicators with different scales were present, it was necessary to transform the original statistical data. Based on the determined minimum and maximum values, the following equations were formed:

For real GDP growth – G:

$$-7 \leq G \leq 7$$

For unemployment rate – U:

$$15 \geq U \geq 2$$

For inflation rate – P:

$$6 \geq P \geq 2$$

For current account balance – B:

$$5 \leq B \leq 5$$

It is necessary to redefine the four scales to be uniform from 0 to α, where α is a numerical constant to be evaluated by normalising the modified indicators to a uniform scale:

$$0 \leq G \leq \alpha; \quad 0 \leq U \leq \alpha; \quad 0 \leq P \leq \alpha; \quad 0 \leq B \leq \alpha.$$

Thus, a perfect square with uniform axes rotated by 45 degrees is formed. The area of the square of a country achieving ideal values of all indicators equals to one (The α value is then determined as follows:

$$W'_A = 2 \times \alpha^2 = 1$$

Then:

$$\alpha^2 = \frac{1}{2}$$

Next, the original values will be transformed to new ones. As Medrano-B and Teixeira (2013) state, just as all original variables have linear scales, so new ones should also be linear. Thus, the modified indicator values are obtained through the following equations:

$$G' = \frac{\alpha}{14}(G+7); \quad U' = \frac{\alpha}{13}(15-U); \quad P' = \frac{\alpha}{4}(6-P); \quad B' = \frac{\alpha}{10}(B+5).$$

Based on the study by Hamdini and Gaidi (2021), the Economic Stability Index (ESI) was calculated:

$$ESI= \frac{1}{4}\left[\frac{1}{14}(G+7)+\frac{1}{13}(15-U)+\frac{1}{4}(6-P)+\frac{1}{10}(B+5)\right]$$

Whereby: $0 \leq ESI \leq 1$

If the economy is performing at its worst (based on Table 1) – i.e., real GDP growth of –7%, unemployment rate of 15%, inflation rate of 6% and current account balance of –5% – then the value of the ESI indicator will be 0. On the contrary, if the economy is performing at its best – i.e., real GDP growth of 6%, unemployment rate of 2%, inflation rate of 2% and current account balance of 5% – then the value of the ESI will be 1.

The misery index was determined in the following way:

Okun's Misery Index (OMI):

$$OMI=P+U$$

Henderson's Misery Index (HMI):

$$HMI=P+U-G$$

To assess the performance of the V4 economies, statistical data published by The World Bank were used.

4. Assessment of V4 performance

First, the economic performance of the Slovak Republic, the Czech Republic, Hungary and Poland will be examined and assessed using GDP per capita. Next, their economic performance using the magic square will be assessed. Finally, the evolution of the misery index in the V4 countries will be examined and countries will be ranked.

4.1. Evolution of GDP per capita in the V4 countries

The gross domestic product per capita indicator expresses the results of economic activity taking place in the territory of a given country, converted on a per capita basis for the sake of objectivity of comparison. Differences in the GDP per capita value in the V4 countries in 2009, 2019 and 2020 are shown in Figure 1.

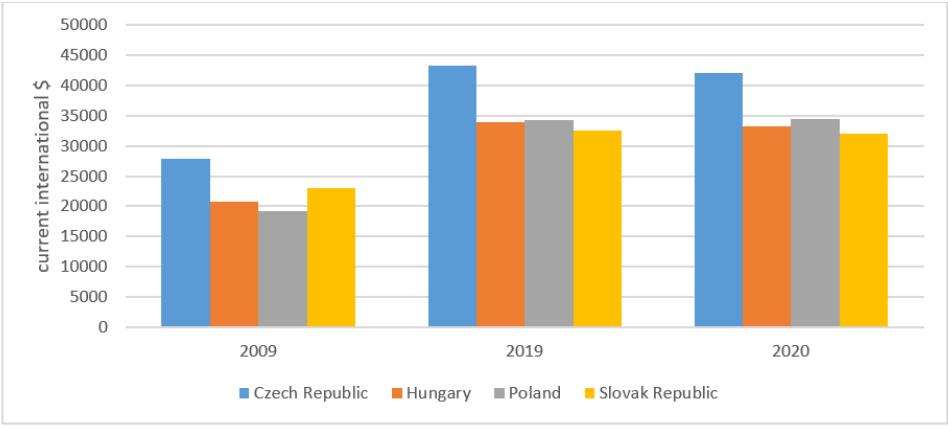

Figure 1. *GDP per capita in PPP in the V4 countries*
Source: *authors' own elaboration based on data from the World Bank (n.d.)*

As illustrated above, the Czech Republic had the highest GDP per capita in each of the analysed years, with a significant gap between the remaining V4 countries. In 2009, GDP per capita in the Czech Republic reached USD 27,782. The Slovak Republic followed with a GDP of USD 23,098 per capita. The lowest GDP per capita value was recorded in Poland. The situation was different in 2019 and 2020, with Poland achieving the second highest GDP per capita with Slovakia lagging behind and ending up in the lowest position among the V4 countries. In 2020, GDP per capita decreased compared to 2019 in the Czech Republic, Hungary and Slovakia, while Poland recorded a slight increase (despite the decrease in GDP).

4.2. Economic performance of the V4 countries in 2009

In the following sections, the magic square will be used to assess the performance of the V4 countries in 2009, i.e., the first year under analysis (the crisis year); in 2019; and in 2020, in which the economy suffered from the COVID-19 pandemic.

In late 2008 and especially in 2009 and 2010, the V4 countries, like other nations, experienced a recession. The recession came as an unexpected external shock causing a sharp decline in economic activity. GDP declined in Slovakia, the Czech Republic and Hungary, which translated into negative economic growth. The biggest declines in GDP were identified in Hungary (by 6.60%), the Slovak Republic (by 5.46%) and the Czech Republic (by 4.66%). Poland was only moderately affected by the recession, and its GDP growth slowed to 2.83%. Figure 2 shows the performance of the V4 countries in 2009.

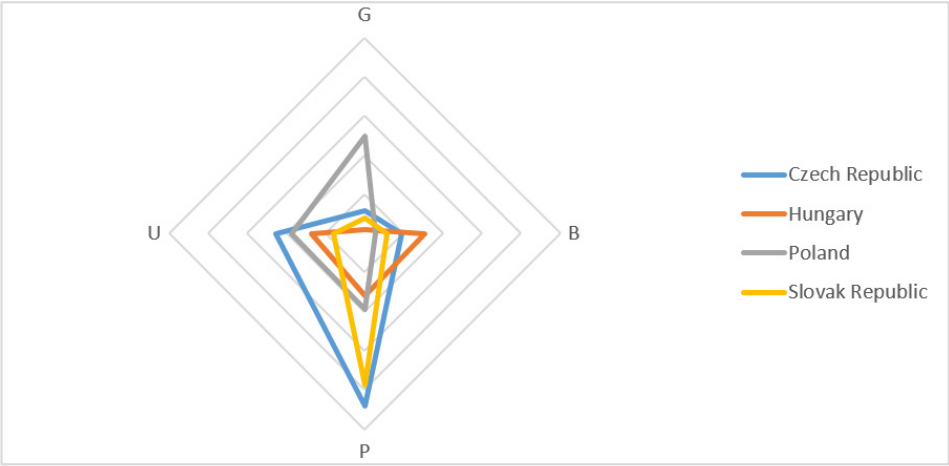

Figure 2. *Magic square in 2009*
Source: *authors' own elaboration*

Lowered economic performance was accompanied by slowed inflation. The inflation rate stood at 4.21% in Hungary, 3.80% in Poland, 1.62% in the Slovak Republic and only 1.02% in the Czech Republic. Low production and job cuts resulted in increased unemployment rates. The highest unemployment rate (12.03%) was recorded in the Slovak Republic. The unemployment rate went up to 10.03% in Hungary, to 6.66% in the Czech Republic, and to 8.17% in Poland.

Concerning external balance, all V4 countries achieved negative current account balance on their balances of payments. The most favourable value of the current account balance of payments to GDP was achieved by Hungary (–0.68%), followed by the Czech Republic (–2.35%) and Slovakia (–3.39%), with Poland as the worst V4 performer (–4.22%).

4.3. Economic performance of the V4 countries in 2019

Having recovered from the negative effects of the 2009 recession, the economies of the V4 countries regained their former conditions. They recorded moderate GDP growth, record-low unemployment rates, and improved external balances.

Over 2019, GDP growth in Slovakia slowed down. The slowdown, however, had no connection with the upcoming depression of 2020 whatsoever. The slowdown was cyclical, and had already been foreseen in the course of 2018. Within the V4 economies, the slowdown was most pronounced in Slovakia. The slowdown in the Slovak economy was accompanied by a similar slowdown across the EU28 (Morvay et al., 2020). Figure 3 shows the magic square for the V4 countries in 2019.

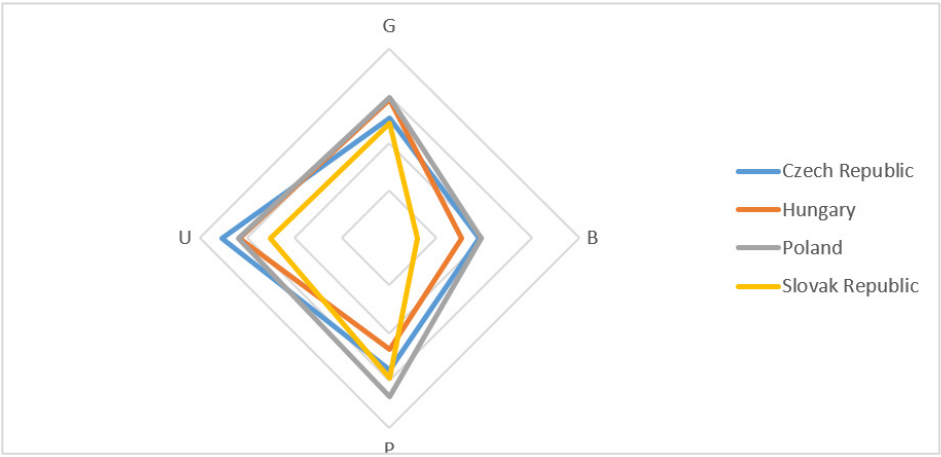

Figure 3. *Magic square for 2019*
Source: *authors' own elaboration*

Compared to 2009, improvements can mainly be observed in the labour market. The unemployment rate in the Czech Republic dropped to 2.01%. In Slovakia, jobless rates fell to record lows of 5.75%. The economic growth rate ranged from 2.61% in Slovakia to 4.74% in Poland. The Czech Republic and Poland also achieved positive BOP current account balances, but Slovakia achieved a negative BOP current account balance of –3.35%. The inflation rate was favourable, reaching 2.23% in Poland and 3.34% in Hungary.

4.4. Economic performance of the V4 countries in 2020

In 2020, the COVID-19 pandemic negatively affected the economic performance of the V4 countries, bringing about periods of decline in economic activity and rises in unemployment. The COVID-19 pandemic had a social and economic impact on all countries of the world, including the V4 nations.

While the depression of 2009 was of an economic nature (external from the point of view of the Slovak economy) in the form of a shock on global financial markets, the depression of 2020 was not, as economic activity was limited and labour force went unused to contain the spread of COVID-19. Restrictions on some activities and on the workforce brought widespread shock to the supply side of the economy. However, the unused labour force meant limited household income and a resulting negative shock for the demand side of the economy (Hudcovsky et al., 2021).

Measures adopted by governments to stop the spread of COVID-19 negatively affected the economic performance of countries and disrupted national labour markets. Countries saw falling GDP and employment rates, and rising unemployment rates. Figure 4 shows the performance of the V4 countries in 2020.

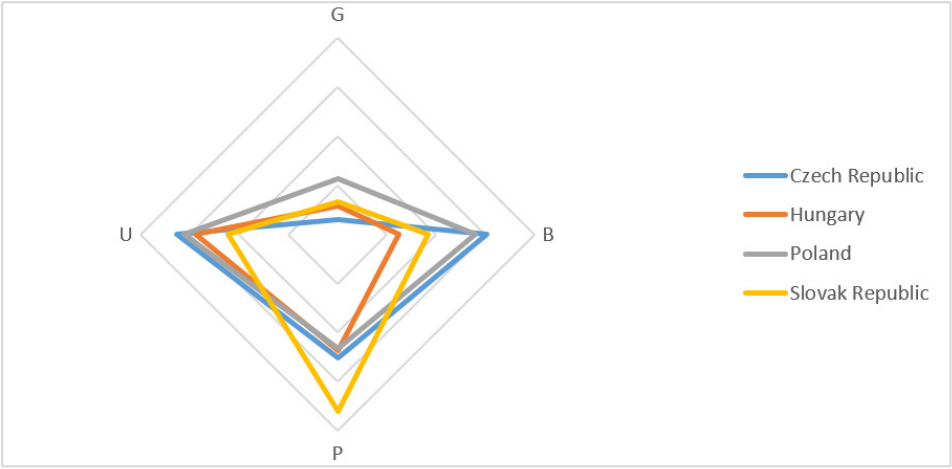

Figure 4. *Magic square in 2020*
Source: *authors' own elaboration*

The COVID-19 pandemic brought about a fundamental change which went hand in hand with deteriorating economic and social indicators. (Hudcovsky et al., 2021). In an attempt to stop the spread of the disease, restrictive measures were adopted. These measures led to declining or slowing GDP growth and dramatically impacted global labour markets. The Czech Republic, Hungary and Slovakia recorded a decline in GDP – the Czech Republic by up to 5.79%. Unemployment did not increase significantly due to the measures adopted to mitigate the negative impact of the pandemic on the labour market. In Poland, unemployment rose by 0.27%, and by around 1% in the remaining V4 countries. Concerning price stability, inflation was the lowest in Slovakia, at slightly below 2%. In Poland, the Czech Republic and Hungary, inflation exceeded 3%. When assessing the external balance, a favourable situation can be observed in the Czech Republic and Poland, which both recorded positives regarding the current account of the balance of payments. Slovakia achieved a slight surplus on the current account of the balance of payments, while Hungary recorded a significant deterioration of this indicator compared to the previous year: 1.48%.

4.5. Comparison of the ESI in V4 countries

Country scores in the magic square were calculated using the ESI; the results for the years under analysis are illustrated in Figure 5.

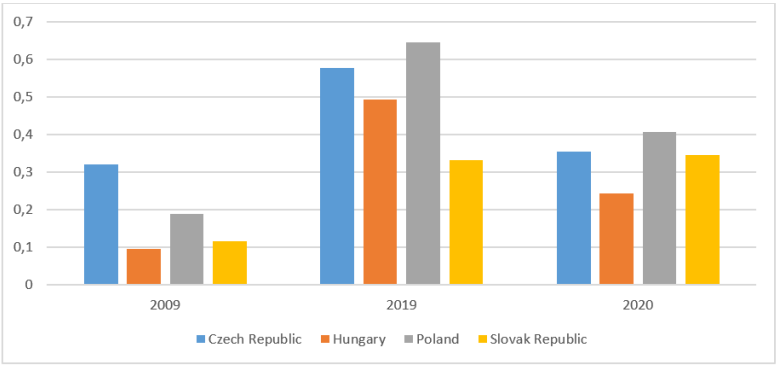

Figure 5. *ESI in V4 countries*
Source: *authors' own elaboration*

A comprehensive assessment of the V4 performance using the ESI yielded interesting results. In 2009, the best position was achieved by the Czech Republic, where the ESI reached 0.320, while the ESI in Hungary was only 0.097. In 2019, ESI values were significantly higher. Poland scored best (mainly due to its higher GDP growth rate) with an ESI value of 0.646. Slovakia lagged far behind with its ESI value of only 0.333. In the pandemic year of 2020, Poland scored the best again (0.407), while Hungary scored the worst (0.244).

4.6. The misery index in the V4 countries

The principle of the misery index is different from the principle on which the magic square works. The lower the misery index values, the stronger the economy and the less misery. The values of OMI and HMI were recalculated, and are shown in Figures 6 and 7.

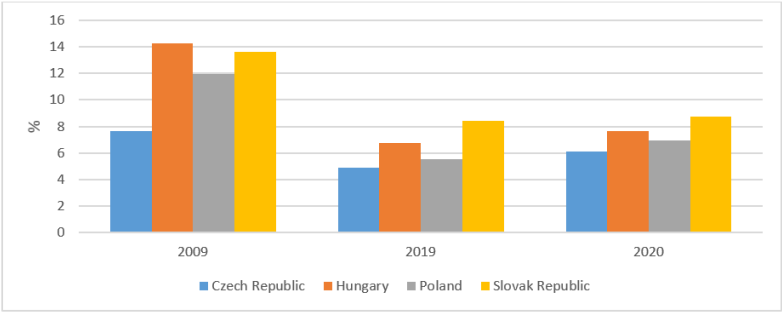

Figure 6. *Okun's Misery Index*
Source: *authors' own calculations*

OMI values were highest in 2009 because the economic crisis caused unemployment rates to climb. The highest OMI value was achieved by Hungary, up to 14.24% compared to 7.68% by the Czech Republic.

In 2019, the V4 economies saw both low inflation and unemployment, which translated into better OMI values than in 2009. In the Czech Republic, the OMI value was only 4.86% and the highest OMI value of 8.41% was found to be in the Slovak Republic. As a result of the COVID-19 pandemic, OMI values went down slightly to 6.10% in the Czech Republic and 8.73% in the Slovak Republic in 2020.

Different results are shown by HMI, in which the rate of economic growth (Figure 7) is incorporated.

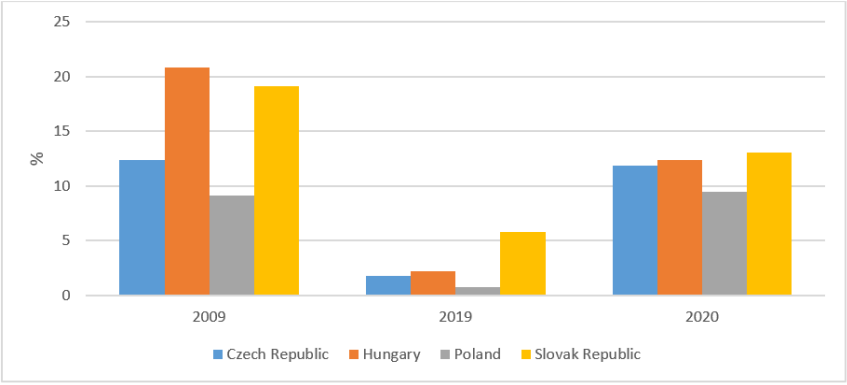

Figure 7. *Henderson's Misery Index*
Source: *authors' own calculations*

The addition of the GDP growth rate to the HMI calculation resulted in larger differences between the V4 countries and also larger differences in the value of the index in the years analysed. In 2009, Hungary (20.84%) and Slovakia (19.10%) scored the worst, while Poland scored 9.13% due to GDP growth. The favourable economic situation of 2019 translated into low HMI values – only 0.76% in Poland compared to 5.81% in the Slovak Republic. In 2020, HMI indicator values decreased in all countries, with Slovakia performing the poorest (13.09%), followed by Hungary and the Czech Republic, with Poland achieving the best score (9.47%).

4.7. Assessment of economic performance and level of economic activity in the V4 countries

Lastly, the V4 economies were assessed and ranked by performance using the relevant indicators. The results are presented in Table 2.

Table 2. *Assessment of economic performance and level of economic activity in the V4 countries*

	2009					2019					2020				
	GDP	**ESI**	**OMI**	**HMI**	**total**	**GDP**	**ESI**	**OMI**	**HMI**	**total**	**GDP**	**ESI**	**OMI**	**HMI**	**total**
Czech Republic	1	1	1	2	**1**	1	2	1	2	**1–2**	1	2	1	2	**1–2**
Hungary	3	4	4	4	**4**	4	3	3	3	**3**	3	4	3	3	**3**
Poland	4	2	2	1	**2**	2	1	2	1	**1–2**	2	1	2	1	**1–2**
Slovak Republic	2	3	3	3	**3**	3	4	4	4	**4**	4	3	4	4	**4**

In 2009, the highest ranked country was the Czech Republic, with the best indicator values (except HMI). Poland took second place, although it was ranked fourth in GDP per capita value, and was followed by Slovakia and Hungary. The situation was different in 2019, when Poland saw an improvement in the value of GDP per capita, which translated into the overall ranking. In 2019, Poland's ranking was the same as that of the Czech Republic. On the other hand, the economic performance of Slovakia deteriorated; thus, Slovakia was ranked worst in three of the four indicators examined. The performance ranking did not change in 2020.

Conclusion

When addressing the assessment of economic performance, central to economic debates has been the issue of sustainable economic and social development. This paper addressed the performance of the V4 economies and their assessment using GDP per capita, magic square and the misery index. The research found that the Czech Republic had the highest GDP per capita of all the V4 countries in each of the analysed years, which also translated into economic performance.

The economic performance of nations is affected by internal and external factors. Regarding the V4 economies in 2009, the Slovak Republic, the Czech Republic and Hungary experienced a decline in gross domestic product, which translated into negative economic growth. Poland was impacted by the recession in a moderate manner, and its GDP growth only slowed down. The highest unemployment rate was recorded in the Slovak Republic. In 2019, the projected cyclical slowdown occurred, and was most pronounced in Slovakia. Compared to 2009, the situation improved mainly in the V4 labour markets. The unemployment rate fell to 2.01% in the Czech Republic and to 5.75% in Slovakia. In 2020, the COVID-19 pandemic negatively affected all V4 countries, and brought about a gradual decline of economic and social indicators. This was due to the restrictive measures taken to stop the spread of the disease, which, in turn, caused a decline or slowdown in GDP growth and disruptions in the labour markets.

A comprehensive assessment of the performance of the V4 countries using the ESI yielded interesting results. In 2009, the best position was achieved by the Czech Republic, where the ESI reached 0.320, while the ESI in Hungary was only 0.097. In 2019, ESI values were significantly higher. Poland scored best (mainly due to its higher GDP growth rate) with an ESI value of 0.646. Slovakia lagged far behind with its ESI value of only 0.333. In the pandemic year of 2020, Poland scored the best again (0.407), while Hungary scored the worst (0.244).

To assess the overall performance and level of economic activity in the V4 countries, the

evolution of the misery index was examined. Recently, misery index modifications have been used extensively to gauge the overall health of the global economy. The values of the original OMI and of HMI were identified, and the ranking of the V4 economic assessment was made. The best performing country was the Czech Republic in all three years under analysis. Slovakia performed the worst in 2019 and 2020.

It is evident that this research has several limitations in terms of the current political and military situation. As the war in Ukraine has been a major blow to the global economy, further research should be done to supplement the current findings.

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WILL EU BE LESS PRODUCTIVE IN THE TIMES OF AGING POPULATION?

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Abstract. *The paper aims to evaluate the impact of aging labour force on productivity, measured as a GDP per person employed and total factor productivity (TFP), in the European Union (EU) countries based on models developed by Calvo-Sotomayor et al. (2019), Poplawski-Ribeiro (2020), Feyrer (2008), and Aiyar and Ebeke (2016). We combine different research methods to address previous criticism and use the most recent data to compare our results with previous trends and draw conclusions about the impact of an aging labour force on productivity. Measuring productivity as a GDP per person employed, the study finds that the aging labour force has a negative and statistically significant effect, which differs between the EU-15 and EU-13 countries, on productivity. Our evidence is not entirely robust since the negative effect of aging labour force on productivity measured as TFP was not statistically significant.*

Keywords: *aging labour force, European Union, productivity, panel data models, total factor productivity*

JEL classification: *C33, D24, J11, J14, J21*

1. Introduction

Productivity can be considered one of the most important factors of economic growth. If productivity grows, more taxes are collected, wage raises and additional investment is created. Productivity growth requires a balanced workforce of young and older workers, but the demographic phenomenon called aging population threatens this balance. As society ages, more and more older people remain in the workforce, potentially affecting productivity. Over the last twenty years, the share of the Europeans in the world population has fallen from 11.89 in 2000 down to 9.64 per cent in 2020, so Europe's demographic importance is inevitably declining. One of the

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reasons for this phenomenon is the declining birth rate, but the rate of population decline is being held back by increasing age. Taken together, these two factors are causing population aging. Worldwide the share of people over 65 increased from 6 in 1990 up to 9 per cent in 2021, and by 2050 it will reach 16 per cent. In the EU, there were 93 million people over 65-year-old, and they accounted for 20.8% in 2021, although in 1999, the older people accounted for only 15.48 per cent of the total population. It is projected that in 2050 the number of older people will increase up to 129.8 million, and they will account for 29 per cent of the total population of the EU.

Previous research has emphasized the negative effects of aging labour force on productivity (Feyrer, 2007; Maestas et al., 2016; Aiyar and Ebeke, 2016; Westelius and Liu, 2016; Adler et al., 2017; Calvo-Sotomayor et al., 2019; Park et al., 2021), but there are studies which identify the positive effects as well (Ilmakunnas and Miyakoshi, 2013; Lee and Song, 2020; Acemoglu and Restrepo, 2017, 2022). Mahlberg et al. (2013) provide results that the effect of the aging population on productivity differs across economic sectors. While a large part of the literature aimed at investigating the impact of society ageing on productivity in a single country: USA (Feyrer, 2008; Maestas et al., 2016); Netherlands (Van Ours and Stoeldraijer, 2011), Canada (Dostie, 2011), Germany (Göbel and Zwick, 2012; Börsch-Supan and Weiss, 2016; Börsch-Supan et al., 2021), Austria (Mahlberg et al., 2013), Hungary (Lovász and Rigó, 2013), Finland (Pekkarinen and Uusitalo, 2012), Japan (Westelius and Liu, 2016), Japan, Korea (Lee and Song, 2020), there are only few research referred to a group of countries: OECD (Feyrer, 2007), 18 advanced economies (Adler et al., 2017), EU-28 countries (Aiyar and Ebeke, 2016); EU-24 countries (Calvo-Sotomayor et al., 2019).

As society ages, the share of older people is increasing, as well as the share of older workers in the total labour force. Various indicators are used to study the impact of aging labour force on productivity. The most commonly used are employment rates of people aged between 55 and 64, and the old-age dependency ratio (the ratio between older people at an age when they are generally economically inactive (i.e., aged 65 and over) and the number of working-age people (i.e., 15-64 years old)). According to the IMF (2016), productivity growth is statistically significantly declining as the share of the 55-64 age group in the total labour force increases. Aiyar and Ebeke (2016) study in the EU found that productivity is declining by 0.1 per cent each year, and projected productivity decline is accelerating to 0.2 per cent every year. It has been concluded that the main channel through which an aging labour force slows output growth per employee is lower productivity, which is often seen as a key driver of economic growth.

There is a lack of recent research on the impact of the aging population on productivity in the EU. Filling this gap, our paper aims to estimate the impact of the aging labour force on productivity in EU countries. This research complements limited empirical evidence estimating the impact of aging population on productivity based not on a single country sample but by applying the panel estimation technique and looking at EU-28 countries. Additionally, the article examines the impact of the aging labour force on productivity, measured as a share of GDP per capita, and on TFP, allowing us to examine whether the aging labour force is affecting productivity.

The rest of the paper is organized as follows: Section 2 provides a theoretical background of how aging population affects productivity, Section 3 presents the developed specification of the model, estimations strategy, and data, Section 4 discusses the main estimation results, and the last section concludes the paper and provides discussion for the future research.

2. Literature review

Workers of different ages have different work experiences and abilities. In this way, workers in different age groups may change or complement each other and productivity in one age group may depend on interactions with workers in other age groups. Such changes in productivity can occur between older and younger workers if, for example, the experience of an older worker increases not only his own productivity but also that of the people who work with him. It is important that the knowledge accumulated by older workers is applied to work activities (Börsch-Supan et al., 2021). Equally important are the knowledge and skills that young workers bring to the labour market. As the population ages and fewer young people enter the labour market, fewer new knowledge, new skills, and competencies will be offered to employers. This may have a negative impact on innovation and productivity growth (Mahlberg et al., 2013).

One of the main research papers on the impact of aging society on productivity is considered to be the study by Feyrer (2007, 2008). Our research is not based on this author's work but relies on the subsequent research that emerged from Feyrer's (2007) study to find the best way to assess the impact of the age structure of the labour force on productivity. It is worth noting that Feyrer (2008) was not categorical in assessing the results obtained for the effects of an aging population. The results are seen as showing a link between demographic change in society and the workforce and changes in productivity. Still, he found that the most productive age group is 40-49 years workers. The increase in this age group's workforce share boosts productivity, but the increase in the share of employees aged 15-39 was related to lower productivity. The increase in the share of employees aged 50-59 years and over 60 also had a negative impact on productivity, but the results were less reliable. The author argued that there is no inverse causal link between demographic changes in the labour force structure and productivity, i.e. fluctuations in productivity do not affect the demographic structure of the labour force.

Previous research on the impact of aging population on productivity is conducted at the level of the enterprise, industry, economic sector, country and group of countries. Studies at the level of the company, group of companies, or one or more industries have found that demographic factor has an impact on productivity, but this impact depends on the technology used, the need for human capital and the specifics of the activity (Sun, 2020; Pekkarinen and Uusitalo, 2012; Börsch-Supan and Weiss, 2016; Martino, 2015). At the country group level, examining the impact of an aging population reveals a decline in productivity (Adler et al. al., 2017; Aiyar and Ebeke, 2016; Calvo-Sotomayor et al., 2019; Poplawski-Ribeiro, 2020), as well as at a one country level (Dostie, 2011; Lovász and Rigó, 2013; Lovász, and Rigó, 2013; Westelius et al., 2016; Maestas et al., 2016; Lee and Song, 2020; Park et al., 2021). Acemoglu and Restrepo (2017) state that they have not identified a negative impact of population and workforce aging on productivity and point out that the potential negative impact of aging population is reduced by process automatization and robotization. No adverse (Acemoglu and Restrepo, 2017; Lee and Song, 2020) effects were observed, or effects were inconclusive in research (Mahlberg et al., 2013; Göbel and Zwick, 2012; Van Ours and Stoeldraijer, 2011; Börsch-Supan and Weiss (2016). Aiyar and Ebeke (2016) also draw attention to the problem of endogeneity in this strand of research, as this problem leads to inaccurate estimation results.

An analysis of previous research has shown that studies analyzing the impact of an aging population on productivity have mostly identified negative effects. A summary of previous em-

pirical studies is provided in Table 1.

Table 1: *Main results of the previous research on the impact of aging population on productivity*

Research period	Research sample	Main results	Methods applied	Authors
2006-2015	Republic of Korea	Significant and negative impact on productivity.	Modified Cobb-Douglas production function and various panel estimators	Park et al. (2021)
1973-2005, 1980-2012	Japan, S. Korea	In Japan and South Korea, aging populations positively impact productivity as older workers work in industries with high information and communication technology (ICT) capital.	Fixed effect, modified Cobb-Douglas production function	Lee and Song (2020)
1985-2014	At least 32 and at most 73 advanced economies and emerging markets	Significant and negative impact on productivity. 1% increase in the share of employees aged 55-64 decreased productivity by 0.7%.	Panel-fixed-effect two-stage least squares	Poplawski-Ribeiro (2020)
1983-2014	24 EU countries	Significant and negative impact on productivity. 1% increase in the share of employees aged 55-64 reduces productivity from 0.106%. up to 0.479%	Fixed effect	Calvo-Sotomayor et al. (2019)
1995-2011	18 advanced economies	Aging could significantly slow TFP growth. 1 per centage point increase in the share of 55–64 years-old age group leads to a statistically significant cumulative decrease in TFP of about 0.7 percentage points over five years (that is, about 0.15 per year).	Decomposition method	Adler et al. (2017)
1950-2014	28 EU countries	Significant and negative impact. Projected workforce aging could reduce TFP growth by an average of 0.2 percentage points every year over the next two decades	Fixed effect	Aiyar ir Ebeke (2016)
1990-2007	Japan	The aging of the labour force has had a significant negative impact on TFP.	Modyfied Feyrer (2007) model and Arellano-Bond GMM estimator	Westelius and Liu (2016)

2003-2006	EU, USA, Asia	A study on the production line in the truck manufacturing industry does not support the view that older workers are less productive, at least up to 60 years old. The result may have been affected because older workers who work productively, show good results, are promoted and do not work in the production line.	Piecewise linear specification	Börsch-Supan and Weiss (2016)
2002-2005	Austria	The positive effect is recorded in the construction and trade sectors. In contrast, in other sectors, the negative effect of the share of older workers on productivity is recorded, but this depends on the age, size, sector and region in which the company operates.	Cobb–Douglas production function	Mahlberg et al. (2013)
1997-2005	Germany	The impact of older workers on productivity has not been confirmed.	Cobb–Douglas production function	Göbel and Zwick (2012)
1986-2008	Hungary	Productivity declines in activities where employees need new skills to do the job.	Cobb–Douglas production function	Lovász and Rigó (2013)
2000-2005	Netherlands	No significant effect on productivity was found in the group of older workers. There was also no difference between the age-related effects on productivity, productivity and wages.	Cobb–Douglas production function	Van Ours and Stoeldraijer (2011)

Source: Own elaboration

A share of GDP per employee (Maestas et al., 2016), value-added per capita (Göbel and Zwick, 2012), the productivity of older workers, the gross factor productivity (Westelius and Liu, 2016; Poplawski-Ribeiro, 2020) are used to measure productivity.

Summarizing the results of empirical research, it can be stated that the topic of the impact of aging labour force on productivity is open in the scientific literature. The studies differ in terms of time periods and research samples because not all data are available to researchers. Our study aims to assess the impact of demographic change on productivity in the EU using the latest available data.

3. Data and model

Our panel data covers EU-28 countries for the period of 1999 – 2019. The choice of the research period depends on the availability of the data in order to cover a sufficiently long period. Based on a study by Poplawski-Ribeiro (2019), the data used in the models will be converted to non-overlapping three-year averages. Since aging is a long-term process, averaging data allows for reducing the impact of economic fluctuations and capturing lagging effects of demographic change. The data is collected from Eurostat, World Bank and Penn World Table 10.1 databases.

Based on the results of the above-mentioned empirical studies presented in Table 1, **Hy-**

pothesis 1 is formulated: population aging has a negative impact on productivity in the EU. To test the first hypothesis, we use two specifications. Eq. (1) is adapted from Calvo-Sotomayor et al. (2019). In this equation, the independent variable is productivity, measured as a real GDP per person employed. Eq. (2) is adapted from the study by Poplawski-Ribeiro (2020) but modified according to Calvo-Sotomayor et al. (2019). In this equation, productivity is measured by TFP, which shows the share of growth in output not explained by growth of labour and capital imputs. Our panel specifications:

$$\Delta \ln Y_{i,t} = \alpha_i + \sqrt{}_t + ß_1 W55_{i,t} + ß_2 YADR_{i,t} + ß_3 OADR_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$\Delta \ln TFP_{i,t} = \alpha_i + \sqrt{}_t + ß_1 \Delta W55_{i,t} + ß_4 \Delta ADR_{i,t} + \varepsilon_{i,t} \quad (2)$$

where α_i is *i*-th country's specific constant, $\sqrt{}_t$ are dummies fore each year *t*, $\varepsilon_{i,t}$ is the idiosyncratic error term. Variables included in the equations are presented in Table 2.

Table 2: *Description of the variables*

Variables	Abbreviation	Description	Database
Productivity	TFP	The share of growth in output not explained by growth of labour and capital used in production, with the standard weighting of 0.7 for labour and 0.3 for capital.	Penn World Table 10.1
	Y	GDP per person employed (constant 2017 USD), calculated as the gross domestic product (GDP) divided by total employment in the economy, USD	Penn World Table 10.1
Aging of the labour force	W55	The share of the total workforce aged 55-64 years	EUROSTAT
Old-age dependency ratio	OADR	The ratio of the number of elderly people at an age when they are generally economically inactive (i.e. aged 65 and over), compared to the number of people of working age (i.e. 15-64 years old).	EUROSTAT
Young-age dependency ratio	YADR	The youth dependency ratio is the population ages 0-15 divided by the population ages 16-64.	EUROSTAT
Age dependency ratio	ADR	The ratio of dependents--people younger than 15 or older than 64--to the working-age population--those ages 15-64.	EUROSTAT
Technological development	R&D	Research and development expenditure, per cent of GDP	World bank
Foreign direct investment	FDI	Foreign Direct Investment, per cent of GDP	World bank
Trade openness	OPEN	The ratio of imports and exports, per cent to GDP (2015 prices)	EUROSTAT

Human capital	HC	Based on the average years of schooling and an assumed rate of return to education	Penn World Table 10.1
Technological progress	ICT	Share of ICT goods, percent of total trade	UNCTAD

Source: Own elaboration

In these equations, various age-dependency ratios are used as control variables that include other channels through which an aging population affects productivity. A higher age dependency ratio (lower for young people or higher for elderly people) indicates a longer average age of the population, which may affect age-related public expenditure, saving rates, and investment levels.

Productivity in individual countries is influenced by the existing institutional environment. In the EU, the challenge of aging population was previously addressed, as this demographic change is specific to developed countries. As EU-13 countries join the EU later, they may not be ready for these demographic changes. Our study divided EU-28 countries into two groups according to the date of accession to the EU. The first group of countries joined EU-15 prior 2004. The second group is the EU-13 countries, which joined the EU in 2004 and later. Majority of these countries are post-Soviet countries. This grouping is based on previous research by Poplawski-Ribeiro (2020), who divided countries into two groups according to their level of development (study covered 68 countries, ingluding advanced and emerging market economies). Meanwhile, Thalassinos et al. (2019) analysing impact of aging population (measured as the active ageing index) on economic development of the EU Member States find important dissimilarities between the EU countries, so authors apply panel analysis in EU–15 and EU–13 country groups. Cristea et al. (2020) use four specific panels, according to active ageing index, also confirm significant dissimilarities of the aging population impact on productivity in the EU countries. The previous studies reveale the need of the research not only in the EU as a whole but also designed for each investigated panel. For the above reasons, **Hypothesis 2 is: the aging labour force has a greater negative impact on productivity in the new EU Member states (EU-13) than in the old EU countries (EU-15).** To test that hypothesis, we will use Eq. (1).

Previous research examining the effects of aging population on productivity rarely accounts for other important productivity factors. In order to assess the impact of aging labour force on productivity while controlling other macroeconomic factors affecting productivity, we formulate **Hypothesis 3: aging labour force has a negative impact on productivity even if other productivity determinants, such as technological development, foreign direct investment, trade openness, human capital and technological progress are controlled.** The econometric specification is:

$$\Delta \ln Y_{i,t} = \alpha_i + \sqrt{}_t + \beta_1 W55_{i,t} + \beta_2 ADR_{i,t} + \beta_3 \Delta FDI_{i,t} + \beta_4 \Delta ICT_{i,t} + \beta_5 \Delta R\_D_{i,t} + \beta_6 \Delta OPEN_{i,t} + \beta_7 \Delta H\_CAP_{i,t} + \varepsilon_{i,t} \quad (3)$$

All terms are explained below Eq. (2) and in Table 2.

Research by Calvo-Sotomayor et al. (2019), Poplawski-Ribeiro (2020) and Aiyar and Ebeke (2016) found that the share of older people in the total number of persons employed is endogeneous. The conventional assumption is that the only endogenous variable in the model is a dependent variable. All other model variables must be exogenous, but they can become endogenous because they are affected by an unobserved variable that is not controlled and becomes

part of the error. Endogeneity leads to biased results because the error-correlated independent variable may reflect its own and the effect of an unobserved factor. To address the endogeneity problem, we use two stages least squares estimator (2SLS) with external instrumental variables (IV). The endogeneity problem in this study, as in other studies analyzing the impact of aging population on productivity, arises from the fact that the share of the different age employed population in the labor force depends not only on the size of the age group but also on the share of the employed in that group.

The increase in productivity per person employed may have a direct effect on the number of employees in the relevant age group. Endogeneity arises from the fact that labor force participation rates in some age groups are sensitive to fluctuations in productivity. The participation rate of the 55-64 age group in the labor force increases in response to a positive change in productivity (Aiyar and Ebeke, 2016). This means that the employment rate of this group is more elastic in terms of changes in productivity than that of other age groups. As a result, the share of this group of workers tends to increase in the total workforce as productivity increases. In other words, the value of this variable is affected by the effect of a positive change in productivity on the relative employment rate of the 55-64 age group.

Research suggests addressing the endogeneity problem by including exogenous instrumental variables using the 2SLS estimator. We instrumented the independent variable *W55* by the share of the population in the 45-54 age group 10 years earlier (IV45_54). Calvo-Sotomayor et al. (2019) and Aiyar and Ebeke (2016) addressed this problem through instrumental variables – the birth rates 10, 20 and 30 years earlier (in our research: IV_10, IV_20, IV_30). The suitability of the instrumental variables for the model is assessed by considering the strength of the relationship between the instrumental variable and the potentially endogenous variable using pairwise correlations (see Annex 1). The instrumental variable is suitable for the modelling when pairwise correlations is greater than 0.2 and statistically significant. According to the results of correlation analysis only variable IV45_54 meets the requirements for instrumental variables and will be used in the model. A brief summary statistics of the variables is presented in Table 3.

Table 3: *Summary statistics of the variables*

Variables	Group of countries	Mean	Std. Dev.	Min	Max
Aging of the labour force	EU-28	12.919	3.5133	4.8501	21.704
	EU-15	13.174	3.5508	5.7328	21.704
	EU-13	12.621	3.4518	4.8501	21.279
Young-age dependency ratio	EU-28	24.311	3.0603	19.460	34.228
	EU-15	25.187	3.1345	20.159	33.477
	EU-13	23.300	2.6372	19.460	34.228
Old-age dependency ratio	EU-28	24.955	4.5604	15.159	36.057
	EU-15	26.193	4.3784	15.159	36.057
	EU-13	23.527	4.3506	15.178	33.176

Age dependency ratio	EU-28	49.267	4.5330	38.457	61.795
	EU-15	51.381	3.8385	42.821	61.795
	EU-13	46.828	4.0236	38.457	57.839
Total factor productivity	EU-28	0.79821	0.17242	0.44095	1.4270
	EU-15	0.90488	0.14779	0.53890	1.4270
	EU-13	0.67514	0.10279	0.44095	0.90923
Productivity	EU-28	76838	27623	22508	209111
	EU-15	96510	21342	55610	209111
	EU-13	54139	12472	22508	78545
Technological development	EU-28	1.4534	0.87046	0.22000	3.8700
	EU-15	1.9607	0.81974	0.53000	3.8700
	EU-13	0.87257	0.47360	0.22000	2.5600
Trade openness	EU-28	1.1186	0.65824	0.27631	4.0917
	EU-15	1.0271	0.74317	0.42571	4.0917
	EU-13	1.2245	0.52537	0.27631	3.1126
Foreign direct investment	EU-28	11.593	37.371	-58.323	449.08
	EU-15	7.0216	14.216	-58.323	86.589
	EU-13	16.818	52.117	-40.414	449.08
Technological progress	EU-28	7.9125	8.3899	0.79342	63.636
	EU-15	6.4948	5.5417	1.0714	36.819
	EU-13	9.5482	10.557	0.79342	63.636
Human capital	EU-28	3.1722	0.31496	2.2092	3.8490
	EU-15	3.1463	0.34106	2.2092	3.7736
	EU-13	3.2021	0.27950	2.5247	3.8490
The share of the total population aged 45-54 years ten years earlier	EU-28	13.1	1.34	9.23	16.0
	EU-15	13.0	1.18	9.23	16.0
	EU-13	13.2	1.50	9.86	15.8
Birth rates 10 years earlier	EU-28	1.56	0.250	1.12	2.43
	EU-15	1.60	0.224	1.19	2.14
	EU-13	1.52	0.270	1.12	2.43
Birth rates of 20 years earlier	EU-28	1.75	0.331	1.13	3.14
	EU-15	1.65	0.295	1.19	3.14
	EU-13	1.85	0.337	1.13	2.46

Birth rates of 30 years earlier	EU-28	2.04	0.410	1.32	3.86
	EU-15	1.95	0.506	1.32	3.86
	EU-13	2.14	0.219	1.54	2.83

Source: Own elaboration

Estimation results

Estimations of Eq. (1) and Eq. (2) For the EU-28 sample are presented in Table 4.

Table 4: *Estimations of the impact of aging population on productivity*

Variable	Coef.	Eq. (1)		Eq. (2)	
		FE	2SLS	RE	2SLS
Intercept	α	0.0143	0.0192	0.0491***	0.0053
		(0.0323)	(0.0276)	(0.0141)	(0.0249)
Aging labour force (W55)	$\beta 1$	-0.0014	-0.0028**	-0.0050	–0.0093
		(0.0008)	(0.0013)	(0.0043)	(0.0136)
Young-age dependency ratio (YARD)	$\beta 2$	0.0013	0.0013*		
		(0.0013)	(0.0007)		
Old-age dependency ratio (OARD)	$\beta 3$	-0.0003	-0.0004		
		(0.0011)	(0.0008)		
Age dependency ratio (ARD)	$\beta 4$			-0.0098***	–0.0118***
				(0.0033)	(0.0040)
N					
R2		0.5481	0.5449	0.3625	0.6015
R2adj.		0.3965	0.5011	0.3347	0.4997
Test for differing group intercepts[(1)] [p-value]		[<0.001]		[<0.001]	
Breusch-Pegan [(2)] [p-value]		[<0.001]		[<0.001]	
Hausman test[(3)] [p-value]		[0.005]		[0.542]	
Wooldridge test[(4)] [p-value]		[0.023]		[0.206]	
Wald test for heteroscedasticity[(5)] [p-value]		[<0.001]		[<0.001]	
Pesaran CD test[(6)] [p-value]		[0.099]		[0.262]	

Source: Own elaboration

All estimations include time dummies. Heteroscedasticity and serial correlation robust standard errors are presented in parentheses. *, **, *** indicates significance at the 10, 5 and 1 per cent levels, respectively.

[(1)] A low p-value counts against the null hypothesis that the pooled OLS model is adequate

in favor of the fixed effects alternative.

(2) A low p-value counts against the null hypothesis that the pooled OLS model is adequate in favor of the random effects alternative.

(3) A low p-value counts against the null hypothesis that the random-effects model is consistent in favor of the fixed-effects model.

(4) A low p-value counts against the null hypothesis: no first-order serial correlation in error terms.

(5) A low p-value counts against the null hypothesis: heteroscedasticity is not present.

(6) A low p-value counts against the null hypothesis: cross-sectional independence.

The estimated coefficients on variables have a theoretically justified impact on productivity and are consistent with previous research. We confirm Hypothesis 1 as we find that impact of aging labour force on productivity in the EU-28 is negative and statistically significant. We also find that the rejuvenation of the society, i.e. an increase in the young-age dependency ratio, has a positive effect on productivity. Our results show that in the countries where the share of older people in the total working population is higher by one percentage point, productivity is 0.28 per cent on average lower. This is in line with the results by Calvo-Sotomayor et al. (2019), who found a negative and statistically significant impact of the aging labour force on productivity. Authors found that an increase in the share of older people in the total working population by 1 per cent decreases productivity by 0.106 – −0.479 per cent. It can be concluded that the growing share of older people in the total workforce is having an increasingly negative impact on productivity, meaning that countries' economies are failing to adapt to the demographic changes and are experiencing increasing productivity losses.

We found no statistically significant effect of population aging on productivity as measured by TFP (see estimations based on Eq. (2) in Table 4). However, although the effect is not statistically significant, it is negative. We find that the increasing age dependency ratio has a negative effect on productivity, and this effect is statistically significant. Our results are similar to those of Calvo-Sotomayor et al. (2019) and Poplawski-Ribeiro (2020), who found a negative and statistically significant effect of an aging labour force on productivity measured as TFP. Changes in the TFP are slow, suggesting that in some countries, the effects of aging labour force have been stronger, in others, it had less or no effects, and therefore has become statistically insignificant in terms of impact across the EU, but has remained negative. Assessing the statistically significant results based on Eq. 2, it can be concluded that in the countries where the age dependency ratio is higher by one percentage point, the productivity measured as TFP is 1.2 per cent on average lower. The results suggest that the aging labour force has a negative and statistically significant impact on productivity in the EU, measured as a share of GDP per person employed. The effect on productivity, measured as TFP, is also negative but statistically insignificant.

Estimations based on Eq. 1 (see Table 5) show that the impact of aging labour force in the EU-15 is negative but not statistically significant. The estimated coefficient β_2 is statistically significant and shows that a higher share of younger people in society positively affects productivity in the EU-15 countries. We confirm Hypothesis 2 as we find that the aging labour force significantly impacts productivity in the EU-13 group.

Table 5: *2SLS estimates based on Eq. (1) in EU-15 and EU-13*

Variable	Coef.	EU-13	EU-15
Intercept	α	0.3689***	-0.1168
		(0.1069)	(0.0953)
Aging labour force (W55)	ß1	-0.0096***	-0.0011
		(0.0041)	(0.0027)
Young-age dependency ratio (YARD)	ß2	-0.0055	0.0065*
		(0.0035)	(0.0033)
Old-age dependency ratio (OARD)	ß3	0.0001	-0.0005
		(0.0037)	(0.0022)
N			
R2		0.7637	0.5759
R2adj.		0.6863	0.4449
Wooldridge test(4) [p-value]		[0.061]	[0.112]
Wald test for heteroscedasticity[5] [p-value]		[<0.001]	[<0.001]
Pesaran CD test(6) [p-value]		[0.721]	[0.114]

Source: Own elaboration

All estimations include time dummies. Heteroscedasticity and serial correlation robust standard errors are presented in parentheses. *, **, *** indicates significance at the 10, 5 and 1 per cent levels, respectively. [4], [5] and [6] are explained in Table 4.

It can be concluded that in the EU-13 countries, where the share of older people is one percentage point higher, the productivity is 0.96 per cent on average lower. It was found that the share of older people aged 55-64 increased on average by 1.65 per cent in Bulgaria and Slovakia over the period 1999-2019. It led to decreasing productivity in these countries by 1.58 per cent per year. No significant negative effects on productivity have been identified in the EU-15, leading to the conclusion that the economies of the EU-15 are more adapted to the effects of an aging population. This may be due to the adaptation of jobs to older workers, the increased use of automation solutions, integration programs for older workers, and higher capital investment. Meanwhile, the economies of the EU-13 are more dependent on the physical labour force, and demographic changes have a significant impact on productivity. The impact of an aging labour force on productivity growth will continue to impact in the future. According to projections in the EU, the share of the population aged 55-64 among all employed by 2030 will increase to 20 per cent and should remain at that level until 2070, and the effects identified in our research will have a significant impact on productivity, especially in the EU-13. As a result, countries with the fastest-growing share of older people will face significant productivity losses.

Estimation of specification based on Eq. 3, which considers not only the variables of the aging labour force, but also includes other variables that influence productivity, shows that the impact of an aging labour force on productivity in the EU is negative and statistically significant

(see Table 6).

Table 6: *Estimations of the impact of aging population on productivity while controlling other variables affecting productivity based on Eq. (3)*

Variable	Coef.	FE	2SLS
Intercept	α	-0.0114	0.0441
		(0.0387)	(0.0350)
Aging labour force (*W55*)	β_1	-0.0012	-0.0035**
		(0.0007)	(0.0014)
Age dependency ratio (*ARD*)	β_4	0.0008	0.0002
		(0.0007)	(0.0006)
Technological development (*R&D*)	β_5	-0.0172	-0.0181*
		(0.0141)	(0.0096)
Trade openness (*OPEN*)	β_6	0.0255	0.0276*
		(0.0222)	(0.0167)
Foreign direct investment (*FDI*)	β_7	<0.001	<0.001
		(<0.001)	(<0.001)
Technological progress (*ICT*)	β_8	-<0.001	<0.001
		(0.0004)	(<0.001)
Human capital (*HC*)	β_9	0.2236	0.1938
		(0.2383)	(0.2192)
N			
R^2		0.5525	0.5357
$R^2_{adj.}$		0.3986	0.4786
Test for differing group intercepts(1) [p-value]		[<0.001]	
Breusch-Pegan (2) [p-value]		[<0.001]	
Hausman test(3) [p-value]		[0.005]	
Wooldridge test(4) [p-value]			[0.017]
Wald test for heteroscedasticity(5) [p-value]			[<0.001]
Pesaran CD test(6) [p-value]			[0.1145]

Source: Own elaboration

All estimations include time dummies. Heteroscedasticity and serial correlation robust standard errors are presented in parentheses. *, **, *** indicates significance at the 10, 5 and 1 per cent levels, respectively. (1) – (6) are explained in Table 4.

We confirm Hypothesis 3 as we find a statistically significant negative effect of aging labor force on productivity after controlling other productivity factors. We also find a statistically sig-

nificant impact (at 10% significance) of technological development and trade openness on productivity. Other variables such as technological progress, foreign direct investment and human capital appeared as statistically insignificant. It can be concluded that in the EU-28 countries with a higher share of older people by one percentage point, productivity is 0.35 per cent lower. In countries where technological development is higher by one percentage point, productivity is 0.18 per cent lower, and in countries with trade openness higher by 1 percentage point, productivity is 2.76 per cent higher.

5. Conclusions

Summarizing the results of previous research, it can be concluded that the aging population is a significant factor negatively affecting productivity, therefore, it is necessary to further study its sources and channels in order to identify the factors that can reduce its negative impact on productivity.

Our research confirms the negative and statistically significant impact of aging population on productivity measured as GDP per person employed in the EU-28, which is in line with Calvo-Sotomayor et al. (2019). We found if the share of employees aged 55-64 of all employees is higher by 1 percentage point, the productivity is lower from 0.25 up to 0.28 per cent. So we can draw the conclusion that the growing share of older people in the total labour force is having an increasingly negative impact on productivity. Aiming to evaluate aging population impact on productivity measured as total factor productivity we found that impact is negative but statistically insignificant, which is consistent previous research.

We also performed an assessment to determine the impact of the aging population on productivity in the EU-15 and EU-13 country groups. Our results show that the aging population has a negative impact on productivity in the EU-13. In this group of countries, a statistically significant and negative impact of aging on productivity has been identified. Meanwhile, a negative but statistically insignificant effect was found in the EU-15. It can be concluded that the economies of the EU-15 are more adapted to the productivity effects of an aging population and that economic and social convergence between Member States in the EU can help reduce the productivity gap between the EU-13 and the EU-15. The ongoing implementation of European Union programs in the EU-13 countries, the application of new technologies, and increased capital investment can be an effective means of overcoming the impact of an aging population on national economies, as well as on declining productivity.

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Appendix 1: *Results of correlation analysis*

	Instrumental variable ΔW55			
An instrumental variable	IV45_54	IV_10	IV_20	IV_30
Correlation Coefficient	0.3024	-0.1074	-0.2045	-0.1670
***p*-value**	0.0001	0.1658	0.0078	0.0305

Data is recalculated to non-overlapping three-year averages

	Variable W55			
An instrumental variable	IV45_54	IV_10	IV_20	IV_30
Correlation Coefficient	0.5937	-0.0977	-0.3710	-0.3708
***p*-value**	<0.0001	0.1732	<0.0001	<0.0001

Data is recalculated to non-overlapping three-year averages

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SUSTAINABLE DEVELOPMENT AND THE DIGITAL TRANSFORMATION OF EDUCATIONAL SYSTEMS

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Abstract. *Aim: Our research concentrates on the sustainable development and digital transformation of educational systems. This topic has gained the special attention of researchers and policymakers in recent years due to the wide spread of information and communication technologies (ICT) and the digital surge that can be observed all around the world. This digital surge, which can also be called a digital revolution, was further deepened by the COVID-19 pandemic, which resulted in the massive closure of schools and universities and the deployment of online and home learning.*

Methods: We use data obtained from researchers and lecturers at universities and higher education institutions in the Czech Republic and Russia between September 2020 and March 2021 to perform ordinal regression analysis. This allows us to test the relationships between effectiveness as a key factor of creativity on one side and motivation to look for new ways of teaching and research during and after the COVID-19 pandemic on the other.

Results: Overall, it appears that there are still many obstacles to the digital transformation of educational systems that might be embedded in the structure and the scope of today's educational institutions. We demonstrate that, at present, universities and higher educational institutions are

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undergoing r`adical change driven by the need to digitize education and training processes in record time, and that many academics lack the innate technical skills for online education. Nevertheless, it appears that young and motivated academics and researchers are keen on embracing new technologies and support the digital transformation of educational systems.

Conclusions: Our results might be useful for decision-makers and stakeholders in universities and higher education institutions for designing their strategies for the digitalization of educational systems.

Keywords: *educational systems, sustainable development, digitalization, COVID-19, information systems*

JEL codes*: I23, I25, O33*

Introduction

In recent years, sustainable economic development and digital transformation have heavily impacted upon educational systems in virtually all countries around the world (ElMassah & Mohieldin, 2020). However, it is quite unfortunate that in today's fast-moving digital world, some countries have failed to take full advantage of technological change. One of the main reasons for the gap in technological innovation and adoption is the lack of digital skills and awareness (Nordhaus, 2019). For example, the Vietnam Digital Evolution Index (DEI), at 46.79, is low compared to other Southeast Asian countries such as Malaysia (69.03), Thailand (55.04), Singapore (90.82), and Indonesia (46.72). It is obvious that DEI insights can help us recognize the need to promote digital change in Vietnam's education sector (Knoema, 2021), but other researchers have concluded that the digitization of schools is a complicated process (Lindqvist & Pettersson, 2019)

As a key player in the national education system, higher education institutions (HEIs) play a role in helping to catch up in several dimensions associated with digital skills development among students, minors, and, to a certain extent, adults. HEIs must embrace digital technologies and become drivers of the growth and development of their own ecosystems. HEIs need to become engines of digital innovation, including the provision of the skills needed to navigate the paradigm shift (Nureev et al., 2020). Quality education is one of the pillars of the 2030 Agenda for Sustainable Development of the United Nations, which aims to promote inclusive and equitable quality education and lifelong learning opportunities. UNESCO has begun preparing the Declaration on Connectivity in Education to support learning and strengthen the resilience of education systems. Digital learning can reduce the cost of access to training and better meet individual needs (OECD, 2020).

The transition to virtual learning is the future of higher education. The current COVID-19 pandemic has changed the way work and life are interrelated on a global scale. University systems must strive to overcome this situation in order to be competitive and to provide high-quality education in a digital transition scenario, where disruptive technological innovations are accelerating change. To achieve this goal, this paper explains the obstacles and challenges that universities face, the technological resources and methods that they must deploy in the current scenario of the transformation of higher education, and the role of higher educational institutions (as well as other business enterprises and state institutions) in the face of COVID-19 upheavals (Pan & Zhang, 2020; Strielkowski et al., 2021; or Trachenko et al., 2021).

In summary, the conceptualization of digitization in small steps enables the analysis of gradual digitization, since it does not end with the complete transformation of the school. Learning involves the transformation of entire activities and systems, including qualitative changes in objects, practices, cultural patterns, and activities (Engeström & Sannino, 2010). This in turn should contribute to the picture of the different levels of learning and the steps of transformation in schools.

We have categorized climate knowledge, for example, as an environmental achievement, but it can also be appropriately considered an academic achievement in an environment where students study science-related materials in a curriculum that is developed based on government standards and standardized tests. However, the inclusion of non-academic achievements (e.g., in the environment, civic engagement, health benefits) as a focus in the government K-12 energy efficiency programs that underpin this review may reflect a desire to disseminate what students learn in school through the framework of traditional academic performance (Ladwig, 2010). However, change is unlikely as long as educational institutions support a pedagogy in which the teacher puts information into the student, and the student relies on the teacher to gain knowledge: a school-wide resilience approach is preferred (Karami-Akkary et al., 2019). One-off measures may have only a small effect, hence continuing education during school years with a focus on several dimensions of sustainability can lead to intelligent changes in the environmental orientation of young students. Other instruments, such as the Attitudes towards Sustainable Development scale, which are based on measuring many aspects of the environment, economy, society, and education, can be tested in similar contexts in future work to examine students' attitudes towards sustainability and their relation to other variables (Biasutti & Frate, 2017). One needs to develop an action plan that looks at how the education sector can mitigate, adapt, educate, and promote equity to respond to and address climate change. The purpose of these resources is to create a solution-oriented society in which people have the skills and knowledge to make a difference in society, the economy, and the environment. Peace education and positive youth development are two examples from many areas with results that are consistent with energy efficiency. Focusing on content, structure, and the results of interest in many peer-reviewed articles devoted to the environmental education of K-12 students published in recent years, our analysis shows that the field of environmental education (EE) research is expanding in various dimensions, including, in particular, diversity of the investigated results.

This paper is structured as follows: section 1 discusses the issues posed by the global network of environmental education, with all educational systems facing the broader environmental problems faced by humanity. Section 2 contemplates the globalization of environmental education and national educational systems. Section 3 focuses on international cooperation, as universities and HEIs worldwide are training specialists in similar areas and finding foreign partners. Section 4 outlines the data and methods. Section 5 reports the results of the empirical model and provides a discussion of its results. Finally, the conclusions offer an overall summary and policy implications, as well as suggestions for professionals and researchers.

1. Global network of environmental education

In recent years, there have been many efforts to build a global network of environmental education, with all educational systems facing the broader environmental problems faced by hu-

manity (Dhawan, 2020). In the last few decades, initiatives such as Agenda 21 and discussions on the Earth Charter have promoted debate on environmental education as an important part of the dialogue on the role of education in relation to human perspectives. Knowledge of social change and social justice can bring about change in local and global societies, but, at least initially, this has not focused on sustainability education because its roots lie in its narrow focus on environmental protection and resource conservation (Aikens et al., 2016).

A socio-political dimension should also be emphasized, as this aims to encourage people to act in accordance with the public good of the environment (Machin, 2012). Education for Sustainable Development (ESD) has many similarities with the distant education (DE) in addressing issues such as climate change, oil scarcity, water pollution, biodiversity conservation, poverty reduction, and human rights. It also extends the social and human rights dimensions of DE beyond those of other education sectors to include a strong environmental focus. The concept of ESD was developed when aiming environmental education at developing the knowledge, skills, values, attitudes, and behaviors of people who care about their environment (Kopnina & Cocis, 2017). The goal of ESD is to help people make decisions and implement measures to improve our quality of life without endangering the planet. ESD promotes the development of the knowledge, skills, understanding, values, and measures needed to create a sustainable world that assures environmental protection, promotes social justice, and promotes economic sustainability. As a necessary tool for the dissemination of environmental responsibility, environmental education in the Global South addresses environmental issues in terms of their impact on different communities and specific needs, where discourse differs on environmental education and sustainable development. Although it was developed in the Global North, where environmentalists focus on conservation and address the needs of communities, the South is pushing a conservation agenda alongside social, economic, and political development (Lele, 2021). The role of environmental education is focused on the potential for economic growth and development, with UNESCO projects on the application of environmental education to sustainable development being declared as creative and effective uses of human potential and capital to ensure rapid and equitable economic growth with minimal environmental impact (Richter & De Sousa, 2019). Figure 1 offers a scheme of online (or offline) education and e-learning for sustainable development.

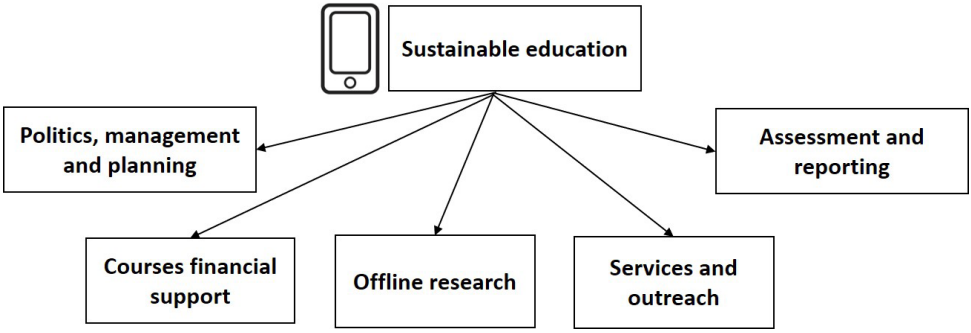

Figure 1. *Education and e-learning for sustainable development*

If environmental education can keep pace with potential audiences, it and the entire envi-

ronmental movement will benefit by remaining relevant to future generations and inspiring individuals to act to protect natural resources and the environment. Overcoming these obstacles is the goal of a partnership recently created by the World Resources Institute (WRI) and the Global Network of Environmental Education Centers. A 1992 survey by the National Consortium for Environmental Education Training found that teachers had difficulty finding help for students. In response, the consortium created a teacher's manual entitled Getting Started, a toolbox of information, and workshops throughout the country to prepare teachers for environmental education. The consortium also linked key sources of K-12 education materials on the environment and sustainable development that could be accessed through websites (Čábelková et al., 2020).

In general, ESD broadens the social and human rights dimensions in educational institutions and other education sectors, with a particular focus on the environment. ESD also promotes social inclusion, and it is at the core of the ECO-UNESCO ECO-Choices program, a drug prevention and awareness initiative that highlights the key role of the environment in human well-being and proposes environmental action projects for young people (Edwards et al., 2020). By providing engaging content and hands-on activities and by leading by example, teachers can empower students to play an active role in the sustainable development movement.

Well-designed and integrated education programs for sustainable development at the school level can have a significant positive impact on raising student awareness in this area. In this context, one can show how collaboration between high schools and universities can play an important role in the development of a comprehensive educational program on the specific topic of sustainability (Kiely et al., 2021). These forms of education can develop and grow, and can examine best practices in the school self-evaluation (SSE) in the context of national education policy, with a particular emphasis on how SSE can fit into this framework. The systematic thinking method of education creates an environment in which sustainability can be integrated into the entire campus, curriculum, and community. Incorporating system thinking into education before the age of 12 enables young people to look at sustainable development issues from different perspectives and work hard to find solutions to complex environmental, social, and economic problems (García-González et al., 2020). Sustainability education in K-12 schools can respond to the complex challenges facing our world by providing learners with experience and knowledge in systems thinking, civic action, and sustainable development goals. Education must be transformative and must enable us to make informed decisions and take individual and collective action to change our society and care for the planet. To do this, we need to take action today, and our education sector can be an important tool to help us decarbonize by 2050 and prepare the next generation for resilience.

Due to the COVID-19 pandemic, states and countries are facing tight budgets. Serving nearly one in six Americans, K-12 public schools can play a vital role in moving towards environmental sustainability. This is why sustainable schools are important; we must give students an educational curriculum, physical location, and organizational culture to foster the development of environmentally conscious global citizens (Ferreira et al., 2020). By introducing sustainability principles into classrooms – both as a mindset and as a pedagogy – teachers are inspiring the next generation of environmentalists and transforming students into global citizens. Leading sustainable lifestyles and traveling with students will be one of the most powerful ways to inspire a new generation of environmental leaders and leaders. One can visit Green Teacher, another non-prof-

it organization that helps educators, both in and out of schools, raise environmental awareness among youth. As primary and secondary schools find innovative ways to meet the needs of students during the COVID-19 pandemic and switch to distance learning, new initiatives aim to make public education have a significant impact on the environment and provide advice for schools to support environmental sustainability. A new report from the Aspen Institute's K-12 Climate Action Initiative examines schools that have a significant impact on the environment and considers government policies that can help schools adopt sustainable practices and advance the school's educational mission in the process (Aspen Institute, 2020).

There are many projects that link vulnerable populations with integrated technology programs to engage underserved students in environmental education and to investigate the effectiveness of integrating technology into their educational experiences. One study observed the effects of the use of digital technologies in outdoor training. High school students conducted a scientific study of their urban ecosystems using geographical information systems (GIS) and computer models in an intensive summer program focusing on urban ecology. In addition to acquiring valuable skills and environmental knowledge, students also experience progress in other academic areas (Barnett et al., 2011). Nature programs are courses that teach students other skills, and the use of outdoor facilities (e.g. schoolyards, nearby parks, public land, nature reserves, wetlands, and national parks) gives the traditional curriculum a sense of wealth and relevance.

2. Globalization of environmental education and national educational systems

In general, it is clear that the process of the globalization of environmental education implies fundamental changes in national educational systems. Educational research must recognize the value of change and provide opportunities for research to rethink what is appropriate and successful in educational practice (Malik, 2018). Innovation in education should embrace the view that interaction and enrichment among each other is for the common good of society. In the globalization of education, it is useful to think outside the box in order to develop our own innovations and create a broad basis for implementation. The problem is that our education system does not provide for the future competencies of the prevailing worldview of our society, which is enshrined in values, content, objectives, and educational methods. It is as if the education system were a prisoner of its history, derived from the worldview of industrial time and scientific reductionism (Marouli, 2021). The implicit goal of education is to convey this world view and our value system to the next generation so that they can become good citizens and administrators of the system. The main difficulty of modernization theory is that it focuses on changes in societies and nations relative to themselves, with Western societies as its main point of reference, neglecting the interconnectedness of these societies, their interdependence, and the role that non-Western countries play in the West's development. Immanuel Wallerstein was one of the earliest and most influential scientists to point out the weaknesses of modernization theory. He developed the theory of the world system to explain how the world expanded to shape relations between societies driven by a capitalist system of economic exchange. In contrast to the emphasis on linear development in modernization theory, he showed that rich and poor societies were trapped in a world system in which the progress of their relative economic advantages and disadvantages was achieved through politics and culture (Gilman, 2018). Globalization implies that information and knowledge are more widely distributed and shared. At the same time, the

arrival of foreign goods, services, and capital into a country creates incentives and demands to strengthen the education system so that a country's citizens recognize the upcoming competitive challenges. Globalization also creates a framework for cooperation between nations on a wide range of non-economic issues, with cross-border implications such as migration, the environment, and legal issues (Wang & Garduno-Rivera, 2021).

Specialization objectives aim to help students develop the knowledge, skills, and dispositions required to be competent citizens and world-class teachers. The new specializations offered by national universities focus on the universal need for continuous improvement of teaching and learning, and offer students a balance between philosophy, theory, practice, and application through joint research projects and field-related activities. The main focus of these specializations is on advanced, innovative, effective, and international approaches, ideas, and strategies in the field of learning that take into account the needs of nations and create contemporary school environments that accommodate different groups of pupils to empower students to become fellow learners in the creation of a sustainable society. The formal education system finds a co-creative and transformative relationship with society, as radical modern learning organizations emerge on both sides that reinforce change and exert their influence in all areas of society (Pavel & Isak, 2022). This process creates a strengthening loop between education and social change, which affects the design of the education system. There are many different ways to achieve financial stability, economic growth, and a higher standard of living, and each country will vary according to the specificity of its national economy and political system. Sustainable development consists of a balance between local and global efforts to meet basic human needs without destroying or damaging the natural environment. Dealing with the tension between sustainability and sustainable development is a key role played by international organizations such as the UN, governments of various countries, NGOs, and civil society organizations (Mensah, 2019).

In order to ensure sustainable development, every company, government, or civil society organization, whether global, regional, or national, is advised and expected to show ownership, leadership, and citizenship. The concept of ESD arose from the need for education to meet the increasing ecological challenges of the planet. ESD aims to empower and equip current and future generations to meet their needs with a balanced and integrated approach to the economic, social, and environmental aspects of sustainable development. It understands that education promotes changes in knowledge, skills, values, and attitudes to enable a sustainable and just society (Shulla et al., 2020).

Based on ITC standards, ESD covers all products – in particular agricultural products, followed by processed foods. The increasing pace of globalization and its impact on the environment is a major global concern. Research is full of conflicting results, but many believe that increasing globalization is harmful to the environment. A large number of environmentalists who support this view base their arguments on the premise that globalization leads to more global demand, which leads to more production. Increasing global demand contributes to the exploitation of the environment and the depletion of natural resources. As environmental concerns mount, an important question is whether deglobalization will have the opposite effect on the environment. Several World Trade Organization (WTO) trade-related measures are compatible with environmental protection and the sustainable use of natural resources. For example, the Green WTO rules instruct countries to protect human, animal, and plant life and to conserve

their inexhaustible natural resources (Philibert, 2019).

Therefore, it would be prudent to be cautious about abandoning the traditional, straightforward, socialized university model, as blind acceptance of "disruptive technologies" will make many question what they know and do, which will make this period of change even harder to graduate from. Rather, the digital transformation of universities will continue to change the teaching, learning, and experiences of students and faculty for years to come. While digital transformation is about how people use technology, not technology itself, research shows that digital technology can make education more efficient, scalable, and accessible. For example, one study pointed out that digital transformation can provide students with knowledge and skills for life and work, as well as reimagining processes such as recruiting and interacting with students in clubs and companies, including student groups during college and after graduation. Although HEIs are at different stages along the journey of digital transformation, other institutions can provide important experience for promoting digital transformation into higher education and becoming digital education institutions. Through social media, web seminars, and virtual seminars, HEIs can allow citizens of other countries to use digital technology (Mhlanga & Moloi, 2020).

During digital learning transformation, the behaviors of universities, students, and employers change, at the same time making this a critical moment for evaluating business results and cases and rethinking strategies and policies from a new perspective. As the education sector recovers from the pandemic, leaders and managers face the challenge of challenging the status quo and introducing new methods of management institutions and organizations. The education industry, like any other industry, can use more technologies and innovative solutions to improve efficiency and survive in the post-COVID-19 world. The core business model of the university must become a digital business model. To this end, most universities need to rethink their IT methods and allocate the necessary level of resources. It is time to realize that in order to create a modern user experience, universities must first invest in efficient IT infrastructure, especially when everything in higher education depends on technology and new cutting-edge technologies. The art building is empty; this will force many institutions to reinvent the way they provide students with experiences and services. With education shutting down all over the world, it is time for university administrators to study how e-learning programs can improve the accessibility of more students. The end of 2020 marks a clear turning point, as students, educators, and government leaders are exploring the cost and value of higher education through new traditional classroom perspectives and multiple digital delivery methods. Education is one of the least digitized and labor-intensive sectors in the economy, which shows that the opportunities and risks associated with technology-related disruption are great. To achieve these goals, this paper explains some of the obstacles and challenges that universities face, as well as the technical resources and methods they use in their current scenarios to transform higher education in response to the spread of COVID-19 (Blankenberger & Williams, 2020). It is likely that we are going to witness a long-term impact of the COVID-19 pandemic, with all of its restrictions on higher education lasting for several years and changing the way we experience higher education. We now see that COVID-19 has redirected and amplified the concerns and actions of universities around the world, reshaping and challenging their interests in ensuring short-term business continuity while ensuring long-term institutional viability. In addition, the COVID-19 pandemic

quickly put pressure on previously predicted trends in education such as the University of the Future. We then move on to more detailed results to answer the second research question which looks at additional factors in detail, providing detailed reports on how rapid change has impacted students and staff and the role of HEIs and systems in this process. This includes questions about the perceived impact of the rapid digital transition on learning outcomes and access to education, higher education readiness, responses to crisis management, major challenges in the transition to online learning, innovation arising from the pandemic, and long-term outlook effects (Watermeyer et al., 2021).

While some students do not like online learning and the digitalization of education, we have to stress that the process is inevitable and needs to be implemented. COVID-19 showed us that online education is not a myth and can be conducted with some creativity and effort. Hence, we need to learn how to use it wisely and within reason in order to ensure the dissemination of knowledge with the basic human need for socializing and being a part of a group.

3. International cooperation

Alongside the aforementioned, one can also acknowledge that international cooperation and exchange are extremely important for sharing ideas and the dissemination of knowledge around the world. International relations programs are conducted at colleges of professional studies, where students are invited to participate as compulsory electives and enjoy the benefits of international experience in an applicable discipline. For a week, students work on the basis of international experience to solve real problems for established multinational organizations, where they act as international consultants and apply their learning to practical scenarios. Students not only study abroad during their schooling, but also receive huge benefits to their education and careers. Some organizations and HEIs that engage these kinds of programs typically have ties to the United States, but tend to cooperate with hundreds of other organizations engaged in international exchanges. After working for a long time in the Middle East and North Africa (MENA countries), they offer experience in program management, proposal development, implementation, event coordination, and training design – not only in these countries, but all around the world.

The World Bank Group (WBG) provides financial and analytical support to governments in a wide range of fields, from systems and institutional development to targeted training programs. It works with countries and multilateral development partners to ensure that individuals have access to high-quality education and training and to help employers gain the skills they need. Countries also need policy interventions to better support skills development and measure the results of programs. There is a need for the WBG to conduct programs and policy research and analysis to improve interventions and the measurement of capabilities. During the resilient recovery phase, the WBG should focus its support on building skills development systems (World Bank, 2021).

Presently, we can observe educational programs that train large numbers of workers, but for the most part there are no mechanisms that enable them to train themselves. We need more emphasis on the fundamental purpose of education, not skills. In recent years, academics have begun to realize that the idea of offering education as an off-site education rather than an on-site one is misguided, because it is more expensive and less effective than self-directed learning.

Therefore, transformation is needed, and whilst it is coming, the questions of how we will face it and how this will change higher education remain, and can only be answered in time.

4. Data and methods

The data used in this study was collected using our own online survey administered in the Czech Republic and Russian Federation between September 2020 and March 2021. We applied the quasi-random method of sampling that featured both the elements of the snowball sampling technique as well as parts of opportunity sampling. All of the participants were recruited either personally via social networks and online modes of communication or via personalized e-mail messages.

The two countries in question were not selected at random but due to their specificities: both represent post-communist countries that embarked on the path of economic transition over 30 years ago; however, the tracks of their development have started to differ for economic, social, and geopolitical reasons. The level of digitalization and e-government participation in both countries is also quite different, with Russia lagging behind the Czech Republic in the early 2000s but quickly catching up and implementing digitalization and e-participation by the early 2020s (United Nations, 2021).

In total, a sample of 400 respondents from the Czech Republic (136 respondents) and Russian Federation (264 respondents) was obtained. The sample consisted of 58% women and 42% men (M ± SD = 45.53 ± 11.46, median 44). All of the respondents completed our questionnaire voluntarily and anonymously.

Since the majority of the respondents operated in the sphere of higher education and learning, most of them had a higher education degree (master's degree or higher). The positions best describing their work duties at their respective universities and research institutions were managers (73%), analysts (14%), and top managers and decision-makers (13%). The survey featured a number of questions, but only a few were used in this study. The questions were answered on a 5-point scale, which ranged from 1 (*strongly agree*) to 5 (*strongly disagree*). Table 1 reports the results of the cross-tabulation of the response related to the personal development induced by online teaching in both countries.

Table 1. *Time for personal development (cross-tabulation of responses)*

			1 – disagree[a]	2[a]	3[a]	4[a]	5 – agree[a]	Total
Country	Czech Republic	% within country	29.20	25.50	19.70	15.30	10.20	100.00
	Russian Federation	% within country	46.00	21.10	14.30	13.20	5.30	100.00
Total		% within country	39.70	23.80	16.40	13.40	6.70	100.00

Note: Due to online teaching, there is more time for personal development: 1 – strongly disagree, 5 –strongly agree

In general, we can observe remarkable differences between the two countries, with online

teaching proving more burdensome in the case of Russia than in the Czech Republic.

Table 2 reports the results of the cross-tabulation of the responses related to engagement in online collaborations induced by online teaching in both countries. Once again, we can see that the digital surge caused by the COVID-19 pandemic had a more positive impact on distant research collaboration in the Czech Republic than in Russia.

Table 2. *Motivation to use distant methods of scientific research (cross-tabulations of responses)*

			1 – disagree[a]	**2[a]**	**3[a]**	**4[a]**	**5 – agree[a]**	**Total**
Country	Czech Republic	% within country	16.10	22.60	29.90	20.40	10.90	100.00
	Russian Federation	% within country	24.50	16.20	20.40	23.80	15.10	100.00
Total		% within country	20.50	19.20	24.60	23.10	12.50	100.00

Note: Online teaching motivated me to use distant methods of engaging in scientific collaborations: 1 – strongly disagree, 5 – strongly agree

Using the data obtained in the course of our research, we can build an ordinal regression analysis in order to test the relationships between the components of emotional creativity on one side and motivation to look for new ways of teaching and research during and after the COVID-19 pandemic on the other. Our formal model can be presented in the form of the following equation (1):

$$motivation = logit\ (\alpha_0 ECI + \alpha_1 age + \alpha_2 gender + \alpha_3 country + \\ + \alpha_4 sciences + \alpha_5 position + e \quad (1)$$

where:

motivation – indicators of motivation;

emotional creativity (ECI) – measured by its subscales of novelty, preparedness, and subsequent effectiveness/authenticity;

age – age of the respondent;

gender – gender of the respondent;

country – country of the respondent;

sciences – type of education (formal sciences, natural sciences, or social sciences);

position – position at the university which best describes the job: lecturer, researcher, manager;

e – is an error term.

The results of the empirical model estimations are presented in the next section and discussed with regard to the research topic and focus.

Research findings

Table 3 reports the results of ordinal regression analysis, with the effectiveness of creativity

as a key factor that enhances motivation for novel ways of doing research during the COVID-19 pandemic.

Our empirical findings confirm that the ECI variable comes through as significant in all cases. Additionally, it became obvious that the effectiveness/authenticity component of emotional creativity proved to be positively associated with motivation for novel ways of doing research during the COVID-19 pandemic, while age was negatively related to the motivation to learn and embrace new technologies regardless of the field of research or education.

Table 3. *Effectiveness as a key factor that improves motivation for novel ways of doing research during the COVID-19 pandemic*

	Qualification enhancement		Online research		Research partners		Interdisciplinary research		Personal development	
	Estimate	**Sig.**	**Estimate**	**Sig.**	**Estimate**	**Sig.**	**Estimate**	**Sig.**	**Estimate**	**Sig.**
Threshold 1	0.462	0.528	-1.033	0.157	0.274	0.712	0.127	0.865	1.595	0.034
Threshold 2	1.275	0.082	-0.068	0.926	1.332	0.073	1.156	0.121	2.619	0.001
Threshold 3	2.375	0.001	0.980	0.179	2.928	0.000	2.714	0.000	3.489	0.000
Threshold 4	3.392	0.000	2.368	0.001	4.246	0.000	4.045	0.000	4.783	0.000
ECI	0.054**	0.002	0.042*	0.012	0.056**	0.001	0.067***	0.000	0.057**	0.001
Age	-0.008	0.311	-0.017*	0.020	-0.006	0.411	-0.014	0.069	-0.012	0.116
Gender (men)	-0.025	0.892	-0.188	0.298	0.131	0.477	0.109	0.556	0.405*	0.029
Country										
Czech Republic	-0.288	0.157	0.141	0.487	0.095	0.647	0.050	0.810	0.617**	0.003
Sciences										
Formal Sciences	0.383	0.270	0.453	0.188	0.053	0.879	0.272	0.437	0.237	0.499
Natural Sciences	0.797	0.070	-0.002	0.997	-0.224	0.616	-0.031	0.944	0.020	0.965
Social Sciences	0.623*	0.014	0.177	0.478	-0.268	0.291	-0.169	0.507	0.080	0.756
Position										
Lecturer	-0.022	0.930	-0.332	0.190	-0.392	0.128	-0.668*	0.010	0.436	0.103
Researcher	-0.228	0.490	0.002	0.994	-0.116	0.728	-0.562	0.093	0.674*	0.049
Pseudo R-Square										
Cox and Snell	0.051		0.043		0.051		0.064		0.069	
Nagelkerke	0.053		0.045		0.054		0.068		0.073	

McFadden	0.017		0.014		0.018		0.023		0.025	
Sig		0.007		0.027		0.007		0.001		0.000
N	400									

Note: Reference Variables: gender (women), country (Russian Federation), science (applied sciences), position (manager). Link function: Logit.

It became apparent that young researchers and lecturers are more motivated in driving digital enhancement into educational and scientific processes and introduce more novel elements into existing structures. In addition, it also appears that system shocks such as the COVID-19 pandemic might also become the triggers of profound changes, such as wide-scale digitalization, that would have taken years to be implemented under normal circumstances (Polycronidou et al., 2021). Here, one can recall the Schumpeterian concept of "creative destruction," which resonates similarly.

Conclusion

Overall, we can see that higher education is undergoing massive digitalization in recent years. This process is reinforced by the sustainable development and digital transformation of educational systems. Various experiments with computer-aided education began in the 1950s, such as the computer-aided teaching program, in which a computer was used to present learning materials from text, audio, and video, and to evaluate students' progress. For example, in 1950, the University of Iowa began developing television courses, and in the 1970s, community colleges in the United States created courses that could be broadcast on local television stations.

The advent of new technologies has also led to teaching methods requiring special training. As evidence grows that there are promising opportunities to engage students, identify difficulties students have with learning materials, and adapt teaching methods, the current gap in the preparation that most doctoral students receive could become a major handicap. More work is needed to develop better methods for colleges to measure student learning, not only for critical thinking and writing, but also for other primary education purposes. Without reliable learning measures, competition among students will not do much to improve the quality of teaching, and applicants will have no way of knowing which universities offer the best teaching.

Research is the engine of growth and innovation, which explains the strong emphasis placed by leading universities on it, but that does not excuse the neglect of the actual education offered to students, including critical issues that prepare them for the real world. Rising graduation rates and educational attainment will do little if students do not learn something of lasting value. Students learn best when they understand what they are learning and control their own learning. A metacognitive approach to teaching helps students take control of their own learning outcomes by using a set of personalized learning strategies to define their own learning goals and monitor their progress towards those goals. Teachers need to know how to help their students assess their own understanding of the best approach to learning.

The 11 members of the UIA work together to identify and test innovative programs that aim to improve students' objectives and create textbooks that work on a large scale to help all students, regardless of background, obtain a degree. This paper is a tutorial on the learning opportu-

nities provided by online and blended learning, as well as practical practices for online courses. A few institutions have made significant progress in improving student success. This is a promising result, given that only three out of ten children who drop out of high school achieve a degree by the age of 25. Schools that support large numbers of non-traditional and at-risk students can opt for a model of blended learning. Teachers can support those who need to learn independently in the room, and students can learn and practice new concepts in a digital environment. For schools with scarce resources, the online laboratory model for blended learning is a viable option to help students to complete courses, including those that are not offered at specific school locations.

Joint learning is the process in which two or more students work together to learn together, consisting of a small group of participants of different skill levels who have a variety of learning activities to master materials and develop teacher-constructed knowledge of content issues. The Flex model of blended learning is an Advance Path Academy approach to blended learning in which schools collaborate with school districts to address the needs of students with behavioral, academic, and socioeconomic challenges. Team members are responsible for learning, teaching, and supporting team-mates in learning. According to a recent UCLA Higher Education Research Institute survey, collaborative learning methods are used in two-thirds of higher education courses.

Online learning does not focus on delivering content, and reproduces the basic teacher-centered and transmissive face-to-face model. Courses offer prepared material, dialogue, feedback, and opportunities for teachers to adapt, but the risk of disaster is high and much of students' distress is invisible. The complicated economic scenarios associated with the online model cover the training that citizens need to be ready to solve new problems. Intelligent pedagogy is a teaching approach that uses technology to improve the learning experience. Examples include the use of Learning Analytics to help tutors design curricula and support students in managing their learning, and the creative use of technologies such as virtual and augmented reality in learning and teaching. To achieve a self-overlapping model of blended learning, successful students must be self-motivated. While many see university as an opportunity to take advantage of promising career prospects, it is also a unique opportunity to think about oneself and consider how a person can benefit from this experience. In return, top lecturers who publish research results generate scholarship income that can be used by doctoral students for their teaching. The journals in which they publish research are based on a questionable business model: they own a profitable publishing empire that generates billions in revenue. We believe that the entire higher education system prioritizes the classroom over the research laboratory, and changing this dynamic is a challenge. Students are paying more and more for less, and student debt is at an all-time high. Many universities exacerbate inequality by accepting students from higher socio-economic backgrounds at higher rates. These problems are compounded by the fact that many high schools in low-income communities do not help students develop the study skills they need to excel in college. Without preparation, students find it difficult to keep up in college and lose the confidence and motivation that are essential to completing their studies.

Thus, barriers to the effective implementation of digital higher education include a wide range of factors, from digital gaps among employees, caused by inadequate training, unwanted attitudes, or systemic isolation, to inequalities between students that increase and arise around the conditions of insufficient preparation for the crisis caused by the COVID-19 pandemic. How-

ever, we need to overcome these barriers to be able to face the challenges that digitalization and other civilizational changes pose to our higher education systems. All of us need to learn how to transform and adapt in order to be able to cope with the new threats and issues that might arise in the years to come.

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THE APPLICATION OF MACHINE LEARNING METHODS IN DETERMINING ATTRACTIVE DEVELOPMENT DIRECTIONS FOR TOURISM BUSINESSES

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Abstract. *This paper proposes a methodical approach to the selection of attractive development directions for tourism businesses. The approach is based on the following machine learning methods: "center of gravity" method; taxonomic indicator of the level of development; hierarchical agglomerative and iterative methods of cluster analysis; methods for analyzing panel data; and Kohonen neural networks. The developed approach includes the following core blocks: classification of countries (regional market segments) according to the level of socio-economic development and safety; formation of a diagnostic indicator system of countries' touristic attractiveness; assessment of the development dynamics of the market geographical segments (countries); classification of countries according to the level of tourist attractiveness; and selection of development directions for*

the tourism industry. The proposed approach is implemented on the data of 35 countries, including the EU countries and the countries of the post-Soviet space. The results show that the most attractive geographic market segments for tourism business development are such countries as Italy, Spain, Croatia, Greece, Portugal, and Poland. These countries are characterized by a high level of security, average cost and barriers to entry into the tourism market, a steady pace of development of the tourism industry, a favorable business environment, attractive natural resources, and developed infrastructure. Comparison of the dynamics of tourist flows with the obtained distribution of countries by the level of tourist attractiveness made it possible to single out Portugal separately, which is characterized by a high level of tourist attractiveness, but insufficient actual intensity of tourist flow. Implementation of the proposed approach in the business processes of travel companies make it possible to improve the quality of management decisions regarding the choice of tourism business development directions.

Keywords: *tourism business, development, tourism product, attractiveness assessment, machine learning*

JEL Codes: *C23, C45, C53, L83*

1. Introduction

In recent years, the tourism business has played a significant role in the global economy. Its share of global GDP demonstrated stable growth from 2010, accounted for 10.4% in 2019, and dropped dramatically to the level of only 5.5% in 2020 due to the COVID-19 pandemic. The highest growth rates of the tourism industry are observed for the developing countries cluster, and for Ukraine in particular (World Travel & Tourism Council, 2021; Statista, 2022).

According to the World Travel & Tourism Council (2021), the total contribution of travel and tourism to global GDP was 6.3% in 2019 (3.4% in 2020). The total contribution of the sector to global employment was 6.9% in 2019 (6.3% in 2020). As for Ukraine, according to forecasts (Shelemeteva, 2019), the share of tourism in Ukraine's GDP will increase to 1.7%; the number of people employed in the tourism industry will be 5.7% by 2027.

Despite the high attractiveness of this sector of the economy, its potential is not fully implemented. Despite the positive dynamics of tourist flow in 2015–2019 and the number of foreign tourists having increased by more than four times, foreign tourists' share in total flow is only 1%. The prevailing share remains outbound tourism, which accounts for 82% of the volume of tourist flow (State Statistics Service of Ukraine, 2019). Such trends in the industry make it necessary for tourism companies to pay more attention on the development of external areas.

It should be noted that the leading positions in the Ukrainian market are occupied by several large national and foreign operators (Piligrim, n.d.), such as Join UP! (27% of the market), ANEX Tour (16% of the market), Accord Tour (8% of the market), TEZ Tour (9% of the market), and Coral Travel (7% of the market). The high level of competition in traditional areas forces newly created or "second cluster" companies, which are close in terms of performance to leading companies, to look for new attractive directions for the development of their tourism businesses and to search for potentially attractive countries for tourists.

2. Literature Review

It must be said that various aspects of the strategic management of the development of tourism companies and the tourism industry, along with problems of the assessment of the tourist attractiveness level of regions, are widely researched in the scientific literature. Thus, the works of Romanova (2004), Kuleshova and Polyakova (2015), Kun et al. (2019), and Assaf and Tsionas (2019) deal with the analysis of factors that have the greatest impact on the development dynamics of the tourism market, assessing the potential of regions for tourism business development and forming a profile of tourism service consumers to increase market share and implement a successful targeted advertising strategy. Studies by Nedelea and Aziri (2013) are devoted to the analysis of the typology of the development strategies of travel companies. Agafonova and Agafonova's monograph (2002) researches the institutional aspects of creating a business environment conducive to the development of travel companies and tourism businesses. In Beydik (2001) and Wenqi et al. (2019), the assessment of regional aspects of the development of tourism businesses and the environmental safety of tourism are researched. The Patsyuk (2007) study addresses the development of tourism businesses in the context of diversifying the activities of old industrial regions and ensuring their sustainable socio-economic development.

A review of the literature allows us to say that despite the undoubted effectiveness of the approaches proposed earlier, the issues of applying machine learning methods to solve the problem of choosing attractive directions for the development of tourism businesses are poorly studied. The implementation of machine learning methods allows us to consider the level of tourist attractiveness of countries as a multidimensional object, which is influenced by a large number of multidirectional, dynamically changing factors, which can be measured in the hundreds. These methods make it possible to compress the information space of initial indicators, conduct analysis in conditions of incomplete, missing data, investigate latent factors of tourism product demand growth, and on this basis increase the speed of preventive response and the quality of strategic management decisions in tourism businesses.

3. Methodology

This paper proposes a methodical approach to the selection of attractive development directions of tourism businesses based on the application of machine learning methods. The approach consists of four core modules, which are presented in Figure 1. The description of each module is given below.

The first module deals with the classification of countries according to the level of socio-economic development and macro regions' safety. The model allows a comparable research database to be formed. The need to build such a classification is associated with the peculiarities of organizing a tourism business and is closely linked with indicators of the socio-economic development of macro-regions. Thus, the share of tourism businesses in GDP varies from 13.2% and 14.6% in developed countries such as Italy and Portugal, to 67.1% in an island state such as the Seychelles (Knoema, n.d.).

To assess the level of socio-economic development and safety, a system of indicators was formed on the basis of a literary source review. The resulting system includes both quantitative and qualitative indicators. Quantitative indicators are GDP, unemployment, consumption, and

inflation. The group of qualitative indicators includes the Global Competitiveness Index (GCI), Global Innovation Index (GII), Human Development Index (HDI), ICT Development Index (ICTDI), and the Index of Economic Freedom (IoEF) (Fabus et al., 2019).

Classification involves dividing the initial set of macro-regions into a relatively small number of classes so that objects belonging to the same class (group) are at relatively small distances from each other. The similarity or difference between countries (classified objects) is measured with Euclidean distance and weighted Euclidean distance.

To build the grouping, hierarchical agglomerative methods were used, which give only a conditionally optimal solution in a subset of local partitions (clusters). However, the advantage of these methods is the simplicity of results interpretation.

The essence of hierarchical agglomerative methods is that in the first step each object is considered as a separate cluster. The process of cluster joining takes place sequentially: based on the distance matrix or similarity matrix, the closest objects are combined. The results of clustering, presented as a dendrogram, allow one to choose the number of clusters at which the total intergroup dispersion will take the maximum value. This number of clusters is used to select the initial conditions of the iterative algorithm of the k-means method (Guryanova et al., 2018).

The second module is aimed at forming the diagnostic space of indicators that assess the level of tourist attractiveness of geographical market segments (countries). To build the model, such methods of reducing the dimension of indicators' space as the "level of development" method and the "center of gravity" method are used.

The multi-vector nature of changes in the initial indicators complicates their analysis and requires their presentation in the form of an integral indicator. This indicator is the result of a convolution of indicators that describe the development of individual subsystems, and is based on the "level of development" method. A detailed description of the "level of development" method is given in Fabus et al. (2019). The construction of an integral indicator includes the following steps: data standardization; determination of the reference point coordinates; calculation of the Euclidean distance between objects and the reference point; and assessment of the integral indicator values. The advantages of the method include the following: it allows one to work with data of any dimension and any nature; the system of indicators can include both stimulating indicators (having a positive impact on the level of the country's tourism attractiveness) and destimulating indicators (having a negative impact); the method contains a built-in procedure for generating a reference point; and the method allows one to obtain a complex normalized estimate, which varies in the range from 0 to 1, and therefore is easily scaled and interpreted.

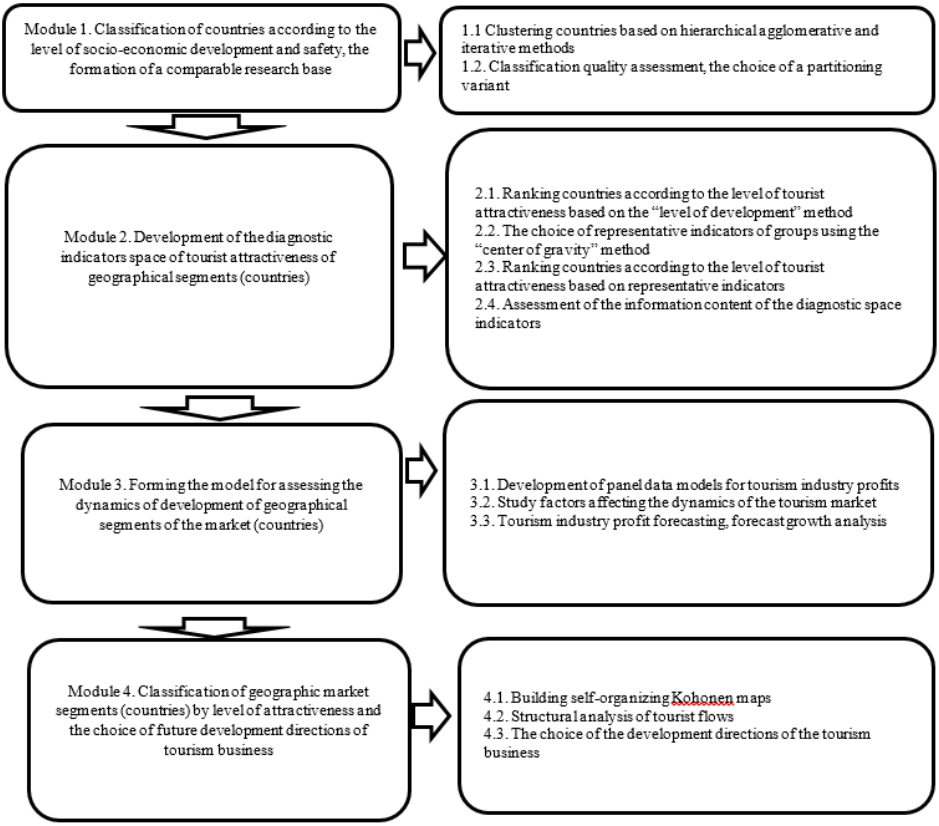


Figure 1. *Module interconnection scheme*
Source: *made by authors*

The "center of gravity" method makes it possible to obtain a system of diagnostic indicators with the following properties: final indicators are closely correlated with the indicators of the group and carry the information loading inherent to the group of indicators; and final indicators do not correlate with each other, so duplication of information is excluded. The formation of the diagnostic indicators system includes data standardization; distance matrix calculation; and representative indicator selection. A more detailed description of the method is given in Guryanova (2013).

The aim of the third module is to assess the dynamics of the development of geographical segments of the market (countries). To build the model, a panel data technique is used. The following panel data models were considered: a conventional panel data model; a fixed effect model; and a model with a random effect with and without lag variables. To evaluate the parameters of the models, the intra-group transformation and the two-step FGLS procedure were used. A more

detailed description of the algorithm for constructing and choosing a model specification is given in Guryanova (2013).

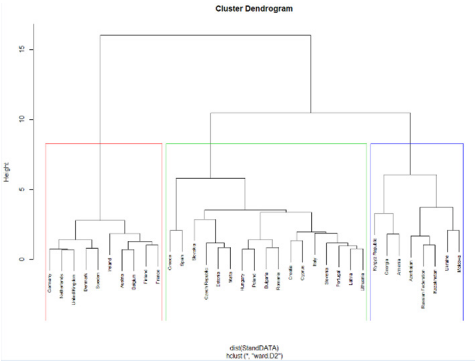
The aim of the fourth module is to classify geographical segments of the market (countries) according to the level of attractiveness and choose the development direction of the tourism business. The classification uses both actual and predicted data series of the dynamics of the development of the tourism market, obtained on the basis of panel data models. To construct the classification, Kohonen self-organizing maps are used – the appropriate algorithm is given in more detail in Kononova (2012).

The implementation of the proposed methodological approach was carried out on the data of 35 macro-regions according to indicators of socio-economic development, tourist attractiveness, and the dynamics of the tourism industry. The information base of the research was generated from the following sources: World Bank (http://data.worldbank.org), World Economic Forum (http://reports.weforum.org/), Global Innovation Index (https://www.globalinnovationindex.org/), United Nations Development Program (http://hdr.undp.org/en/content/human-development-index-hdi), ICT Development Index (https://www.itu.int/net4/ITU-D/idi/), Index of Economic Freedom (https://www.heritage.org/index/explore?view=by-region-country-year), and World Travel & Tourism Council (https://www.wttc.org/).

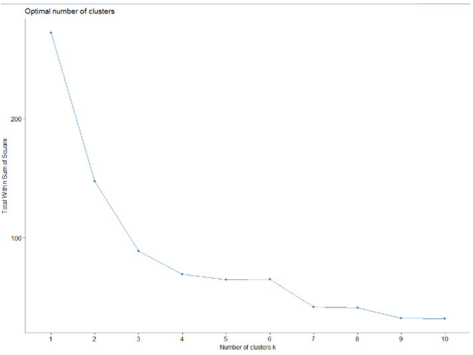
Data processing was carried out using Statistica, R, Deductor Studio, and EViews.

4. Results and discussion

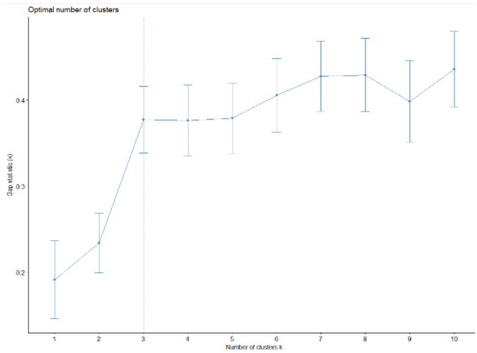
In the first module of the study (see Figure 1), countries were grouped according to the level of socio-economic development and safety. The information base for building a grouping, as mentioned earlier, consists of such indicators of socio-economic development and safety as GDP, consumption, unemployment, inflation, global competitiveness index, etc. The data set describes 35 countries, including EU countries and post-Soviet countries. The results of clustering based on the hierarchical agglomerative Ward method are shown in Figure 2a. The dendrogram indicates that the initial set should be divided into three clusters. To justify the number of clusters into which it is necessary to divide the initial population, the "scree" method, the GAP method, and the method based on the NbClust function (Figures 2b–d) were also used.



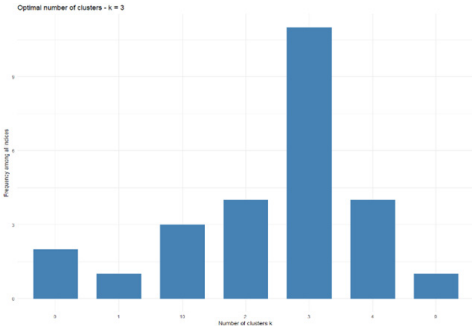
a) Classification dendrogram (Ward method)



b) Schedule of "scree"



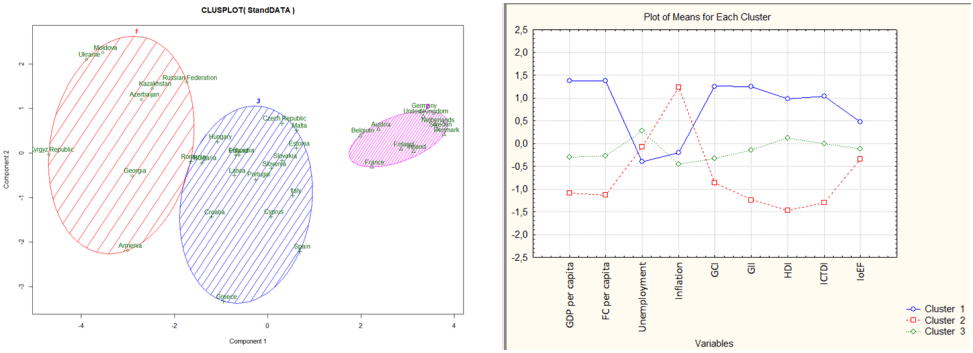
c) GAP method results



d) NbClust function results

Figure 2. *The rationale for the number of clusters*
Source: *made by authors*

The obtained optimal number of clusters was used for clustering countries using the "*k*-means" method (the results are presented in Figure 3).



a) Cluster composition *b) Plot of means for each cluster*

Figure 3. *Classification results based on the k-means method*

Source: *made by authors*

As can be seen from Figure 3, the first cluster was formed by countries with a high level of socio-economic development. They are characterized by high values of per capita GDP, consumption, global competitiveness index, global innovation index, and human development index. Moreover, the inflation level and unemployment level are the lowest here. This group of countries includes Austria, Belgium, Finland, France, Germany, Ireland, the Netherlands, Sweden, and the United Kingdom. This group is characterized by a developed infrastructure, a high level of safety, and political stability. At the same time, this cluster demonstrates the highest levels of competition and has barriers to entry into the market. The second group includes countries with low levels of socio-economic development. This group includes Russia, Moldova, Kyrgyzstan, Kazakhstan, Georgia, Azerbaijan and Armenia. Ukraine belongs to this cluster, too. Low living standards, low infrastructure development, and an unstable political situation are all factors which negatively affect the development of the tourism industry. In particular, the negative influence of the political factor can be easily seen in Ukraine in 2015, when the flow of tourists decreased by 17% due to political events in 2014 (State Statistics Service of Ukraine, 2019). The third cluster includes countries with medium levels of socio-economic development and competitiveness. These countries are characterized by medium per capita income, medium consumption, and low inflation. This cluster is the most attractive for travel companies in terms of the formation of new tourism products. The latter is explained by the fact that the favorable state of the business environment in these countries is combined with acceptable entry barriers. This group includes Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Italy, Latvia, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, and Spain.

The second module of the study (see Figure 1) was aimed at ranking the countries of the third cluster and Ukraine by the level of attractiveness of the tourism industry.

The World Travel & Tourism Council data were considered as initial data. The study included such groups of factors as: natural and cultural; political and institutional; socio-demographic; material and technical; and financial and economic. Since the indicators are multidirectional and difficult to interpret, the integral indicator of tourism attractiveness was calculated according to

the "level of development" method. The results are shown in Table 1.

As can be seen from the Table 1, such countries as Spain, Portugal, Greece, Estonia and the Czech Republic have the highest levels of tourism industry competitiveness according to all selected criteria (natural and cultural; political-institutional; socio-demographic; logistical; and financial and economic factors). At the same time, a low level of attractiveness is typical for Ukraine and Romania.

To select factors that have a dominant influence on the development of different groups of factors – such as natural and cultural, political and institutional, socio-demographic, material and technical, and financial and economic – the "center of gravity" method was used. The results of this analysis are provided in Table 2.

Table 1. *Distances to the reference point and the integral indicator of tourism attractiveness*

Country	Euclidean distance (C_{i0})	Integral indicator of tourism attractiveness (d_i^*)	Country	Euclidean distance (C_{i0})	Integral indicator of tourism attractiveness (d_i^*)
Ukraine	12.09	0.12	Malta	6.68	0.38
Bulgaria	7.64	0.29	Poland	8.08	0.25
Croatia	7.86	0.27	Portugal	4.92	0.55
Cyprus	8.10	0.25	Romania	9.64	0.11
Czech	6.47	0.40	Slovakia	7.89	0.27
Estonia	5.89	0.46	Slovenia	7.68	0.29
Greece	6.53	0.40	Spain	4.18	0.61
Hungary	7.85	0.27	Italy	7.22	0.33
Latvia	7.15	0.34			

Source: *made by authors*

The selected representative indicators were used to build a complex assessment of the level of attractiveness of the tourism industry. The value of the correlation coefficient between integral indicators found on the basis of a complete and truncated system of indicators is 0.85, which indicates the presence of a strong connection. This allowed us to conclude that the formed system of diagnostic indicators is rather informative and can be used for further analysis. The above approach makes it possible to reduce the dimension of the information space of indicators and conduct a comprehensive analysis of the level of attractiveness of the tourism industry in conditions of low information availability of indicators without losing information significant for decision-making, since the values of integral indicators on both the original and reduced systems give identical ranking results.

Table 2. *List of representative indicators found on the basis of the "center of gravity" method*

Group	Representative indicator	Symbol
Natural and cultural	Natural resources	**X1**
Political and institutional	Prioritization of the tourism industry	**X4**
Socio-demographic	Human resources and employment	**X8**
Material and technical	Marine and land infrastructure	**X9**
Financial and economic	Business environment level of development	**X15**

Source: *made by authors*

In the third module (see Figure 1), a model is built that allows the dependence between tourism industry profits (Y) and exogenous factors (X1, X4, X8, X9, and X15) to be studied. The following options for the panel data model were considered: the regular model; the fixed model; and the random effect model with and without lag variables. Among all possible specifications of the model according to the quality criteria, the model with a fixed effect was selected, taking into account lag variables:

$$Y_{i,t} = c_i + 18590.2 + 830.7 \cdot X1_{i,t-1} - 1406.3 \cdot X9_{i,t-1} - 1333.5 \cdot X15_{i,t-1} + \varepsilon_{it}, \quad (1)$$

c_i – i-th country fixed effect.

The values of the Student's criterion (t_{a0}=16.31; t_{a1}=4.91; t_{a2}=-7.04; t_{a2}=-26.31) allow us to conclude that the model parameters are statistically significant with a 99% confidence level. The values of the coefficient of determination, Fisher's criterion, and Durbin-Watson statistics (R^2=0.99; F=5231.08; DW=1,78) indicate the statistical significance and adequacy of the model as a whole.

It should be noted that the panel data model was developed with and without lag effects. The values of the Student's criterion showed the presence of a lag in the influence of such factors as natural resources, the level of development of the business environment, etc., on the profit dynamics of the tourism industry. The version of the model without taking into account lag involves the development of local forecasts of the factor variables X1, X9, and X15 for 17 countries of the 3rd cluster, i.e., the development of the 51 local forecasts to find the predicted value of tourism industry profit (Y). Accounting for lag variables allows us to reduce the dimension of the forecasting problem. Model (1) was characterized by a higher approximation accuracy (m.a.p.e. = 6.19%) compared to the model without lag variables (m.a.p.e. = 6.87%). The predicted profit values found on the basis of the model (1) are given in Table 3.

Table 3. *Forecasts of tourism industry profits based on panel data model*

Country	Tourism industry profits forecast, millions of UAH	Growth rate	Country	Tourism industry profits forecast, millions of UAH	Growth rate
Ukraine	2532.86	0.63	Latvia	1377.24	1.07
Bulgaria	3594.30	0.94	Malta	2389.69	1.07
Croatia	9849.24	1.01	Poland	10191.34	0.93
Cyprus	4386.43	0.99	Portugal	17820.13	1.03
Czech	6789.13	0.94	Romania	1829.60	0.97
Estonia	1707.29	0.96	Slovakia	2453.76	1.01
Greece	17640.09	1.00	Slovenia	3105.97	0.99
Hungary	7421.21	1.05	Spain	58954.62	0.98

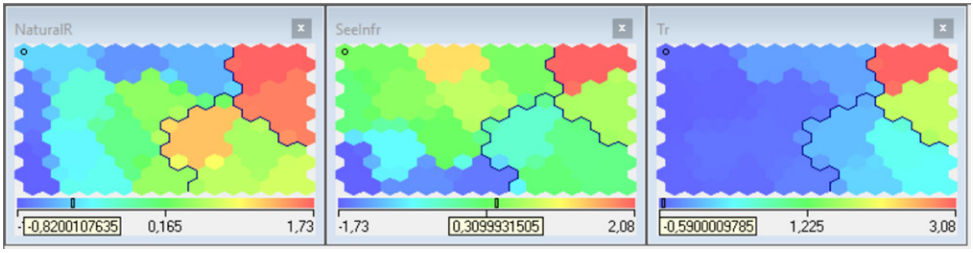
Source: *made by authors*

The chain rate of profit growth, found on the basis of a comparison of forecast data (Table 3) and actual data, made it possible to identify geographical segments with increasing demand (where growth rate exceeds 5%) and stable demand. According to the forecast, the positive dynamics of the development of the tourism industry are typical for Latvia, Malta and Hungary. Sustainable development is observed in Croatia, Greece, Portugal and Slovakia. The rest of the countries are characterized by damping dynamics.

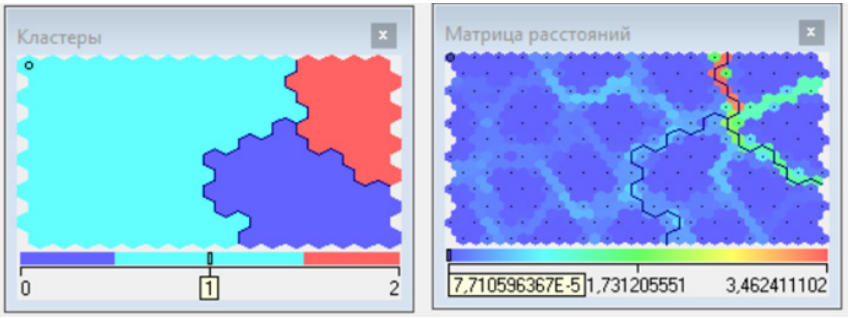
In the fourth module (see Figure 1), a classification of geographical segments of the market (countries) by level of attractiveness was implemented. As model input, we used the predicted profit values (Table 3) and the values of representative indicators X1, X4, X8, X9, and X15 (Table 2), reflecting the influence of natural-cultural, political-institutional, socio-demographic, material-technical, financial, and economic factors. The model allows one to choose the direction of the development of the tourism business. Self-organizing Kohonen maps were used as mathematical research tools; the classification results are shown in Figure 4.

According to the clustering results (see Figure 4), the cluster with code "2" (red color on Figure 4b) was formed by such countries as Italy and Spain. They are characterized by high values of the "Natural Resources" and "Level of Infrastructure Development" factors (Figure 4a). This cluster is attractive enough for investment, as for the countries there are fairly stable trends in the development of the tourism business.

The cluster with code "0" (blue color on Figure 4b) includes Croatia, Greece, Portugal, and Poland. These countries have a fairly developed infrastructure and a favorable business environment for the development of the tourism sector. In addition, the "Natural Resources" factor also shows significant potential and opportunities for further development (Figure 4a).



a) Initial data maps



b) Distance matrix and clusters

	Country	NaturalR	SeeInfr	Tr	Номер ячейки	Расстояние до центра ячейки	Номер кластера	Расстояние до центра кластера
▶	Україна	-1,4	-1,73	-0,6	160	5,381711443084 62E-13	1	0,521943873238003
	Болгарія	0,44	-1,59	-0,45	182	1,960915702771 81E-14	1	0,497461197332355
	Кіпр	-0,65	-0,79	-0,53	97	1,568463525945 85E-13	1	0,187752417929493
	Чехія	-1,15	1,32	-0,27	9	1,065111534946 45E-13	1	0,483555750501468
	Естонія	-0,82	0,31	-0,59	34	5,443641054740 22E-12	1	0,171767678976043
	Угорщина	-0,99	0,31	-0,24	6	1,332162298759 34E-13	1	0,320144195246759
	Латвія	-1,26	0,03	-0,63	0	1,640771301835 28E-11	1	0,273938780551148
	Мальта	-0,43	0,43	-0,61	68	9,110498092826 43E-12	1	0,180191759507812
	Румунія	-0,54	-1,46	-0,57	179	2,698646573782 22E-13	1	0,362912589121659

c) Composition of clusters (fragment

Figure 4. *Kohonen network classification results*
Source: *made by authors*

The classification results were compared with the rating of the top 10 countries (UN World Tourism Organization, https://www.unwto.org/) in terms of the number of foreign tourists (Table 4).

As can be seen from Table 4, countries from the 1st and 2nd clusters (the highest level of tourism business attractiveness) are situated within the mentioned rating (they account for more than 90% of the flow of foreign tourists). The exception is Portugal, which is situated in the cluster with a high level of attractiveness, but is not present in the rating. This allows us to make a conclusion about the priority and prospects of this segment for the development of the tourism services market.

Table 4. *Rating of the top 10 European countries by the number of foreign tourists*

Country	The number of foreign tourists, million people	Share of tourists,%	Cluster according to the level of tourist attractiveness
France	82,570	20.38%	not included in the sample
Spain	73,315	18.09%	Cluster with code "2" (Figure 4b) – very high attractiveness level
Italy	52,372	12.92%	Cluster with code "2" (Figure 4b) – very high attractiveness level
Great Britain	35,814	8.84%	not included in the sample
Germany	35,555	8.77%	not included in the sample
Austria	28,121	6.94%	not included in the sample
Greece	24,799	6.12%	Cluster with code "0" (Figure 4b) – high attractiveness level
Poland	17,471	4.31%	Cluster with code "0" (Figure 4b) – high attractiveness level
Croatia	13,809	3.41%	Cluster with code "0" (Figure 4b) – high attractiveness level
Denmark	13,333	3.29%	not included in the sample

Source: *made by authors*

5. Conclusions

Thus, the studies conducted in this work allow us to draw the following conclusions.

A methodical approach to the selection of attractive development directions of tourism businesses based on the application of machine learning methods has been developed. This approach is based on: the methods of cluster analysis; reduction of the indicator space dimension methods; the panel data technique; and Kohonen neural network models (Figure 1). The approach allows one to improve the quality of management decisions regarding the choice of investment direction when creating a new product and developing a tourism business.

The results obtained during the practical implementation of the methodological approach are listed below. A classification of countries according to the level of socio-economic development and safety has been developed (Figures 2–3); a diagnostic indicator space for the touristic attractiveness of geographical segments (countries) has been formed (Tables 1–2); a model for assessing the dynamics of development of geographical segments of the market (countries) has been developed (Table 3); and models for classifying geographical segments of the market (countries) according to the level of attractiveness (Figure 4) have been developed.

The results showed that the most attractive geographical segments of the market for the development of tourism businesses are such countries as Italy, Spain, Croatia, Greece, Portugal, and Poland. These countries have high levels of safety, medium costs, low market entry barriers (Figure 3), steady growth rates of the tourism industry (Table 3), favorable business environments, attractive natural resources, and developed infrastructure (Figure 4).

It should also be noted that a comparison of the dynamics of tourist flows with the obtained distribution of countries according to tourist attractiveness (Table 4) allows us to distinguish such a geographical segment of the market as Portugal, which is characterized by a high level of tourist attractiveness, but low actual intensity of tourist flow.

The application of the obtained results in travel agencies' activities will improve the quality of management decisions regarding the choice of development directions of tourism businesses.

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APPLYING SOCIAL MEDIA IN THE HOTEL SECTOR: SATISFACTION WITH THE FACEBOOK PAGES OF HOTELS AND INTENTION OF FUTURE VISIT

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Abstract. *This study is carried out with the main objective of analyzing the determining factors for the gratification of Facebook users when accessing a hotel's Facebook page and verifying the relationship between satisfaction with the Facebook page and the intention to visit a hotel. This study surveyed 404 Facebook users in Vietnam. The methods of exploratory factor analysis, confirmatory factor analysis, and structural equation modeling are used to process the data. The results conclude that the factors affecting satisfaction with hotels' Facebook pages are information, convenience, and social interaction; in addition, satisfaction with these Facebook pages has a positive effect on the intention to visit a hotel. This study contributes to hotels by helping them to understand the expectations of customers on their Facebook pages. From there, suggestions as to how to take measures to improve their presence on Facebook and enhance their competitiveness on the virtual platform are provided.*

Keywords: *Facebook, hotel, satisfaction, stimulus organism response theory, uses and gratifications theory*

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JEL Codes: *L82, L86, Z33*

1. Introduction

In recent decades, the development of tourism and the hotel industry has witnessed information technology's great contribution (Collins et al., 2013). With the surprising advantages of speed and software, more and more people are tending to use the internet as a purchase channel (Connolly & Olsen, 2000). The internet has become a foundation of social media, where people do not only use it to market online but also to create their content (Balakrishnan et al., 2014) and interact with others. As a result, the major form of direct sharing has changed from face-to-face meeting to technology-based meeting. This has significantly contributed in the hospitality industry because of its dependence on intermediates such as travel agencies for introducing and selling products (Amaro & Duarte, 2015). In fact, reservations via travel agencies can lead to increased prices due to commissions compared to direct booking at hotels. Based on social media, hotels can create their own pages, such as a Facebook page, for the purposes of providing information about their room systems, prices, promotion policies, as well as online booking (Connolly & Olsen, 2000). With respect to customers, they can seek information about rooms, compare prices, and partly assess the quality of a hotel via reviews and interactions with others on the hotel's social media platforms without contacting travel agencies before deciding on their reservations. Therefore, using social media to dispense information has been seen as a competitive tool in the hospitality industry (Pemsteiner & Rauseo, 2000; Van Hoof et al., 1999). Among social media platforms, Facebook is well known as the vital social media form. The widely popular phenomenon of Facebook use has also been seen in the hotel industry (Leung & Baloglu, 2015)including the determinants, the process and the consequences of hotel Facebook marketing, as Facebook – the most popular social media platform – has become an important marketing tool for hotels. Design/methodology/approach The study proposed an integrated model consisting of antecedents and consequences of Facebook marketing based on both marketing and social psychology theories. A pseudo hotel Facebook page was created and an online survey was conducted to collect data. Structural equation modeling (SEM.

The result of Connor's 2011 research indicated that most international hotels have created their own Facebook page (Connor, 2011). Facebook is seen as a brand-building tool by many companies, as well as an effective way to improve support from customers by enhancing their emotions (Smith, 2013). Haigh et al. (2013) showed that interaction on a Facebook page brings positive perceptions about a company to customers, and attitudes towards a hotel's Facebook page are seen as elements motivating the booking intentions of customers, as well as word of mouth on Facebook (Leung & Baloglu, 2015). For hotels, effective engagement on Facebook increases their competitiveness, reputation, and sales by targeting the right customers and optimizing marketing resources (Wang & Kubickova, 2017). With the prevalence and competitive role of Facebook, it is vital for both researchers and hotel managers to comprehend the factors that increase the gratification of Facebook users when accessing hotels' Facebook pages. As a result, hotel managers can enhance their Facebook page management abilities.

In Vietnam, customers are today adequately facilitated in their purchase decision through various social media platforms, especially Facebook. According to the data of one survey, Facebook was voted the most used and loved social network: 97% of internet users use Facebook with

a full profile, and 94% are daily users (Q&Me Vietnam Market Research, 2020). According to the same statistics, the average adult spends at least 3 hours per day on social networks, and most people have made at least one purchase through Facebook (Q&Me Vietnam Market Research, 2020). Consequently, hotels must adapt to the new changes that occur in the Vietnamese market to reach customers and conduct business.

However, research has shown that limited knowledge of Facebook is prevalent in significant numbers of hoteliers (Leung & Baloglu, 2015). In terms of the hospitality context, researchers have concentrated on: hotel website quality to customer satisfaction, leading to intention to purchase (Ali, 2016; Kim et al., 2006); the influence of Facebook on intention to purchase (Duffett, 2015); and Facebook page content (Cervellon & Galipienzo, 2015). Very few researchers have assessed the motivation of customers to access hotel Facebook pages, except for Choi et al. (2016) and Leung and Baloglu (2015). Therefore, this research was conducted to contribute to a better understanding regarding this subject. To achieve this goal, this research used both the Mehrabian–Russell environmental psychology model (S-O-R theory) and Uses and Gratifications (U&G) theory to explain and provide the factors impacting customer satisfaction regarding a hotel's Facebook page and, in turn, how this influences hotel visit intention. Through the findings of the study, some significant recommendations for hotel managers are provided.

2. Literature review

2.1. Facebook and the hotel industry

There is no doubt that interaction between guests and companies has changed for the better thanks to the evolution of information technology (Hanna et al., 2011). In the era of WEB 1.0, communication was almost one-way, because stakeholders could only access a large amount of content through reading, listening, and viewing, and could not interact. Meanwhile, WEB 2.0 technology, with the emergence of social networks, has led to the sharing, cooperation, consumption, and communication of information (Aral et al., 2013). This form of media is based on a group of online tools which aim to enhance the way people interact with each other and facilitate the exchange of knowledge, especially when moving from a monologue (from the company to the clients) to a conversational form (Hansen et al., 2010). In the modern world, the use of social networks is more popular than ever (Statista, 2018), especially for tourism in general and the hotel industry in particular. For this reason, the hotel industry is considered to be strongly influenced by the appearance of this form of media (Sheldon, 1997; Werthner & Klein, 1999).

Facebook is widely used throughout the tourism industry (Leung et al., 2013), especially in the hotel sector (Albayrak et al., 2021; Cervellon & Galipienzo, 2015). Previous research has shown that using Facebook provides users with 3 forms of experience, including: a cognitive experience, a sensory experience, and an emotional experience (Smith, 2013). Therefore, this platform plays an important role in affecting consumer decisions at all phases of purchase. Facebook positively affects the needs recognition, information search, actual purchase, and post-purchase evaluation phases of the hotel selection decision-making process (Abuhashesh et al., 2019). These experiences are supposed to drive user behavior, such as by leaving comments on a page or sharing with others (Oracle, 2012). In the hospitality industry, emotional experiences can come from customer-hotel interactions through positive comments and Facebook chats, which

drive purchase intention and increase customer loyalty to the hotel (Kasavana et al., 2010). The sensory experience is expressed through the information, images, and videos provided by the hotel, and a lack of information on a Facebook page is also considered to be the main reason why guests do not return to a hotel's Facebook page. In the survey by Cervellon and Galipienzo (2015), it was shown that for young clients, the attitude towards the Facebook page is the decisive factor in choosing whether to stay at a hotel or follow the hotel's Facebook page (Oracle, 2012). Moreover, Facebook can be used as a communication tool between customers to share experience, knowledge, and opinions about products or services (Yoo & Lee, 2017), and such shared information can affect the decision of customers to choose a certain hotel (Zhang et al., 2017). Furthermore, the customer's relationship with the products and services does not end after purchase. Customers reassess their beliefs, opinions, and attitudes from the first opinion they formed at the beginning of the hotel accommodation selection process, and this sustains business growth (Brassington & Pettitt, 2007). Dissatisfied customers can spread their negative experiences and comments about products or services in many different ways on Facebook, which can influence other potential customers (Sweeney & Craig, 2010). Therefore, hotel managers need to satisfy customers and meet their expectations.

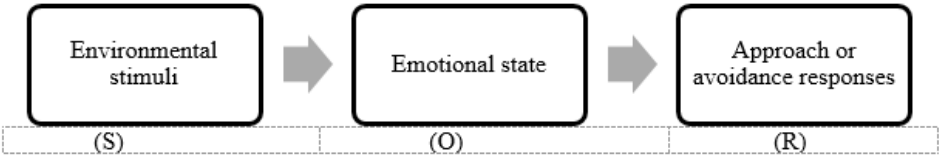
Moreover, Facebook can be used as a communication tool between customers to share experience, knowledge, and opinions about products or services (Yoo & Lee, 2017), and such shared information can affect the decision of customers to choose a certain hotel (Zhang et al., 2017). Furthermore, the customer's relationship with the products and services does not end after purchase. Customers reassess their beliefs, opinions, and attitudes from the first opinion they formed at the beginning of the hotel accommodation selection process, and this sustains business growth (Brassington & Pettitt, 2007). Dissatisfied customers can spread their negative experiences and comments about products or services in many different ways on Facebook, which can influence other potential customers (Sweeney & Craig, 2010). Therefore, hotel managers need to satisfy customers and meet their expectations.

In addition, many hotels use social networks for recruitment by posting job offers on social media, communicating with partners, or reporting hotel news (García et al., 2017). Consequently, many hotels began to pay their attention to creating their own Facebook pages. Facebook provides information, images, videos about hotels and room systems, as well as available services for clients. Using Facebook helps hotels to promote customer interaction and to improve their business affairs. When customers press the "like" button on a Facebook page owned by a hotel, these users can access an updated page and interact with other users and hotels on Facebook. In order to attract visitors and users towards clicking the Facebook page of a hotel, hotels often provide information about promotions on their Facebook pages (Syed-Ahmad & Murphy, 2010). Although Facebook is the social networking site with the largest number of consumers, to date there is still little research on the details of Facebook's context, especially in the tourism and hospitality sectors. These few studies have only evaluated the impact of Facebook on the creation of oral advertising (Minazzi & Lagrosen, 2013; Sanz-Blas et al., 2017; Cervellon & Galipienzo, 2015). Very few studies have analyzed the motivation of customers to visit hotels' Facebook pages, or how satisfaction on a hotel's Facebook page affects the customer's intention to visit. Therefore, this study is conducted to assess the theoretical basis of – and to provide hotel managers with recommendations regarding – the reasons why customers visit a hotel's Facebook page and

the aspects that affect customer satisfaction on Facebook.

2.2. The Mehrabian–Russell environmental psychology model, 1974 (the S-O-R theory)

Mehrabian and Russell (1974) introduced the theoretical framework for the environmental psychology model in 1974. The theoretical framework proposes that environmental stimuli (S) affect the user's emotions (O); from there, this shapes their intentions or behavior (Mehrabian & Russell, 1974). Many past studies in the context of the retail domain have studied and applied this framework (Ong et al., 2012), in which stimulating factors include social factors, design factors, and the environment. Furthermore, this analytical framework is also believed to be important in predicting online customer behavior (Hsu et al., 2012; Kawaf & Tagg, 2012; Manganari et al., 2011). The results of the research by Chang and Chen (2008) showed that the quality and brand of the website impact significantly on the trust and risk perception of customers, which affects the purchase intentions of customers.



In the tourism sector, this model has been used to evaluate the websites of hotels and travel agencies with respect to satisfaction and reservation intention (Gao & Bai, 2014; Ali, 2016). Consequently, the study by Ali (2016) shows that factors such as usable and private aspects of a hotel website or safety and basic function of hotel website act as stimulants of customer perception. This perception affects satisfaction with the hotel's website, leading to the intention to use the hotel's services and website (Ranganathan, 2012). Based on S-O-R theory and the results of many previous studies, it can be confirmed that elements of the website or social network presence work as stimuli in the framework of S-O-R, affecting the satisfaction of customers and thus impacting their purchase intention.

2.3. Uses and Gratifications theory

U&G theory was introduced with the aim of explaining how people actively use communication media to satisfy their specific needs (McCay-Peet & Quan-Haase, 2016). In other words, U&G theory is like an instrument that determines the core factors of the motives for the selection and use of the means (Papacharissi, 2002). This theory has been widely applied to all types of media, from traditional media such as radio, television, or newspaper, to new media (Choi et al., 2016).

New media requires a higher level of interactivity from its users compared to other traditional media (Ruggiero, 2000). Therefore, the rapid development of these media has prompted the application of U&G theory to explain people's behavior with the use of media.

According to the results of many investigations into psychological and behavioral aspects

of internet users to identify motivations for internet use, U&G theory has been effective in understanding the motivations and needs for using the internet, including using social networks (Ko et al., 2005; Larose et al., 2001). The adaptability of U&G theory when studying the use of social networks has been realized, and many results have confirmed that this theory is relevant to explain the use of social networks (Park et al., 2009; Quan-Haase & Young, 2010).

2.4. Gratification factors for Facebook

This study proposes five factors, synthesized from previous studies, to evaluate the satisfaction of visitors to a Facebook page created by a hotel: information, convenience, entertainment, self-expression, and social interaction.

a) Information

Information satisfaction refers to the various levels of useful information provided by a website (Chen & Wells, 1999; Luo, 2002). In the consumer purchasing decision process, finding information about products and services is an essential step (Liang & Lai, 2002). The search for information on online websites is increasing, especially for the tourism and hospitality sectors (Gregory & Breiter, 2001). The reason that explains this trend is that because tourism products are intangible, diverse, and dependent, to reduce the risk of using a lodging service or travel experience, consumers want to browse and compare reviews from travel experiences that are widely available on online social networking sites (O'Connor & Frew, 2002). In the study about business strategies in the hotel industry by Jeong et al. (2001), a dramatic growth in the number of online reservations was witnessed when increasing customer satisfaction with online information. Among the online platforms used by the hotel industry, Facebook is considered the most popular form of social media (Statista, 2017). Users use hotel Facebook pages to seek room data as well as reviews from other guests (Mccarthy et al., 2010). These experiences influence customers' attitudes about the hotel's Facebook page, which in turn leads to hotel booking intentions, or even word of mouth advertising (Leung & Baloglu, 2015).

Therefore, the study proposes the following hypothesis:

H1: Information satisfaction has a positive impact on customer satisfaction with the hotel's Facebook page.

b) Convenience

Finding online information through a social network has be a wide trend in the travel and accommodation industry (Jang, 2004; Seiders et al., 2000). This trend has motivated companies to develop marketing policies on social networking sites. Facebook is regarded as one of the most useful marketing channels in the hotel industry (Friebe & Campbell, 2010). This leads hotel companies to pay increased attention to the quality of their Facebook pages, in order to provide customer satisfaction when accessing Facebook. Based on the similarities of Facebook to the hotel's website and social media, Choi et al. (2016) studied the impact of convenience in the context of a Facebook page. Their results show that the convenience factor of the Facebook page plays a considerable role in enhancing online customer satisfaction with the Facebook page of hotel.

Therefore, the study proposes the following hypothesis:

H2: Convenience satisfaction has a positive impact on customer satisfaction with the hotel's Facebook page.

c) Entertainment

Entertainment represents how exciting, cool, and imaginative a site is (Chen & Wells, 1999). Therefore, entertainment satisfaction refers to the level to which a user rates the use of the media or the website as fun and entertaining (Eighmey & McCord, 1998). Users spend their time for the purposes of relaxing through interaction with social media. Therefore, when social media entertainment satisfies user demands for such purposes as enjoyment, relaxation, and excitement (Papacharissi & Rubin, 2000), these positive emotions will efficiently impact on user satisfaction with that media. The entertainment aspect can be perceived through hedonic aspects including color, music, images, graphics, videos, and reaction (Davis et al., 2008). For the tourism sector specifically, Facebook users can entertain themselves by browsing their friends' pages, viewing photos and videos, reading news on Facebook (Special & Li-Barber, 2012), and promoting positive entertainment on Facebook, thus estimating user satisfaction with the Facebook page (Basak & Calisir, 2015).

Therefore, the study proposes the following hypothesis:

H3: Satisfaction with entertainment has a positive impact on customer satisfaction with the hotel's Facebook page.

d) Self-expression

Self-expression denotes the levels to which the individual attempts to manage the impressions that they make on other's thought (Berry & Howe, 2004; Kang & Park-Poaps, 2011). One feature that makes Facebook unique is that users can update their information and images to create a profile for themselves. Facebook is a tool to help people express themselves to other users (Bumgarner, 2007). According to Sheikh and Dhaha (2013), individuals provide information on Facebook to create an image of themselves, and it is believed that this motivation is related to users' satisfaction with Facebook (Special & Li-Barber, 2012). This result is supported by the study of Seidman (2013) and Valentine (2011), which suggests that the motive of self-expression has an effective impact on the use of Facebook. A study on hotel Facebook page satisfaction conducted by Choi et al. (2016) also confirmed that self-expression when sharing customer feelings and opinions about a hotel makes users feel satisfied about the hotel's Facebook page (Kang & Park-Poaps, 2011).

Therefore, the study proposes the following hypothesis:

H4: Self-expression satisfaction has a positive impact on customer satisfaction with the hotel's Facebook page.

e) Social interaction

Social interaction refers to the motivation of an individual to receive communication or interaction with other individuals (Whiting & Williams, 2013). Papacharissi and Rubin (2000) expanded this concept to include the level of connection, communication, and showing users with other users based on the website platform or social networking site (Berry & Howe, 2004). Social networking sites provide forms of interaction for visitors with similar interests to know about, interact with, and exchange information about products, services, and brands (Muntinga et al., 2011). In the hotel industry, customers interact with each other on social media to share good or bad experiences during their stay at a hotel (Lian & Yoong, 2019), which could provide the results of their emotional experience, impacting on satisfaction and intention to book a hotel (Kasavana et al., 2010; Sanz-Blas et al., 2017).

Therefore, the study proposes the following hypothesis:

H5: Social interaction satisfaction has a positive impact on customer satisfaction with the hotel's Facebook page

2.5. Consumer satisfaction, intention of hotel visit, and the proposed model

Satisfaction is considered to be the key factor for a customer's positive intentions and behaviors, including: revisit; purchase intention; repurchase intention; and long-term loyalty (Kang & Park-Poaps, 2011; Su & Huang, 2018). In the online context, when shoppers are satisfied with the website, they have an increased probability of buying online (Anderson & Srinivasan, 2003; Wang et al., 2015). The purchasing intention is known as the ability of a guest to buy a specific product or service (Dodds et al., 1991); applied to the hotel sector, this is the intention to visit or reserve a hotel room (Kang & Park-Poaps, 2011). In their research on customer e-satisfaction in 12 hotels in Beijing, Kim et al. (2006) showed a favorable link between satisfaction and the intention to book a room online at a hotel. Choi et al. (2016) supported this finding, adding that customers with a high satisfaction towards a hotel's page on Facebook tend to visit that hotel in the future.

Therefore, the study proposes the following hypothesis:

H6: Satisfaction with a hotel's Facebook page has a positive impact on the intention to visit the hotel.

The study proposes the following model:

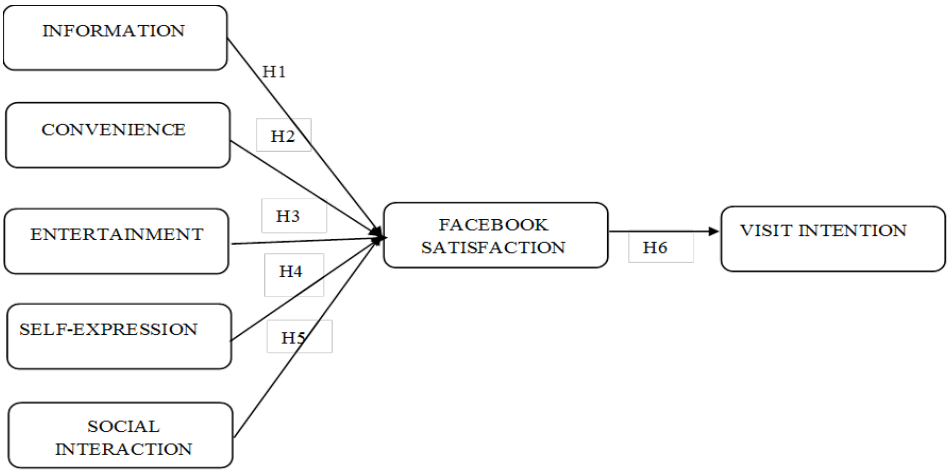


Figure 1. *Proposed model*

3. Methodology

3.1. Study context: Facebook applied the hotel sector in Vietnam

Within the framework of the development of tourism worldwide, tourism in Vietnam has shown outstanding growth. According to a report from the Vietnam Tourism Organization, the

hotel industry is taking advantage of this and developing rapidly. The tourist service has witnessed a significant improvement in quality. By 2019, the country had 30,000 tourist accommodation establishments with 650,000 rooms, including 171 hotels of 5-star and 295 hotels of 4-star quality (Giang, 2020), resulting in tough competition in the Vietnamese hospitality industry. To make a difference and improve competitiveness, each hotel is constantly looking for and improving factors in business activity. In particular, the application of information technology is an important factor in contributing to the success of the business, in which Facebook has emerged as a potential marketing tool because of its huge number of users. In fact, at least 269 hotels, from three- to five-star, have a presence on Facebook in Vietnam.[1] However, in Vietnam, there have been very few studies related to the topic of social media, in particular Facebook, in the hotel sector. Therefore, this empirical study was conducted in Vietnam to provide practical implications alongside a contribution via theoretical implications.

3.2. Research instruments

a) Design of the questionnaire

A 25-question questionnaire was developed that included 21 variables of 7 factors and 4 elements of demographic information. Most of the items employed in this study, except for 4 items related to demographic information, were assessed by five-point Likert scales, which range from *strongly disagree* (1) to *strongly agree* (5).

b) Sample

The sample size depends on the requirements of the research based on the data collected and the relationship proposed by the study (Totawar & Prasad, 2016). However, in truth, sampling also depends on the time and financial capacity of the researcher. Researchers have proposed sampling from many different points of view. According to Bollen (1986), a reasonable size is a sample with 5 respondents per 1 observed variable, and preferably 10 respondents per 1 observed variable. This study implemented sampling from this point of view, so the ideal sample size in this study had to be greater than 250 for a total of 25 observed variables. The total number of valid questionnaires was 404. Therefore, the final sample size was sufficient for obtaining stable results within the structural equation model, which has statistical testing power.

An online survey was conducted to collect information from respondents who were Facebook users and who knew about hotels' Facebook pages. The questionnaire was created on Google Docs and was then shared via Facebook from May 6 to August 6, 2020. A total of 421 responses were collected, with 17 containing insufficient information and 404 providing complete information. The data are shown in Table 1.

[1] Before testing the research hypotheses, a study was used to establish the presence of Vietnamese hotels on Facebook. Based on the registry of the Vietnam Tourism Organization, a database of 891 three- to five-star hotels was found. Due to the limited investigation time, not all 891 hotels could be checked. Therefore, 269 hotels were selected. It was observed that all 269 hotels, 100% of the sample, had a presence on Facebook. To see the list of the Facebook pages of the selected hotels, visit: https://drive.google.com/file/d/1osK9YjxokcXwZdcsU2UD52FvZxh0NkeD/view?usp=sharing

Table 1. *Data characteristics*

Items		Frequency	Percentage (%)
Gender	Male	186	46.04%
	Female	218	53.96%
Age (years)	Under 18	3	0.74%
	19–25	165	40.84%
	26–40	215	53.22%
	41+	21	5.20%
Marital status	Single	218	53.96%
	Married	186	46.04%
Education level	Less than high school	10	2.46%
	High school	38	9.41%
	College/university	297	73.52%
	Post-graduate study	59	14.61%

Source: authors.

c) Analysis techniques

The study used the SPSS 18 and AMOS 24 tools. After analyzing data demographics, the collected data were summarized and condensed by exploratory factor (EFA) analysis before including the procedures of multivariate analysis. In order to test the reliability of the scales in the proposed model, the study used Cronbach's alpha reliability coefficient, while the quality of all the measurement models with Structural Equation Modeling (SEM) was examined by a Confirmatory Factor Analysis (CFA). In the final step, SEM tests were run to test the hypotheses.

4. RESULTS

Exploratory factor analysis (EFA) and Cronbach's alpha

Exploratory factor analysis was performed for all observed variables. The results of the extraction of 7 factors to Eigenvalues was 1.068, and the total variance extracted was 77.512% (>50%), showing that the EFA model is appropriate. The 7 analytical factors condensed 77.512% of the variation of the observed variables. The KMO coefficient was 0.719 (>0.5); statistical significance of the Bartlett test was established, with Sig. = 0.000 (<0.05). As the factor loading of all was greater than 0.5 (see Table 2), all were kept for the following analysis.

The analytical results of Cronbach's alpha (see Table 2) show that the scales ensured intrinsic consistency because Cronbach's alpha was greater than 0.7. Specifically, Cronbach's alpha of information (INF), convenience (CONV), entertainment (ENT), self-expression (SE), social interaction (SI), satisfaction with the Facebook page (FPS), and intention to visit the hotel (HIV) were: 0.812; 0.845; 0.887; 0.778; 0.899; 0.744; and 0.885, respectively.

Table 2: Exploratory factor analysis and Cronbach's alpha analysis

Factor	Factor loading	Eigen value	Cumulated variance explained (%)	Cronbach's alpha
SI: Social Interaction		4.458	21.229	0.899
SI1 – To find similar reviews about hotel services	0.818			
SI2 – To compare with other reviews about hotel services	0.942			
SI3 – To seek empathy with other clients about hotel services	0.946			
ENT: Entertainment		2.843	34.767	0.877
ENT1 – It is entertaining to me	0.909			
ENT2 – I enjoy surfing the hotel's Facebook page (HFP)	0.780			
ENT3 – It is fun to use	0.917			
VIH: Intention to visit the hotel		2.436	46.368	0.885
VIH1 – I hope to visit the hotel in the future	0.854			
VIH2 – Given the chance, I would like to stay at the hotel in the future	0.920			
VIH3 – Given the opportunity, I intend to stay at the hotel in the future	0.894			
CONV: Convenience		2.003	55.904	0.845
CONV1 – To get information about hotel services quickly	0.734			
CONV2 – To save time during hotel room shopping	0.906			
CONV3 – Can be accessed from anywhere	0.921			
INF: Information		1.864	64.781	0.812
INF1 – Useful information can be found	0.784			
INF2 – New knowledge can be understood from information on the HFP	0.892			
INF3 – To get information on product quality faster in comparison with other channels	0.845			
SE: Self – Expression		1.606	72.427	0.778
SE1 – To share positive hotel experience with others	0.727			

SE2 – To share negative hotel experience with others	0.810			
SE3 – To help others users to have a good hotel experience	0.815			
FBS: Facebook page satisfaction		1.068	77.512	0.744
FPS1 – Experiences obtained made me satisfied	0.845			
FPS2 – Visiting HFP was the right decision	0.821			
FPS3 – Visiting HFP made me happy	0.753			

Source: authors

4.1. Confirmatory factor analysis

Table 3 shows the test results of the convergence values of 7 full-scale models. The convergent validity of any measurement model should be supported by its item reliability, construct (composite) reliability, and average variance extracted. Standardized loading estimates of all items in this study ranged from 0.532 to 0.995, exceeding the required value of 0.5 (Bagozzi & Yi, 1988). The results show that the reliability of the observed variables (normalized weighting, SMC, t-value) satisfied the requirement of the convergence test, so that the observed variables achieved reliability. On the other hand, the research concepts were satisfactory because the combined reliability (CR) was greater than 0.7 and the average extraction variance (AVE) was greater than the recommended level of 0.5 (Table 3).

The AVE method (Fornell & Larcker, 1981) was applied to test distinction. This method shows that when the correlation between the two constructs is less than that of the AVE of both constructs, a distinction is achieved between the two. Table 4 shows that all values met the requirements of the discriminant validity test, from which the discriminant value of all relationships between scales is guaranteed.

The test results of the general scale model of the entire model through CFA showed that the model had a Chi-square statistical value of 367.6 with 168 degrees of freedom ($p = 0.00$), and a relative Chi-square in terms of degrees of freedom ($cmin/df = 2.188 < 3$). Other compliance metrics, such as GFI, IFI, CFI, NFI, and TLI, all exceeded the recommend value of 0.9; both PNFI and PCFI met the requirement (>0.5); and RMSEA = 0.054 (<0.08) (Table 4). Therefore, the general scale model is suitable for the actual data set. In addition, the calculation of skewness in the analysis showed that the value of all variables measured was between −0.5 and 0.5, the data were fairly symmetrical, and the value of kurtosis was between −2.0 and 2.0, which is considered acceptable in order to prove normal distribution (Table 3).

Table 3. *Calculation of skewness and kurtosis*

	INF1	INF2	INF3	CONV1	CONV2	CONV3	ENT1	ENT2	ENT3
Skewness	−0.433	−0.480	−0.496	0.449	0.285	0.455	0.181	−0.348	−0226
Kurtosis	−0.471	−0.643	−0.824	−1.714	−0.277	−0.667	−861	0.546	−0.925
	SE1	**SE2**	**SE3**	**SI1**	**SI2**	**SI3**			
Skewness	−0.274	−0.322	−0.101	−0.150	−0.224	−0.130			
Kurtosis	−0.943	−0.804	−1.044	−1.119	−0.699	−0.612			
	FPS1	**FPS2**	**FPS3**	**VIH1**	**VIH2**	**VIH3**			
Skewness	0.242	0.148	−0.406	0.339	−0.163	0.310			
Kurtosis	−1.246	−1.080	−1.288	−1.160	−1.072	−1.238			

Table 4 shows the test results of the convergence values of 7 full-scale models. The results reveal that the reliability of the observed variables satisfied the requirement of the convergence test, so the observed variables were reliable. On the other hand, the research concepts are satisfactory because the combined reliability (CR) was greater than 0.7 and the average extraction variance (AVE) was greater than the recommended level, that is, 0.5.

Table 4. *Convergent validity of the measurement model*

Factor	Variable	Observed variable reliability			CR	AVE
		Standardized Loading Estimates	SMC	t-value		
INF	INF1	0.624	0.390	12.165***	0.826	0.619
	INF2	0.944	0.891	-		
	INF3	0.759	0.576	14.355***		
CONV	CONV1	0.611	0.373	13.319***	0.857	0.732
	CONV2	0.895	0.802	19.949***		
	CONV3	0.920	0.846	-		
ENT	ENT1	0.940	0.884	27.781***	0.896	0.745
	ENT2	0.707	0.500	17.537***		
	ENT3	0.923	0.852	-		
SE	SE1	0.584	0.342	11.727***	0.815	0.601
	SE2	0.891	0.794	16.716***		
	SE3	0.817	0.667	-		
SI	SI1	0.672	0.451	17.400***	0.914	0.785
	SI2	0.956	0.914	43.040***		
	SI3	0.995	0.990	-		

FPS	FPS1	0.706	0.498	9.858***	0.747	0.505
	FPS2	0.856	0.733	-		
	FPS3	0.532	0.383	8.689***		
VIH	VIH1	0.754	0.568	18.478***	0.891	0.745
	VIH2	0.940	0.883	-		
	VIH3	0.864	0.746	22.354***		

Source: authors

Note: GFI = 0.922; IFI = 0.960; CFI = 0.960; PNFI = 0.743; AGFI = 0.893, PCFI = 0.671; RMSEA = 0.054, NFI = 0.929 and TLI = 0.950

The AVE method was applied to test the distinction. This method shows that when the correlation between the two constructs is less than that of the AVE of both constructs, a distinction is achieved between the two. Table 5 shows that all values met the requirements of the discriminant validity test, from which the discriminant value of all relationships between the scales is guaranteed.

Table 5. *Discriminant validity of the measurement model*

AVE/ R2	INF	CONV	ENT	SE	SI	FPS	VIH
INF	0.787						
CONV	0.221	0.821					
ENT	0.024	0.165	0.863				
SE	0.157	0.282	0.562	0.775			
SI	0.166	0.041	0.149	0.167	0.886		
FPS	0.193	0.208	0.096	0.130	0.139	0.711	
VIH	0.151	0.029	0.053	0.189	0.214	0.123	0.856

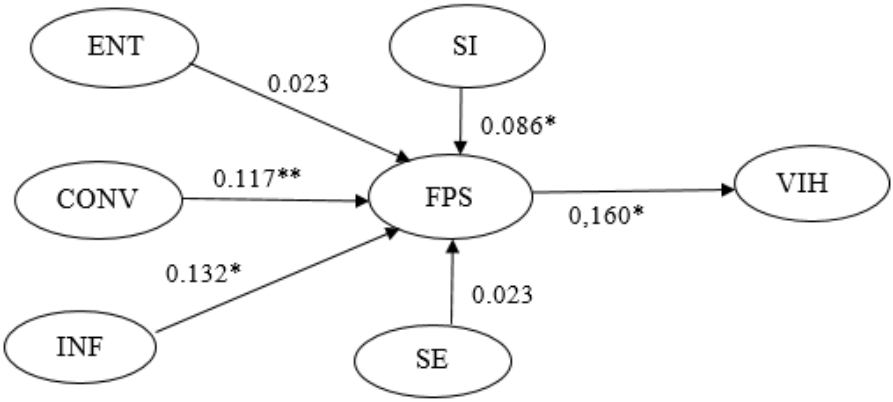
Source: authors

Structural equation modeling (SEM)

a) Accessing the overall goodness-of-fit of the model

The proposed research model was tested through Structural Equation Modeling (SEM) analysis, with 7 structural models and a correlation matrix of 21 observed variables (Figure 2). The SEM results depicted in Figure 2 are $\chi 2 = 393.7$ ($p = 0.00$), $df = 173$, $\chi 2/df = 2.276$ (<3), IFI = 0.956, TLI = 0.946 (>0.9), PNFI = 0.761 (>0.5), and RMSEA = 0.056 (<0.08). Overall, these results show a good fit for the proposed structural model.

Figure 2. Results of structural equation modeling (SEM)



Note: ***p < 0.001, **p < 0.01, *p < 0.05.
Source: authors

b) Research hypothesis testing

Table 6 shows the results of the direct relationship analysis and is used to test the proposed hypotheses. As a result, there are only three factors – namely, information, convenience, and social interaction (estimate = 0.132, 0.117, and 0.086, respectively, $p < 0.05$) – that play a vital role in enhancing user satisfaction with the hotel's Facebook page (FPS). This supports H1, H2, and H5. More specifically, information and convenience gratification have a significant contribution to the satisfaction of Facebook users regarding a hotel's Facebook page, in comparison with the minor impact of social interaction. Meanwhile, in testing the effects of self-expression and entertainment on user satisfaction, the findings show that both factors did not influence customer satisfaction, meaning that H3 and H4 are not supported.

Hypotheses examining the link between user satisfaction with a hotel's Facebook page and its performance, namely future hotel visit intention, were demonstrated to be meaningful in this model (estimate = 0.160, $p < 0.05$) (see Table 5).

Table 6. *Results of research hypotheses*

Causal path	Hypotheses	Estimate	S.E.	C.R.	P	Test results
INF→FPS	H1	0.132	0.055	2.421	0.015	Supported
CONV → FPS	H2	0.117	0.044	2.634	0.008	Supported
ENT → FPS	H3	0.023	0.055	0.409	0.682	Not Supported
SE → FPS	H4	0.023	0.043	0.530	0.596	Not Supported
SI → FPS	H5	0.086	0.043	1.984	0.047	Supported
FPS → VIH	H6	0.160	0.065	2.447	0.014	Supported

Source: authors

5. Conclusion

5.1. Discussion and implication

This study provides a number of theoretical and practical implications. The theoretical implications indicate that this study provides further analysis of the determining factors of user satisfaction which are the reasons for visiting hotels' Facebook pages and thus the intention to visit the hotel. The application of the Mehrabian–Russell environmental psychology model and U&G theory helps to explain why consumers use social media as a tool for exchange with hotels. It also serves as a stimulus to explain the reasons for accessing this virtual platform. The factors obtained from the results contribute to the theory in explaining how gratification of the use of Facebook is generated in the hotel sector. Specifically, this study explains the positive impact that the integration of information, convenience, and social interaction have when visiting hotels' Facebook pages and on fostering the intention to stay in hotels.

This finding indicates that only some of these factors are key drivers in creating user satisfaction and improving customer intentions to visit. In addition, unequal roles in contributing to dimensions of customer satisfaction are demonstrated in this study. Specifically, the results show agreement with prior research which has suggested that, in context of the internet and social networking, information plays the most vital role (Liang & Chen, 2009). In fact, today more and more people tend to access hotels' Facebook pages to receive information rather than searching on other websites. This can be explained by the fact that on social media such as Facebook, besides official information from hotels, they also collect information from feedback or comments. Furthermore, seeking information plays a vital role in the process of deciding on a product because of reducing risk – especially in the hospitality industry, where products are intangible. Therefore, providing sufficient information about a hotel and its elements on the hotel's Facebook page acts as a useful way to improve the satisfaction of online users. In additional, hoteliers should pay attention to addressing the questions that users leave ¬¬on their Facebook page, as well as keeping information up-to-date in order to support customers in selecting their desired services.

A substantial effect of the convenience factor on Facebook users' satisfaction with hotel Facebook pages was also demonstrated in the present study. This finding is in parallel with those of Srinivasan et al. (2002), Kim et al. (2006), and Choi et al. (2016). Convenience-satisfied people

are more likely to stay longer on a website as well as engage in human-human interaction (Ko et al., 2005). When a Facebook page offers a convenient feeling to users, they extend their stay on Facebook to search for information and interact, which can in turn meet their needs and shape their satisfaction regarding a hotel's Facebook page. Hotel managers can design a Facebook page that customers can get information from, use, and navigate easily, which in turn can help customers to reduce time consumption and can lead to their satisfaction. In terms of social interaction, this is also identified as an antecedent of user satisfaction for a hotel's Facebook page. Via a Facebook page, customers can interact with other users, hence they can search for common and useful reviews when selecting accommodation that would satisfy their need for love and belonging according to Maslow's demand pyramid (1943).

Although existing research has shown the significant roles of 2 dimensions in improving users' satisfaction – entertainment and self-expression (Basak et al., 2015; Li et al., 2017; Choi et al., 2016) – in this study both factors did not influence customer satisfaction with a hotel's Facebook page. The development of the internet led to huge entertainment tools, so perhaps Facebook users do not consider a hotel Facebook page as a tool for the purposes of relaxation. In the other words, customers access the Facebook page of a hotel to search for information on products, services, and prices, and to interact with others. Self-expression is the highest need of a human, according to Maslow (1943), in which people wish to express themselves and be recognized. Because of security and privacy aspects of a hotel's Facebook page, which could include unknown users or fake accounts, people may tend to ignore this as a suitable place to express themselves.

The favorable relationship between social networking satisfaction and purchase intention has been proved in many prior studies. This study is no exception. These findings indicate that when customers are satisfied with a hotel's Facebook page, they are more likely to stay in the hotel in future. By fulfilling the user's needs of information, convenience, and social interaction with their hotel's Facebook page, hoteliers can enhance the potential number of customers that could make use of their services.

The practical implications present a new perspective on how hotels can communicate more effectively with their customers, explaining how they can obtain greater effectiveness and responsiveness from customers through Facebook given the factors that affect customer satisfaction when visiting the hotel's Facebook page. Furthermore, this study helps hotels to better analyze the new, changed communication environment: more creativity is required to capture the attention of Facebook users who may be potential customers. Hotels should incorporate Facebook into their virtual marketing strategies as it proves to be an excellent platform to attract the attention and interaction of potential customers; thus, it stimulates the intention to visit the hotel.

5.2. Limitations and future research

The limitations of this study include data collection: clients of the hotel industry are often both national and international tourists; however, in this study, the respondents were solely Vietnamese. Therefore, the sample does not entirely accurately represent all customers on Facebook. The survey was also conducted online, so it was difficult to respond to the respondents' doubts when answering the questionnaire, leading to some invalid responses due to missing data.

Finally, and as a future line of research, the respondent information shows that the sur-

veyed ages of 18–25 and 26–40 represented 94% of the total, so future studies could focus on analyzing these generations through multi-group analysis. In addition, it is possible to apply research on other social networks sites that are also very popular in Vietnam, such as YouTube, Instagram, or Zalo.

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