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INFORMATION COMMUNICATION PROMOTING INSURANCE SALES: USE OF CHATBOT TECHNOLOGIES

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Abstract. The development of information and communication technologies (ICT), and especially of artificial intelligence, provides opportunities at a qualitatively new level in the digitalisation of a number of business processes. Similarly, the insurance sector can digitise many of its capabilities by using AI-based chatbot technology to provide another channel for customer communication. The advantages of this channel are indisputable: geographic and temporal independence, cost reduction, inclusion in various social networks, etc. On the other hand, this new communication channel has not been sufficiently well researched from the point of view of consumer attitudes. This paper presents research that seeks to identify user attitudes that are key to the usability of chatbot technology. The research is in two parts: a quantitative empirical study of consumers and a survey of insurance professionals. The results show that chatbots and AI offer various use cases in the insurance industry, such as sales support, lead generation, online insurance contracting, customer service, claims management, personalisation of insurance offers, customer retention, cross-selling, insurance policy management, risk prevention and consulting, and integration of smart devices and IoT. The research allows for increasing awareness of customer attitudes toward the use of chatbot technology and can lead to an increase in the effectiveness of communication in the insurance business.

Keywords: digitalization; Chatbot technologies; information and communication technology (ICT); insurance; communication; sales; artificial intelligence (AI)

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JEL Classifications: G22, M15, O33

1. Introduction

Chatbots are becoming an integral part of the digital transformation of many industries, including the insurance sector. This change is mainly due to continuous advances in artificial intelligence (AI) and machine learning (ML) technologies, which have made chatbots increasingly sophisticated and capable of understanding and responding to customer inquiries precisely and quickly. Chatbots have emerged as a valuable tool in the insurance industry, serving various functions ranging from sales and customer service to claims management and risk assessment. Their ability to operate around the clock, handle multiple inquiries simultaneously and provide immediate responses greatly improves operational efficiency, customer engagement and satisfaction.

Insurance chatbots are typically programmed to answer frequently asked questions, help customers choose appropriate insurance policies, guide them through the purchase process and even manage claims. They assist customers with complex insurance terminology and terms by making information easier to understand. Chatbots also play an important role in insurance, generating leads and providing sales support. They can engage potential customers visiting the company's website or social media platforms, provide basic information about insurance

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products and respond to inquiries. In this way, they can collect contact data and pass those leads on to the sales team, improving the company's ability to convert leads into actual customers.

Additionally, insurance chatbots are a policy management tool. They can help customers manage their policies, make changes and access contract details. This self-service feature provides customers with a convenient and easy way to manage their insurance policies without the need to contact customer service or fill out complex forms.

Chatbots also play a crucial role in risk prevention and advisory services. They can inform customers of potential risks and suggest preventative measures, helping mitigate damage and reduce long-term costs.

Integrating chatbots with smart devices and the Internet of Things (IoT) offers additional possibilities. By analysing data from connected devices such as smart homes, vehicles or wearables, chatbots can provide more accurate insurance quotes and inform customers of potential risks or areas for improvement.

However, successfully deploying chatbots in the insurance industry comes with challenges, including ensuring data privacy and security, managing customer expectations, and maintaining a balance between automated and human interactions. Therefore, insurance companies must develop comprehensive strategies to use chatbots while addressing these potential issues effectively.

Empirical research into the usability of chatbots in the insurance industry has scientific and practical importance for several reasons. From a scientific perspective, it contributes to understanding how artificial intelligence, machine learning and communication technologies transform traditional industries such as insurance. It examines the impact of these technologies on customer behaviour, business processes and overall industry dynamics. This knowledge can be instrumental in shaping further research and development in this area.

From a scientific and applied perspective, the study provides new knowledge to help insurance companies optimise their operations, improve customer service and increase sales. Given the competitive nature of the insurance market, companies must use innovative solutions like chatbots to stay ahead. Therefore, understanding how to effectively and efficiently use the technological capabilities of chatbots for communication and sales is critical.

2. Theoretical background

2.1. Application of artificial intelligence, including chatbots in the insurance sector

The primary discussion on the different applications of AI in various aspects that improve the organisations' overall performance, including its connection with customers, is vivid and very fruitful nowadays. The subject is actual for both practitioners and scholars. As one of the leading sectors of the economy, the insurance sector is also an actual field for applying Artificial Intelligence (AI). For instance, Pisoni and Díaz-Rodríguez (2023) propose a new approach for insurance based on AI. From the point of view of employees of an organisation, Gupta, Ghardallou, Pandey, and Sahu (2022) explore the adoption of AI in the insurance industry. Authors argue that the support of top managers and the company's financial stability positively affect the adoption of AI in the organisation.

Bermúdez, Anaya and Belles-Sampera (2023) reveal the benefits of using explainable AI techniques in life insurance products. Nuruzzaman and Hussain (2020) focus on the application of chatbots and develop specific chatbots designed purposely for the insurance industry's needs. Authors admit that chatbots offer businesses an enhanced method to engage with their customers, ultimately boosting customer satisfaction. For customers, they offer a more efficient and convenient means of getting their queries addressed, eliminating the need to wait on hold over the phone or exchange multiple emails.

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Based on the importance and impact on business, chatbots as a tool for direct connection between an organisation and its different publics (especially with their customers) are the subject of a scientific and practical discussion itself. Alagarsamy and Mehrolia (2023) explore four major banking chatbots and conclude that trust in chatbots has a notable and positive effect on user satisfaction, attitude, and behavioural intention, providing strong support for their influence in these areas.

Interesting researches dedicated to different aspects of using AI in insurance sector are developed by Mullins, Holland and Cunneen (2021) and Tugui et al. (2022) explore the ethical point of view in using big data analytics for customers; Cosma and Rimo (2024), Chang (2023) and Ma and Ren (2023) pay attention on the new technologies and Insurtech; Bednarz and Manwaring (2022), explore the impact of gathering external data on consumer insurance contracts; Schrijver, Sarmah and El-hajj (2024) and Maiano et al. (2023) study the application of data mining in the fight against automobile insurance frauds; Ellili et al. (2023), propose a bibliometric review on the application of big data in insurance sector; Lange et al. (2023), study the choice for the right modern build automation tools for an insurance company etc.

2.2. Chatbot as a modern tool of communication between organisation and customer

In the line of communication between an organisation and its customers, trust has to be considered one of the critical elements in this relationship. Huang, Markovitch, and Stough (2024) explore the role of trust. They argue that their experiments support existing industry surveys, indicating that chatbots generally have low consumer trust, which hinders their widespread acceptance and sustained usage. To address this trust issue, improving AI chatbots' problem-solving and relational abilities could be a promising long-term solution. However, they suggest that marketing strategies, like trust priming and optimisation of the collaboration between chatbots and human agents, could enhance service experiences compared to relying solely on either live agents or chatbots (ibid). One of) the proposed solutions, including gaining customer trust, is suggested by Rese and Tränkner (2024), who found that the goal of the chatbot is to offer accurate recipe suggestions after a brief conversation, minimising the need for extensive input from the user. Given these results, they suggest enhancing the capabilities of task-oriented chatbots by incorporating features that support their ability to assist users. According to scholars, this could involve optimising the use of common phrases and responding appropriately to related topics and non-request interactions (ibid). Janson (2023) examined how two anthropomorphic design elements impact social presence, satisfaction, trust, and empathy towards a chatbot. The author argues that both anthropomorphic design elements significantly affect social presence. In addition, the scholar admits that social presence plays a crucial role in shaping trusting beliefs, empathy, and satisfaction and also acts as a mediator for both anthropomorphic design elements in influencing satisfaction with a chatbot.

2.3. Anthropomorphism in Chatbots

Xie, Liang, Zhou and Jiang (2024) deal with one interesting aspect of using chatbots in communication with customers. Usually, one of the biggest disadvantages of AI technologies is the lack of expressed feelings and different kinds of emotions. The authors explore customers' satisfaction levels from the chatbot's expressed humour. They found out that the effectiveness of humour expressed by chatbots in enhancing service satisfaction depends on several factors, including the bot's competence, ability to entertain, and its perceived social presence (ibid). In this line of consideration, Zhang et al. (2024) propose research also devoted to emotional expression by AI. According to them, when chatbots convey concern for customers, they can enhance customer satisfaction by minimising instances where expectations are not met. Specifically, scholars reveal that factors such as the customer's objectives, how human-like the chatbot's appearance is, and the relationship between the customer and the chatbot can influence how emotional expressions impact expectancy violations (ibid).

Zogaj, Mähner, Yang and Tscheulin (2023) explore the impact of chatbot anthropomorphism and gender on customers' behaviour. They argue that the process of making chatbots more human-like has a positive effect on how consumers perceive the similarity between themselves and the chatbot (self-congruence). This, in turn, according to scholars, enhances consumers' intentions to make purchases. Authors recommend that brands planning to integrate chatbots into their online retail platforms should incorporate anthropomorphic design elements. Understanding customers' self-concepts is crucial for determining the appropriate design cues for chatbots. Anthropomorphism and the ability to interact are the focus of the research developed by Sun, Chen and Sundar

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(2024). According to them, when messages exchanged with a chatbot are highly interactive, it tends to cultivate favourable attitudes towards the chatbot itself and the advertisement it represents. This positive reception is often achieved by reducing any disappointment or surprise (violated expectancy) users might experience (ibid). Deeply researching the effects and impact of the anthropomorphic design of chatbots on customers, Lu, Min, Jiang and Chen (2024) concluded that when chatbots are designed with anthropomorphic features, it positively impacts users' expectations for both practical and emotional aspects. Furthermore, the authors admit that employing an anthropomorphic communication style enhances users' emotional expectations regarding service (ibid).

The effectiveness of chatbots in online shopping is explored by Fu, Mouakket and Sun (2023). Scholars reveal that the readiness traits of customers, such as optimism and innovativeness, along with the human-like attributes of chatbots like empathy and social presence, tend to foster trust among customers towards the chatbot technology. However, when customers perceive chatbots as too human-like (anthropomorphism), it diminishes their trust. The authors also emphasise that customers' trust in chatbots significantly impacts their willingness to adopt this new technology (ibid).

The effects and impact of using emojis by chatbots in the communication process to get as close as possible to human conversation is comprehensively explored by Yu and Zhao (2024). They conducted three experiments to examine how emojis impact interactions with chatbots. The findings show that emojis make chatbots seem warmer but don't necessarily make them appear more competent. However, this warmth-enhancing effect increases overall satisfaction with the service, especially when the chatbots are used for enjoyable tasks and are programmed in advance rather than highly autonomous (ibid).

2. 4. The level of acceptance, satisfaction and further improvements of Chatbots

Acceptance and level of satisfaction, which are the proper indicators for the effectiveness of communication between chatbots and humans in customer-organisation relationships, are also essential to the overall development of AI and generative chatbots. Zhu, Zhang and Liang (2023) studied the relationship between chatbot response style and the level of customer satisfaction. Scholars revealed that when chatbots address service issues, providing specific responses enhances customer satisfaction more effectively than abstract responses. The accuracy of empathetic understanding plays a significant role in mediating the connection between chatbot response styles and customer satisfaction. In cases where responses are abstract, enhancing the chatbots' cuteness can mitigate the negative impact of reduced empathetic accuracy on customer satisfaction (ibid). Sarraf, Kar and Janssen (2024) admit that chatbots are significantly revolutionising the customer service sector. With the emergence of AI-powered chatbots such as ChatGPT, companies increasingly integrate them into their customer service strategies to enhance overall support quality. However, there needs to be a notable oversight in optimising the user experience aspect of these interactions (ibid). Meng, Li, Shi and Huang (2023) also try to propose new ideas for further acceptance of chatbots. They reveal that using a double-sided message approach boosts customers' inclination to engage with AI chatbots, with perceived authenticity playing a pivotal role as a mediator in this process. Additionally, authors admit that customers' attitudes toward interacting with AI chatbots can be influenced by the types of demands they have—whether they're making complaints or inquiries (ibid).

Men, Zhou, Jin and Thelen (2023) proposed interesting research dedicated to one specific aspect of the chatbot for the organisation – the possibility of strengthening the connection between the public and the organisation via chatbot social conversation. Their findings affirm that engaging in social conversations with chatbots can significantly influence how the organisation deploying them is perceived and the outcomes of relationships between the organisation and the public. Moreover, the perceived corporate character directly impacts the quality of these relationships, highlighting the potential of employing AI-driven social chatbots for enhancing public relations efforts (ibid). Conversely, Zheng et al. (2023) admit that chatbots sometimes make mistakes during conversations, providing inappropriate responses that can compromise the confidentiality of product and marketing details. According to scholars, this can lead to decreased business profitability and create cost-related challenges. The authors suggest using advanced AI models built on deep learning principles to enhance chatbot performance. They introduce a multiheaded deep neural network model designed to rectify logical and fuzzy errors commonly encountered in retrieval-based chatbot models (ibid).

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Li, Li, Chen and Chang (2024) focus on further developing the possibilities of acceptance of chatbots, including in the line of communication between business organisations – and customers. After conducting six scenario-based studies and an interview, the authors discovered that when humans collaborate with AI, they can leverage their abilities to enhance AI systems' credibility and effectiveness, thereby promoting greater acceptance of chatbots. However, this positive effect was not evident when the AI's capabilities were evident or when the human experience with the service was negative (ibid). Wang, Li, Fu and Jin (2023) also admit that consumers tend to have more negative emotional experiences when engaging with chatbot services compared to human interactions. Consequently, this leads to a decrease in trust towards chatbot services despite no discernible difference in the solutions provided by chatbots and humans. According to scholars, this suggests that for chatbot designers or providers, mitigating negative consumer emotions towards chatbots is equally, if not more, crucial than merely enhancing algorithm accuracy (ibid).

In summary of the literature review, the application of generative AI-based chatbots will be further improved in the next few years with the rapid development of new technologies and innovations. Companies willing to be customer-oriented, including in the insurance sector, have to be ready and open to this new challenge.

3. Methodology of the research

The study's main objective is to determine which factors contribute to a particularly effective communication model. The theses are based on the assumption that customer behaviour has changed as a result of the new media because new communication channels have emerged. The change in consumer behaviour has an impact on the entire consulting process. Methodologically, the aim is to examine the theoretical considerations qualitatively and quantitatively.

Thesis of the research:
Communications between companies and their customers based on chatbots with artificial intelligence enable shortening the relationship between them, and their combination with other appropriate means of communication would increase company efficiency and customer satisfaction

Hypotheses

1. There are correlations between the scales of the Universal Theory of Acceptance and Use of Technology (UTAUT) model and the intention to use chatbots.
2. There are correlations between the scales of the Universal Theory of Acceptance and Use of Technology (UTAUT) model and the current use of chatbots.
3. There are correlations between the general attitude towards chatbots on the one hand and the intention to use them or their current use on the other.
4. There are gender-specific differences with regard to the use of chatbots. Men use chatbots more frequently than women.
5. There are age-specific correlations with regard to the use of chatbots. The probability of using chatbots decreases with increasing age.
6. There is a difference in the correlation between the general attitude towards chatbots and the attitude towards the suitability of chatbots for simple or more complicated concerns.

The qualitative research
Expert interviews are a significant component, purposed to gather nuanced insights from professionals in the field. These interviews inform surveys administered to insurance agents and customers, adding practical depth to the study. The choice of a mixed-method approach with open and closed questions in the interviews enables the collection of rich data while still ensuring comparability. This research design accords with the guidance of leading scholars like Mayring, who advocates for the flexibility and closeness to the subject that qualitative research offers. However, it is also critically aware of the potential for bias and manipulation in qualitative methods, and thus also incorporates quantitative data, analysed through statistical programs like SPSS and Excel, for objectivity.

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To further the reliability and validity of the research, the study undergoes pretesting phases that are aimed at refining the research instruments, ensuring that the questionnaires are not too long, redundant, or incomprehensible. Online distribution of the questionnaires facilitates broad participation and eases data transfer to statistical programs for analysis. Ultimately, the study is not just a theoretical exercise; it also seeks to offer practical solutions informed by real-world expertise and feedback, thereby contributing to communication in the insurance business.

The quantitative empirical research

The quantitative empirical research adopts a cross-sectional study design to address the research questions through quantitative analysis. Data collection was conducted through an online survey, which was open for participation for three weeks in May 2022. The questionnaire was hosted on Uniprk's online survey portal, which uses EFS-Survey software. Participants received the survey link directly via email or WhatsApp, which was also shared on social media platforms.

The first part of the questionnaire focuses on collecting demographic and sample-relevant information such as age, gender and educational background of the respondents. After ensuring that participants were aware of data protection regulations, they were assured of the anonymity of their responses. The estimated time required to complete the survey was between 10 and 15 minutes. The survey explored respondents' attitudes towards using chatbots in the context of buying insurance. Items were similarly structured to gather information on the general need for communication processes when purchasing insurance and previous experience and confidence in using chatbots.

The Universal Theory of Acceptance and Use of Technology (UTAUT) model was used to measure chatbot acceptance, with 20 items on a five-point Likert scale. Scores could range from 20 to 100 points. The scale was adapted but inspired by a study by Anderson, Schwager, and Kerns (2006). It included subscales such as performance expectancy, effort expectancy, social influence, facilitating conditions, behavioural intention, and actual use. In addition, the control variable' experience with digital technology' was included to account for influences in the use of digital technologies and to allow for a more nuanced evaluation of hypotheses.

The acceptance of chatbots within the framework of the UTAUT model was surveyed with the aid of 20 items, whereby the respondents were provided with a five-point Likert scale with the answer poles (1) do not agree at all to (5) agree completely for their assessment. Accordingly, between 20 points and 100 points could be scored in determining the acceptance of chatbots. The scale used here was adapted but based on a study by Anderson, Schwager, and Kerns (2006). It contains the following subscales with the number of items listed:

1. Performance expectation (4 items)
2. Expenditure expectation (4 items)
3. Social influence (4 items)
4. Supportive environment (4 items)
5. Intention to use (2 items)
6. Actual usage (2 items)

The control variable "experience with digitality" was also surveyed in order to identify influences in the use of and experience with digital technologies. This procedure offers the opportunity to take into account differences in the use of digital technologies when testing the hypothesis.

The following questions provide insight into the elements of the UTAUT model and serve as sample items for the subscales:

Performance Expectation: I spend less time with a chatbot to get an answer to standard insurance policy questions than I do with a service representative.

Effort expectation: When buying an insurance policy, I can use a chatbot without assistance.

Social influence: The topic of chatbots is present in my everyday work among people.

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Supportive environment: It's important to me that I can use a chatbot when buying insurance via my smartphone.

Intention of use: I intend to use a chatbot when purchasing insurance in the next 12 months.

Actual use: I'm sure I'll be using a chatbot when I purchase an insurance policy in the next 12 months.

The control variable' experience with digitality' was collected in order to also determine influences in the use of or experience with other digital technologies. This provided the opportunity to consider general differences in the use of digital technologies when testing the hypotheses.

The data collected was analysed using SPSS, version 28. After exporting the data from the survey portal and importing it into the statistical software, the dataset was checked for missing or irrational values. First, descriptive statistics were calculated. Due to the predominantly nominal or ordinal level of the variables, frequency analyses were carried out. The internal consistency of the scales was then assessed using Cronbach's alpha, which gives an indication of the reliability of the scale. A total of N=133 participants took part in the study. The youngest participant was 19 years old, and the oldest was 67 years old at the time of the survey.

The interview process is illustrated in Figure 1 shown:

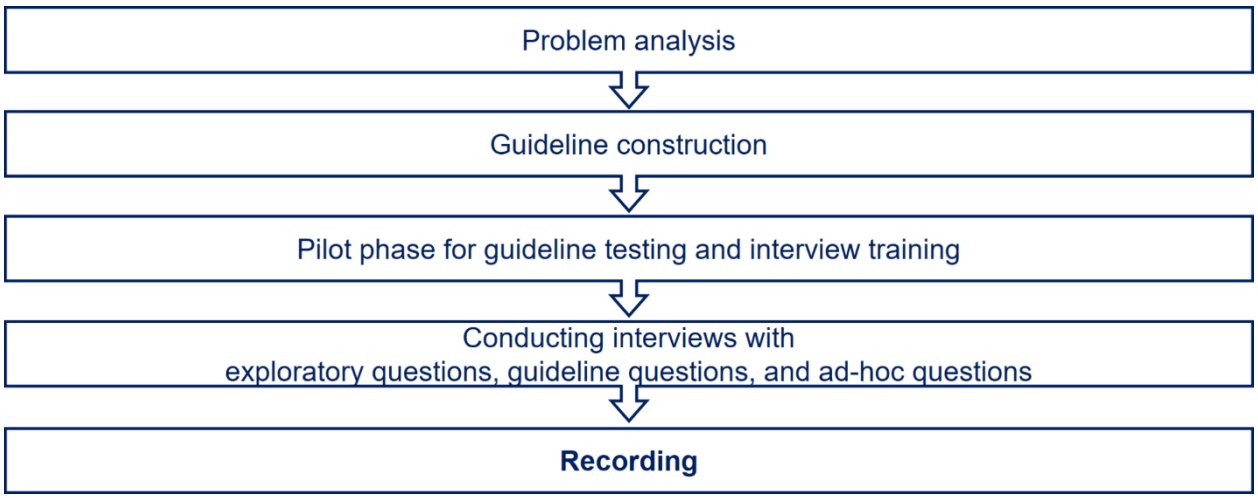


Figure 1. Interview procedure

The interviews are evaluated using qualitative content analysis. In this method, the data is evaluated empirically, and the context of the communication is considered with regard to the thesis. Figure 2 outlines the process.

Starting from the definition of the data area, the actual situation is considered and the material is processed. The analysis is then consolidated in its orientation and the question is approached in a differentiated manner. The analysis technique is determined and the definition of the variables is formed. By three categories, the analysis steps are divided, and after the examination of these, the interpretation is begun.

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This empirical research work corresponds to a cross-sectional study, whereby the research questions are to be answered with the help of a quantitative study. The data collection was done through an online survey, which was accessible for participation during a period of 3 weeks in May 2022. As a survey platform, the questionnaire was entered into the virtual survey portal of the provider Unipark, which uses the survey software EFS-Survey.

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The link was sent to the participants directly via email or WhatsApp. Furthermore, the link was shared via social media.

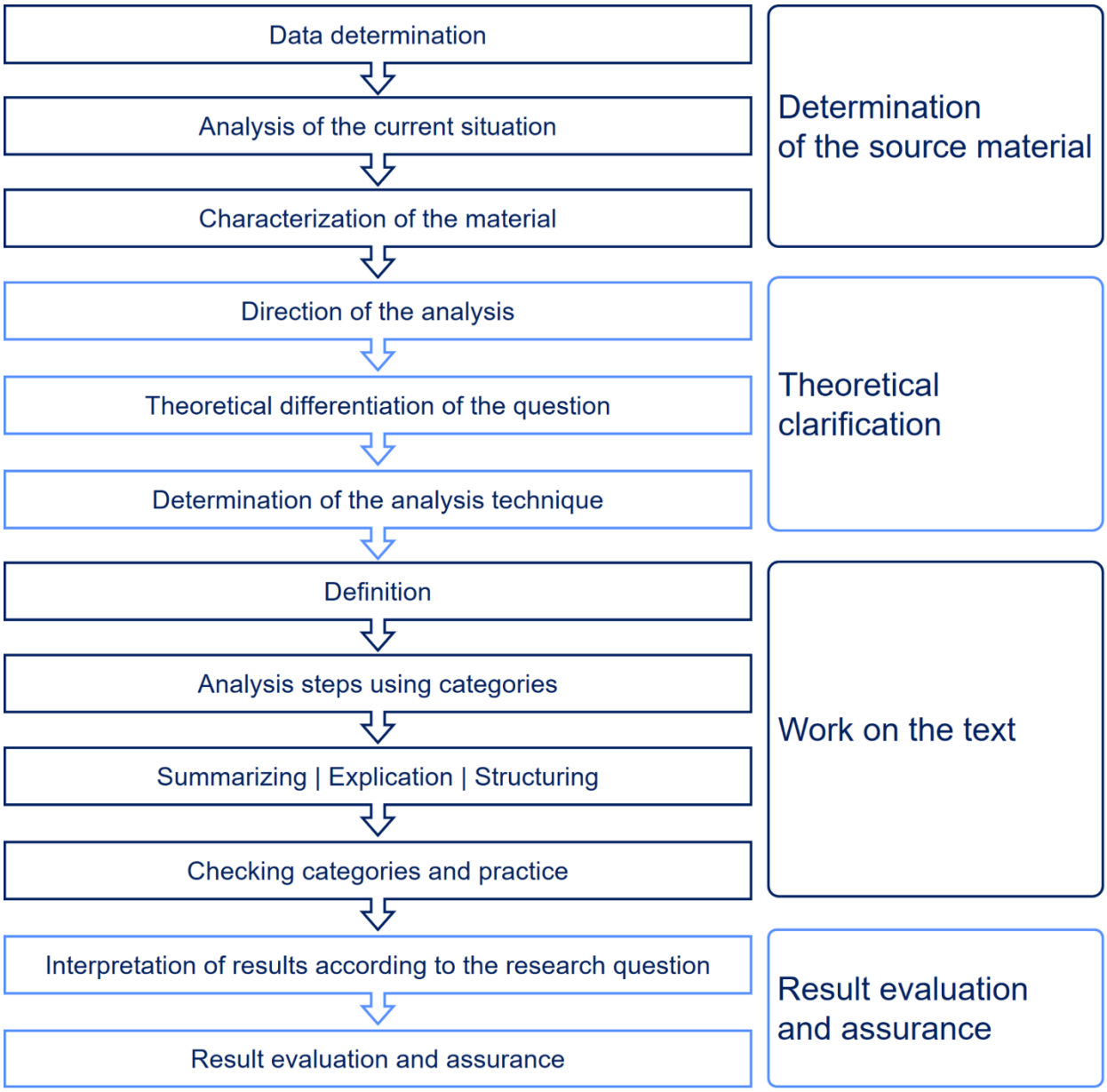


Figure 2. Empirical approach

Evaluation methods

The data was analysed using the statistical program SPSS, version 28. After exporting the data from the survey portal, the data was imported into the statistical software. As an inclusion criterion for participation in the survey, prior experience in dealing with chatbots was required. For this reason, an item was implemented in the questionnaire to determine past experience with chatbots. If the item' experience with chatbots' was answered in the negative, the respondent was excluded from further data analysis.

Following the examination of the data set, the descriptive statistics were first evaluated. Due to the predominantly nominal or ordinal scale variables, frequency analyses were calculated. For age, the descriptive statistical parameters suitable for interval-scaled variables, such as the mean, the standard deviation, and the minimum

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and maximum, were determined. The scaling of the scales Performance Expectancy, Effort Expectancy, Social Influence, Supportive Conditions, Intention to Use, and Actual Use was done by summing up the items. Furthermore, the internal consistency of the scales was determined. The consistency measure Cronbach's alpha was used for this purpose.

There is no exact specification as to what level Cronbach's alpha should be in the context of scientific research. For group studies, a Cronbach's alpha of 0.7 is generally assumed. A Cronbach's alpha <.07 corresponds to insufficient reliability, while a Cronbach's alpha between 0.7 to 0.8 corresponds to good reliability. Cronbach's alpha between 0.8 and 0.9 corresponds to very good reliability, while a value above 0.9 indicates excellent internal consistency.

Subsequently, the items of the scales were summed up, resulting in the scales already described.
Although a sample size > 30 subjects can be assumed to have a normal distribution of data based on the central limit theorem, the distribution of the scales was examined using a Shapiro-Wilk test, as looking at the pattern of responses by subjects can provide valuable evidence of irrational results.

4. Survey Results and Discussion

The extent to which the respondents had already had experience with digital communication when purchasing insurance policies was surveyed. The evaluation showed that, with 54.0%, the majority had little experience with digital communication tools when buying insurance policies, while 26.0% had some experience with digital communication tools. Further data on experiences with digital communication tools can be seen in Figure 3.

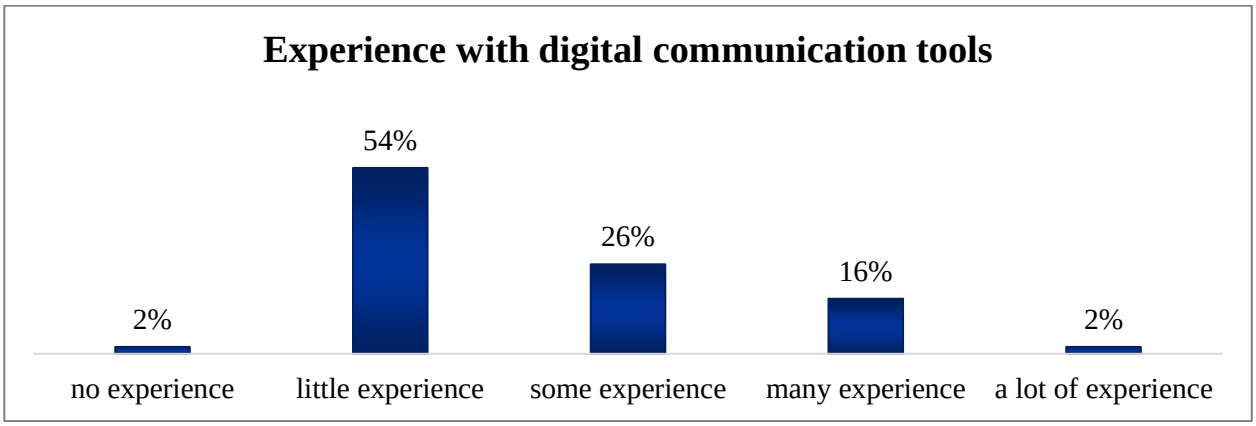


Figure 3. Experiences with digital communication tools in the purchase of insurance policies.
Source: own research

In addition, the study participants were asked about the importance of trust in the competence of the insurance employee. Here, the analysis showed that 36.0% of the respondents tended to agree that trust in the competence of the insurance employee was of high importance. In comparison, another 36.0% of the respondents answered this question with 'partly, partly'. Further information on the importance of trust in the competence of the insurance employee can be found in Figure 4.

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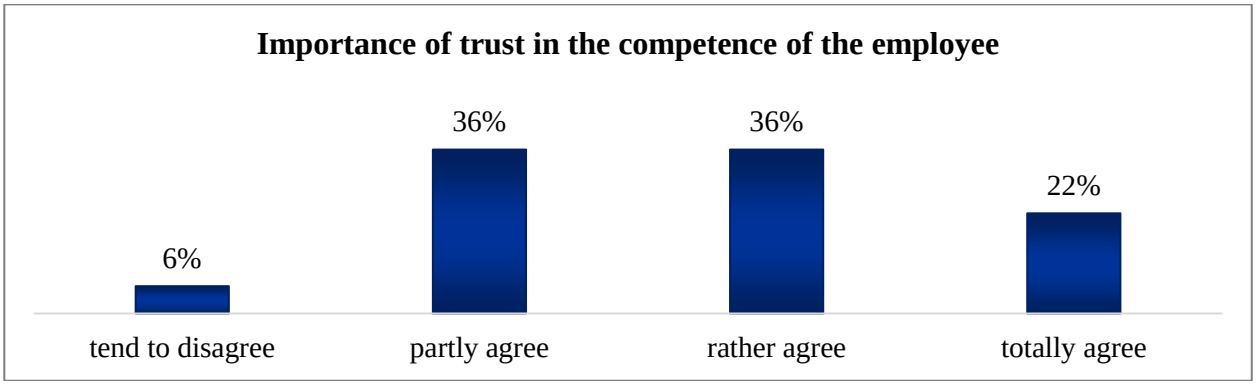


Figure 4. Attitude of high importance with regard to trust in the competence of the insurance employee.
Source: own research

Furthermore, it was determined to what extent the respondents agreed with the statement, "Customer proximity to the insurance employee is very important to me. The data analysis showed that most respondents, 38.0%, fully or rather agreed with this statement. 22.0 % chose the neutral answer option 'partly, partly' (Figure 5).

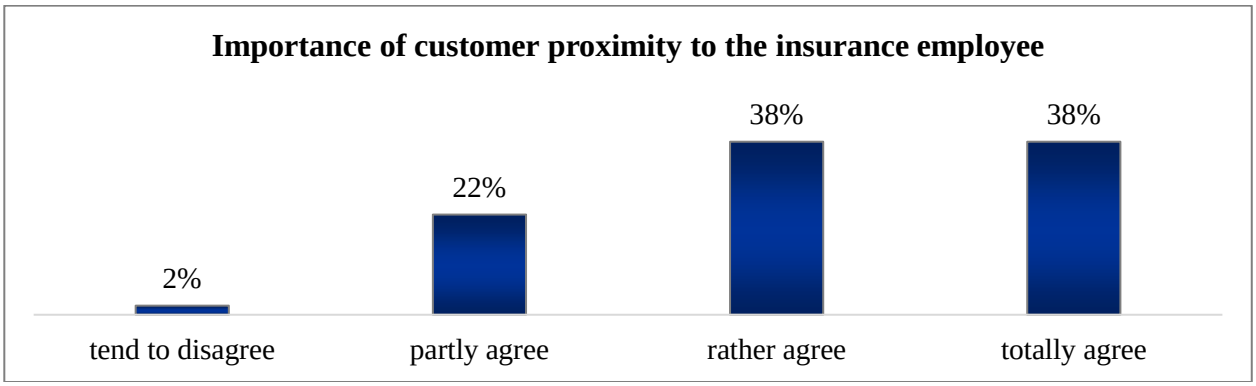


Figure 5. Attitude towards the importance of the insurance employee's proximity to the customer
Source: own research

The subjects were also asked about their experiences regarding chatbots when purchasing insurance policies. No experience with chatbots when purchasing insurance policies resulted in the exclusion of the respondent from the data analysis. 66.0% of respondents reported having little experience with chatbots when purchasing insurance policies, while another 34.0% reported having some experience with chatbots.

80 % of the respondents would prefer chatbots to a human for simple concerns, while 20 % would prefer to entrust a human with simple concerns. Complicated concerns would have 22.0 % of respondents prefer to entrust to a chatbot, while 78.0 % prefer to entrust a human.
The general attitude towards chatbots was surveyed using a scale from (1) very negative to (6) very positive (Figure 6).

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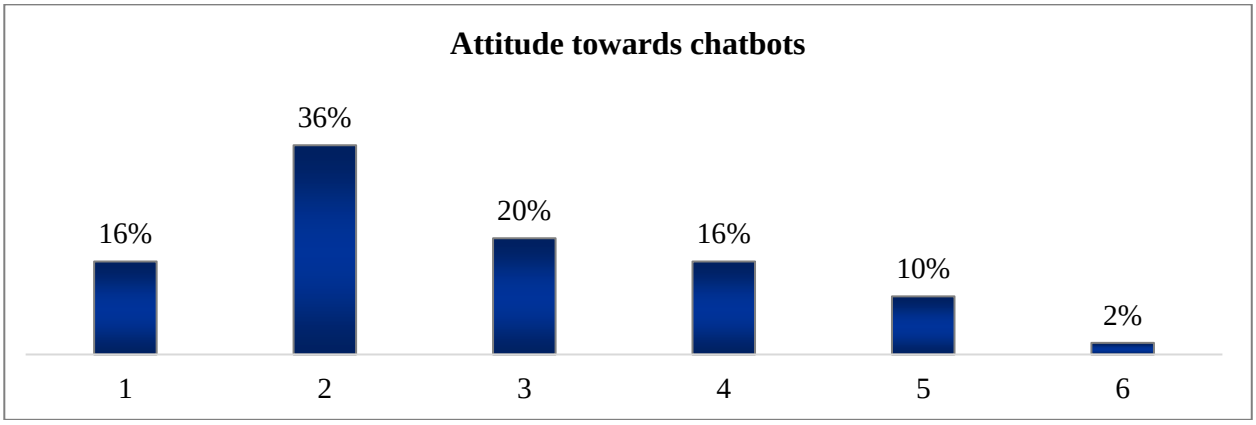


Figure 6. The general attitude towards chatbots
Source: own research

4.1. Confirmation of hypotheses

Hypothesis 1

There are correlations between the scales of the UTAUT model and the intention to use chatbots.

H1a (EL) Expected performance has a significant positive influence on the intention to use digital applications (chatbots) in customer communication. Pearson correlation analysis was calculated to test the hypothesis, with one-sided significance testing due to the directional formulation of the hypothesis. At r = -.202 and p = .080, the correlation test between performance expectancy and intention to use chatbots was not statistically significant. Accordingly, there was no correlation between performance expectancy and usage intention. The null hypothesis is retained.

H1b (EA) Expected effort has a significant positive impact on the intention to use digital applications (chatbots) in customer communication. Once again, a Pearson correlation analysis was calculated to test the hypothesis, and due to the directional formulation of the hypothesis, one-sided significance was tested here as well. At r = -.362 and p = .005, the correlation test between effort expectancy and chatbot usage intention was statistically significant. There was a negative correlation between effort expectancy and intention to use. Accordingly, as effort expectancy increases, the intention to use chatbots decreases. The effect was of medium strength at r = |.362|.

H1c (U) Supportive conditions have a significant positive impact on the intention to use digital applications (chatbots) in customer communications. Pearson correlation analysis was calculated to test the hypothesis, with one-sided significance testing due to the directional formulation of the hypothesis. At r = .048 and p = .371, the correlation test between the supporting conditions and the intention to use chatbots was not statistically significant. Accordingly, there was no correlation between the supporting conditions and the intention to use. The null hypothesis is retained.

H1d (SE) Social influence has a significant positive impact on the intention to use digital applications (chatbots) in customer communications. Once again, a Pearson correlation analysis was calculated to test the hypothesis, and due to the directional formulation of the hypothesis, one-sided significance was tested here as well. At r = -.394 and p = .002, the correlation test between social influence and chatbot usage intention was statistically significant. There was a negative correlation between social influence and intention to use. Accordingly, as social influence increases, the intention to use chatbots decreases. The effect was of medium strength at r = .394|. All correlations are shown in Table1.

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Table 1. Correlation table (Pearson correlation), intention to use chatbots

	1	2	3	4	5
Performance Expectation	--				
Expenditure expectations	.831**	--			
Social_influence	.428**	.680**	--		
Under_frame	-.131	-.091	-.024	--	
Intention of use	-.202	-.362**	-.394**	.048	--

** Correlation is significant at the 0.01 level (1-sided).

Hypothesis 2

There are correlations between the scales of the UTAUT model and the current use of chatbots.

H2a (EA) Expected performance has a significant positive impact on the current use of digital applications (chatbots) in customer communication. Pearson correlation analysis was calculated to test the hypothesis, with one-sided significance testing due to the directional formulation of the hypothesis. At r = -.247 and p = .042, the correlation test between performance expectancy and current use of chatbots was statistically significant. However, there was a negative correlation between performance expectancy and the current use of chatbots. Accordingly, as performance expectancy increased, the current use of chatbots decreased. The null hypothesis is retained.

H2b (EL) The expected effort has a significant negative impact on the current use of digital applications (chatbots) in customer communication. Pearson correlation analysis was calculated to test the hypothesis, with one-sided significance testing due to the directional formulation of the hypothesis. At r = -.248 and p = .042, the correlation test between expected effort and current use of chatbots was statistically significant. There was a negative correlation between effort expectation and the current use of chatbots. Accordingly, as the expectation of effort increases, the current use of chatbots decreases. The null hypothesis is rejected.

H2c (EL) Supportive conditions have a significant positive impact on the current use of digital applications (chatbots) in customer communications. Pearson correlation analysis was calculated to test the hypothesis, with one-sided significance testing due to the directional formulation of the hypothesis. At r = .085 and p = .278, the correlation test between the supporting conditions and the current use of chatbots was not statistically significant. Accordingly, there was no correlation between the supporting conditions and the current use of chatbots. The null hypothesis is retained.

Table 2. Correlation table (Pearson correlation), Current use of chatbots

	1	2	3	4	5
Performance Expectation	--				
Expenditure expectations	.831**	--			
Social_influence	.428**	.680**	--		
Under_frame	-.131	-.091	-.024	--	
Current use	-.247*	-.248*	.085	-.236*	--

** The correlation is significant at the 0.01 level (1-sided).

* The correlation is significant at the 0.05 level (1-sided).

H2d (SE) Social influence has a significant positive impact on the current use of digital applications (chatbots) in customer communication. Once again, a Pearson correlation analysis was calculated to test the hypothesis, and due to the directional formulation of the hypothesis, one-sided significance was tested here as well. At r =

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-.236 and p = .049, the correlation test between social influence and the current use of chatbots was statistically significant. However, there was a negative correlation between social influence and current use of chatbots. The null hypothesis is retained. The coefficients of all hypothesis tests (hypothesis 2 and sub-hypotheses) can be seen in Table2.

Hypothesis 3
There are correlations between the general attitude towards chatbots on the one hand and the intention to use them or their current use on the other.

H3a With increasingly positive, general attitudes towards chatbots, the intention to use chatbots in customer communication increases. To test the hypothesis, a Spearman's rank correlation analysis was calculated, with a one-sided hypothesis test due to the directional formulation of the hypothesis. At rSP = -.169 and p = .121, the correlation test between general attitude regarding chatbots and intention to use chatbots was not statistically significant. Accordingly, there was no correlation between the attitude regarding

H3b With increasingly positive, general attitudes regarding chatbots, the current use of chatbots in customer communication is rising. Once again, a Spearman rank correlation analysis was calculated to test the hypothesis, again testing one-sided for significance due to the directional formulation of the hypothesis.
At rSP = -.181 and p = .104, the correlation test between general attitude regarding chatbots and current usage was not statistically significant. Accordingly, there was no correlation between the attitude regarding chatbots and the current use of chatbots in customer communication (cf. Table 13).

Table 1. Correlation table (Spearman correlation), General attitude towards chatbots, intention to use and current use

	1	**2**	**3**
General setting.	--		
Intention of use	-.169	--	
Current use	-.181	.191	--

Hypothesis 4
There are gender-specific differences with regard to the use of chatbots. Men use chatbots more frequently than women.

Levene's test for variance homogeneity was not statistically significant at F(48) = 2.081 and p = .156, so it could be assumed that variance homogeneity was present. At t(48) = -0.582 and p = .282, testing the difference was not statistically significant. Accordingly, men did not use chatbots more frequently than women. The null hypothesis is retained.

Hypothesis 5
There are age-specific correlations with regard to the use of chatbots. The probability of using chatbots decreases with increasing age.

Pearson's product-moment correlation analysis was used to test the hypothesis. At r = .274 and p = .027, testing of this relationship was statistically significant. The correlation was positive. Accordingly, the use of chatbots increases with age. The null hypothesis is retained.

Hypothesis 6
There is a difference in the correlation between the general attitude towards chatbots and the attitude towards the suitability of chatbots for simple or more complicated concerns.

This hypothesis is first tested using a rank correlation analysis according to Spearman. Subsequently, both correlation coefficients are tested for significant differences using a Fisher-z test. At rSP = .038 and p = .795, testing the relationship between general attitudes toward chatbots and attitudes regarding the suitability of chatbots

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for simple concerns was not statistically significant. At rSP = .047 and p = .748, testing the relationship between general attitudes toward chatbots and attitudes regarding the suitability of chatbots for more complicated concerns was not statistically significant.

The difference in these correlations was not statistically significant at z = 0.044 and p = .965. Accordingly, there was no difference with respect to the relationship between general attitude and attitude about whether and to what extent chatbots are suitable for simple or more complicated concerns. The null hypothesis is retained.

Finally, multiple linear regression analysis was used to illustrate the extent to which the predictors (1) performance expectancy, (2) effort expectancy, (3) social influence, (4) supportive environment, and (5) current use of chatbots can predict the criterion intention to use chatbots. The calculation of a regression model is subject to the following conditions, which must be checked in advance (Bortz, Döring, 2006):

- The data set must be free of outliers. Values that are three standard deviations from the mean of the corresponding scale are considered outliers.
- There must be independence between the residuals and the variables.
- There must be independence between the variables.
- Multicollinearity between variables must be excluded.
- The residuals must conform to a normal distribution.
- The variance of the residuals must be constant for all values of the predictors (homoscedasticity).

First, the data set was checked for outliers. The check of the normal distribution of the residuals of the dependent variables showed that they were normally distributed (see also Figure7):

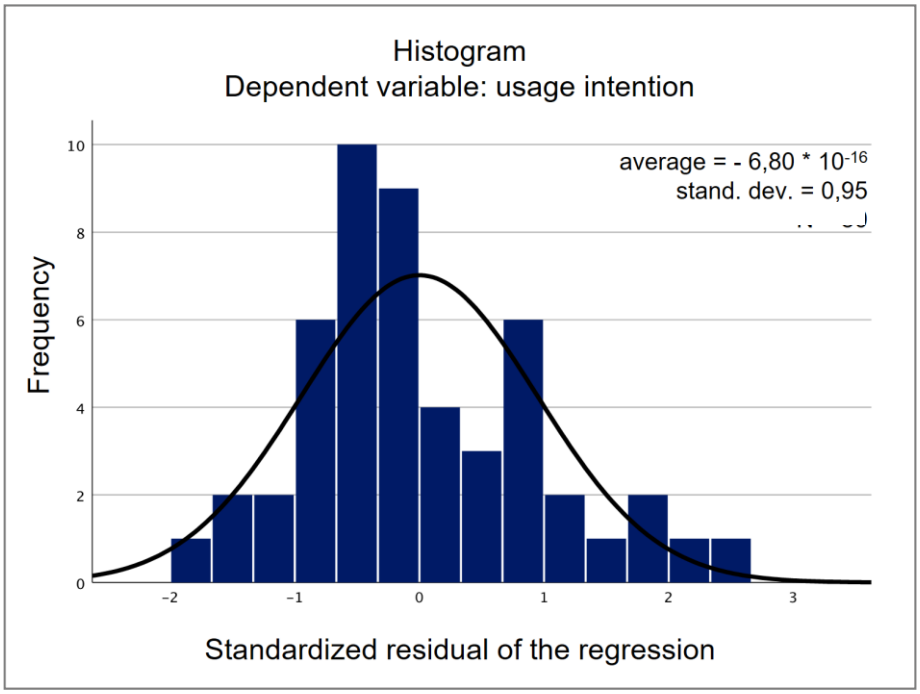


Figure 7. Normal distribution of the residuals as a normal distribution histogram

The residuals were linearly related to the dependent variable usage intensity, as can be seen from the corresponding diagram (P-P diagram) (see also Figure 8).

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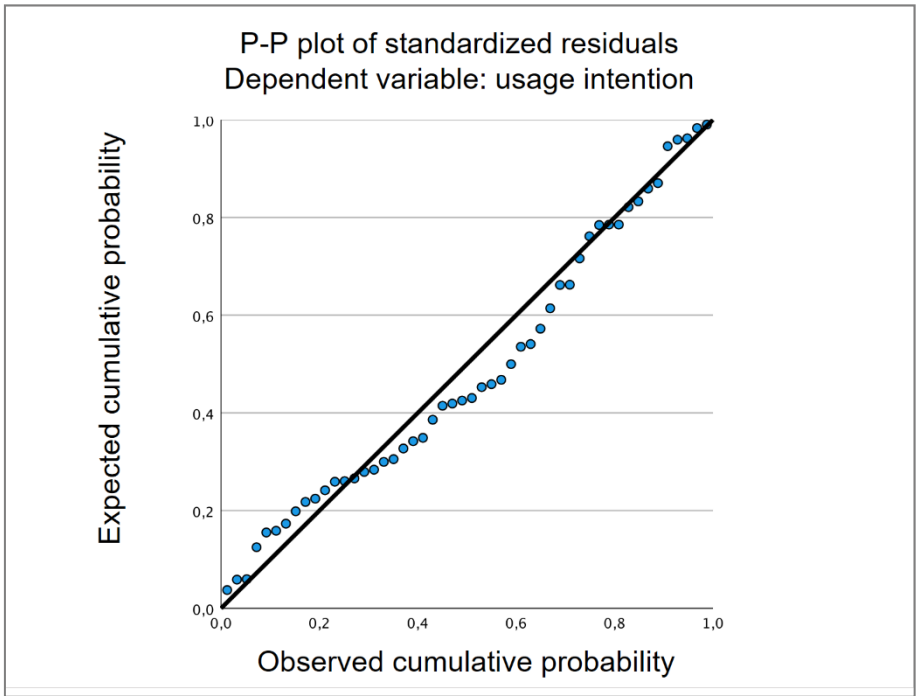


Figure 8. Linearity of the residuals as PP diagram

The residuals of the independent variables scatter over the entire range of the dependent variable usage intensity so that homoscedasticity was not violated either (see Figure 9):



Figure 9. Scatter plot for the detection of homoscedasticity

The Durbin-Watson statistic was used to test the independence of the residuals. A positive autocorrelation exists when this test statistic takes values close to 0, while values close to 4 may indicate a negative autocorrelation. In the optimal case, the results of this test statistic are close to the value 2. In the present case, the result of the Durbin-Watson statistic was 2.184, so an autocorrelation could not be assumed. The independence of the residuals was therefore given for the present data (according to Bortz, Döring, 2006).

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Possible multicollinearity between the predictors can be revealed by interpreting the values of the variance inflation factor (VIF). According to Bortz and Döring (2006), a value greater than 10 indicates the presence of multicollinearity, with the highest value in this test being 5.540, so it can be assumed that there was no multicollinearity between the predictors.

The regression model selected here was not statistically significant $F(5, 44) = 2.051$; $p = .090$. None of the predictors selected here was able to make a significant contribution to explaining the variance in the criterion intention to use.

4.2. Interpretation of the results

There was no link between performance expectations and the supportive environment in the context of chatbot use on the one hand and chatbot usage intention on the other. However, with decreasing effort expectations regarding using chatbots, the intention to use them increased. With decreasing social influences regarding chatbots, the intention to use them also increased.

There was no correlation between the supportive environment in terms of chatbot use and actual chatbot use. As performance expectations regarding chatbots decreased, current usage of chatbots increased. Also, as effort expectations regarding chatbot use decreased, the current use of chatbots increased. Finally, as social influences decreased, the current use of chatbots increased.

There was no correlation between the general attitude towards chatbots on the one hand and the intention to use or the current use of chatbots on the other.

It was also impossible to show any difference in the current use of chatbots between men and women. The use of chatbots increased with age. Possible correlations between the attitude towards chatbots and the perceived suitability of chatbots for simple concerns or more complicated concerns did not differ significantly from each other.

The predictors of performance expectancy, effort expectancy, social support in using chatbots or support on the environment, and current use of chatbots could not predict the intention to use chatbots in customer communication.

Another potential issue is the self-selection of participants who may already have some experience or opinion on the topic of chatbots and digital insurance policies, which could influence the results. Data collection took place via online surveys distributed through email, WhatsApp, and social media, which may mean that the sample is not representative of the entire population, especially those less tech-savvy.

The operationalisation of the constructs was done using self-developed items and an adapted scale based on a previous study. This could affect the validity and reliability of the measurements, especially if the developed items were not sufficiently validated. In addition, some constructs, such as chatbot acceptance, were measured using Likert scales, which, while helpful in capturing attitudes and opinions, may still be susceptible to bias and subjective interpretation.

Finally, the control variable experience with digital was collected to account for differences in the use of digital technologies. However, this variable may not cover all possible factors influencing participants' behaviour and attitudes toward chatbots and digital insurance policies.

4.3. Qualitative analysis

The interviews with various experts show that communication is extremely important in selling insurance policies. Trust, clarity and authenticity are decisive factors in achieving successful deals. Insurance terms and conditions are complex; communicating this information is crucial to sales success. Transparency and

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comprehensibility are important for retaining customers in the long term. However, the importance of communication also depends on the type of insurance. While simple insurance policies, such as motor vehicle insurance, can be taken out online, products that require explanation, such as occupational disability insurance, require personal consultation. The experts emphasise that digital and analogue communication channels are necessary to reach the "hybrid customer." Customers prefer different forms of communication depending on their age and needs. Email and WhatsApp are often preferred communication channels, while video chats play a subordinate role. Reachability and responding to customer needs are essential success factors in selling insurance policies. Some experts emphasise the importance of stories and references to convince customers and stress the importance of online presence. Overall, it is clear that communication is seen as essential in selling insurance policies and is crucial to sales success.

The results of the interviews also show that the choice of communication channels in the insurance industry depends on the target group and the customer profile. In general, personal contact is seen as particularly important, especially for older customers and for the conclusion of contracts. However, younger customers, the "digital natives," are more familiar with digital solutions and communication channels such as apps, emails and WhatsApp. Communication should be transparent, understandable and customer-specific. It is important to respond to customer wishes and offer different communication channels. Customer satisfaction plays a crucial role, as does the ability to adapt to the customer and be flexible. Interviewees also consider the differences between B2B and B2C customers, with video calls being used more frequently in the current situation, especially in the B2B sector. Customer expectations in terms of communication include quick and easy accessibility, value-added information, trust-building, and direct added value in advertising. The insurance industry is seen as split between digitally affine and non-digital representatives. Some interviewees expect changes in the market in the next few years, such as a boom in insurance sales on Instagram and YouTube or a slump in the life insurance market.

The interviewees described the need for digital customer communication in insurance policy sales as important in responding promptly to customer inquiries and keeping up with the times. However, acceptance varies depending on the age of the customers and the type of products. Younger customers are more open to digital communication, while older customers prefer personal contact. For complex products, many customers prefer the face-to-face communication channel. The Corona pandemic has reinforced the trend toward digital communication. Many interviewees use digital communication tools such as email, WhatsApp, Zoom, Skype and online presence. Some see benefits in digitising signatures, while others express concerns about privacy and trust. The acceptance of digital customer communication in insurance policy sales depends on established and widely used communication options. Some interviewees emphasise the importance of transparency, benefits, and speed in improving adoption. Others mention the use of apps and support staff to ensure quick responses. Interviewees' experiences with digital sales are mixed. Some succeed with newsletters and social media, while others receive little response to such activities. Some separate personal and professional communications, especially when using Facebook and WhatsApp. Overall, most interviewees see the need for digital customer communication in insurance policy sales, although the level of acceptance and preferred forms of communication vary by customer group and product.

In the interviews with various experts, different opinions and experiences were gathered regarding using chatbots in customer communication and insurance policy sales. Some interviewees recognise the value of chatbots as helpful tools for quick and straightforward responses to customer inquiries and for generating customer information. However, they also stress the importance of data protection and the possibility of combining chatbots and live chats. Other experts believe that chatbots need to be more user-friendly and often do not provide the desired answers because the many different wording options limit them. Some interviewees believe that well-programmed chatbots and the availability of live service staff are important to ensure that the product is available in the first place. Some interviewees have no experience with chatbots and, therefore, cannot judge their usefulness in digital communication. However, they note that customers generally accept digital communication tools and adapt to the customer's needs. Other experts are aware of chatbots as a possibility for digital customer communication but do not offer them because they believe that chatbots cannot replace humans and that many customers still prefer personal contact. Some interview participants have already had positive

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experiences with chatbots, especially in the area of insurance policy sales. They can imagine that it would be possible to conclude an insurance policy via a chatbot and consider this a positive development. On the other hand, other experts are sceptical and do not believe that chatbots can provide adequate communication, as insurance policies are too complex and face-to-face conversation remains essential. Some interviewees see chatbots as applicable for initial contact and answering simple questions, but they believe exclusive chatbot communication is inappropriate because insurance is complex. Other interviewees have had negative experiences with chatbots and consider them ineffective and frustrating for the customer. They do not believe chatbots will ever be smart enough to work well in the insurance space. Overall, the interviews show a mixed picture regarding the role of chatbots in customer communication and insurance policy sales. While some experts recognise the benefits and opportunities of chatbots, others are sceptical and prefer face-to-face contact. The future development of chatbots and their integration into customer communication will continue to be of great interest.

In the interviews, the acceptance of digital communication tools in digital sales of insurance policies was described as having increased through Corona. Managers play a crucial role by paving the way and sharing the enthusiasm. Employees must be trained to convey competence in the digital domain and reduce fears. Customers need to experience competence and transparency, while insurance companies need to become more transparent and authentic. However, the acceptance of digital forms of communication depends on the acceptance of society as a whole and varies depending on the age of the customers. Some interviewees suggest increasing adoption through incentives, such as bonuses for digital signatures and targeted communication of available digital tools. It is emphasised that digital forms of communication should be designed to be simple, understandable, clear and user-friendly. Sales reps and executives can help by demonstrating the options, promoting them, and taking customer feedback into account. Security and trust with regard to digital signatures should be strengthened by using simple software and communicating the benefits of digital communication. To increase acceptance among older customers, sales staff should pay attention to transparency and security in digital processes and not neglect personal contact. Some interviewees rate the acceptance of digital customer communication as rather low, as many customers prefer personal contact and perceive insurance as a complex topic. Managers can support their employees by creating the framework conditions for digital communication and improving the company's IT infrastructure. Overall, it is clear that acceptance of digital communication in the insurance business is higher among younger customers than older ones and that trust, transparency, and security are decisive factors. Sales staff and managers can help improve acceptance by educating customers about the benefits, offering simple and user-friendly solutions, and responding to individual needs.

5. Conclusion and recommendations

The presented research proves the main thesis: Communications between companies and their customers based on chatbots with artificial intelligence enable shortening the relationship between them, and their combination with other appropriate means of communication would increase company efficiency and customer satisfaction. The research provides guidelines for using chatbot technology in communication with insurance services clients.

This research examines the role of chatbots and artificial intelligence (AI) in insurance companies' sales and communications. It analyses quantitative and qualitative data to understand the impact of digitalisation and chatbots on customer behaviour and companies.

The interviews with experts from the insurance industry show that communication is a decisive factor in the successful sale of insurance policies. Trust, clarity and authenticity are essential, while transparency and comprehensibility are necessary for long-term customer retention. The choice of communication channels depends on the target group and customer profile, with younger customers preferring digital solutions while older customers value personal contact. The Corona pandemic has reinforced the trend toward digital communication. Opinions on using chatbots in customer communication and insurance policy sales are mixed. Some experts recognise the value of chatbots, while others are sceptical and prefer personal contact. The acceptance of digital communication tools has increased due to Corona, but managers, employees and customers need to be trained

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to convey competence in the digital domain and reduce fears. Digital communication should be simple, understandable and user-friendly to increase acceptance.

The results show that chatbots and AI offer various use cases in the insurance industry, such as sales support, lead generation, online insurance contracting, customer service, claims management, personalisation of insurance offers, customer retention, cross-selling, insurance policy management, risk prevention and consulting, and integration of smart devices and IoT.

The study of customer and communication levels shows that customer behaviour is influenced by various factors described by transaction theory, exchange theory, motivation theory, and trust concept. Intermediaries play a critical role in influencing the buying and communication process. They can apply advice and advisor strategies to manage conflicts of interest between customers and sellers.

The analysis of expert interviews and quantitative data highlights the importance of communication in insurance policy sales and the role of communication channels, especially in digital sales. The study shows that integrating chatbots and AI into the sales and communication process allows insurance companies to increase efficiency and customer loyalty while reducing costs.

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ROLE OF SOCIAL MEDIA IN SPREADING CONSPIRACY THEORIES*

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Abstract. The development of human civilization is currently – in the middle of the third decade of the third millennium – highly dynamic, inextricably linked to the development and introduction of new, modern technologies in all spheres or sectors of society. Information and communication technology is one of the most dynamically developing sectors. The wide use of various advanced systems, tools, and smart devices in connection with the mass use of the Internet and a wide range of interactive social media platforms brings a new way of communication among people and searching, receiving, and spreading information. Such developments bring many positives but also negatives in the form of abuse – especially of social media – to spread misleading, altered, distorted, deceptive and/or invented information, for example, in the form of different conspiracy theories to influence people's thinking and actions. Some conspiracy theories can be just harmless fun or an expression of a certain disbelief or scepticism. However, some can be very dangerous; they can be part of hybrid threats spread by state and/or non-state actors to disrupt the functioning of democratic societies, undermining trust in democratic institutions, principles, rules, etc. That is why today, conspiracy theories represent a threat and a challenge to society, especially democratic society, and that is also why the authors of this paper deal with them as part of the interdisciplinary scientific research carried out.

Keywords: Conspiracy theories; hybrid threats; democratic society; modern technologies; media; social networks

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Additional disciplines: information and communication; political sciences; sociology

1. Introduction

The modern human civilization is significantly influenced by deepening globalization processes, which are manifested to a greater or lesser extent in all spheres of society's life. With one of the manifestations of the current modern age, closely connected with the growing computerization, internetization and digitalization of society, the dynamic emergence of new media and the rapid development and increasingly massive use of sophisticated information and communication technologies, systems and means, a new range of possibilities has also appeared, such as all kinds of news, information, or theories to search. And a new range of options for creating or modifying them and then further sharing and spreading them. At the same time, however, a new range of possibilities for abusing modern technologies and devices (Hajdúková & Šišulák, 2022; Wang, et al., 2023) and spreading invented, altered, distorted, deceptive and misleading information through them, for

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example, in the form of various conspiracy theories to influence people's thinking and actions (Green & Douglas, 2018; Ivančík & Nováková, 2023; Hajdúková, 2023). The spread of some conspiracy theories, which react to various significant events, phenomena or processes taking place around us, thus represents a threat that can have very adverse consequences for individuals, social groups, organizations, and the entire human society. As the proliferation of conspiracy theories coincides with advances in information and communication technologies (Sambol et al., 2023), the online discourse on conspiracy theories is flourishing today. For this reason, several recent studies in this area have focused on the spread and exposure of conspiracy theories in social media (Gambini et al., 2024; Mitchell, 2024; Kaye & Johnson, 2024; Daunt et al., 2023; Sambol et al., 2023; Valenzuela et al., 2023).

It is widely recognized that the current capacity for mass online communication on social media carries various dangers: fake news, disinformation, or conspiracy theories that can be precisely targeted to a specific audience (Mitchell, 2024). Some conspiracy theories can be just harmless fun or a manifestation of a certain incredulity or scepticism about official explanations for some politically, economically, socially, militarily, or otherwise significant events, phenomena, or processes (for example, economic, financial, energy crises, wars, conflicts, epidemics, pandemics, climate changes, tragic events, deaths of prominent personalities, etc.). However, some can be very dangerous, as they can be part of hybrid threats spread by state and/or non-state actors with the primary goal of influencing the thinking, opinion, actions and behaviour of the population and, at the same time, creating chaos, polarizing and destabilizing society, disrupting its normal functioning, undermining authority and trust in democratic institutions, democratically elected representatives, democratic principles and also in the ability to solve current problems of society in the target countries. At the same time, they can lead to the support of violence, extremism, radicalism, ethnic, racial, or religious intolerance. This is also why some conspiracy theories currently represent a severe threat and challenge for democratic societies (van Prooijen & Douglas, 2017; Ivančík, 2022).

For this reason, we have decided to contribute to the current research in the field of conspiracy theories and hybrid threats as part of our scientific research activity and, using relevant methods of interdisciplinary scientific research, to participate in the clarification of these terms, which are increasingly used in the modern information society. At the same time, as part of the presentation of our scientific findings, we offer interested parties from the ranks of both the scientific and academic community, as well as practitioners, an insight into where the students of our academies obtain information, which sources they prefer when searching for information, whether they trust them, whether they consider the media, the Internet and social networks as tools for the spread of hybrid threats and also whether they believe conspiracy theories to be part of the spread of hybrid threats.

2. Conspiracy theories as part of hybrid threats

Conspiracy theories have become a widespread phenomenon in recent years. With a particular insight, it can even be said that they have become one of the phenomena of contemporary modern society. Undoubtedly, the above-mentioned rapid development in communication and information technologies, systems and means, the massive expansion of the Internet and the massive use of social networks contributed significantly to this. Conspiracy theories provide alternative explanations of significant historical or contemporary political, social or other events (phenomena, things, stories) with claims of secret conspiracies by people or groups trying to achieve their own goals at the expense of the majority of the population (e.g., gain or increase their power, subvert and control society, limit the activity of public institutions, etc.) (Uscinski, 2018). Therefore, many different conspiracy beliefs regarding a wide range of topics have recently appeared in the online space. Notable examples include unconventional interpretations of climate change (Samantray & Pin, 2019), the 9/11 attacks (Mahl et al., 2021), political movements such as QAnon (De Zeeuw et al., 2020), and/or theories related to the COVID pandemic -19 (Puri et al., 2020). As a result, the dissemination of such information can have far-reaching consequences for both individuals and society as a whole.

Belief in conspiracy theories has occurred in every historical period (Groh, 1987; Ucsinski & Parent, 2014). Although in the past the importance of anticipating real conspiracies and creating conspiracy theories was often important for human survival due to their frequent occurrence, which could lead to his death (Van Prooijen &

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Van Vugt, 2018), an enormous number of current conspiracy theories are in terms of their content irrelevant and illogical. American surveys show that up to 55% of people believe in at least one conspiracy theory - for example, the one that claims that a group of Wall Street bankers organizes the financial crises to get even richer from the crises and dominate the world economy (Oliver & Wood, 2014). The situation is no different even in the countries of the so-called Vyšehrad Group (V4) because in Slovakia, Poland, Czechia, and Hungary, more than one-third of the population still believes in the conspiracy theory that Jews are trying to dominate the world (Krekó, 2015).

Studies published based on research carried out in the field of belief in conspiracy theories confirm that a person who believes in one conspiracy theory is generally more likely to believe in other, seemingly unrelated conspiracy theories (Goertzel, 1994; Swami et al., 2011). The effort to understand users' inclination towards conspiracy theories is thus of great interest because it can offer valuable insights into the spread of ideologies without limiting the analysis to a particular conspiracy theory. This understanding is crucial for assessing the roles played by the individuals involved and taking appropriate measures to mitigate the impact of this phenomenon (Gambini et al., 2024).

The importance of understanding and investigating this phenomenon stems not only from their irrational nature but mainly from research that has pointed to the negative connection between belief in conspiracy theories and the safety of individuals and society. Belief in some conspiracy theories is closely connected with organizing and advocating violent protest actions (Chayinska & Minescu, 2018), with extremism, radicalization and violence committed by some extremist groups (Bartlett & Miller, 2010). Likewise, belief in some conspiracy theories is associated with the promotion of xenophobia, racial, ethnic and religious hatred, polarization of society, etc.

Some conspiracy theories can be considered one of the forms of hybrid threats precisely for the above reasons. Their dissemination is by no means just harmless fun or a manifestation of a certain scepticism on the part of some individuals about the official explanations of some significant events but represents a carefully thought-out move, the only real intention of which is to promote predetermined strategic political and ideological goals. These are not just "regular conspiracy theories", such as those about aliens living among us because their spaceship crashed on Earth and they can't get home, so they took human form and adapted to life on Earth, or about a staged moon landing, which did not happen but was filmed in a movie studio to show the Americans to the world that they are better than the Russians in conquering space, or about Elvis Presley, Princess Diana, Michael Jackson and other famous people who, according to these theories they staged their death to live their next life peacefully, in seclusion, without ubiquitous media and sensationalist journalists (Greig, 2019; Uscinski – Parent, 2014). In this case, as stated above, these are elaborate conspiracy theories spread for support in achieving predetermined strategic political and ideological goals based on individual methods and procedures used to spread hybrid threats within the conduct of hybrid warfare. It is a conscious and deliberate activity aimed at manipulating the general public through disseminating various fabrications, lies, half-truths, misleading, distorted videos, images and/or stories to achieve set goals.

Based on the information above, this type of conspiracy theory is a form of political propaganda that aims to promote political and/or ideological goals. They use a proven strategy for this - they offer attractive explanations of significant events, phenomena and processes, which, although untrue and objectively improbable, focus the public's attention in the desired direction. However, individual actors pursue their interests and goals by spreading conspiracy theories (Qassam, 2019).

The essence of conspiracy theories is that nothing is as it seems at first glance, and everything is connected to everything. In other words, conspiracy theories try to convince people that there is a particular group of people - the so-called conspirators - usually representatives of elites (for example, the Rockefellers, Rothschilds, Windsors, Murdochs), the government (American, British, German, Israeli) or secret services (CIA, FBI, NSA, Mossad), some organizations (G7, NATO, EU) or secret societies (Bilderberg Society, Freemasons, Illuminati, etc.) or famous personalities (e.g. Bill Gates or George Soros) who secretly plan and organize everything that happens. Fictional conspirators are usually presented as enemies of the people.

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Conspiracy theories thus divide the world into good and evil, We versus They. At the same time, conspiracy theorists argue that people must look beneath the surface to uncover the actions and intentions of conspirators who go to great lengths to hide their true intentions. The assumption is that if the one or those who want to know how it is or was, that is, to know the "real truth", they must "drill, dig deep enough" to discover the hidden connections between people, institutions, and events (phenomena, processes), which explain what happens or happened (Byford, 2011).

Some conspiracy theories can be considered part of hybrid threats because they are part of non-military, unconventional and asymmetric combat methods and part of conducted information, psychological and intelligence operations aimed at influencing the opinion, thinking and behaviour of the population in the target countries and reducing the resistance of the attacked society. In terms of definition, hybrid threats can be characterized as a set of coercive and subversive activities, conventional and unconventional, military and non-military methods and tools, used systematically to achieve specific goals without a formal declaration of war and under the pretext of a standard response (Ivančík, 2016). They are applied by activities characterized by centrally controlled intelligence and information activity, by the activity of non-state actors, including paramilitary groups, or by the deployment of the armed forces of a state actor without designation. Such activities can begin before openly declared military operations (EU, 2016; Jurčák & Turac, 2018; NATO, 2023).

From the perspective of relevant international organizations, NATO defines hybrid threats as a combination of military and non-military and covert and overt means, including disinformation, cyber-attacks, economic pressure, the deployment of irregular armed groups and conventional forces. Hybrid methods blur the lines between war and peace and try to sow doubt in the minds of the target population. Their goal is to destabilize and undermine societies (NATO, 2022).

According to the European Union, state or non-state actors can use and coordinate hybrid threats to achieve specific political goals. Hybrid campaigns are multidimensional, combining coercive and subversive measures using both conventional and unconventional tools and tactics. They are designed to be challenging to detect or attribute. These threats target critical vulnerabilities and seek to create confusion that would prevent quick and effective decision-making. Hybrid threats can range from cyber-attacks on critical information systems by disrupting essential services such as energy supplies or financial services to undermining public trust in government institutions or deepening social differences (EU, 2018).

According to the National Security Analytical Center, hybrid threats are characterized by the simultaneous use of several tools in a coordinated manner to exploit the vulnerabilities (weak spots) of the adversary and subsequently weaken his decision-making processes while maintaining a certain degree of plausible deniability. The strategic goal of these threats is to weaken public trust in democratic institutions, deepen unhealthy polarization at the national and international levels, question the fundamental values of democratic societies, as well as gain geopolitical influence and power through damaging and influencing democratic decision-making processes (NBAC, 2021).

For a better understanding of the investigated issue and to create a comprehensive picture of why some conspiracy theories can be considered part of hybrid threats, it is necessary - within the framework of the theoretical-methodological starting point of the investigation of the issue - to mention other closely related terms, such as hybrid influence, hybrid activity (action) and above all hybrid warfare.

Hybrid influencing is an act that the instigator achieves through several mutually complementary methods and the use of the vulnerabilities of the target society. Hybrid influencing is realized through economic, political, or military use and other tools. It can also be carried out using information and communication technologies and social networks, while the methods can be used simultaneously or sequentially (YT, 2017: 95).

A hybrid activity (action) is an activity characterized by ambiguity, which arises from the combination of using conventional and unconventional means - disinformation, fake news, interference in political debate or elections, disruption of functionality or attacks on critical infrastructure, implementation of information and cyber

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operations, various forms of criminal activities and asymmetric use of military assets and warfare (Zandee et al., 2021: 8).

A hybrid war can be understood as an armed conflict led by a combination of non-military and military means to force the adversary to take actions it would not have taken on its own through their synergistic effect. At least one side of the conflict is the state. The primary role in achieving the goals of the war is played by non-military means in the form of information and psychological operations, propaganda, economic sanctions, embargoes, criminal activities, terrorist activities and other subversive activities of a similar nature, which are conducted against the entire society, especially against its political structures, state authorities administration and self-government, the economy of the state, the morale of the population and the armed forces (Kříž et al., 2015: 8).

Overall, in the case of hybrid war, it is a way of conducting a modern armed conflict. A conflict that does not start with a shot and certainly not with a declaration of war. A conflict that the attacked society does not even know about at first does not even suspect or admit that it has been attacked and is at war. It is a dynamic combination of military and non-military (political, diplomatic, economic, technical/technological, humanitarian, diversionary, terrorist, criminal, etc.) activities carried out by state and non-state actors, regular and irregular formations, using disinformation, propaganda, sanctions, and other tools. and methods and implementation of information, cyber and psychological operations (Ivančík, 2016: 148).

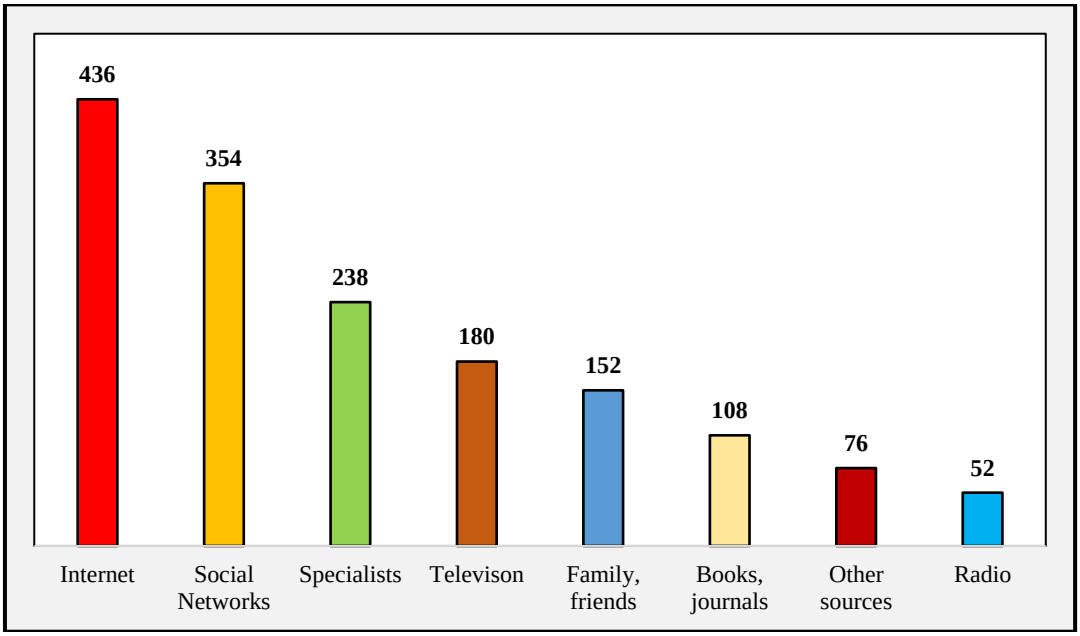
3. The spread and perception of conspiracy theories as part of hybrid threats

The use of various fabrications, lies, half-truths or twisting of facts to influence individuals or even the entire public within the framework of hybrid activities, as we have already mentioned above in the text, is nothing new, but if it is combined with sophisticated means, such as today's modern smart devices, means and technologies, with the environment of social networks and the Internet, or the activity of hackers, there is a new and extreme threat of the spread of various types of conspiracy theories, disinformation, hoaxes or so-called fake news, which represent a danger not only for individuals, social groups and organizations but in some cases a security threat for the entire contemporary democratic society (Ivančík & Nečas, 2022).

The emergence and rapid development of the Internet and social networks have radically changed how people communicate and obtain information today. This new way of communication is characterized by the very high speed with which information is transmitted. Social networks offer the highest level of interaction that current communication can provide users. Access to all kinds of information on the Internet and social networks is almost unlimited and, compared to other options, very cheap and mostly wholly free. Also, the lack of effective and efficient measures aimed at regulating online content, in contrast to that provided through traditional media, makes the online environment of the Internet and social networks extremely interesting and tolerant.

Research carried out at the Academy of the Police Force in Bratislava and the Academy of the Armed Forces in Liptovský Mikuláš in 2023, in which 532 students of internal and external bachelor's, master's and doctoral studies took part, confirmed that the Internet and social networks represent the two most used options for obtaining information. They are followed by experts, television, family, friends, acquaintances, the press, books, magazines, newspapers, radio, or other sources of information (graph 1).

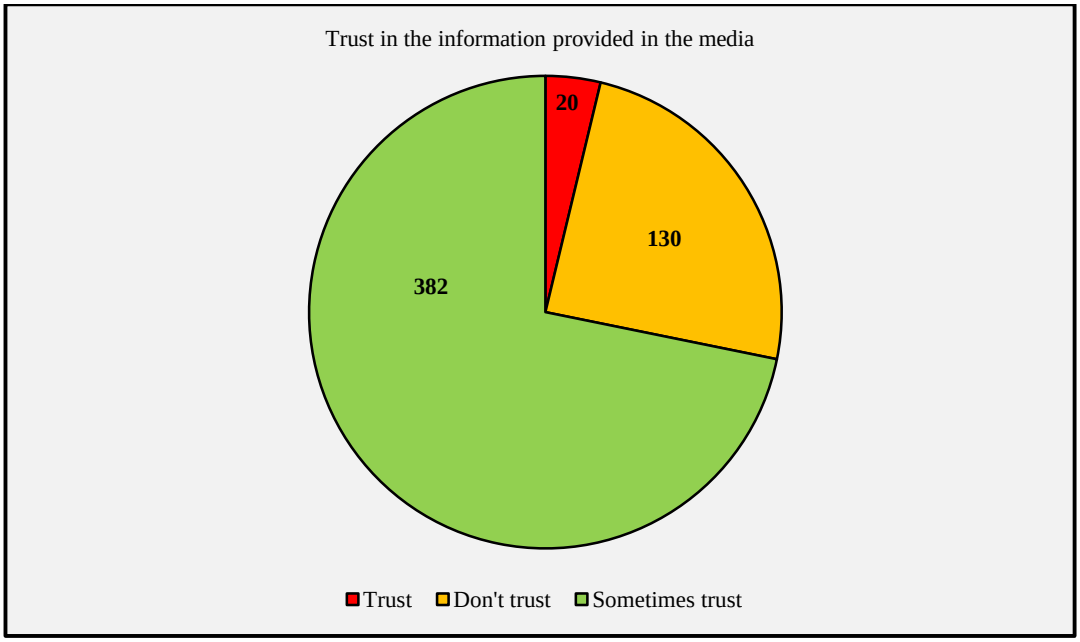
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Graph 1. Overview of the possibilities used by students in obtaining information (number of students)
Note: For this question, students could mark the three most used options for obtaining information

Source: Own research, 2023

The following graph explains why students use the Internet and social networks more often to obtain information than traditional media (television, radio, books, magazines, newspapers). It follows that only 20 (3.76%) students fully trust information from the media, compared to 130 (24.44%) who clearly do not trust the information provided in the media. Most students, up to 382 (71.80%), trust information obtained from the media only sometimes (graph 2).



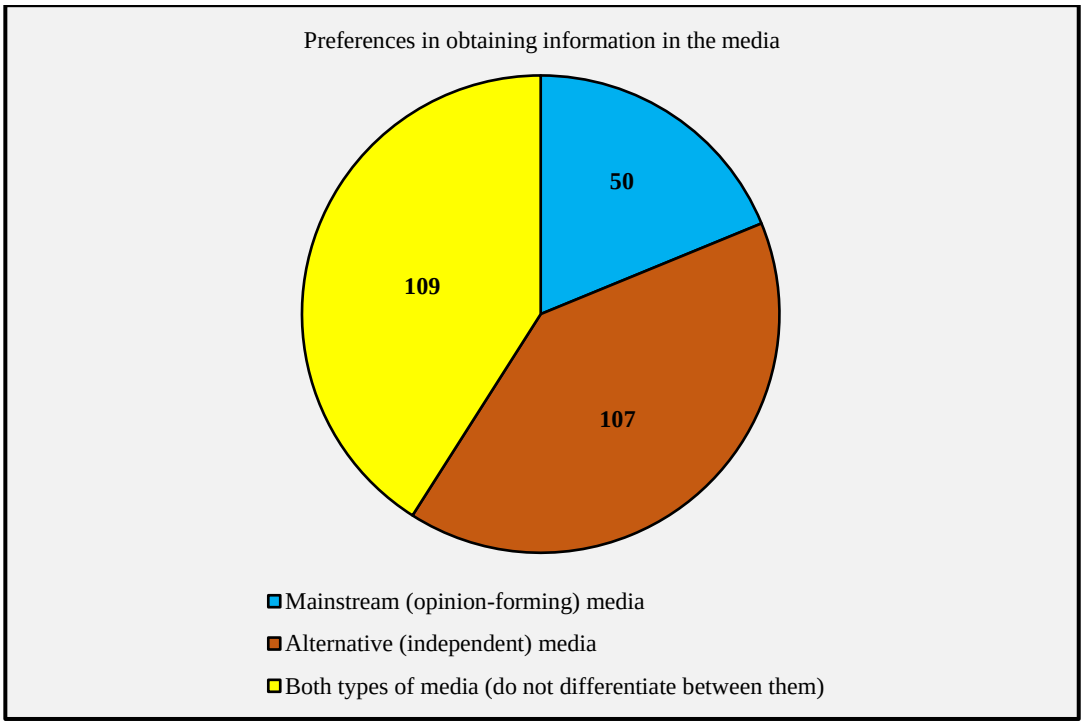
Graph 2. Overview of students' trust in the information provided in the media (number of students)
Source: Own research, 2023

Considering the low trust of students in the information provided by the media, in this context, we were interested in whether students - if they do use information from the media - prefer mainstream (opinion-forming)

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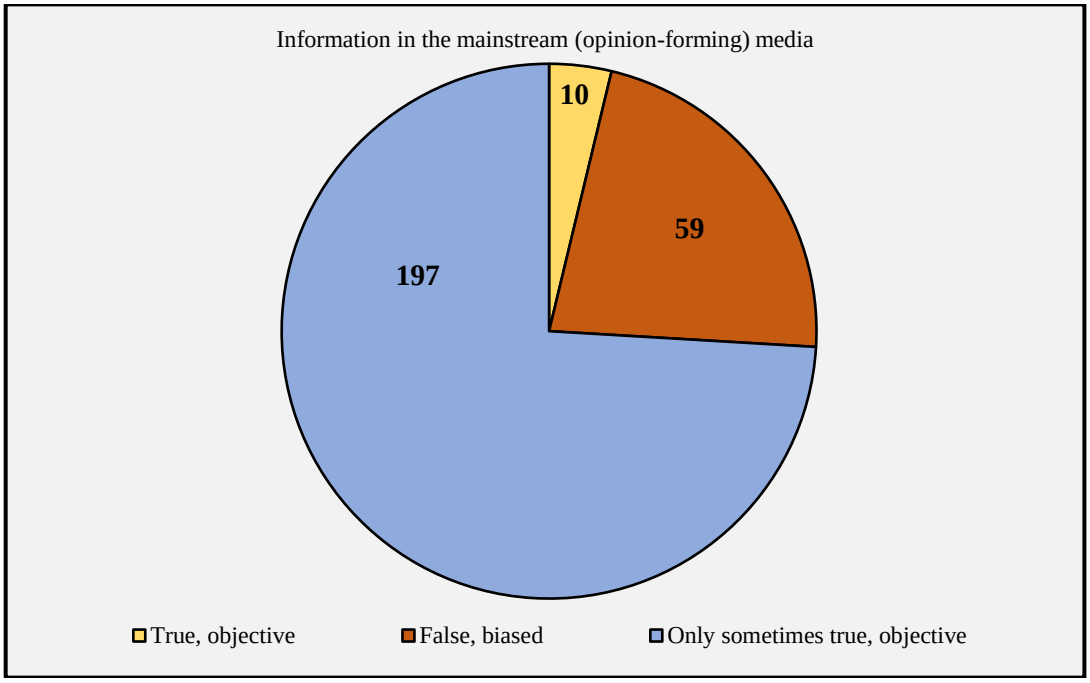
media when obtaining information or whether they prefer to obtain information from alternative (independent) media (portals, resources). The respondents' answers show that more than four-tenths of students (40.98%) need to differentiate between media when obtaining information. A slightly smaller part of students (40.22%) prefers to use alternative (independent) media, and the smallest part of them – less than one-fifth (18.80%) – prefer mainstream (opinion-forming) media (graph 3).

The higher trust of students in alternative (independent) media compared to mainstream (opinion-forming) media is also confirmed by the following answers to the question, which was used to determine whether they consider the information presented in both types of media true or objective. It follows from the answers of the respondents that only 20 students (3.76%) consider the information presented in the mainstream (opinion-forming) media to be true, or objective. In contrast, up to 118 students (22.18%) consider the information published in these media false or biased. The largest part of respondents (394), which represents almost three quarters (74.06%), stated that they consider the information published in the mainstream (opinion-forming) media to be true or objective only sometimes (graph 4).



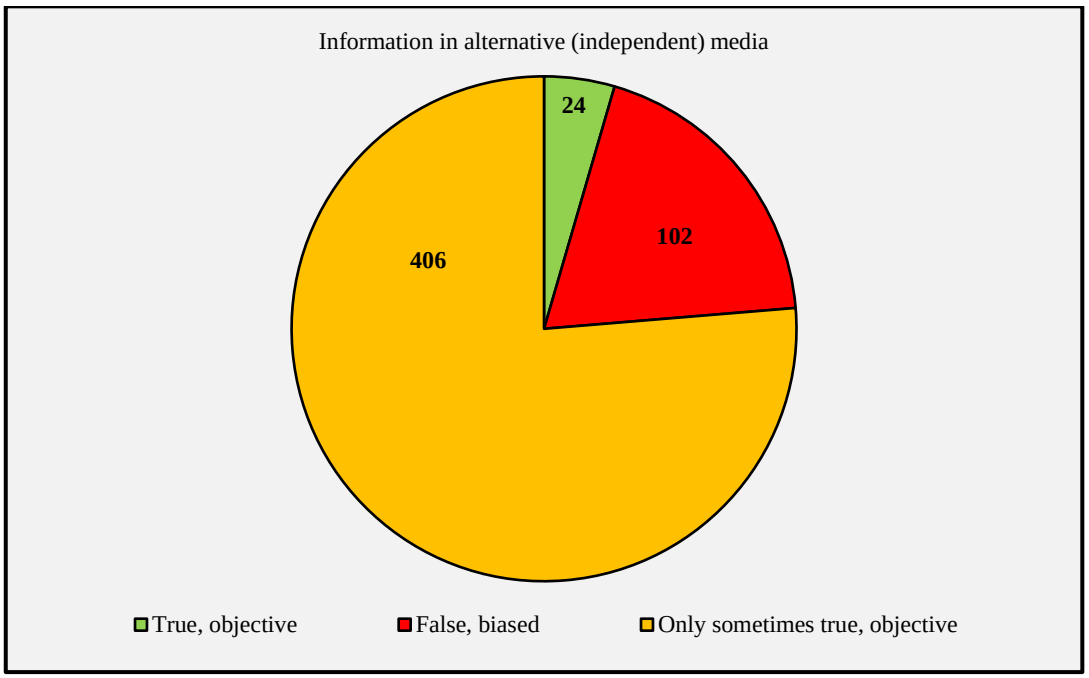
Graph 3. Overview of students' preferences in obtaining information in the media (number of students)
Source: Own research, 2023

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Graph 4. Overview of students' opinions on truthfulness or objectivity of information presented in mainstream (opinion-forming) media (number of students)
Source: Own research, 2023

The slightly higher trust of students in alternative (independent) media compared to mainstream (opinion-forming) media is confirmed by the following answers. They show that while 24 students (4.51%) consider the information presented in alternative (independent) media to be true or objective, 102 students (19.17%) consider the information published in these media to be false or biased. The largest part of respondents (406), more than three quarters (76.32%), said that they consider the information published in alternative (independent) media to be true, or objective only sometimes (graph 5).

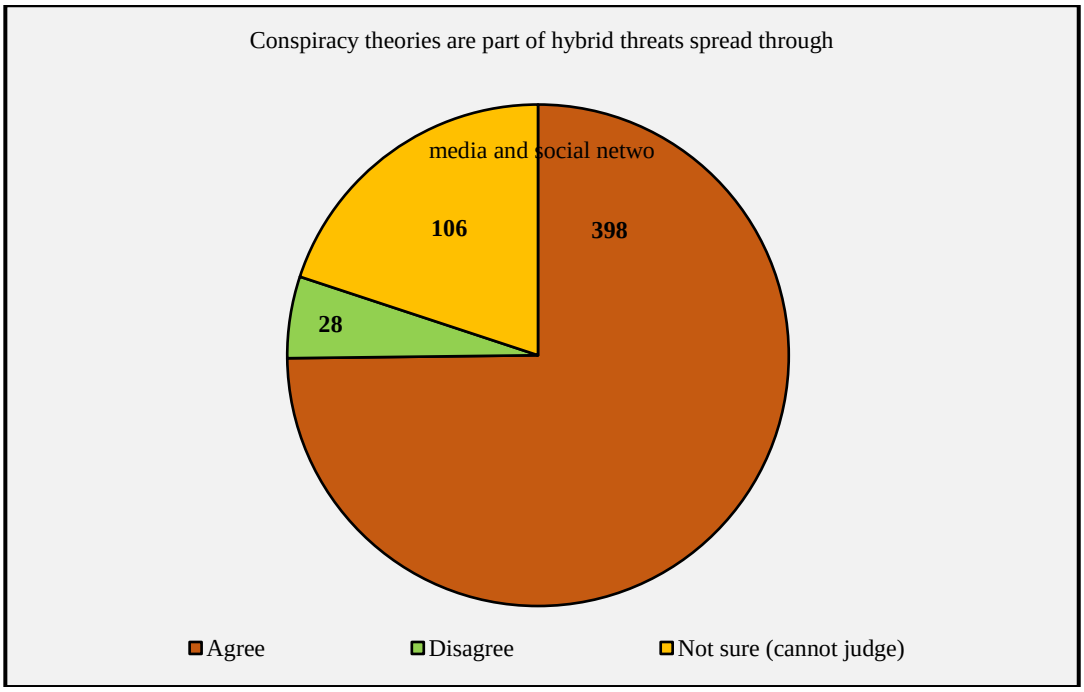


Graph 5. Overview of students' opinions on truthfulness or objectivity of information presented in alternative (independent) media (number of students)
Source: Own research, 2023

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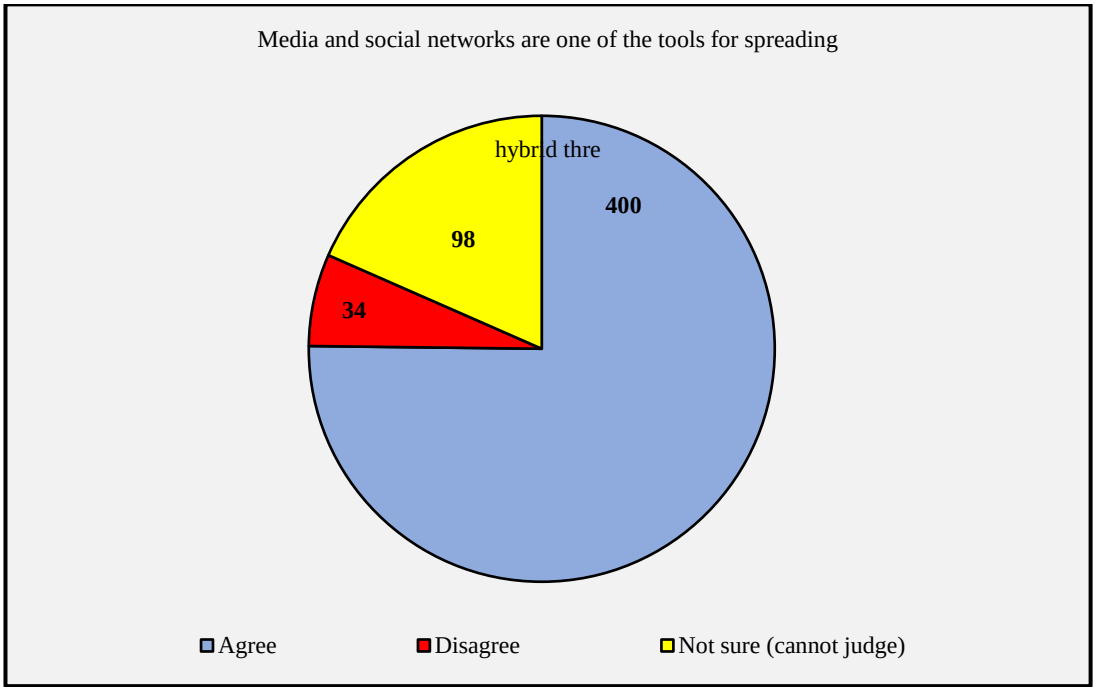
Although students expressed higher trust in the truth and objectivity of information presented in alternative (independent) media than in mainstream (opinion-forming) media, faith in the truth and objectivity of information in both media types is generally low. The largest group of students is those who consider the information presented in both media types to be accurate and objective only sometimes.

These results are very closely related to the opinions expressed by students when asked if they consider conspiracy theories to be part of the hybrid threats disseminated through the media and social networks in the context of hybrid warfare. It follows from the answers of student respondents that almost three-quarters of them (74.82%) identify with this opinion. Only roughly one-twentieth of students (5.26%) disagree with it, and one-fifth (19.92%) are not entirely sure or cannot assess it (graph 6).



Graph 6. Overview of students' opinions on whether conspiracy theories are part of hybrid threats spread through the media and social networks (number of students)
Source: Own research, 2023

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Graph 7. Overview of students' opinions on whether the media and social networks are one of the tools for spreading hybrid threats (number of students)
Source: Own research, 2023

Following this, we asked the students whether they consider the media and social networks to be one of the tools for spreading hybrid threats in the conduct of hybrid warfare. The answers were very similar, as more than three-quarters (75.19%) of the student respondents believe that the media and social networks are one of the tools for spreading hybrid threats in the conduct of hybrid warfare. Only 6.19% of respondents do not agree with this opinion, and less than one-fifth (18.42%) are not entirely sure or cannot assess it (graph 7). The views of students reflect processes in contemporary society. Therefore, the obtained results must be considered when designing policies to fight against disinformation spreading via social media.

Conclusions

In recent decades, our way of social functioning has changed significantly due to the dynamic development of human society, especially in the field of information and communication technologies, systems, and means. In the last three years, the coronavirus pandemic and measures taken to eliminate its spread and protect public health have significantly contributed to this change. The progressive internetization, computerization and digitization of society, as well as the advent of new media and the massive use of social networks, have brought many positives, but also several negatives. These are usually related to anonymity on the Internet and social networks, distorting reality or showing unrealistic values that should not even be values. Media, the Internet, and social networks have become a fixed part of our daily lives. These, especially the Internet and social networks, have become very powerful information and communication tools that have changed the way of interpersonal communication.

There is nothing surprising about this because it brings many positives; for example, we can talk to a classmate from primary or secondary school or from the university or a friend from childhood whom we haven't seen for years. We can find out the interests of a person we like, whom we recognize, where we can go on vacation or a trip, what accommodation options are there, etc. The Internet and social networks also significantly accelerate the flow of information and data and the spread of thoughts and ideas. Among the positive effects, we can also mention various support groups for people who have different health problems or belong to a minority community, help in education or provide space for education, creativity, or self-expression, if used correctly.

Unfortunately, the Internet and social networks and their mass use (and in many cases also abuse) also have their dark sides, and there are quite a few of them. One of them is (among others) the fact that they provide an opportunity to spread through them various conspiracy theories that can very adversely affect people's thinking, actions, and behaviour, disrupt the functioning of society, question existing democratic values and principles, the functioning of democratic institutions, the ability to act, to solve problems, thereby endangering the entire democratic society. Together with some media, some conspiracy theories represent one of the tools for spreading hybrid threats within the framework of conducting a hybrid war. The above is also confirmed by the results of research carried out among students of internal and external studies as part of bachelor's, master's and doctoral studies at the Academy of the Police Force in Bratislava and the Academy of the Armed Forces in Liptovský Mikuláš.

This is also why the state and its competent institutions need to take effective and efficient measures to combat hybrid threats, support prevention and education in media literacy, and work with information. Increasing awareness of conspiracy theories, improving the ability to recognize and detect them, as well as eliminating their spread as much as possible, would certainly mean fewer opportunities for, for example, populism, radicalism, extremism, xenophobia, or polarization in society. For this reason, the state's involvement in this issue is desirable and necessary. On the other hand, we all must realize that the possibilities of the state are not endless; not everything will be solved by the state, so we must contribute to eliminating the influence of conspiracy theories and their spreaders on our lives.

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GOOD PRACTICES OF USING ARTIFICIAL INTELLIGENCE IN THE DIGITALIZATION OF HIGHER EDUCATION*

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Abstract. The present research is dedicated to the good practices of using AI in the overall digitalization of higher education. The primary objective is to identify good practices used by the universities in implementing AI technologies in their everyday life for educational and administrative needs. At the same time, our additional goal is to understand the expectations of students for further implementation of AI in universities. We developed our research in 2 main stages: the first one – the collection and identification of good practices of universities with AI and digitalization, and the second one – is devoted to students' expectations. We conducted 25 interviews with representatives of 18 Bulgarian universities responsible for digitalization. The second stage was to provide a survey among students (n=254). Our findings reveal that digitalization is one of the leading priorities for universities; most universities have specific strategic documents for digitalization. Several challenges are outlined for smooth digitalization: lack of sufficient resources (including financial, administrative capacity, etc.); unwell-prepared infrastructure (including lack of shared vision for the different systems used so far within the university); the emergence of various types of resistance (both in academic and administrative staff) etc. The significant advantage for universities using AI is seen in the improved quality of the educational process (including the introduction of new educational perspectives through new technologies), improved administrative service, and enhanced public image, which reflects an increased number of potential candidates.

Keywords: Digitalization; Artificial Intelligence; Higher education institution; Digital Education

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JEL Classifications: M00, M14, M15, O33

1. Introduction

Nowadays, digitizing services offered by businesses and entities in Public Administration is essential for securing competitiveness, a high level of efficiency and a chance for the sustainability of organizations. As the crucial mediator and bridge between the education system and the labor market for young people, universities should propose high-quality educational services accompanied by relevant administrative services. Digitization has to be considered as a key to new development from all these perspectives.

Digitization and, more precisely – AI in universities, is not a simple and sporadic process. It requires the combined efforts of different experts, staff and managers. But first of all, it requires the existence of a comprehensive concept of digitization of the university; it requires the commitment of the rector's management (such as

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strategic decisions and the direction of development to be followed); on the other hand, it requires dedication on the part of IT professionals, on whom the initial main activity falls to develop and build the necessary infrastructure, together with all the required security procedures, and subsequently to maintain it at a high level. Secondly, once the required infrastructure is built, academic and administrative staff must engage with digitization. Again, this is not a smooth and seamless process because changes come with new efforts from the staff. However, the main goal - achieving high-quality educational and administrative services and meeting the requirements and expectations of students- deserves additional efforts, which will subsequently be rewarded - both by the larger intake of students and their high degree of satisfaction.

Usually, young people are willing and open to new technologies and changes. For them, the digital world is as natural as a traditional one. This observation is likely strengthened and strengthened with each passing year. The generations coming to universities are increasingly digitized and expect universities to be at an extremely high level as institutions and centers of cutting-edge technology.

The current article is in this line of consideration. We want to outline good practices implemented in universities using Artificial Intelligence and compare them with students' expectations. Namely, on this basis, we could propose new ideas for further development and implementation of AI in the everyday life of universities.

2. Literature review

The main topic of Artificial Intelligence and its application in different aspects of both professional and personal life has been the epicenter of scientific discussions for the last few years. However, the discourse is complex and covers a variety of features – from a purely technological point of view through the social impact on humans to different economic perspectives. Therefore, higher educational institutions are not an exception when we consider digitalization and, more specifically – using AI for other purposes in university (usually for improving the level of education through innovative elements, but also using AI for various administrative services developed for students).

In this line of consideration comes the research of Hornberger, Bewersdorff and Nerdel (2023), who explore university students' level of AI literacy. Their findings indicate notable differences in AI literacy levels among students, with the majority demonstrating a basic comprehension of AI concepts. Students with a technical study background or prior exposure to AI tend to possess a higher level of AI literacy. In turn, Jo has focused on studying the behaviour of students and office experts and their attitudes towards using some elements of artificial intelligence, including ChatGPT. Exploring the specifics of ChatGPR, the scholar admits that its capacity to learn and engage in conversation closely resembles human interaction, blurring the line between artificial and genuine communication (Jo, 2023). The author also claims that university students and office workers are actively utilizing the benefits of AI-driven tools. These tools assist them in various aspects, such as learning support, research assistance, time management, and automating tasks (ibid). Darvishi et al. (2024) explore AI tools' impact on how university students learn. For this purpose, the scientific team conducted comprehensive empirical research (among 1625 students from 10 countries). Their findings are exciting – they admit that students relied on AI assistance rather than learning from it. Scholars also found that when AI assistance was removed, students could depend on self-regulated strategies to some extent, but they were not as effective in filling the knowledge gap. They discovered that combining human-AI approaches, known as SAI (self-regulated strategies with AI assistance), was not more effective than AI assistance alone. They concluded that the combination of self-regulated strategies and AI was not found to enhance the learning outcomes beyond what AI assistance could achieve on its own (Darvishi et al., 2024).

Providing quality education is one of the primary objectives of any university worldwide. Therefore, technologies and techno-innovations, including using AI to improve educational processes, are also subjects of sound science interest. In this line of consideration, Tan and Cheah (2021) propose a gamified AI-enabled online learning application which helps university students improve their attitude and perception in more challenging courses such as physics. Hamid et al. (2023) explore the attitude of university students to use AI tools in the

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learning process. Scholars discovered that using ChatGPT positively impacted group collaboration and student engagement. It increased their motivation and encouraged them to ask more questions. However, scholars admit that some students needed help understanding the information provided by ChatGPT, which led them to question its reliability and credibility.

Authors conclude that despite these challenges, most students recognized the potential of ChatGPT to eventually replace traditional methods of seeking information. They believed that with further improvements, ChatGPT could become a valuable tool for accessing information and acquiring knowledge (Hamid et al. (2023). Athilingam and He (2024) admit that using AI-based technology could negatively impact the ability of students to think. They claimed that despite all the controversial roles of ChatGPT and new technologies in the educational process, the better response could be to integrate ChatGPT as an assistant tool in the learning process rather than banning new technologies (ibid). Boubker (2024) has a different opinion. He conducted research, and the results indicated that the perceived usefulness of ChatGPT had positively influenced how often students used it and their overall satisfaction with it. This, in turn, led to an enhanced individual impact on their learning experience. The scholar concluded that his findings have significant implications for managers in higher education institutions (HEIs) in improving teaching practices in the digital age. HEI managers can act by incorporating ChatGPT or similar AI technologies into their teaching methodologies. This can help renovate and enhance the learning experience for students. By leveraging the benefits of ChatGPT, such as its perceived usefulness in facilitating learning and increasing satisfaction, managers can adapt their teaching practices to align with the digital age. This could lead to more effective and engaging educational experiences for students in HEIs (ibid). Dai, Liu and Lim (2023) also claim that ChatGPT and generative AI have enormous potential to empower students in their educational efforts.

On the other hand, scholars admit that this technological innovation comes with a price, which requires joint effort from all stakeholders, including HEIs management, academic staff, etc. Interesting research on the applicability of AI and different AI tools in education has also been developed by Chung et al. (2021), Kaufmann (2021), Yilmaz and Yilmaz (2023), Chen, Zhu and Castillo (2023), etc. Chiu (2024) perceives the possibility of transforming the higher education system using generative AI to prepare students for new requirements of the labor market and society, which generative AI will power.

Rodway and Schepman (2023) explore the influence of integrating AI educational technologies on the anticipated satisfaction of university students with their courses. Their findings reveal a fascinating picture of the level of student satisfaction integrating AI tools in the educational process at universities. Authors admit that while students generally expressed a moderate level of comfort with AI educational applications, their satisfaction with courses decreased when considering the hypothetical implementation of such technology. Notably, discomfort levels were highest when AI applications involved assigning final grades or providing support for well-being (ibid).

Nguyen, Le, Hoang and Nguyen (2021) developed the possibility of using ChatBot to improve the university's admission process and, primarily, to provide basic information for potential and actual candidates for students at the university. They describe the methodology used for building a chatbot for the student's admission and admit that for this purpose, ChatBot can save person-hours and, at the same time – provide adequate and relevant information to the target group at any time. An exciting application of AI chatbots for helping university students is proposed by Liu et al. (2022). The scholars explore the possibilities of providing support to university students who are in depression using for this purpose AI Chatbot.

Another opportunity where AI could also be used successfully in universities is in human resource management (HRM). Universities typically have large teams of academics and administrative staff, and in this line, AI could help drastically soon. Some ideas on the usage of AI in HRM are developed by Pan and Froese (2023), Anguelov (2023), Chowdhury et al. (2023), Radonjić, Duarte and Pereira (2022), Rodgers et al. (2023), and others. On the other hand, different applications of AI tools could also be implemented for general management improvement of the universities for instance, in their decision-making process (Baabdullah, 2024); innovations and innovation policy – Sjödin et al. (2021); mathematical algorithms in AI for enhancing

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productivity (Ilieva, Anguelov, Nikolov (2019)); big data analytics (Mantri& Mishra; 2023), sustainable organization development (Sulich, Sołoducho-Pelc, Grzesiak, 2023); organizational transformation (Nosova et al., 2022; Kulkov, 2021); improvement of employee collaboration, including collaboration between AI and employees (Chowdhury et al., 2022; Sliwa, Krzos, & Piwoni-Krzeszowska, 2021) etc.

Along with various applications of AI in everyday life of the universities (both educational, scientific and administrative services), some authors also pay attention to the other side of the usage of generative artificial intelligence and its impact on the assessment of students in higher education institutions. Moorhouse, Yeo and Wan (2023) present the change in rules for evaluating universities due to the use of generative AI. Considering the current educational and employment environment, the authors concluded that it could be advantageous for universities to incorporate Generative Artificial Intelligence (GAI) into the assessment process. According to them, to implement this, instructors must acquire a new skill set termed ngenerative artificial intelligence assessment literacy (ibid). Fesenmaier and Wöber (2023) also admit that generative AI has been met with numerous cautions, leading to universities globally either prohibiting or placing restrictions on their utilization.

Based on the literature review, the use of AI in higher education, with all the positive and negative consequences, is yet to develop and deepen. In this regard, universities should be agile and proactive in providing quality education and introducing as many new technologies as possible into their daily lives. Thus, they will simultaneously respond to the changing reality, business requirements, and a large part of the students' expectations.

3. Methodology of the research

The primary objective of the current research is to identify good practices used so far by universities in implementing AI technologies in their everyday life for educational and administrative needs. At the same time, our additional goal is to understand the expectations of students in the further implementation of AI in universities. We used the following methodology to achieve this goal, graphically presented in Figure 1.

We started with identifying the main objective of the research. The research is a part of the implementation of the overall project, financed by the Bulgarian National Research Fund and titled "Digitalization of the Learning Process in Higher Education - identification and Management Model". According to the project's action plan, we have to identify good practices of universities in implementing AI technologies and, based on this, to propose concrete ideas for further implementation of AI in the digitalization process of universities. Therefore, our major goal of concrete research is to develop a workable proposal for further integration of AI into the everyday life of universities.

The next step was to identify several specific sub-objectives, which will lead to the implementation of our primary goal. The specific objectives of the research are as follows:

- to collect information and identify good practices for using AI in universities in Bulgaria
- to understand the perception and attitude of students regarding the integration of AI into everyday life at universities
- to compare the state of play with the expectations of students and, on this basis, to propose workable ideas for further integration of AI in universities

Once we had the main objective and sub-objectives, we could select concrete tools for their achievement. For this purpose, we developed our research in 2 main stages: the first is dedicated to collecting and identifying good practices of universities with AI and digitalization, and the second is devoted to students' expectations. To carry out the first stage, we used personal interviews (semi-structured) and a review of the available information in international scientific databases. For the second stage, we developed and used a specifically designed questionnaire. The results of these two phases of the research are presented in the next part of the article.

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The next step was to conduct interviews with representatives of the management of several Bulgarian universities responsible for digitalization. As a result of this step, we had 25 interviews with representatives of the 18 Bulgarian universities (located in Sofia, Burgas, Plovdiv and Blagoevgrad). The analysis of these interviews allows us to make a relatively straightforward conclusion on the state of play in the digitalization process for the universities in Bulgaria and to outline the significant problem areas so far.

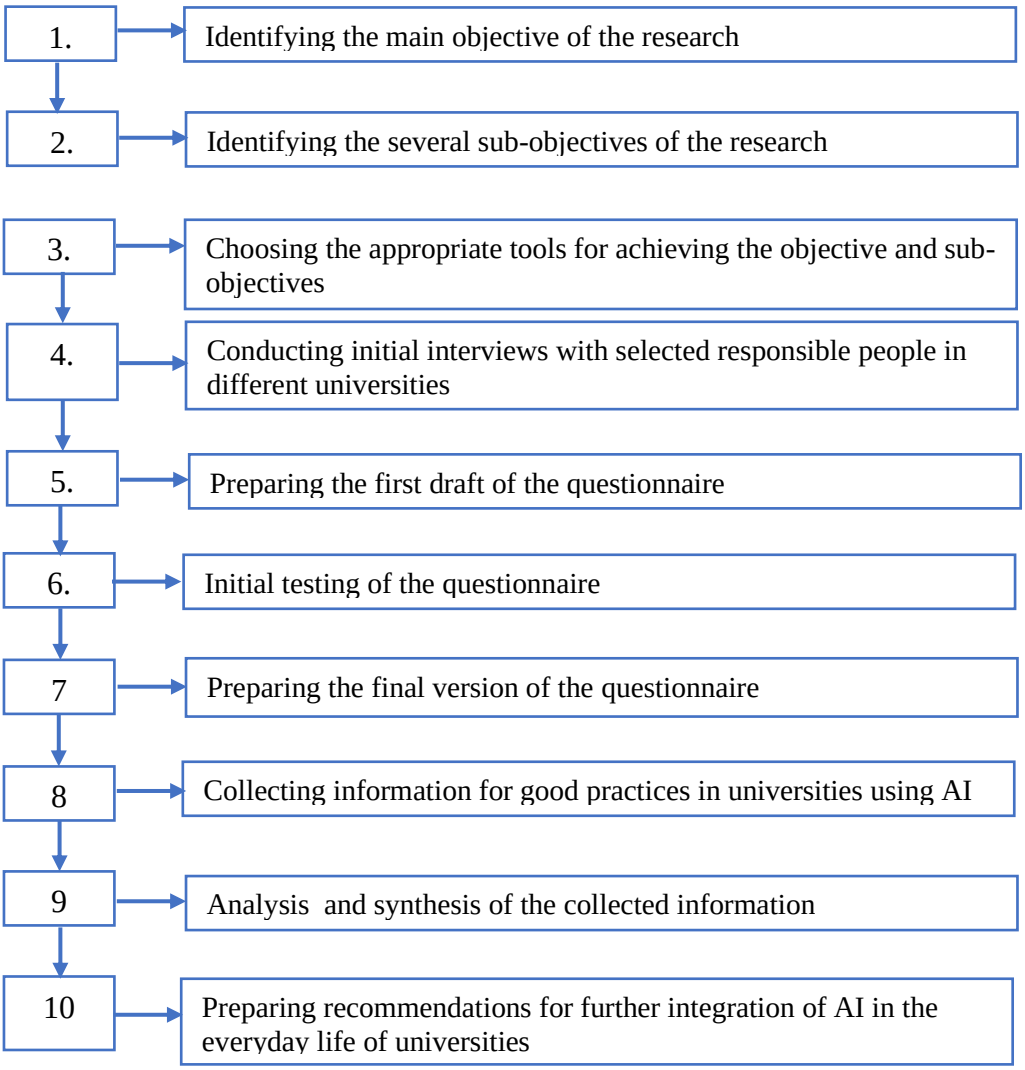


Fig. 1. Methodology of the research

Based on the understanding of the situation regarding digitalization in universities, we prepared the first draft of the questionnaire so that students could understand their major attitudes and perceptions of using AI in everyday life. When we were ready, we tested this initial questionnaire draft with students willing to participate in a focus group for such a subject. The majority of the students were open and expressed their positive attitude toward the subject of the research, namely, using AI in universities. After this initial testing, we had to review three questions to achieve more correct information. The final version of the questionnaire contains 19 questions in total: 5 for the demographic profile of the respondents and the remaining 14 questions – devoted to the concrete purpose of the research.

Once we had the final version of the questionnaire, we posted it on the Internet (using Google Forms) and sent a link to all available channels (including social media, intranet channels of universities, emails, etc.) to reach as many university students as possible. Before filling in the survey card, all respondents were informed that

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this research is anonymous and voluntary, being done solely and exclusively for scientific purposes to improve the quality of digitization of the Bulgarian universities. As a result, we received 254 responses.

We could analyze and synthesize the collected information when we closed the period for filling out the questionnaire, which was available for three months. We used the information to compare it with the current situation of university digitalization. Based on this, we make several recommendations and proposals for further integration of AI in the everyday life of universities.

4. Survey Analysis and Results

4.1. Analysis and results from the interviews with representatives of the Bulgarian universities

We started our research with semi-structured interviews with representatives of the management of several universities in Bulgaria. The leading idea when we conducted the interviews was to cover universities with different profiles – including economic, humanitarian and technical universities- to have as comprehensive as possible understanding of the state of play in the digitalization process of Bulgarian universities. On the other hand, we select colleagues who are willing to share such internal information for their universities.

Based on the analysis from the interviews, the following main findings could be summarized:

- the major part of the representatives of the management of the Bulgarian universities claims that digitalization is defined as one of the leading priorities for the university;
- The majority of managers admit that the university has approved specific strategic documents devoted to the digitalization of the universities
- several challenges are outlined for smooth digitalization: lack of sufficient resources (including financial, administrative capacity, etc.); unwell-prepared infrastructure (including lack of common vision for the different systems used so far within the university); emergence of various types of resistance (both in academic and administrative staff) etc.
- a significant advantage for universities using AI is seen in the improved quality of the educational process (including the introduction of new educational perspectives through new technologies), improved administrative service, and enhanced public image, which is considered to reflect an increased number of potential candidates.
- For several representatives of the universities, the lack of expert IT staff (as well as the impossibility of attracting such staff) and lack of sufficient financial resources are defined as the most significant critical points in front of the university's digitalization process.
- All of the management representatives admit that digitalization is a crucial part of securing the university's sustainability.
- Almost all of the management representatives admit that the level of digitalization will be vital in defining whether a university is successful or not in the next few years.

4.2. Analysis and results from the survey among university students

At the same time, the opinions and perceptions of the students regarding the level of digitalization of the universities and their expectations for further development are also interesting for comprehensive study when we explore the good practices of universities using AI for educational and administrative purposes. In this consideration, we provided a specific survey among university students. This survey was voluntary and anonymous and used to collect as much correct information as possible. As a result of our efforts, we collected 254 responses to our questionnaire from students representing different Bulgarian universities.

The first part of the questionnaire contains questions collecting demographic information of the respondents. The results are presented in Table. 1.

The majority of respondents are between 17-and 22 years old (with a share of 69%), followed by students aged 23-30 (which are 26% of our respondents), and the smallest group is the students over 30 years (approximately 4%). This result is logical, considering that according to the Bulgarian educational system, the sec-

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ondary level of education usually ends at 18. At the same time, the majority of our respondents (153 or 60%) are students in Bachelor programmes, followed by the students in Master programmes (34%), and respectively PhD students are the smallest group of respondents (with a share of 5%). In terms of the form of education, the majority of students participating in the survey are in regular form (73%), while 26% of students are in distance learning form of education. The relatively small representation of part-time students could be explained for several reasons: first of all, the regular students are more university-oriented and willing to participate in some voluntary activities that have no direct impact on their current university results. This directly leads to the degree of motivation and engagement between part-time students and the university. For part-time university students, work usually comes as a first priority. Then, the university and study, while for students in a regular form of education, study is the absolute priority for this specific period of their life. Secondly, logically, the main activities of university lecturers are with regular students. Therefore, the direct communication between regular students and lecturers is stronger than between lecturers and part-time students. All this means that the university has to reconsider the manner of engaging part-time students in university activities to involve them more actively in various university projects and initiatives.

Table 1. Demographic profile of the respondents

Specification	**Answers in number and %**		
Age	Between 17-22 years	Between 23-30 years	Over 30 years
	176 (69,3%)	67 (26,4%)	11 (4,3%)
Educational Qualification Programme	Bachelor degree	Master degree	PhD Degree
	153 (60,2%)	87 (34,3%)	14 (5,5%)
Form of education	Regular/ Full time	Distance learning/ Part-time	
	186 (73,2%)	68 (26,3%)	
Birthplace	Sofia	City, regional centre	Small town/village
	139 (54,7%)	79 (31,1%)	36 (14,2%)
Place of study	Sofia	Big cities	Faculty in small town
	143 (56,3%)	84 (33,1%)	27 (10,7%)

The birthplace of students is relatively clear for the Bulgarian situation, but here, the comparison of results between birthplace and place of study for university students is more interesting. As the birthplace is concerned, half of our responders were born in Sofia (55%), which fact is not surprising due to one very important reason: the urbanization process and regional development for the last decades in Bulgaria transformed the capital Sofia into the country's largest and most economic developed city. There is increased internal migration from small villages and towns to the capital and other big cities. This directly reflects the number of young people born in Sofia and big cities, while the population in other regions decreased. Again, the majority of students and responders in this survey are studying in Sofia (56%), which is explicable, considering that the majority of universities and the biggest universities in terms of the number of students are located in Sofia. At the same time, the research team is also located in Sofia, which also impacts the number of participants in the survey students who study in Sofia.

The second part of the survey contains specific questions devoted to university students' attitudes toward using AI technologies in everyday university life. We started with the fundamental question, "How often do you use technology (such as computers, smartphones, or tablets) for your academic activities?" as a starting point for developing the survey. The questions, along with predefined answers and the results are presented in Figure 2. Most responders claim that they use different technologies several times a day for academic purposes (83%). The other 15% admit that they use it several times a week. Only 2% of our respondents claim they use technology for academic reasons several times a month. Here, maybe the key element in this question is the inter-

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pretation of the "academic activities". We purposefully left this interpretation to the students so that we could draw a main conclusion from this question about students` commitment to university activities. For some students, checking for new e-mails in the university mail account was also an academic activity. In contrast, other students interpreted this term more restrictively, such as preparing and working on specific tasks the professors assigned. Whatever the interpretation of this question was, the accumulation of responses indicates that most students use various technologies for academic purposes daily.

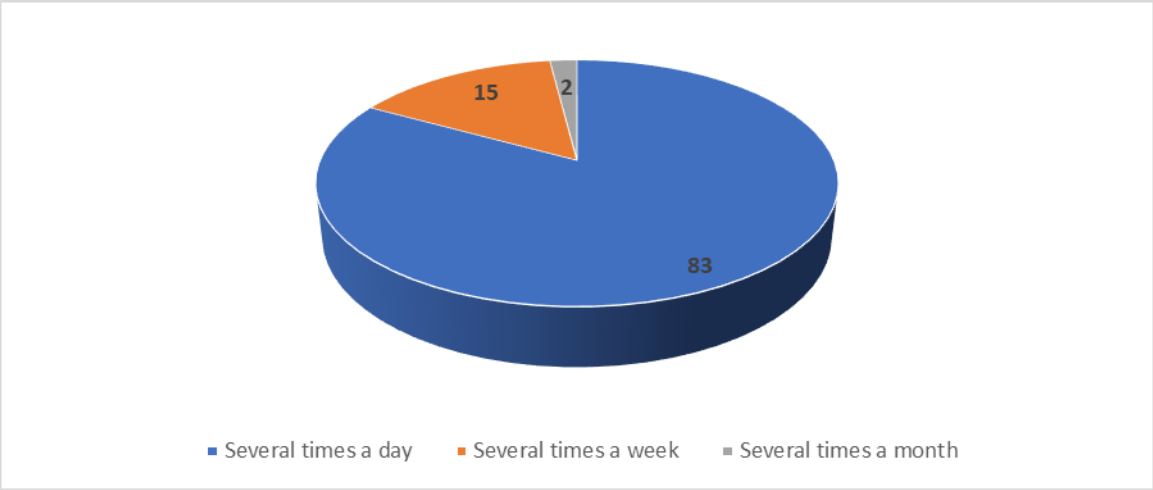


Fig. 2. Frequency of the usage of technology for academic purposes by university students (in %)

The second question was, "Are you familiar with the concept of Artificial Intelligence (AI)?". This question aimed collecting self-assessment of the students about their level of knowledge of the concept of AI. This is the fundamental question, which will give us the main idea of the starting point for the students' understanding of this concept. We ranged the closed answers according to the 5-point Likert scale. The answers are presented in Figure 3.

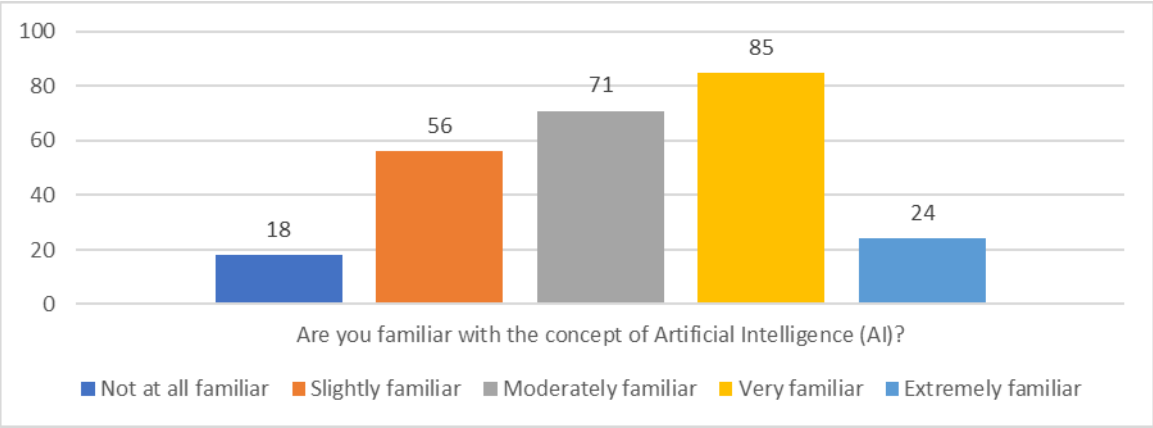


Fig. 3. Self-assessment of the students on their familiarity with the concept of AI

As shown from the figure above, the biggest group of respondents claim they are very familiar with AI (85 persons or 33%) and the other 24 persons (or 9%) believe they are highly familiar with the concept. Here, we also have to focus on 71 persons (or 28%) who consider themselves moderately familiar and the other 56 respondents (or 22%) who admit they are slightly familiar. 18 people assert that they are not familiar at all. These results are not surprising for several combined reasons. First, for young people and the new generation, new technologies and innovations are an invariable part of their daily life. Therefore, they are much more willing to take the time to explore an innovation, especially if it is considered prestigious and fashionable in their circles. From this perspective, the relatively high percentage of people who rate themselves as very familiar with the concept is a logical result rather than a surprising fact. Second, young people are much more pragmatic and practical-oriented than the older generation. Therefore, if they understand that a tool, including

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an AI-based one, will benefit them, they will go to the trouble to explore it in preparing various tasks and assignments. At the same time, the question could be tricky to interpret: from one side, the purely theoretical aspect of the concept of AI (which will explain the relatively high level of people choosing moderately familiarity with the concept) and on the other side, some could interpret the question on the actual usage of such type of tools.

“Have you ever used any AI-based tools or applications for academic purposes?" is the next question and collects information on the experience that university students already have with these types of tools. Again, the questions' answers are predefined following the logic of a 5-point Likert scale (Figure 4).

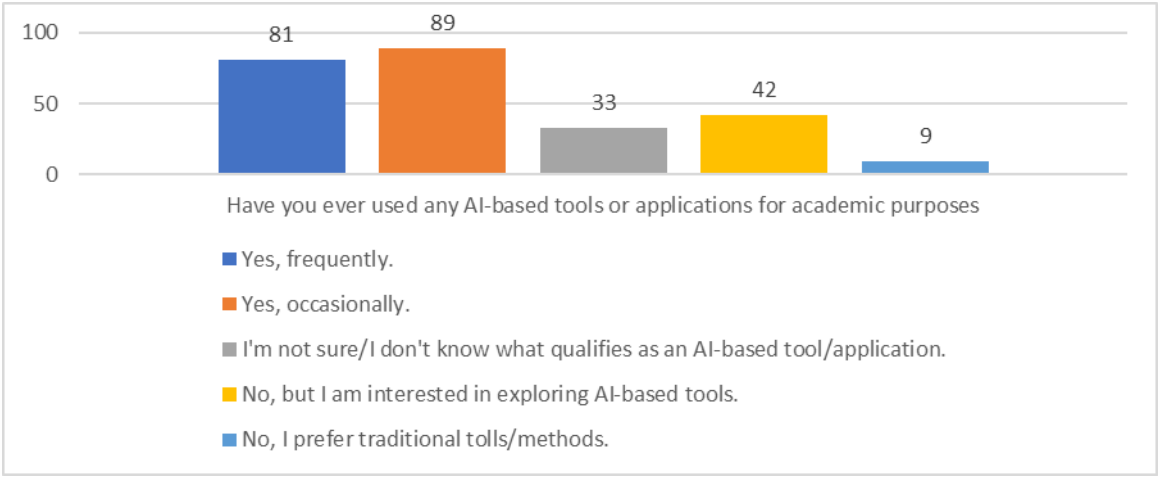


Fig. 4. Usage of AI-based tools and applications from students for academic purposes

Here, the two major groups (in total 170 or almost 70%) of respondents answered positively, with a slight change in frequency. 32% of them claimed that they used AI-based tools frequently, while 35% argued that they used AI-based tools occasionally. At the same time, 33 persons, or 13%, are unsure or need to learn the qualification of AI-based tools and applications. One of the possible explanations for this relatively high level of uncertainty could be that the practice of using AI tools for preparing different tasks has been controversially accepted by university professors so far. We do not have clarity or specific guidelines and rules at the university level allowing or prohibiting the use of AI by students in preparing tasks and assignments. At the same time, 42 persons, or almost 17%, argue that they are interested in exploring such types of tools and applications, and only 9 persons (or 3%) prefer to use traditional methods when preparing tasks.

The next question is, "What areas of university life do you think could benefit from implementing AI technology?". Here, respondents have predefined answers again, and multiple choices are possible.

As seen from Figure 5, most students (232 respondents or 91%) believe that AI will be helpful in teaching and learning activities, including personalized learning and tutoring. The fact that this option was selected from the impressive part of respondents is evidence of the priority of this specific field of implementation of AI in university. Academic life is not just a random mix of different activities, it is a whole new experience. But the heart of this experience is still the learning and teaching activities, whose importance is once again proven through the students` answers.

The second area of AI implementation in universities comes with different administrative processes (chosen by 211 persons or 83%), including admission, registration, and specific other activities. This means that, according to students, the administrative processes could be drastically improved by using AI. Some university procedures are already digitized, but AI could still enhance their effectiveness. Bulgarian universities have already practiced with digital exam protocols, students record, including exam results, etc. However, the analysis of this data, including their usability for the strategic management decisions for the further development of the university and also developing new specific policies (for instance, how to attract new potential students

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in Bachelor and Master degrees; how to achieve better attendance in classes and participation and motivation of students to enter in different national and international competitions in their subject field of education etc.).

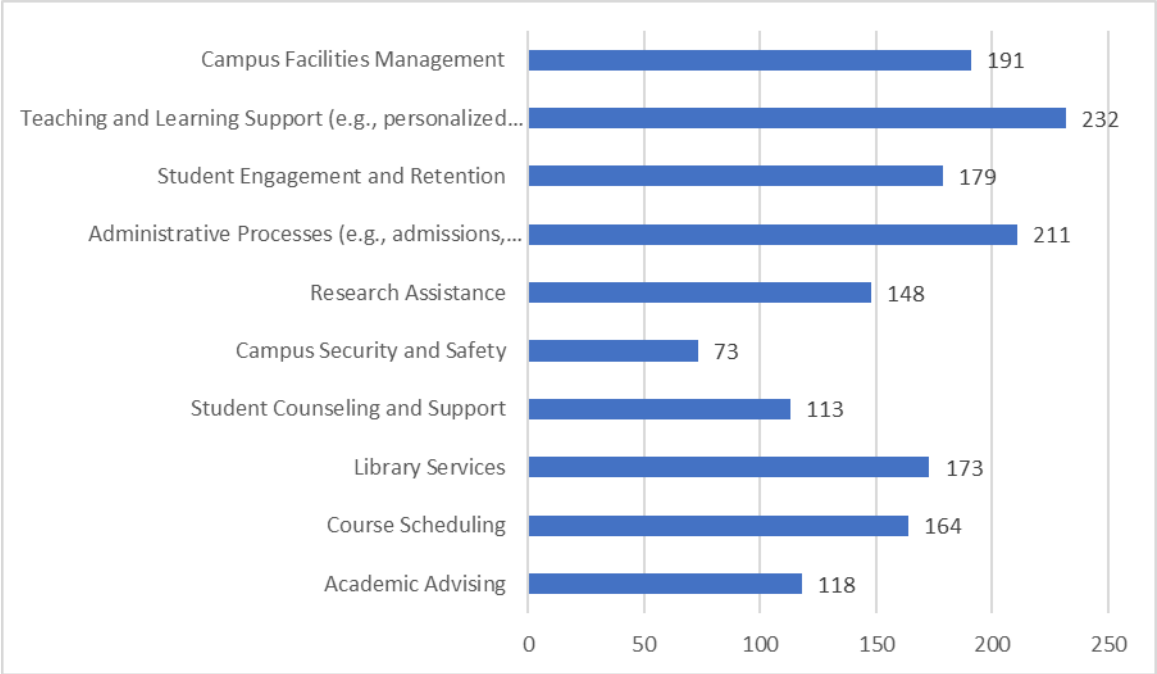


Fig. 5. Possible areas of applying the AI-technology in university

The third place is for Campus facility management, with 161 preferences and a share of 63%. The relatively high level of this implementation of AI in universities, claimed by students, could also be interpreted as their desire to improve the overall management of the campus further. AI technologies could improve operational efficiency and enhance the campus environment's overall quality for students, academic and administrative staff, and visitors. By integrating AI-driven solutions into facility management practices, universities can achieve cost savings, sustainability goals, and user satisfaction while effectively using campus resources.

The fourth place is for the student's engagement and retention, a position chosen by 179 persons and a share of 71%. AI technologies offer potent capabilities for enhancing student engagement, retention, and success in universities by providing personalized support, proactive interventions, and data-driven insights to support students' diverse learning needs and help them achieve their academic goals. By integrating AI-driven solutions into teaching, learning, and student support services, universities can create more inclusive, supportive, and effective learning environments that foster student success and retention.

Very close to the previous result is the option of the Library Services, which is recognized by 173 and has a share of 70%. At first glance, this is the most understandable option – a combination of Library services and AI, which will be helpful in many student activities, including task preparation, exam preparation, individual tasks, etc. At the same time, AI could be considered a modern tool to return young people to libraries and give libraries new opportunities for future development in the digital era. It is a very satisfying result that, according to university students, using AI in the library is considered relatively high in the ranking. Perhaps it is their very pragmatic point of view, but still, this could be the possibility of a new future strategy for library services and development.

Next comes the option for Course Scheduling, which is selected by 164 persons with a share of 64%. AI can be utilized for university course scheduling in various ways, leveraging its data analysis, optimization, and decision-making capabilities. AI algorithms can analyze vast data, including course offerings, student preferences, lecturers` availability, room capacities, and scheduling constraints. AI can generate schedules that minimize conflicts and maximize resource utilization by applying optimization techniques, such as genetic algorithms or simulated annealing. AI offers powerful capabilities for optimizing university course scheduling and

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improving efficiency, responsiveness, and satisfaction for students, professors, and administrators alike. By harnessing AI technologies, universities can create more streamlined, personalized, and effective scheduling processes that enhance the academic experience.

Research Assistance was chosen by 148 persons or 58% of respondents. AI can be a valuable tool for providing research assistance to university students. AI-powered tools can help students conduct comprehensive literature reviews by analyzing vast repositories of academic papers, journals, and research articles and retrieving information from online databases, libraries, or educational resources.

118 respondents (46%) shared the selected Academic Advising option. AI has the potential to revolutionize academic advising by providing personalized support, predictive insights, and data-driven decision-making tools that empower students to achieve their educational and career goals effectively. By integrating AI technologies into academic advising practices, universities can enhance student engagement, retention, and success across diverse student populations.

Student Counselling and Support is the next option, outlined by 113 respondents and 44% share. Students may not as well recognize this implementation field as it is its potential. AI can drastically enhance the capacity of universities to provide accessible, responsive, and personalized counselling and support services to students, ultimately promoting their mental health, well-being, and academic success. However, it's crucial to complement AI-driven interventions with human support and oversight from trained counsellors, mental health professionals, and other campus resources to ensure comprehensive and holistic student support.

Campus security and safety takes the last position in this ranking, with a share of 29%. This low result could be explained by the country's relatively high level of security and safety. Still, it is a very important aspect where AI can lead to overall improvement. Although university students neglect this subject, the university management must embrace the opportunity to strengthen campus safety and security. AI can provide proactive threat detection, real-time monitoring, and intelligent response capabilities. By leveraging AI-driven solutions with traditional security measures and human oversight, universities can create safer and more secure environments for students, faculty, staff, and visitors.

The next two questions assess the possible technological solution in two fundamental aspects. The first one is devoted to administrative services and reads: "Do you believe that AI can improve the efficiency of administrative tasks within the university (e.g., admissions, enrollment, scheduling, etc.)?". Here, predefined answers were structured using the 5-point Likert scale (Figure 6).

Nothing surprising is the results achieved in this question. An impressive part of 175 persons, or 69% of respondents, agree with the statement that AI can improve administrative procedures. Only 19 people think AI cannot help universities in these specific activities, and the other 14 people cannot decide. Our responders highly appreciate the apparent potential of AI for improving administrative tasks and services.

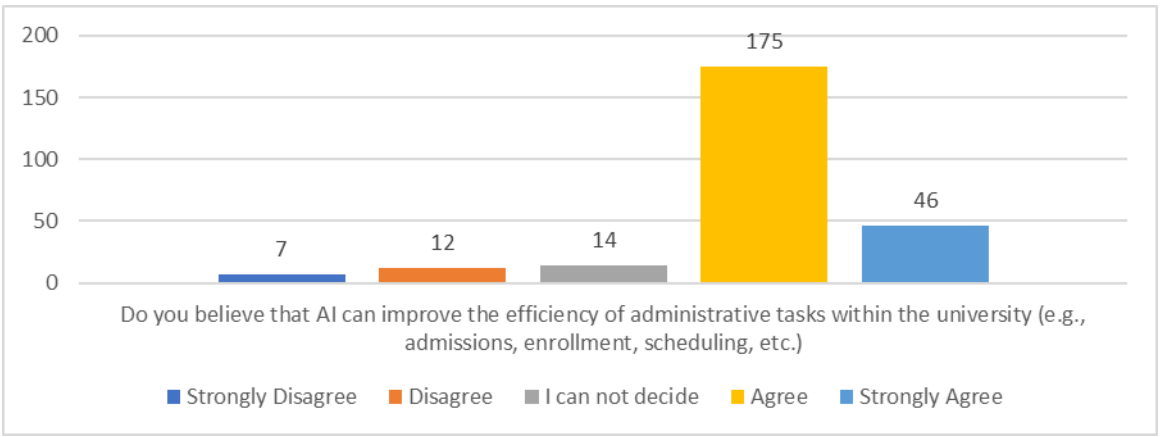


Fig. 6. Intentions on the improvement of administrative services of universities by using AI

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The next question collects the students` opinions on using AI in assessment. The following question is: How comfortable would you be with using AI for grading assignments or exams? Results are presented in Figure 7.

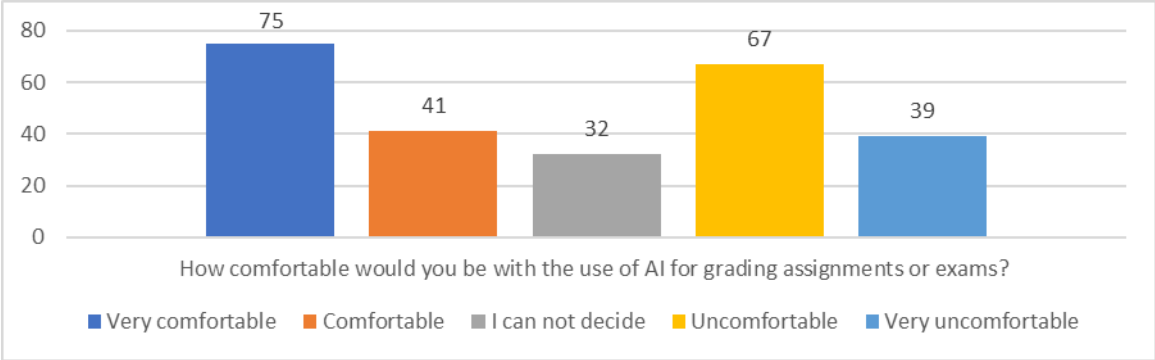


Fig. 7. Students` attitude on their assessment using AI technologies

As shown in the figure above, the answers have no clear preference. Notably, the greatest accumulation of responses is on the highly positive attitude chosen by 75 persons (almost 30%). This means that 30% of our respondents claim they are comfortable using AI for grading assignments or exams. If we add the number of people who answered positively to this question, we get 116 approvals (or a share of 46%). At the same time, the total number of people who stated that they would not feel comfortable using AI in their assessment is 106 (or 42%). Therefore, the answer to this question divides our respondents almost equally. At the same time, it should be noted that most positive opinions on this question are concentrated to the extreme degree – "very comfortable"- while the disapproval opinions are focused to the "uncomfortable" degree. The number of people choosing the option "I cannot decide" remains relatively high, considering the actuality of the topic and, in general, the attitude of young people towards the use of new technologies (32 or 12%).

The next question explores university students' attitudes toward the ethical aspects of using AI in universities. The question is the following: "In your opinion, what are the potential ethical concerns associated with using AI in universities?" Students had the possibility of multiple choice of predefined answers. Results are presented in Figure 8.

According to the answers accumulation, there are four leading ethical aspects of using AI in university for university students. First place, with the highest result, is the threat of "depersonalizing the learning experience, diminishing the role of human interaction" (217 votes or 85%). This answer is followed by the "lack of possibility to disagree with the exam result" (215 votes or 84%). Therefore, due to the insignificant difference in the results (2 votes), these are the two top concerns of students. In third place comes the lack of possibility of the right to choose whether or not to use AI for education (with 208 votes), followed by the threat of broken relationships between professors and university students (195 votes).

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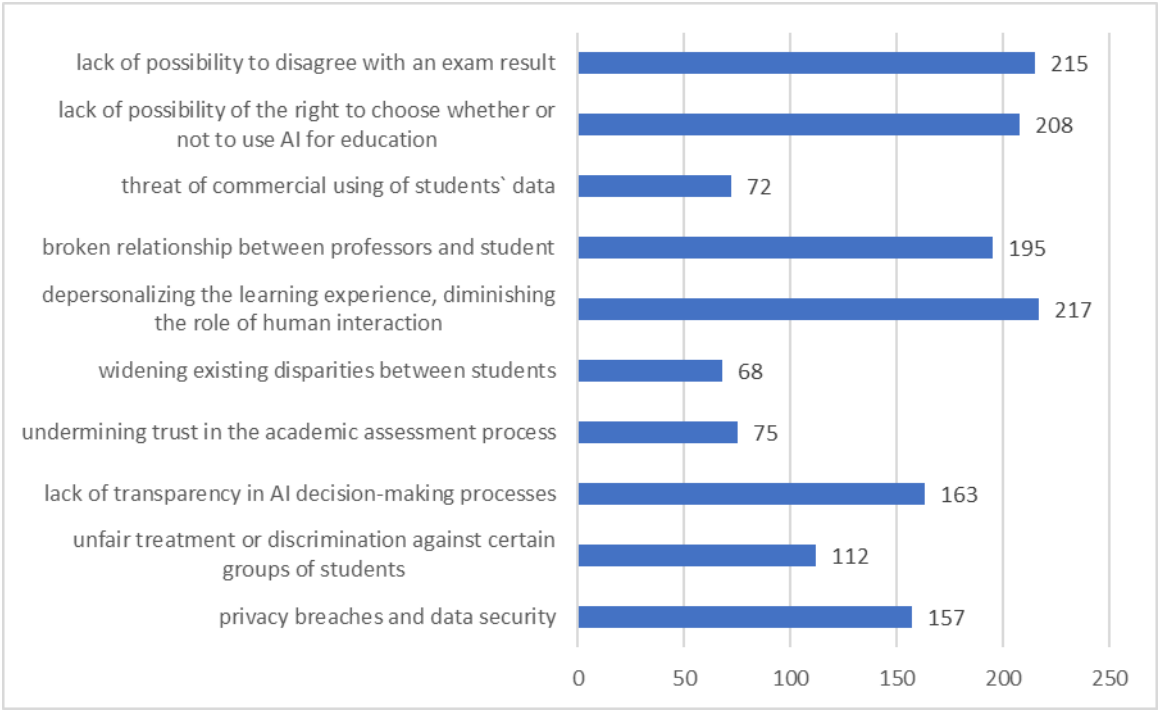


Fig. 8. Ethical aspects of using AI in universities

In the last three positions, with the fewest votes, are the answers "undermining the trust in the academic assessment process "– 75 votes, "threat of commercial using of student's data" - 72 votes and "widening disparities between students" – 68%. Most of our respondents do not recognize these three options as severe ethical threats.

The next question is, "Would you prefer AI-based tutoring or personalized learning systems over traditional teaching methods?". Again, answers are structured according to a 5-point Likert scale.

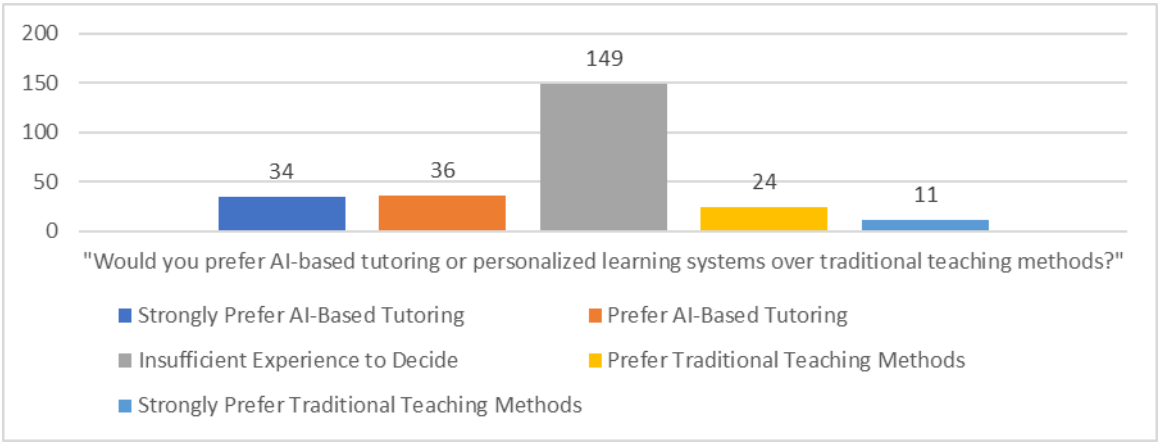


Fig. 9. Preferences of types of tutoring

The results show that most of our respondents define themselves as people with insufficient experience to judge their preferences between traditional tutoring or AI-based (149 or 59%). At the same time, the two groups supporting AI-based tutoring collected 70 votes in total (or 27%), while proponents of traditional tutoring remain barely 14% (Figure 9).

The question is: "Would you be interested in participating in workshops or training sessions on AI technology offered by the university?" Again, the answers to this question were predefined according to the 5-point Likert scale.

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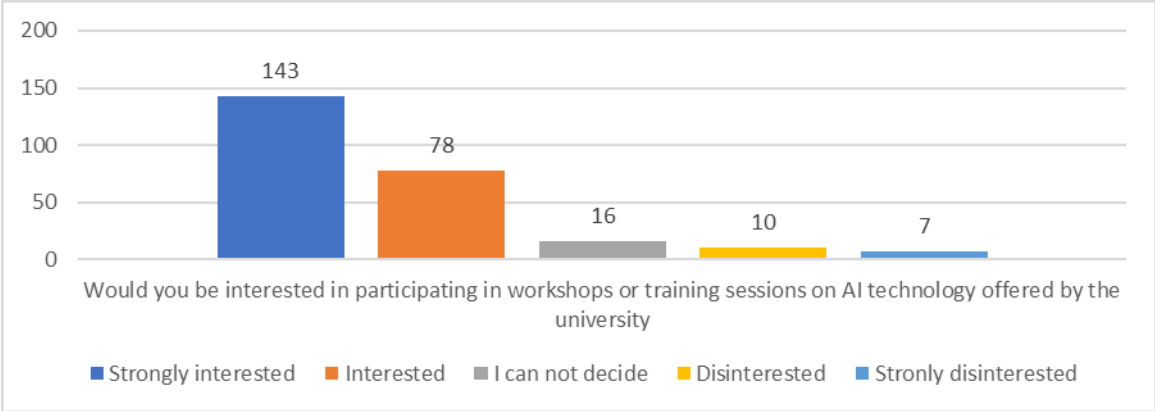


Fig. 10. Potential participation in training on AI technology

The results in Figure 10 are clear and definite – 221 persons, or 87% of our responders, claim their positive decision to participate in a workshop or training session devoted to AI technology organized by the university. This makes such training a horizontal issue, with massive interest among students despite their university major. Only 7 people expressed their strong disinterest, which could be defined as an insignificant share, and the other 16 could not decide. It should be borne in mind that this hesitation may be due to the subject of study itself - AI-based technologies, but it may also be related to other, radically different reasons - such as a busy schedule, personal commitments, etc. However, most respondents are very positive and open to such opportunities.

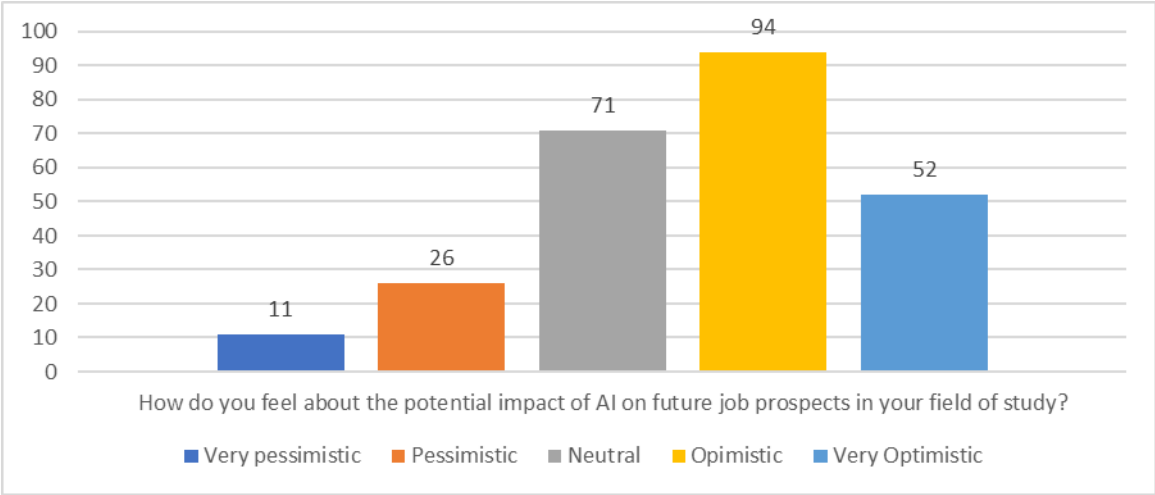


Fig. 11. Potential impact of AI on future job prospects in the field of study of responders

In general, students assess the impact of AI technology on their future job prospects very positively (Figure 11). Only 37 persons (or 14,5%) believe that AI will negatively impact their job opportunities in the field of study. At the same time, 94 persons are optimistic, and the other 52 are very optimistic about their future professional realization despite the presence of AI. This significant 57% of all respondents in the two degrees of optimism could be interpreted differently. First of all, it could be considered as pure acceptance of changes due to technological development. Young people are usually more willing to accept any changes, and the new generation that is born and raised with the latest technologies and innovations is usually positively oriented to the impact of AI on their professional and social lives. Second, it is also possible that students (especially in the first few years of their university education) do not have a clear idea of the specifics of professional life and, therefore, perceive the impact of AI only positively.

Next following is "How confident are you in your ability to use AI tools and technologies for academic or research purposes?" The two options of confidence collect the majority of votes, with a predominance of "con-

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fident" (chosen by 78 persons) over "very confident" (selected by 63 respondents). 47 people claim they are unconfident in using AI tools and technologies, and 32 need to be more confident. At the same time, 34 people remain neutral on this question. However, 141 or 55,5% of students participating in the survey claim different levels of confidence in using AI for academic purposes (Figure 12).

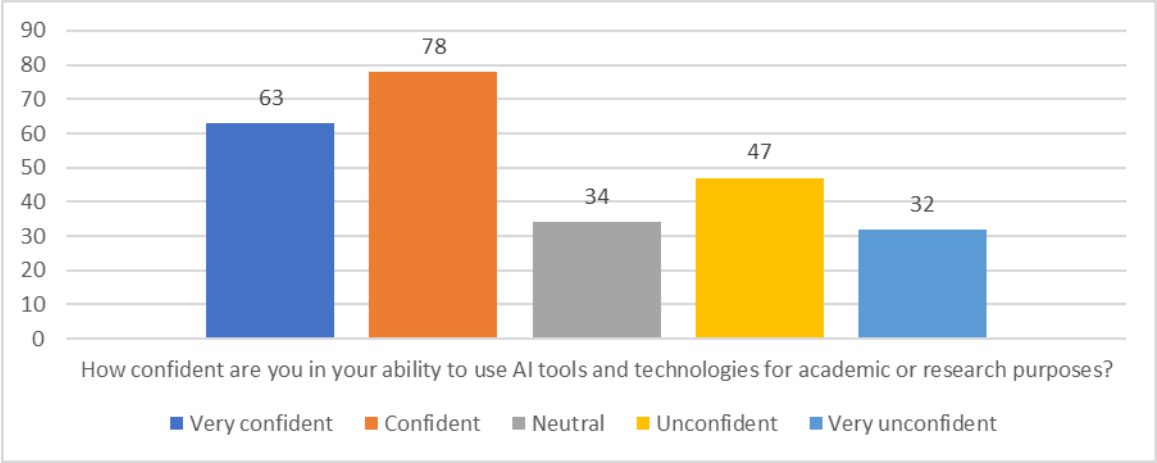


Fig. 12. Self-assessment of confidence of students to use AI tools for academic purposes

The following question focuses on the university's future strategy and the role of AI in this development. The question is, "Do you believe universities should invest more resources in AI research and development?" Here, the picture is obvious – the majority of respondents answered "yes" (198 or 78%), and only 15 persons chose "no" (6%). At the same time, we have 41 persons who cannot decide (16%). According to students, the future development of universities is closely connected with AI and AI-based technologies, and universities have to invest purposefully in this direction (Figure 13).

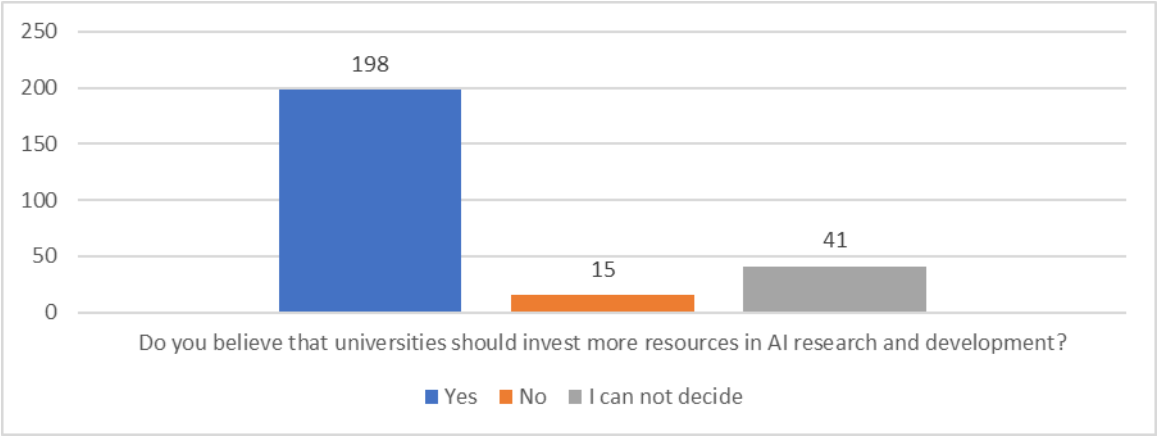


Fig. 13. Future investments of universities in AI development

The results of the question "How important do you think it is for universities to prioritize teaching AI-related skills and knowledge to students across different disciplines?" are presented in Figure 14. Once again, the majority of responders define such a topic as important or very important – 164 (or 65%). The surprising thing in the answer is that nearly 20% of the respondents chose the two options because of the unimportance of this learning topic. Perhaps one of the possible explanations for this relatively high percentage is that such students consider themselves sufficiently competent and sufficiently familiar with AI technologies. For them, such kind of training will be a waste of time.

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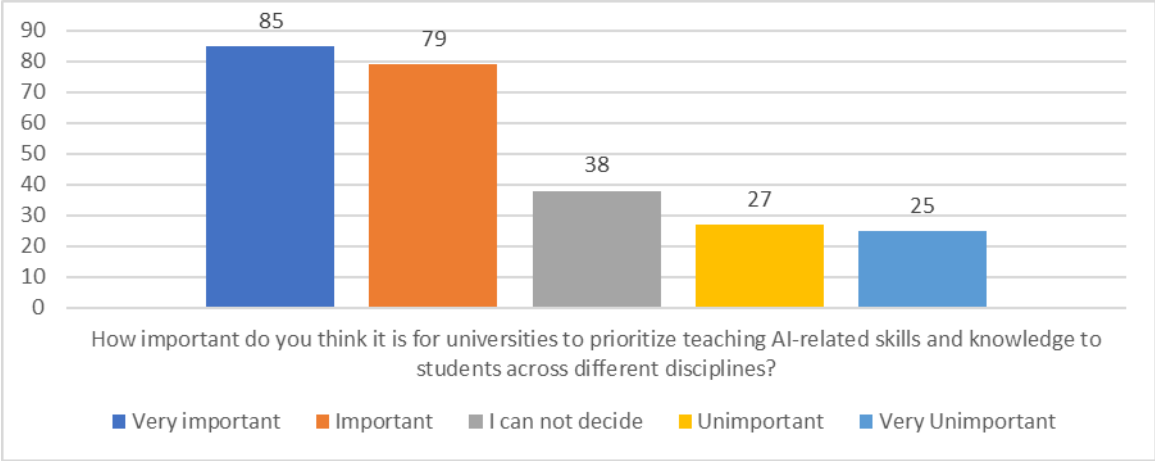


Fig. 14. Importance of teaching AI-related skills and knowledge in universities

The survey's last question is the following: "How do you think AI can contribute to improving the overall educational experience for university students?" The first three leaders of answers, receiving the most votes, are connected with personal customization, learning experience, and the possibility of digital evaluation. The first answer, according to the number of preferences, is "tailored learning platforms" (207), followed closely by the customized learning experience (201, only 6 votes difference), and third place is for the computerized/ digital evaluation (198). The last option is the possibility of facilitation of group projects, which needs to be more broadly recognized as the possibility of improving the educational experience.

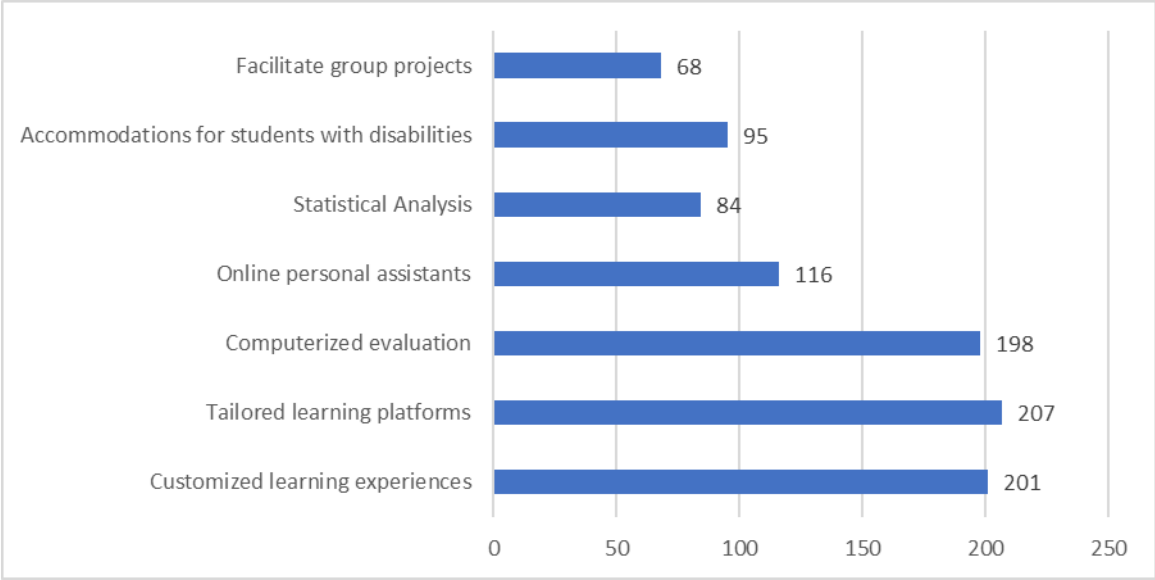


Fig. 15. Possibility of improving the overall educational experience of university students

In summary, the general viewpoints held by university students regarding AI remain optimistic (Figure 15). Still, their opinions vary and are shaped by many factors, including their level of interaction with AI technologies. According to the survey, most students eagerly embrace AI, recognizing its capacity to enrich educational endeavours and streamline various aspects of university life. Conversely, some minor cohorts harbour reservations, expressing apprehensions about potential job displacement, ethical quandaries, and privacy infringements associated with AI technologies.

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5. Conclusion and recommendations

In conclusion, integrating Artificial Intelligence technologies within universities signifies a pivotal juncture poised to revolutionize the landscape of higher education. This transformative potential extends across teaching, learning, and research, offering many opportunities to reshape traditional practices and enhance the educational experience for all stakeholders.

By leveraging the capabilities of AI-driven solutions, universities stand to unlock a wealth of benefits. Notably, implementing AI promises to foster personalized learning experiences tailored to individual students' unique needs and preferences. Educational content can be dynamically curated and delivered through adaptive learning platforms and intelligent tutoring systems, catering to diverse learning styles and fostering deeper engagement and comprehension.

AI presents unprecedented opportunities to streamline administrative processes and optimize resource allocation within university ecosystems. From admissions and enrollment management to course scheduling and student support services, AI-powered systems can automate routine tasks, alleviate administrative burdens, and enhance operational efficiency, enabling institutions to redirect resources towards more strategic initiatives and student-centric endeavours.

Furthermore, the integration of AI technologies holds profound implications for advancing the frontiers of academic research and innovation. By harnessing the capabilities of AI in data analysis, predictive modelling, and computational study, scholars can unlock new insights, accelerate discoveries, and address complex societal challenges.

However, the successful adoption of AI in universities necessitates a nuanced approach that prioritizes ethical considerations, privacy protections, and equity principles. As AI algorithms increasingly shape decision-making processes within educational contexts, there is a pressing need to ensure transparency, accountability, and fairness in algorithmic outcomes. This requires robust governance frameworks, ethical guidelines, and mechanisms for addressing biases and mitigating unintended consequences.

Safeguarding the privacy and security of student data is paramount in an era marked by heightened concerns over data breaches and unauthorized access. Universities must implement robust data protection measures and adhere to regulatory standards to uphold the trust and confidence of students and other stakeholders.

As AI technologies evolve, universities must commit to ongoing evaluation and improvement to ensure that AI-driven initiatives align with institutional objectives and educational values. This necessitates a culture of continuous learning and adaptation, wherein feedback mechanisms and performance metrics are leveraged to refine AI algorithms and enhance their efficacy and reliability over time.

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CORPORATE SOCIAL RESPONSIBILITY SPOTLIGHT ON SMALL AND MEDIUM ENTERPRISES IN ETHEKWINI MUNICIPALITY (SOUTH AFRICA)

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Abstract. There is a need for corporations located in various municipalities of South Africa (SA) to play an active, socially responsible role in ensuring that human beings can realize their potential with dignity and equality within a healthy environment. Corporate social responsibility (CSR) is increasingly intrinsic towards conventional business functions from research and development to marketing as part of creating jobs for the local communities. Small and medium enterprises (SMEs) are likewise urged to ensure that the lives of vulnerable communities are improved and transformed for the better and that economic, social, and technological progress occurs in these communities. SMEs are essential contributors to economic development in SA, the continent, and the world at large and are responsible for making a meaningful contribution to society. This study sought to investigate the perceptions regarding the CSR of SME owners in the eThekwini Municipality. Data collection from 210 SME owners or managers in the eThekwini Municipality revealed a significant relationship between community involvement, environmental awareness, and community upliftment in the quest to build long-term relationships within communities.

Keywords: Corporate social responsibility (CSR); Small and medium enterprises (SMEs); social and environmental aspects; social responsibility activities; community involvement; and environmental awareness; eThekwini municipality; South Africa

Reference to this paper should be made as follows: Manchidi, N.H., Mkhize, T. 2024. Corporate social responsibility spotlight on small and medium enterprises in eThekwini Municipality (South Africa). *Entrepreneurship and Sustainability Issues*, 11(4), 63-78. http://doi.org/10.9770/jesi.2024.11.4(4)

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1. Introduction

The triple challenges of poverty, unemployment, and inequality remain the most significant requirements for the sustainable development of the South African economy. This calls for all stakeholders, including government and private businesses, to collaborate and ensure that the standard of living is set up amongst citizens. As several organizations hold on to international standards and corporate social responsibility (CSR) developments, there is still ample space for growth. Predominantly in South Africa (SA), where significant economic and social inequality challenges still exist and efforts are needed to ensure equal access to essential goods and services, CSR could still grow and improve. CSR originated in the early 1930s after the Wall Street crash of 1929 exposed corporate irresponsibility in larger organizations. It is a business management concept that continues to be the focus of business operations and a common topic of research for experts and scholars from various fields (Selvamuthu, Logeswari, & Karthika, 2021). The concept of CSR also sought to address the social effect of business entities and has become gradually critical to participants in recent years (Schröder, 2020).

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Additionally, CSR can indicate sustainability to ensure the firm connects with a broad scope of stakeholders (Epure, 2021). Sadly, so far, CSR ideas have been inclined to concentrate predominantly on big and global enterprises (Selvamuthu, Logeswari & Karthika, 2021; Chen, Xu & Zhang, 2021). However, even though their business scale is lesser than big enterprises, SMEs can also contribute to social and ecological change via the steps they can take because of their global presence, as they make up over 90 per cent of international businesses and account for between 50 and 60 per cent of employment (Andriyani & Rochayatun, 2023).

The Companies Act in SA, number 61 of 1973, does not obligate organizations to participate in CSR projects. Therefore, social responsibility rests with the government at different levels, such as local, provincial, and national, in providing social welfare for its citizens. Amongst others, the government spends on various social grants and helps to advance society in health care, housing, education, safety, and the environment. The 1994 dispensation of democracy in SA showed a picture of unequal society in various areas, including infrastructure, education, economic power, and access to essential services. In addition, owing to the previous regime of apartheid in the country and the inevitable need for social development and a prosperous society, the role of charity in SA became necessary (Kabir, Mukuddem-Petrsen & Petersen, 2015). Therefore, various conversations and debates around CSR are deemed ongoing amongst SA organizations. In addition, among the leading proponents of CSR in SA are the country's Johannesburg Stock Exchange (JSE), the legislative framework for the promotion of Broad-Based Black Economic Empowerment (BBBEE), the trade union federation Congress of South African Trade Union (Cosatu) and various organizations representing civil societies as well as institutes (Kabir, Mukuddem-Petrsen & Petersen, 2015).

Gradually, organizations have become more prominent in active participation in CSR activities, including social and community projects. In other words, the government's sole role has steadily changed since the 20th century since societies are putting pressure on partnerships between governments and businesses to identify and act on their social responsibilities (Dias et al., 2018). As such, the inclined association between customers and companies will likely create an advantage beneficial to the business in question (Pour, Nazari & Emami, 2014). This is because organizations are deemed not only to make money but also to be part of the communities where there is a valued interaction between the employees, customers, and the communities (Cooper, 2022). Thus, consumers often feel that when they use a product of a socially responsible company, they are doing their part. In the same way, the more socially responsible the company becomes, the more supportive its community and consumers become.

Corporations in the eThekwini Municipality produce various products ranging from food and beverages to chemicals, clothing, and metal products. Small and medium enterprises (SMEs) in this region (eThekwini Municipality) comprise a wide-ranging firm, from established conventional family businesses hiring over a hundred employees (medium-sized companies) to the survivalist self-employed from the poorest layers of the population (formal and informal businesses). Therefore, this sector (SMEs) remains the highest contributor to the industry and the municipality's economic activities. SMEs, thus, play a significant role in helping economic growth and equitable development of various national economies globally (Smith, Discetti, Bellucci & Acuti, 2022).

SA has an estimated 2.6 million SMEs that comprise 37 per cent of formal businesses, 54 per cent of micro-enterprises and 15 per cent of companies in rural areas. The profile of business owners includes those who spotted the opportunity and those who felt it was necessary to start businesses because there was no alternative source of income. In addition, two-thirds of SME owners do not have employees, while 32 per cent employ between one and ten employees (OECD, 2022). In developing economies such as SA, many SMEs are owned by family members, private individuals, or a small group. These businesses need help with long-term survival and sustainability (Mitter & Aichmayr, 2019).

Despite the survival and sustainability challenges, SMEs continue to contribute increasingly towards gross domestic product (GDP), poverty alleviation and job creation. For example, an increase in contribution towards GDP from 18 per cent in 2010 to 40 per cent in 2020 was realized in SA through SMEs (OECD, 2022). However, the survival of businesses, including SMEs, depends on making profits and wealth addition to the country's

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economy (Haddoud, Jones & Newbery, 2017). In addition, the survival of businesses also relies on the interaction between the company and its internal and external social environment and outside social aspects (Turyakira, 2018). Attention to the function of businesses relative to CSR has, therefore, become imperative to the survival of modern businesses. In turn, social responsibility has also become one of the dominant themes in business (Zaid, Wang, & Abuhijleh, 2019). Kim, Woo, Uysal, and Kwon (2018) posit that most companies have been practising CSR and environmental responsibilities to contribute to the well-being of the communities and societies they interact with. CSR highlights that businesses are part of the larger society in which they exist and account to society for their performance. In general, organizations will find it only possible to operate with the community's involvement; hence, consideration for social participation is significant.

Social responsibility has become one of the dominant themes in business (Zaid, Wang, & Abuhijleh, 2019), and the turn of the millennium has seen an increased interest in CSR from emerging economies, joined by several written materials on CSR (Jamali, Karama & Blowfield, 2017). As such, the emergence of different CSR standards is palpable in organizations such as multinational companies and those operating in global value chains (Fransen, Kolk & Rivera-Santos, 2019). The majority of these multinational organizations strive to build corporate characters and derive benefits from endless connections involving suppliers and producers in developing countries (Hayat, Khan & Alim, 2021). Furthermore, companies in a globalized world have recognized CRS as a driver of innovation and part of business initiatives to deliver the required business results. Therefore, companies from various sectors and sizes are inclined to be interested in socially responsible policies, global growing trends, external pressures, and efficiency gains. Boateng, Amoako, Acheampong, and Abraham (2022) point out that embarking on CSR is not only an obligation for the business but also an essential means for gaining an edge over competitors and creating a positive image of the business. CSR in businesses has therefore become imperative to the survival of modern enterprises and one of the dominant themes in business (Zaid, Wang, & Abuhijleh, 2019). In addition, companies' survival generally depends on particular attention to aspects of CSR activities, their excellent reputation, and the benefits they receive from the public (Turyakira, 2018).

2. Literature Review

2.1. CSR activities and components of SME

Various components of SMEs in CSR activities involve four categories: workforce-oriented CSR activities, market-oriented CSR activities, environmentally-oriented CSR activities, and society-oriented CSR activities.

Workforce-oriented CSR activities

The focus of this category is on the implementation of policies that promote practices of fairness, health, and safety, as well as the development of employees within the SME (Bulawit et al., 2023). It can also be described as concerns associated with the health of the workers (Ahmad et al., 2022). Furthermore, health and safety in the workplace must, amongst others, be complemented by better working conditions, fair treatment to employees as well as fair remunerations (Selvamuthu, Logeswari & Karthika, 2021). Therefore, Workforce-oriented activities reflect various issues that employees and employers face, such as labour relations, health and safety, discrimination, and harassment (Smit, 2021; Yusoff & Adamu, 2016). Sadly, the problem of violence, harassment and bullying is something prevalent in SA which needs to be understood fully and be addressed due to its severity in the workplace (Smit, 2021). Likewise, these activities also involve how communication occurs between employers and their employees, as well as the process of making decisions and allowing employees to participate.

There is an expectation that businesses become transparent when conducting business activities to maintain a positive relationship with customers, investors, suppliers, and other business partners to fulfil a market-oriented CSR activity. In this instance, businesses' long-term success depends on creating sustainable revenue for products and services. Customers, however, are amenable to forming relationships with companies that produce eco-friendly products, such as using environmentally friendly packaging. In addition, customers increasingly tend to be loyal and satisfied with businesses that are environmental agents in the marketplace. Furthermore, society expects business organizations to undertake CSR, which goes beyond legal obligations and profit maximization to include economic and ecological sustainability and social development (Inyang, 2013). A

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business organization in any form is seen as a creation of a society whose survival is dependent on this very society. Therefore, it is incumbent upon businesses to improve and add value to products and services in the market.

Market-oriented CSR activities

This category focuses on ethics and accountable practices by SMEs when interacting with consumers, suppliers, and other stakeholders in the marketplace (Bulawit et al., 2023). These activities include product quality, acceptable business operations, and general customer service (Selvamuthu, Logeswari & Karthika, 2021; Binssawad, 2020). Thus, businesses with sound market CSR activities understand customers' needs and handle this as their moral obligation (Hansen, Mcdonald & Hatfield, 2023). Hence, they will put more prominence on it for customer satisfaction and competitiveness (Bhuiyan, Baird, & Munir, 2022). On the other hand, business performances are generally determined by market activities (Hoang & Thanh, 2020) to improve their balance sheet (Long, Li, Wu, & Song, 2019; Oduro & Haylemariam, 2019).

Environmental-oriented CSR activities

With this category, SMEs are more inclined to prioritize concerns related to the environment (Bulawit, Pajarilaga, Padolina & Bulawat, 2023), such as saving water and energy as well as environmental use of natural resources (Selvamuthu, Logeswari & Karthika, 2021). Further activities relate to minimizing adverse environmental impact and contributing to its sustainability (Van-Thanh & Szilárd, 2021). For example, SMEs should use cheaper, ecologically friendly containers to enhance their image and grow their effectiveness. Additionally, providing a favourable work environment, skills development, and training will motivate employees to have a sense of security at work and, thus, a competitive advantage (Rashiti & Skenderi, 2022).

Society-oriented CSR activities

Companies strive to maintain a strategy that ensures positive relations with communities around where they operate their businesses (Van-Thanh & Szilárd, 2021). This can be achieved by supporting local sports, cultural events, welfare, and education and creating employment opportunities and support for low-income people (Selvamuthu, Logeswari & Karthika, 2021). In essence, societal CSR activities accommodate local communities and aid them in their basic social needs (Binsawad, 2020). Thus, this category comprises generosity, community advancement projects, cooperation with local associations, and community social welfare involvement (Bulawit et al., 2023). In other words, businesses that are keenly involved in their communities will be motivated to embrace and sustain practices that can be used to support relevant CSR initiatives (Andrivani & Rochavatum, 2023).

2.2. CSR Engagement Outcomes

SMEs that engage in CSR activities are bound to enjoy various benefits, such as improved reputation and increased competitive advantage, which may positively affect the market share and sales (Schaefer, Terlutter, & Diehl, 2019; Yusoff & Adamu, 2016). This is because customers are inclined to be loyal and committed to purchasing goods and services from firms with self-respect and respect for local communities (Lu et al., 2020). As such, companies can achieve efficient performance through CSR activities by providing products and services beyond customers' expectations and in line with their needs at a reasonable price (Kim, Yin & Lee, 2020). On the other hand, an excellent social reputation requires the business to consistently uphold desirable and valued standards by external stakeholders (Turyakira, Venter & Smith, 2014). The rise in CSR engagements increases the awareness and knowledge from customers' perspective regarding the fact that with the help of CSR, it is possible to successfully develop an outward impression, which influences the reaction of their brand during a crisis (Tworzydło, Gawronski & Szuba, 2020).

2.3. Contrasting Arguments on CSR

Proponents of CSR

Organizations' operations and conduct affect society and the environment because these operations do not exist in isolation (Klopotan, Kordos & Ggurevic, 2020). In this instance, supporters of CSR suggest the development and application of CSR approaches as a prospect for organizations to thrive (Fatima & Elbanna, 2022). Participation in CSR activities is an essential element amongst the corporate sector, government, and other agencies in society that must be duly considered vital (Kabir, Mukuddem-Petersen & Petersen, 2015). In essence, firms that participate in CSR activities are well positioned to contribute towards improving the general

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quality of life for employees and uplifting social welfare (Carroll & Shabana, 2010). CSR, therefore, ensures that companies conduct business ethically and responsibly. Effectively, this suggests that for businesses to have a healthy environment in which to function, there must be a commitment to the viability of companies.

Opponents of CSR

With all the positive things that come with CSR, there are equally dissenting arguments on the concept and its practices. For example, those opposed to CSR continuously challenge the notion of it making a positive contribution to the business and some point to what they call a secret agenda to CSR (Saeed & Sroufe, 2021). Accordingly, some scepticisms question CSR as considered a simple behaviour of charitable business on two fronts: first, a billion-dollar business that donates money while contaminating the ecology can claim to practice CSR, and second, regardless of the business's economic resources, its gift will qualify as CSR (Sheehy, 2015). In other words, the discussions around business behaviour need to get to the heart of identifying the phenomenon leading to a definition of CSR (Sheehy, 2015). Additionally, amongst various definitions of CSR, the one broadly acknowledged is that of businesses that contribute voluntarily to sustainable development. However, over time, CSR policies have experienced substantial modifications, with a change from the manager's obligation to the business's overall accountability within society (Lamarche & Bodet, 2018). CSR is further criticized for being used as a meaningless instrument to project the appearance of being responsible while not making any realistic changes (Cao, 2017). Thus, CSR has been labelled as an instrument that makes slight variations in the fundamental structures of the global capitalist arrangement and instead serves as a camouflage for businesses to continue as usual (Wettstein, 2020).

2.4. Importance of CSR for SMEs

A popular view of CSR is that such programs fundamentally benefit businesses because enterprises that execute CSR should obtain returns (Taylor, Vithayathil & Yim, 2018). Thus, CSR activities play a considerably positive role in market competition, and therefore, it is essential for long-term sustainability and competitive advantage (Kim, Yin, & Lee, 2020). CSR might also build trust and recognition with the government to develop a greater propensity to receive future and available government subsidies as an encouragement to continue undertaking activities and initiatives to benefit local communities (Xu & Liu, 2019). Furthermore, forming collaborations with private and public sectors through the CSR programme can improve SMEs' innovation, learning orientation, performance, and general competitiveness (Ratna Wati, Murwani & Wahyono, 2018). Also, customers prefer to do business with firms that embrace good business ethics and therefore, responsible firms can attract more customers than others (Sharma, Poulose, Mohanta & 2018). Logically and justifiably, a firm that provides CSR activities aims to collaborate and establish corporations with other organizations that are also respectful to the needs of society and are amenable to creating a network of socially responsible companies for sharing common ideas and achieving desired results (Lu et al., 2020). Ultimately, suppose society believes a firm violates social norms. In that case, it will provide less support to the firm's operation, resulting in operational and financial struggles for the business (Banker et al., 2022).

2.5. General Social Responsibility and SMEs in South Africa

SMEs are responsible for maintaining relationships with their primary stakeholders, such as customers, employees, and suppliers. Rhee, Park, and Petersen (2021) argue that SMEs risk losing their customers, having non-participating employees and experiencing a poor supply chain network should they upset their primary stakeholders. CSR actions that appease customers include respect for their rights, fair trading practices and compliance with quality standards. On the other hand, employees expect training, skill development and creating an environment of good work-life balance. Finally, suppliers hope to do business under fair conditions, terms and negotiations (Pfajfar et al., 2022). Equally, relationships with secondary stakeholders such as governments, civil organizations, and local communities must be maintained. The actual values of CSR are converted into the market of goods and services that can be sold. Thus, SMEs are mere supply networks through which these goods and services are distributed without necessarily assuming the cost of CSR activities. They do so along the value chain, concealing their responsibility and perceived impact (Roth et al., 2020).

The role of government leadership in CSR and economic management is diminishing, leaving the market incapable of regulating the social system (Tien et al., 2019). On the other hand, CSR is a new concept for SMEs, especially in developing economies (Van-Thanh & Szilárd, 2021). Therefore, the study of CSR in SMEs can

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provide a greater comprehension of successful CSR methods from the perspective of SMEs. SMEs committed to social responsibility ought to realize whether their attempts supply the anticipated values for society, the environment, and their business. Thus, studies related to CSR in SMEs can provide insight into the challenges and strengthening circumstances in executing CSR at the SME level. This helps identify SMEs' challenges and develop proper approaches to address these barriers. Studies connected to CSR practices in SMEs can also expose the reasons that influence the incentive for SMEs to engage in CSR practices so that they can assist in designing strategies and plans that encourage the active participation of SMEs in social and environmental efforts (Andriyani & Rochayatun, 2023).

3. Research Design and Methodology

The study followed a quantitative and positivist paradigm, assuming that actual, objective, observable, natural, and verifiable facts on CSR and SMEs are considered. Primary data collection was executed through a five-point Likert scale questionnaire, with additional space provided at the end of each question for additional comments where applicable. To minimize potential errors during the interviews, pre-testing of the questionnaire was performed amongst 20 SME owners or managers to fix questions that were identified as challenging, complex for respondents to understand, or which could be misleading and biased. In addition, the pilot study was also assisted in fine-tuning the wording, time estimate, length, and number of questions.

3.1. Population and Sample

SMEs must be aware of the responsible business and moral reasons for practising CSR and the associated benefits in the eThekwini Municipality. Also, there is a perception that CSR practices involve large corporations and exclude SMEs. With the eThekwini Municipality supplier database comprising 5000 (N=5000) registered SMEs in 2019, a systematic sampling method was used to take a smaller sample according to a set scheme. Thus, only the SME owners or managers whose businesses have a social responsibility program and are registered on the eThekwini Municipality supplier database were considered for participation in the study. The 250-sample size (n=250) was considered for the purpose, precision, size, and availability of time and resources.

3.2. Data Collection and Analysis

A self-administered questionnaire was hand-delivered to all 250 SME managers and owners visiting their respective sites during February and March 2020. A sequence of questions was posed using a five-point Likert-scale to ask participants to state the degree to which they agree or disagree with statements and to select their level of agreement with the statement, ranging from" strongly agree" to "strongly disagree" or "not at all" to a large extent". The response rate was 84 per cent, and 210 completed the questionnaires. Data was analyzed using the Statistical Package for Social Services (SPSS) version 22 to calculate statistics on descriptive reliability and correlation of the data. Factor analysis ensured to establish the most relevant constructs of the study.

3.3. Ethical Consideration

At all times, all participants' identities were kept secret without compromise and data was kept strictly confidential. Strict compliance with the University of South Africa's policy on research ethics and the standard operating procedure on research ethics risk assessment was adhered to as stipulated by the college research review committee (CERC) in the College of Economic and Management Sciences.

4. Results

4.1. Descriptive statistics

Tables 1 and 2 provide a comprehensive analysis of SMEs and the perceptions of CSR participation based on five critical statements: the size of the business, return on investment, improved quality of life, reduction of societal problems and the business's success.

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Table 1. Summary of respondents' responses: SME owners' perceptions about CSR.

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total
B1a Businesses have a responsibility to make social contributions.	11 5.3%	24 11.5%	21 10.0%	88 42.1%	65 31.1%	209 100.0%
B1b Being socially responsible has a return on investments.	7 3.3%	23 11.0%	42 20.1%	67 32.1%	70 33.5%	209 100.0%
B1c Businesses that are socially responsible improve the quality of life.	8 3.8%	26 12.4%	32 15.3%	74 35.4%	69 33.0%	209 100.0%
B1d Corporate social responsibility reduces societal problems.	25 12.0%	28 13.5%	25 12.0%	71 34.1%	59 28.4%	208 100.0%
B1e Corporate social responsibility is a critical success factor of a business.	15 7.2%	26 12.4%	45 21.5%	87 41.6%	36 17.2%	209 100.0%

Table 2. Summary of respondents' responses: SME owners' perceptions about CSR – the variables treated as scale in measurement level

	Mean	N	Std. Deviation
B1a Businesses have a responsibility to make a social contribution	3.82	209	1.149
B1b Being socially responsible has a return on investments.	3.81	209	1.117
B1c Businesses that are socially responsible improve the quality of life.	3.81	209	1.139
B1d Corporate social responsibility reduces societal problems.	3.53	208	1.347
B1e Corporate social responsibility is a critical success factor of a business.	3.49	209	1.131

The data (73%) significantly reflect that business size does not drive the desire or capability to engage in social responsibility. A business, therefore, has an inherent obligation to participate in CSR activities irrespective of the proportions. In other words, CSR should only partially be left to large enterprises, but SMEs must also play social responsibility roles. Being socially responsible, therefore, provides an opportunity for improved return on investments (65.6%) and the society's value of life (68.4%). Furthermore, CSR reduces societal problems (62.5%) and is a critical success factor in business operations.

Notwithstanding CSR's positive impact, SMEs are considered incapable of engaging in social activities, and in this regard, the size factor must therefore be considered (16.8%). Moreover, investment return on SMEs is often minimal (14.3%) to allow participation in social activities, and their involvement will not necessarily improve their quality of life. In addition, engaging in CSR from an SME's perspective does not necessarily reduce societal problems (25.5%) and is not entirely a critical success factor of a business (19.6%).

4.2. Factor Analysis

Table 3. Component analysis of five constructs

	Component				
	1	2	3	4	5
C1i The business contributes to sports activities	.793				
C1h The business makes efforts to improve the health of the community.	.710				
C1j The business contributes towards cultural activities in the community.	.670				
C1q The business provides financial support to one or more environmentally friendly initiatives.	.543				
C1c The business offers bursaries to employees' dependents.		.778			
C1b The business contributes towards employee's education.		.775			
C1f The business participates in crime-fighting initiatives in the community.		.728			
C1a HIV/AIDS counselling, alcoholism, and substance abuse.			.732		
C1e The business obeys all relevant Laws of the municipality.			.709		
C1g The business donates money and other goods to local charitable associations.			.580		
C1p The business disposes of recycled materials in production and packaging.				.786	
C1o The business disposes of waste in an environmentally friendly manner.				.728	
C1n The business transparently contracts its business.				.672	
C1l The business is customer-driven.					.863
C1k The business enjoys treating its customers fairly.					.859

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Table 3 shows five constructs namely, (i) community involvement (substantiated by four statements, i.e., C1i, C1h, C1j and C1q); (ii) employee development (substantiated by three statements, i.e., C1c, C1b and C1f); (iii) community upliftment (substantiated three statements, i.e., C1a, C1e and C1g); (iv) environmental awareness (substantiated by three statements, i.e., C1p, C1o and C1n); and (iv) customer orientation (substantiated by two statements i.e., C11 and C1k).

4.3. Reliability Statistics

The reliability scores in Table 4 relate to the perception of CSR dimensions, namely, community involvement, employee development, and customer orientation, illustrated as 0.686, 0.693 and 0.682, respectively.

Table 4. Reliability stats for the five extracted components

Subscale	Description	Number of Items	Cronbach's Alpha
C1	Community involvement	4	0.686
C2	Employee development	3	0.693
C3	Community upliftment	3	0.565
C4	Environmental awareness	3	0.599
C5	Customer orientation	2	0.682
Overall	**All dimensions**	**15**	**0.732**

These results mean that the reliability CSR dimension did not meet the Cronbach's alpha value of 0.70 reliability threshold as recommended by Purwanto and Sudargini (2021). This does not mean it is poor, as Cronbach's alpha value is considered poor only when it is less than 0.60 (Taber, 2018). Other reliable CSR dimensions, including community upliftment and environmental awareness, are illustrated as 0.565 and 0.599, respectively, as shown in Table 4. This result demonstrates that the two CSR dimensions are poor. Therefore, overall reliability scores for all five dimensions of CSR are above 0.70, which is deemed to be within acceptable limits.

4.4. Correlation Statistics

Table 5 below shows the correlations among the latent constructs (Pearson's).

Table 5. Correlations among the latent constructs (Pearson's)

	Community involvement	Employee development	Community upliftment	Environmental awareness	Customer orientation
Community involvement	1				
Employee development	.462**	1			
Community upliftment	.204**	.270**	1		
Environmental awareness	.188**	.115	.277**	1	
Customer orientation	.060	-.030	.157*	.139*	1

**. Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed).

There are positive relationships between community involvement and employee development (r=0.462; medium effect size; p≤ 0.01), community upliftment and community involvement (r=0.204; small effect size; p≤ 0.01), and between environmental awareness and community involvement (r=0.188; small effect size; p≤ 0.01). Table 5 further indicates positive relationships between community upliftment and employee development (r=0.270; small effect size; p≤ 0.01), environmental awareness and community upliftment (r=0.277, smalleffect size; p≤ 0.01). Additional positive relationships exist between customer orientation and community upliftment (r=0.157; small effect size; p≤ 0.05) as well as between customer orientation and community upliftment (r=0.139, small effect size; p≤ 0.05). Thus, all the correlations were significant at the 0.05 level (2-tailed).

5. Discussion

The results generated two discussion points, namely, the perception of SMEs concerning CSR and the CSR activities of SMEs in e-eThekwini within the municipality. These two points are discussed below.

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5.1. Perception of SMEs concerning CSR

The literature reveals that big businesses have plenty of disposable resources and therefore can, as opposed to SMEs, which naturally have limited resources (Beitzen-Heineke, Balta-Ozkan & Reefke, 2017). However, small businesses still need to practice CSR as it can be used as a competitive advantage and position a business more favourably than other businesses in the same industry. This study reveals that 73 per cent of all businesses support CSR practices, irrespective of how big or small. The study further argues that CSR practice in the business environment can potentially lure potential investment from investors and support from general society, local community, and governments (Wisdom et al., 2018). This is attested by 65.6 per cent of the respondents who agreed that CSR increases return on investment and provides reciprocal benefit as both business and society tend to gain, hence the improved quality of life. In other words, SMEs can use CSR programmes to gain a competitive advantage and long-term survival in the market.

5.2. CSR Activities of SMEs in eThekwini Municipality

This study reveals that SMEs only contribute towards employee education, which has the highest mean score of 2.02 and is more prominent and appreciated among eThekwini Municipality residents. It argued that through CSR, SMEs can attract employees with the resilience and competence necessary to achieve business goals and objectives (Dias et al., 2019). Responsibility and support of SMEs for CSR should not only be based on environmental building. Still, they must also cut across developing employees as capacity building to show that more attention is paid to the workforce's development (Beitzen-Heineke et al., 2017). It further emerged that SMEs in eThekwini Municipality provide various social activities, including sponsorships on education, safety, security, and maintenance of public facilities. Some charitable obligations include activities that respond to community expectations of businesses as good corporate citizens (Caroll & Shabana, 2010).

6. Contribution of the Study

Few studies were undertaken in the eThekwini Municipality around CSR and the undertakings by SMEs in the different sectors of the economy. Not much testimony is linked to CSR support, indicators, and guidelines for emerging economies such as South Africa (Gajadhur, 2022). However, there is a recognition that CSR remains a platform for companies to contribute to sustainable growth for an agenda on sustainable advancement (Riano & Yakovleva, 2019). The five SME dimensions shown in Figure 3 are therefore initiated to guide SMEs on appropriate measures to take in engaging CSR activities in South Africa. Firstly, community involvement entails the business's contribution to the community's well-being. Secondly, employee development requires a dedicated approach to the professional development of the employees while at the same time ensuring their security within their communities. Thirdly, community upliftment entails businesses abiding by the laws while engaging in charitable activities. Fourthly, environmental awareness calls for companies to dispose of and recycle materials in an environmentally friendly and transparent manner. Fifthly, community involvement entails the fair treatment of customers. The SMEs CSR dimensions underscore the vital link between society and business in creating value and sustainability in communities (Gajadhur, 2022). The authors suggested their framework for SME components on CSR (Figure 1).

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SMEs CSR DIMENSIONS	**Community involvement**	**The business contributes to sports activities**
		The business makes efforts to improve the community's wellbeing.
		The business contributes towards activities in the community
		The business provides support to environmentally friendly initiatives
	Employee development	The business offers bursaries to the dependents of the employees
		The business contributes towards employee's education
		The business initiatives crime-fighting mechanisms within the community
	Community upliftment	The business sponsors HIV/AIDS counselling, alcoholism, and drug abuse
		The business obeys all relevant laws of the municipality
		The business contributes financial and other resources to local organization
	Environmental awareness	The business disposes of used recycled materials in production and packaging
		The business disposes of its waste in an environmentally friendly manner
		The business contacts its business in a transparent manner
	Customer orientation	The business is customer-driven.
		The business enjoys treating its customers fairly

Figure 1. Framework for SME Components on CSR

7. Recommendation for future studies

Regardless of the business size, SMEs should take responsibility for contributing to social issues because being socially responsible has a return on investments. However, the potential for return on investments should encourage responsible social contribution to society. Also, authorities in SA at national, provincial, and municipal levels of government need to develop programs that upskill SMEs so that the owners and managers of these businesses are familiar with government policies that can be used as guidance for engaging in CSR. This study makes the following three recommendations for future studies to further assist policymakers with specific reference to the promotion of SME social responsibility:

1. A similar study can be conducted on a larger sample, which includes other municipalities from other provinces in SA.
2. A study should be conducted on action-oriented areas such as the success of different policies and techniques to increase the uptakeof CSR amongst SMEs at the sector level and the typology of SMEs about the engagement in CSR.
3. Future studies should integrate quantitative and qualitative techniques (methodological triangulation) to enhance the credibility and validity of research findings.

8. Conclusion

Out of 250 questionnaires distributed to the selected SMEs that appear in the database of eThekwini Municipality in KwaZulu-Natal province, 210 were returned, which resulted in an 84 per cent response rate. Accordingly, an above 80 per cent response rate is regarded as excellent and large enough to conduct exploratory factor analysis. Whether the business is small, medium, or large, there is a need to contribute towards social issues of employees, customers, and the entire society. CSR engagement provides a competitive advantage and reduces societal problems. Five SME CSR dimensions are established: community involvement, employee development, community upliftment, environmental awareness, and customer orientation—the framework for SME components on CSR (Figure 1) guides examining SMEs' perceptions towards CSR. Little CSR activities were implemented by SMEs in the eThekwini Municipality due to a lack of resources. These businesses are content to exist for as long as they make a profit that sustains the business.

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APPENDIX 1: Questionnaire

PERCEPTIONS REGARDING THE CORPORATE SOCIAL RESPONSIBILITY OF SMALL AND MEDIUM ENTERPRISE OWNERS IN THE ETHEKWINI MUNICIPALITY

Dear respondent

Thank you for your time and willingness to complete the following survey. The purpose of the study is to explore perceptions regarding the corporate social responsibility (CSR) of Small and Medium Enterprise (SME) owners in the eThekwini Municipality.

There are no correct or incorrect answers.

Please answer questions by placing a cross (X) in the appropriate block.

SECTION A

SCREENING QUESTIONS: BACKGROUND ABOUT YOUR BUSINESS

(If the respondent does not meet the inclusion criterion outlined in questions 1 and 2, then he/she should not complete the questionnaire.

Question 1

How long has your organization been in existence?

5 - 10 years	
11 - 15 years	
16 - 20 years	

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More than 20 years	

Question 2
How many people are employed in your business?

1-5	1
6-10	2
11-15	3
16-20	4
Other	5

Question 3
Indicate your business sector or to which one of the following categories does your business belong?

1	Agriculture, forestry and fishing.		9	Clothing, footwear, and textiles.	
2	Chemicals; chemical, rubber &plastic products.		10	Construction & Building materials.	
3	Educational services.		11	Electronic & electrical equipment.	
4	Engineering/Manufacturing.		12	Financing, insurance, real estate &business services.	
5	Food producers & processors.		13	Health services.	
6	Leisure, hotels & catering services.		14	Paper, printing & Publishing.	
7	Personal & household services		15	Retail trade.	
8	Transport, communication &storage.		16	Wholesale trade.	
	Other (please specify)				

Question 4
What is your role in this business?

Manager	1
Business owner	2
Senior employee/ Supervisor	3

Question 5
Please indicate your age group.

18 – 30	1
31 – 40	2
41 – 50	3
51 – 60	4
61 - 65	5

Question 6
Please indicate your annual turnover (estimation only)

Less than R 50 000	1
R 50001 – R100 000	2
R 100 001 – R 150 000	3
R 150 001 – R 300 000	4
More than R 300 000	5

SECTION B
CORPORATE SOCIAL RESPONSIBILITY (CSR) ACTIVITIES
In this research study, Corporate Social Responsibility is understood to relate to a business' concern for society's welfare and relationship to the society within which the business operates. Corporate Social responsibility means to be aware of and be active in assisting society to overcome societal or environmental problems. CSR is when a business is aware of societal problems and plays an active role in benefitting society by helping to alleviate these problems.
Question 1
This question relates to the perceptions of Small Medium Enterprises owners about Corporate Social Responsibility.
What is your understanding of Small Medium Enterprises Corporate Social Responsibility in eThekwini Municipality?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Irrespective of size, businesses have a responsibility to contribute to social issues e.g., donation to sports teams, bursary, HIV Aids awareness campaigns.	1	2	3	4	5
Being socially responsible for the community has a return on investment (profit).	1	2	3	4	5
Businesses that are socially responsible improve the quality of life of the society.	1	2	3	4	5
Corporate social responsibility reduces societal problems e.g., crime, drug abuse, HIV and Aids, teenage pregnancies, poverty, hunger.	1	2	3	4	5
Corporate social responsibility is acritical success factor of a business.	1	2	3	4	5

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SECTION C
CSR ACTIVITIES CURRENTLY IMPLEMENTED BY SMES
Question 1
Please indicate to what extent your business is involved in the following corporate social responsibility activities.

	Not at all	To a small extent	To someextent	To a moderateextent	To a large extent
HIV / Aids counselling, alcoholism, andsubstance abuse	1	2	3	4	5
Contribution towards education ofemployees.	1	2	3	4	5
The business contributes offers bursaries to the dependents of the employees.	1	2	3	4	5
The business offers staff developmentsuch as skills training	1	2	3	4	5
The business obeys all relevant by lawsof the municipality.	1	2	3	4	5
The business is involved in crime-fighting initiatives in the community.	1	2	3	4	5
The business donates cash and othergoods to local charitable organizations.	1	2	3	4	5
The business is involved in efforts toimprove the health of the community.	1	2	3	4	5
The business contributes to sportsactivities in the community.	1	2	3	4	5
The business contributes towards cultural activities in the community	1	2	3	4	5
They enjoy treating customers fairly.	1	2	3	4	5
The business is customer drivenbusiness.	1	2	3	4	5
The business is charging fair prices tocustomers.	1	2	3	4	5
The business conducts its activities in atransparent manner.	1	2	3	4	5
The organization disposes of its waste in an environmentally friendly manner.	1	2	3	4	5
The organization uses recycled materials in production and/or packaging.	1	2	3	4	5
The organization provides financialsupport to one or more environmental. friendly initiatives.	1	2	3	4	5

SECTION D
CHALLENGES EXPERIENCED BY SMEs WITH REGARD TO CSR ACTIVITIES
Question 1
Please indicate the challenges that your business experiences when implementing corporate social responsibility activities.

Challenges	Stronglydisagree	Disagree	Neither agree nordisagree	Agree	Stronglyagree
There are no clear governmentpolicies to guide us regarding corporate social responsibilities	1	2	3	4	5
The business lacks employees with expertise to implement corporate social responsibilities	1	2	3	4	5
Unfavourable economic conditions, e.g., economic recession.	1	2	3	4	5
Lack of government support. e.g., advisory support for licensing and obtaining credit startup costs	1	2	3	4	5
Lack of support from the bankingsector and other financial institutions. e.g., Industrial development corporation (IDC) and small enterprise developmentagency (SEDA)	1	2	3	4	5

Question 2
In your opinion, what other challenges are you faced with when considering CSR?

_____

Data Availability Statement: More primary data be obtained from the corresponding author on a reasonable request.

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DATA SECURITY RISKS AND THEIR PREVENTION: LATVIAN ENTERPRISES IN THE CONTEXT OF SELECTED COUNTRIES

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Abstract. An increasing number of organizations in Latvia are directing their efforts toward digitizing information and data storage. With the onset of the COVID–19 pandemic, there was an essential surge in the number of employees working remotely, eliminating the constraints of their physical workplace. Consequently, the challenges concerning data security within organizations have amplified. The main aim of this study is to explore and recognize the risks related to logistics data protection and subsequently formulate recommendations for mitigating or preventing logistics data security risks in Latvian enterprises. This research is centred on examining the prevailing data security trends in Latvia. An academic literature review was undertaken to gain insights into the core attributes and legislative measures governing data security in Latvia. Statistical and content analyses were employed to uncover deficiencies and risks in data security. The main results show that the data security and risk management measures in Latvian enterprises do not depend on the industry represented by the enterprise, thus applying the commonly used data security protection measures and risk management approaches. The research concluded that, in Latvia, the primary data security risks arise from internal and external threats.

Keywords: logistics; data security; ICT security measures; data security regulations; data privacy; business enterprises

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JEL Classifications: O10, R49

Additional disciplines: law; sociology; information and communication; informatics

1. Introduction

The significance of data security and the application of preventive measures related to ensuring logistics data safety in enterprises has considerably increased over the past decade. The growth of digital solutions such as IoT, robotics, and big data in logistics automation (Navickas et al., 2022; Nica et al., 2023; Lincenyi et al., 2023; Shen & Zhang, 2024) raised people's concerns about the security of those technological advancements (Hick et al., 2024). Nowadays, the amount of processed logistics data has significantly increased (AlShaer et al., 2019) due to the use of sensors for tracking delivery or product maintenance, which has assisted in connecting humans, factories, shipments, and machines. Shameli-Sendi (2020) points out the necessity of defining enterprises' security needs, allowing the integration of preventive measures and risk assessment in everyday operations. It

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should be emphasized that logistics data security should be assessed in terms of logistics operations, e-commerce (Ding & Zhao, 2021; Markos et al., 2023; Androniceanu & Georgescu; 2023), and national security (Nguyen et al., 2023).

Therefore, the study aims to study and identify risks associated with data protection to develop recommendations for preventing or reducing logistics data security risks in Latvian businesses. The main tasks undertaken in this regard were:

- To analyze theoretical aspects and the legal acts regulating data security.
- To gather and examine empirical information regarding data security (DS) and protection (DP).
- To evaluate the core measures and risks related to logistics DS in enterprises.
- To come up with recommendations for logistics DS risk reduction in enterprises.

The research begins by undertaking an academic overview of the literature that recognizes Latvia's key concepts and legal mechanisms regulating data security. Then, it turns to statistical and content analysis that reflects the challenges and issues encountered in logistics data protection. Moreover, the research delves into the various data security measures implemented by Latvian enterprises. This includes security measures like strong password authentication, software updates, and data backup, which are evaluated in the context of different categories of enterprises. Afterwards, the study identifies and analyzes the main measures and risks associated with data security in Latvian enterprises. It specifically focuses on internal and external threats and the implications of logistics data security risks on organizations. Based on the findings from the various analyses, the research develops recommendations for preventing or reducing logistics DS risks in Latvian enterprises. These recommendations aim to provide practical solutions for enhancing data security.

Data used in the study can only be obtained from official countries or European Union (hereinafter – EU) level statistical datasets due to publishing delays, which restricts data sources to those dealing with data security. The research period is from 2013 to 2022. This case study has assessed the main trends and risks associated with data security in enterprises in Latvia; situation analysis regarding another country and comparisons with other countries are included in the research.

2. Theoretical background

The problem of data security is actively discussed in entrepreneurship. Doss et al. (2022) raised concerns about excessive DS demand, while Qatawneh & Al-Okaily (2024) highlighted the importance of interconnectedness between technologies, operational efficiency, and system operations. Ali (2020) points out safety problems arising from the lack of data security measures and people's training and compliance problems. In contrast, Li et al. (2020) point out that data security risks should be divided into two categories: DS issues and application security matters, thus agreeing that the main concerns regarding DS arise from integrity, confidentiality, and privacy protection and communication.

In addition, Kennedy and Millard (2016) focus on data security as one of the main problems in enterprises and summarize the main benefits and challenges of laws related to data protection regulation. Therefore, data protection legislation in Latvia is divided into EU legislation and national laws. Three principal regulations regulate the data collection, storage, and usage industry in Latvia – General Data Protection Regulation 2016/679 (hereinafter – GDPR), The Data Protection Law Enforcement Directive 2016/680 as well as Personal Data Processing Law, which is the national law in data protection in Latvia:

- GDPR (REGULATION (EU) 2016/679, 2016) entered into force on 24 May 2016 and has been applied since 25 May 2018. This regulation was developed to reduce fragmentation in national systems and unnecessary administrative burdens by clarifying rules for companies and public bodies.
- Data Protection Law Enforcement Directive 2016/680 (DIRECTIVE (EU) 2016/680, 2016) entered into force on 5 May 2016 with the condition that EU countries had to transpose it into their national law. The directive secures the fundamental right of citizens to data protection when law enforcement bodies use personal data for law enforcement objectives. It aims to guarantee that the personal data of victims,

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witnesses, or suspects of crime are appropriately secured and will facilitate cross-border collaboration in the fight against corruption and terrorism.

- Personal Data Processing Law (2018) entered force on 5 July 2018. As this is national law, it is designed to supplement the General Data Protection Regulation and The Data Protection Law Enforcement Directive. The objective of this law is to create legal prerequisites for setting up a system for the protection of personal data (hereinafter – the data) of a natural person at a national level by providing for the institutions necessary for such purpose, determining the competence and essential principles of operation thereof, as well as regulating the process of data protection officers and provisions of data processing and free movement.

The concept of the data and the risks are discussed in scientific literature. Patil et al. (2020) define the data as representing ideas or objects previously collected as characters, symbols, numbers, and pictures. In turn, the term "data security" is discussed by Naim et al. (2023), referring to it as the process of ensuring the safety of digital information. However, Patil et al. (2020) emphasize that data protection relies on confidentiality, authenticity, and integrity. Moreover, Gupta et al. (2021) focus on data assurance as the significant reason causing data security risks. Data security is the leading indicator for measuring the level of data privacy. In addition, Filippova et al. (2021) and Katina et al. (2023) defined risk factors that influence key performance indicators in an enterprise and affect the effectiveness of systems and processes.

As Kraska et al. (2019) stated, data may be treated in compliance with one of the six lawful instances: consent, agreement, legal obligation, lifeless interests, public interest, and legitimate interest. It confirms the content of the legal norms that obtaining approval or permission to process and store data is necessary.

In addition to the classification provided by Kraska et al. (2019), the EU has determined the requirements for systems that store data. Shastri et al. (2019) consider that these requirements are: 1) Controlled data storage and access to the storage system based on a legal basis, including access limitations; 2) Queries, in which access is defined and all data collected is associated with purpose; 3) System-wide erasure is based on data subject rights to erase data stored by the enterprise.

According to Subbalakshmi and Madhavi (2018), four significant risks associated with company IT data security are data security, privacy, reliability, and storage threats. Liu et al. (2016) focus on the increase in data usage and security and protection problems associated with big data and cloud data, as well as safety from intruders and controlling user accessibility in the CSPs. These two major and foremost requirements are of primary importance.

IT data security concerns are studied not exclusively by researchers but also by international auditing companies such as PwC or EY. For example, PwC (A Practical Guide to Risk Assessment, 2008) indicates that to prevent IT data security threats resulting from legal requirements and professional or self-regulatory obligations, several forms of risk assessments are frequently undertaken within enterprises. EY has addressed an equivalent evaluation in the information security study (EY Global Information Security Survey, 2020).

Contrary to Liu et al. (2016), the EY information security survey divides threats or risks by the person category – outsiders, neutral or unknown, and insiders. The report highlighted that “the increase in activist attackers, who this report shows were the second most common source of material or significant breaches, underlines how the cybersecurity function needs a much deeper understanding of its organization’s business environment.” EY survey (EY Global Information Security Survey, 2020) shows that “the cyber and privacy threat is increasing and expanding”. 6 out of 10 organizations (59%) have confronted an occurrence of threats in the previous 12 months. As the EY discloses, 48% of boards accept as true that cyber-attacks and data breaches will more than moderately influence their business in the following 12 months. Around one-fifth of these attacks (21%) arose from “hacktivists” (defined as tech-enabled, political, and social activists) and another one-fifth from organized crime groups (23%). Undoubtedly, all this impacts not only the crime problem but also more global problems in the economy (Remeikiene et al., 2022).

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In turn, Bruni et al. (2023) suggest reconsidering collaboration with 3PL service providers to reduce data security risks, justifying this opinion by the level of experience those companies have in different logistics operations management. Another suggestion for risk prevention is the establishment of effective communication channels (Sravan et al., 2023) and investment in the newest digital technologies (Helmold et al., 2022) mentioned before.

Despite a separate strand of research in data security issues, more research is still needed in the context of ongoing digitalization. The authors seek to fill this gap by studying Latvia's enterprises in the context of other European countries.

3. Research methodology

The research incorporated conventional scientific methods, including literature review, data visualization, statistical analysis, synthesis, and monographic or descriptive methods. Through the methods above, we could examine the significance of data security, its concept, and the preventative actions taken by Latvian enterprises. The share of employees using the Internet to perform their duties regularly, the main activities of the enterprises in terms of customer data processing, and the core data security measures employed in Latvian enterprises have been examined. The literature was previously discussed to identify DS, logistical data, regulations focusing on data security, and the most common risks encountered by organizations processing data. The literature evaluation concentrated on gathering the most important details about the core risks associated with data processing in Latvian enterprises and the main preventive measures to ensure the security of logistical data.

The initial examination was steered in the following databases: Web of Science, Scopus, and Science Direct, and was constructed on the following keywords: logistics data, DS legislation, DS, and data. Primary literature sources were carefully chosen and grounded on the aim and topic of the research, as well as the availability of full-text articles. The research paper was developed on multiple data sources associated with data security, as the primary source was the Official Statistics Portal of Latvia. Still, due to the limited coverage in EU-level databases and delay in publishing, the information related to the data security measures applied was used with the latest available data. The study's scope covers from 2013 until 2023. The study methodologies employed were graphical and content analysis.

The comprehensive examination of the scientific works and statistical information endorsed the writers of the research to accomplish the previously indicated purpose of the article. This research should be considered as the next step of the previously conducted research by the authors Jurgelāne-Kaldava and Batenko (2023) about the topic ”Assessment of Data Security Implementation in the Supply Chain Enterprises in Latvia” where the authors focused on the DS measures applied in supply chain enterprises and recommendations for their improvement.

4. Results and discussion

The potential logistics data security risks are directly linked to internet usage at the workplace. Even though many enterprises in Latvia focus on process automation, the primary data security concerns arise from the employees' knowledge of the preventive measures applied. According to data from the Central Statistical Bureau of Latvia (Official Statistics Portal of Latvia, 2024), as evidenced by Figure 1, the overall usage of the Internet has increased among all sizes of companies.

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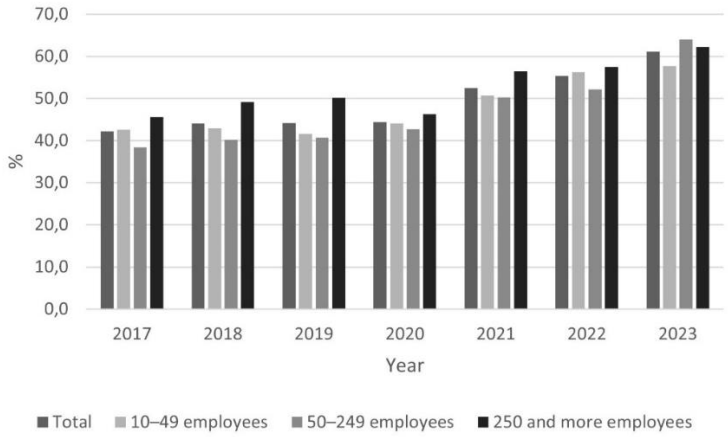


Figure 1. Employees using internet connection regularly in their jobs in Latvian enterprises from 2017 – 2023, %.
Source: authors created based on Official Statistics Portal of Latvia, 2024

Despite the increased use of the Internet by employees of all companies, it is essential to understand how digitalization in Latvian companies looks in the context of other countries. Figure 2 below shows that Latvian companies with over 10 employees are characterized as having very low or low digital intensity. Anyway, the digital intensity in Latvian enterprises is much higher than in Romania, Greece, and Bulgaria). Since the increase in digitalization is inevitable, data security issues will become more urgent.

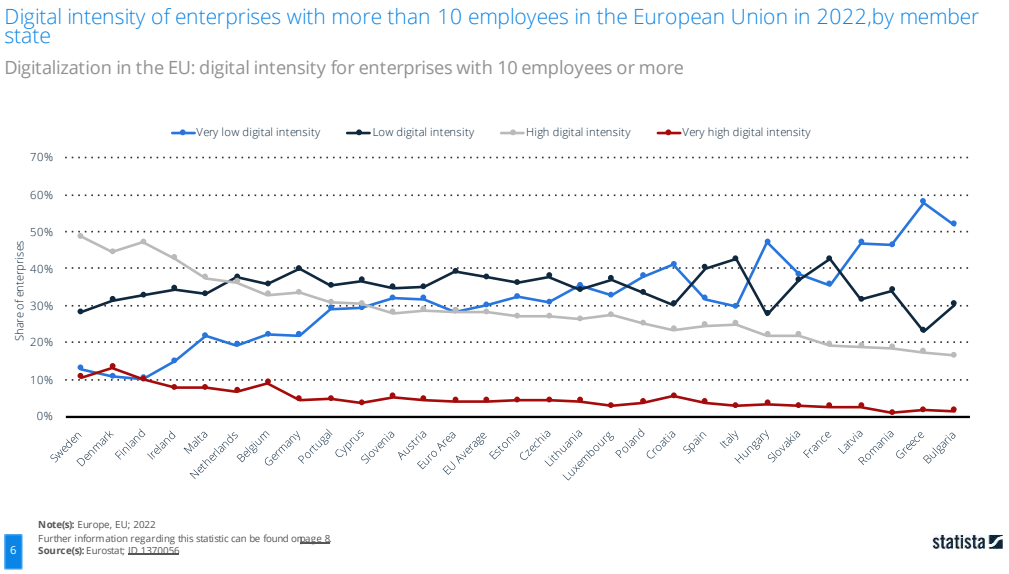


Figure 2. Digital intensity in European and Scandinavian countries in enterprises with more than 10 employees
Source: Statista

It should be reflected that the notable increase in Internet and mobile internet usage is related not only to technological advancements and the digitalization of services but also to the COVID-19 pandemic and the necessity for transferring services offered online.

To ensure the performance and functioning of essential business operations, companies must compile and store various logistics data related to their activities, employees, and customers. Table 1 illustrates the activities' growth as a percentage relative to the baseline year 2013.

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Table 1. The growth of activities conducted by companies in Latvia to process information on clients (CRM) in 2013 – 2021, % compared to the baseline year 2013

Enterprises	Activity	2013	2014	2015	2017	2019	2021
Total	The collection*	12.9	10.6	17.6	15.4	12.4	16.3
	The analysis**	12.1	10.4	13.6	13.2	12.2	12.4
10–49 employees	The collection*	10.4	8.0	14.6	12.2	10.6	13.5
	The analysis**	10.0	8.2	11.5	10.7	10.8	10.3
50–249 employees	The collection*	24.2	21.1	28.0	27.6	18.6	26.7
	The analysis**	21.4	19.0	21.1	22.9	16.3	19.9
250 and more employees	The collection*	36.5	37.8	56.1	46.7	36.1	48.0
	The analysis**	30.7	33.4	38.3	37.3	32.8	37.6

Source: Official Statistics Portal of Latvia, 2022

* The collection refers to "the collection, storing and making available information about customers to various business functions"
** The analysis refers to "the analysis of information about customers for marketing purposes"

Examining the objective of information and data processing: "The collection, storing and making available information about customers to various business functions," it should be stated that the total percentage of enterprises engaged in such operations increased by 26.4%, with the most significant increase by 31.5% for enterprises with 250 and more employees, followed by 29.8% and 10.3% increase for enterprises with 10 – 49 employees and 50 – 249 employees accordingly. Compared with the previous, the purpose of information and data processing: "The analysis of information about customers for marketing purposes," has an overall growth of 2.45% compared with 2013. The number of companies processing customer data with 10 – 49 employees and companies with more than 250 employees has increased by 3.0% and 22.5%, respectively, but for companies with 50–249 employees, it has decreased by 7.0%. This decrease is related to the start of the implementation of the GDPR in 2017, which means that companies need to ask permission from the data subject (customer) to obtain, collect, and store the data. The most considerable decrease for the companies with 50 – 249 employees could be explained by the fact that companies did not have an internal data collection, compilation, and storage policy and policy related to customer relations, while the smaller companies with 10 – 49 employees have more robust relationships with customers and similarly, as companies with 250 and more employees have better customer relationships management and can more easily get the permission of data processing and storage (Official Statistics Portal of Latvia, 2024).

The most significant risks related to logistics data in ensuring business operations are associated with organized criminal groups implementing organized attacks. Still, it is necessary to highlight that a substantial amount (approximately 32%) comprises insiders – employees. It should be noted that in some instances, the Republic of Latvia laws even provide criminal liability to the company board (Teivāns-Treinovskis et al., 2022). Therefore, limiting access to different data and monitoring employees' activities is essential to eliminate or prevent data security risks.

Notably, 19 per cent of Latvia's enterprises experienced cyber security incidents in 2022, while Poland experienced 29,7 per cent and Bulgaria just 11 per cent (Figure 3). The differences can be caused by various reasons: level of digitalization, resilience, or decisions not to disclose incidents. No data available allows us to compare countries according to cyber incidents. Still, we assume that types of incidents are similar and can be illustrated by those in Italy in 2018 (see Figure 4 below). The main reasons for not reporting cyberattacks in Italy in 2018 are illustrated in Figure 5. These available data signal that there might also be numerous cyber-attacks in other countries, which are not reflected by statistical data.

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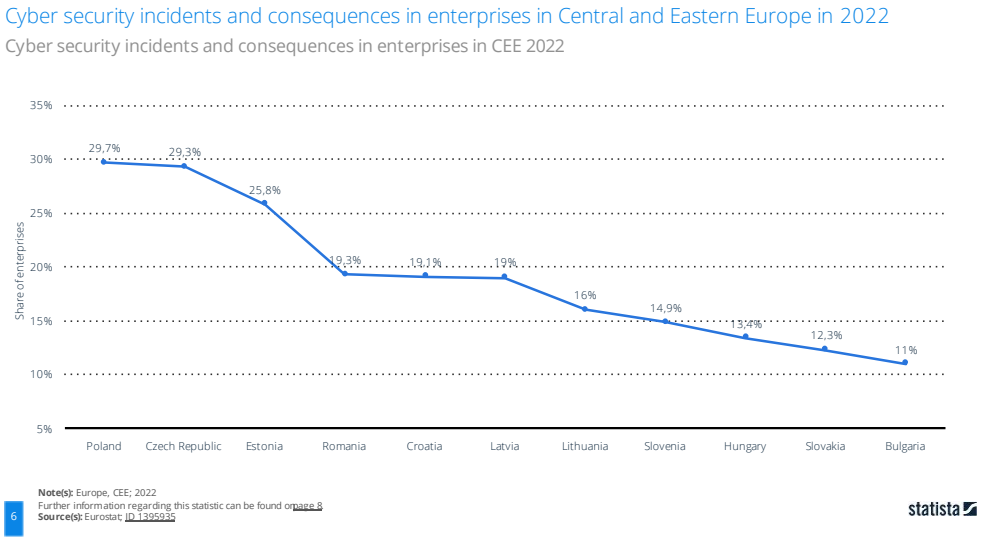


Figure 3. Share of enterprises experienced cyber security incidents in Central and Eastern Europe in 2022
Source: Statista

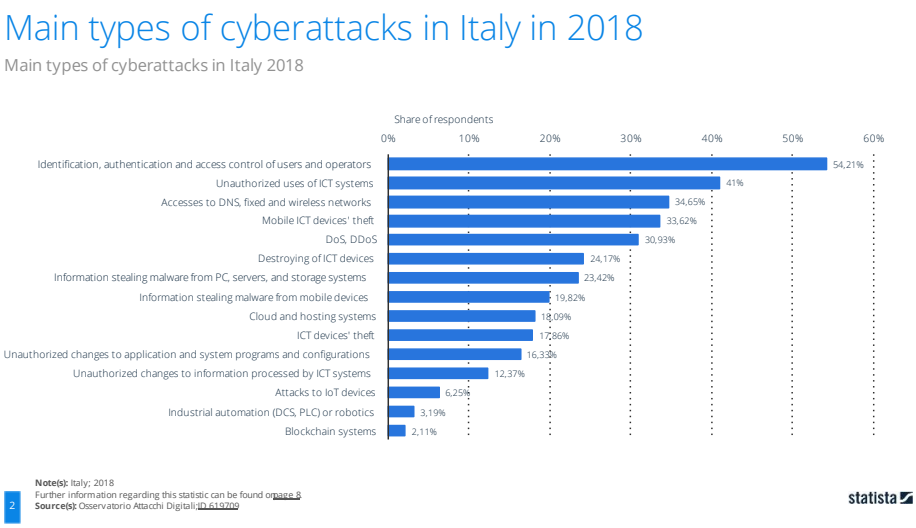


Figure 4. Types of cyber-attacks in Italy in 2018
Source: Statista

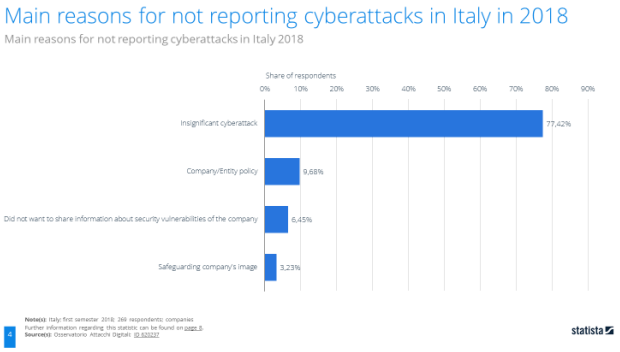


Figure 5. Main reasons for not reporting cyberattacks in Italy in 2018
Source: Statista

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For further analysis of activities carried out by enterprises to ensure the prevention of logistics data security risks, categories defined by the Central Statistical Bureau of Latvia will be used. IT security measures can be divided into the following categories – strong password authentication, keeping the software up-to-date, user identification and authentication via biometric methods, encryption techniques for data, documents or e-mails, data backup to a separate location, network access control, VPN, maintaining log files for analysis after security incidents ICT risk assessment, ICT security tests (see Figure 6).

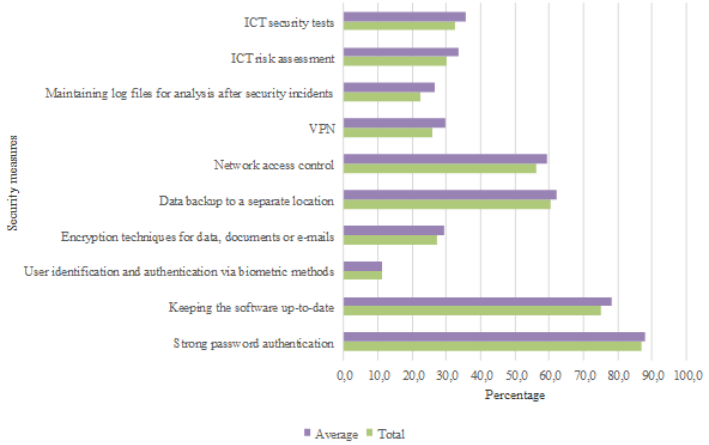


Figure 6. ICT security measures in Latvian enterprises in 2019, %.
Source: authors created based on Official Statistics Portal of Latvia, 2020

The most commonly used data security measures applied for all categories of enterprises are strong password authentication and keeping software up-to-date. On average, strong password authentication is one of the security measures used by 86.9% of companies analyzed (88.6% on average), but 75.1% keep software up-to-date (78.1% on average) (Official Statistics Portal of Latvia, 2024).

Generally, everything in terms of security is adopted by enterprises to secure intellectual property, client data, and confidential information of the enterprise. In addition, the less common security measures applied are user identification and authentication via biometric methods. This method uses 11.1% of companies analyzed (11.3% on average). This method is more widely used in information and communication technology companies (23.3% of all enterprises) and scientific laboratories (16.6% of all enterprises), where it is necessary to restrict access to confidential data. Based on the research, the companies processing logistics data apply strong password authentication (23.0% of all enterprises) and keep software updated (38.5% of all enterprises). (Official Statistics Portal of Latvia, 2024). This summary shows that enterprises collecting, storing, and processing data related to logistics do not apply customized security measures but rely on the traditionally accepted data security measures followed by average or non-existent risk management strategy applications.

Latvian enterprises' ICT data security measures are similar to those in other countries. Data on security measures in Poland (Figure 7), Czechia (Figure 8) and Belgium (Figure 9) are provided below.

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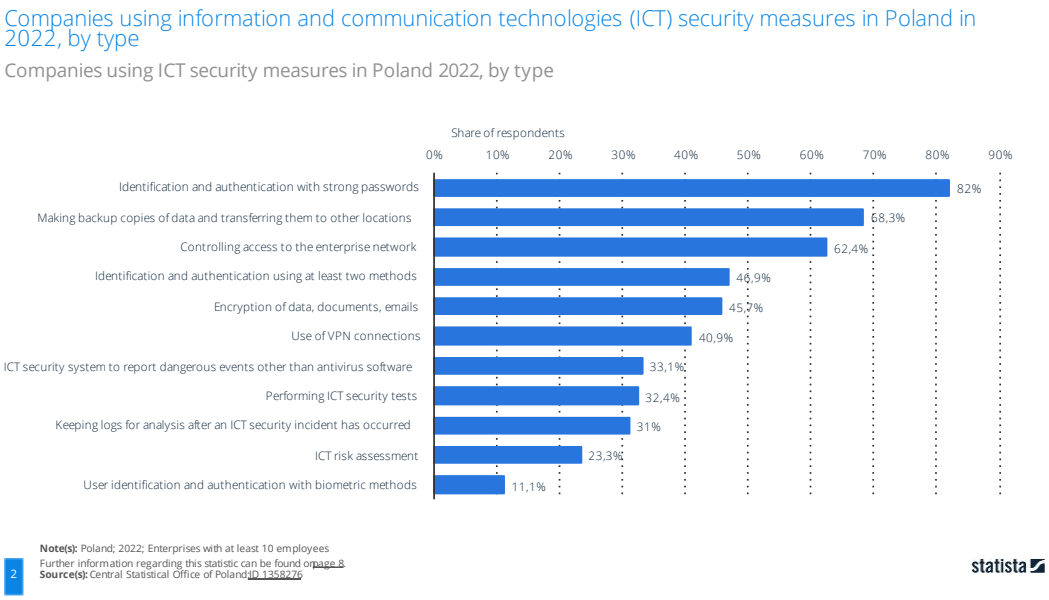


Figure 7. ICT security measures in Poland in 2022
Source: Statista

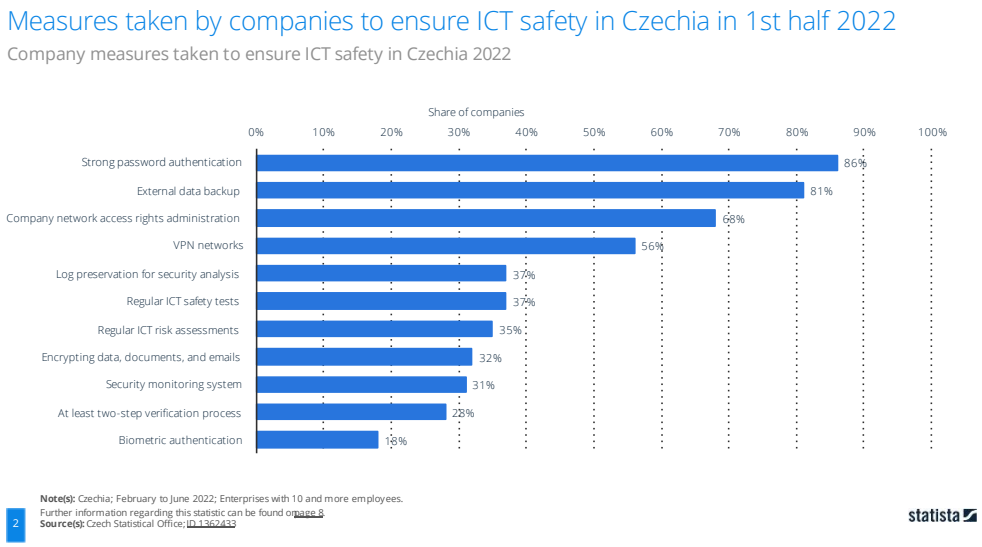


Figure 8. ICT security measures in Czechia in 2022
Source: Statista

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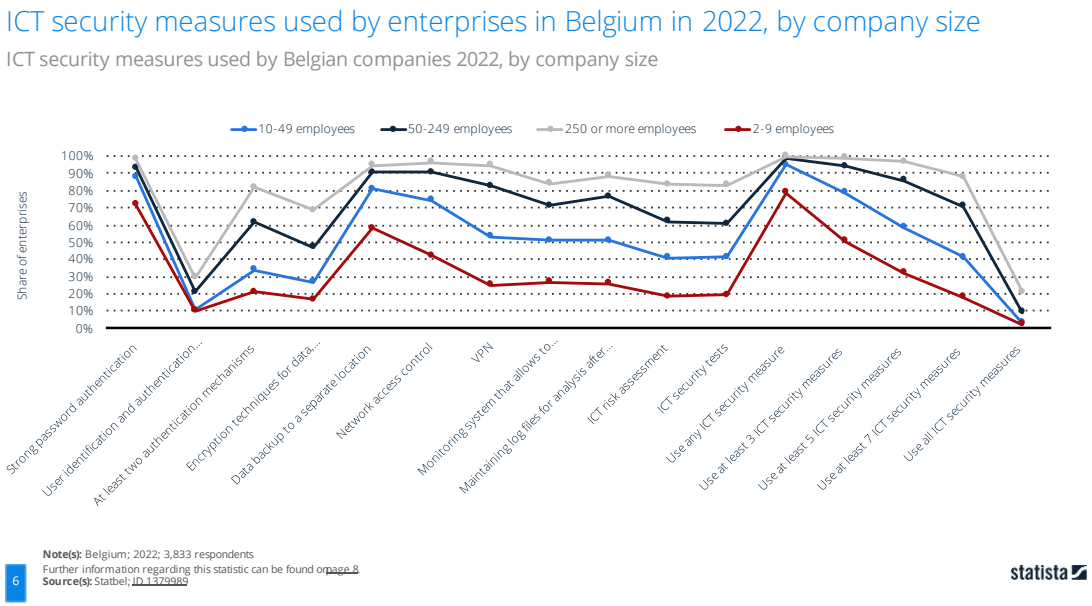


Figure 9. ICT security measures in Belgium in 2022
Source: Statista

The available data allows us to claim that Latvian enterprises' data security risks are similar to those of selected European countries. Latvia is characterized by slightly lower digital intensity in enterprises with more than 10 employees than analogic enterprises in European and Scandinavian countries. It allows us to expect the growth of digital intensity to bring more urgent issues in cyber security. Latvia has the potential to overcome the problems since the country applies contemporary measures similar to those used by other analyzed countries.

5. Conclusions

The study identified that the general measures to ensure data security in enterprises in Latvia are related to the frequency of data acquisition, processing, and storage. Latvian enterprises' most commonly used data security measures are strong password authentication, software updates, and data backup. It was not identified that the data security measures would differ based on the enterprise's industry or data processing type. Some patterns of the data analyzed require further investigation. For example, the factors leading to the decision to apply more advanced or customized data security measures and how to create customized data protection measures for the data related to the logistics operations that are usually linked to different internal systems and any internal or external threats may lead to the disruption in enterprises' operations.

In addition, the assessment of the main legal acts and different requirements related to data security in Latvia shows that enterprises should follow specific rules and procedures for data collection, storage, and usage, for example, the conditions included in GDPR and Personal Data Processing Law. In contrast, there was a significant decrease in the amount of data processed after the GDPR came into force and stabilized enterprises' business operations to meet the main legal requirements. This means that data security concerns regarding processing logistics data may arise due to the possible fines following the law and to customers' and employees' actions.

Moreover, the content and data analysis results show the necessity of more formal risk management in enterprises with 10 – 49 and 50 – 249 employees, as currently, following the data analyses, those enterprises steadily increase the amount and frequency of the data processed. The research showed that both enterprises with 10 – 49 and 50 – 249 employees have closer customer relations, thus facilitating risks related to violating the requirements for data processing and storage.

The most significant risks related to logistics data processing may arise not only from the outside but also from the employees due to personal interests or lack of knowledge in data management. The reported outcomes demonstrate that the overall number of crimes committed caused by DS in Latvia remains on a downward trajectory – 1/3 of crimes were explicitly committed by workforce members of the enterprise; hence, it is vital to enforce DS procedures for the protection of information and data for example, through restricting access to the systems or deploying various forms of authentication that gather information about files or information access. Therefore, data security risks concerning the data in wide-ranging logistics should be assessed and evaluated regularly. It is recommended that risk management strategies in the enterprise be developed, implemented, and regularly updated. It is suggested that the traditional data security measures mentioned above be incorporated.

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THE IMPACT OF REMOTE AND HYBRID WORK ON THE PERCEPTION OF BURNOUT SYNDROME: A CASE STUDY*

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Abstract. Remote work and working in a hybrid model have become terms that have been referred to quite often due to the coronavirus pandemic. This article aims to describe whether there is a direct link between the different work modes during the pandemic, the preference for the work mode in the post-pandemic period and the degree of perceiving burnout syndrome. The methods of an anonymous electronic questionnaire survey implemented by the CAWI method and statistical methods (calculation in IBM SPSS Statistics 28.0 software – frequency, percentage, valid percentage, cumulative percentage) were used. A test of the independence of two variables was used using Pearson's goodness-of-fit test, where Pearson's chi-square test statistic was used as the test criterion. Cronbach's alpha coefficient was used to calculate and determine the reliability of the entire questionnaire. The primary outcome was that during the post-pandemic era, respondents would prefer the hybrid work model (60.3 %). The perceived burnout symptoms among respondents working in different work modes vary (8.1 % - 15.8 %) but are generally low. The result of this study is a recommendation for the public sector, in the event of the coronavirus pandemic or any similar situation – to use a hybrid model that does not lead to burnout syndrome.

Keywords: pandemic; remote work; hybrid model; burnout syndrome; public sector; Moravian-Silesian Region; Czech Republic

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1. Introduction

The pandemic of the virus disease COVID-19 caused by the coronavirus SARS-CoV-2 became a global economic and social disturbance (ManpowerGroup, 2020). The adverse effects of this virus have been felt in both developed and developing economies (Siddiquei & Khan, 2020; Besenyő & Kármán, 2020), including, of course, the Czech Republic.

According to Article III of Government Resolution No. 1102 26th October 2020, concerning the implementation of a crisis measure, the Government, with effect from 00:00 28th October 2020, required employers to use a

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remote work module if employees could perform it at their place of residence concerning the nature of the work and operating conditions (Valíčková & Němeček, 2020). The coronavirus pandemic has affected all sectors of the economy to a various extent (Tittelbachova et al., 2022; Zimmermannova et al., 2022). Most public sector employees had to switch to a remote module overnight due to the nature of their work. Another section of public sector employees worked in a hybrid model, and a small proportion worked in office work only. Public sector employees work mainly in offices, some in the field. Their work is to provide essential services to the public (such as health care, education, social security programs, public safety, administrative services, etc.). They also deal with administrative and management tasks to ensure the smooth running of government organizations, collect and interpret data, and ensure compliance with laws and regulations. Their job description also includes inspections and audits. These activities can be implemented through remote work or a hybrid model (Ministry of Labour and Social Affairs, 2023).

Even the most conservative employers had to reevaluate their ways of functioning. Remote work and working within a hybrid model have become a pandemic phenomenon (HR News, 2021). However, the option to work remotely or in a hybrid model was distributed unequally across sectors, regions, and workers' education levels. Exploring remote work or work in a hybrid model is both relevant and necessary. Even in the future, in our conditions and other similar economies, people will work remotely or in a hybrid model because a similar or identical situation may arise. The outcome of this study, which focused on public sector employees in one region of the Czech Republic, can help select and adopt a work mode that will guarantee the needed productivity of employees and organizations and reduce any possible adverse effects.

This article aims to describe whether there is a direct link between the different work modes during the pandemic, the preference for the work mode in the post-pandemic period and the degree of perceiving the burnout syndrome; based on this study also recommends the public sector, which work mode to choose if the same or similar situation occurs in the future, as it did during the pandemic. The paper's aims will be achieved through an electronic survey using a questionnaire developed by the authors.

2. Theoretical background

2.1 Remote work and hybrid model

The concept of remote work or working in a hybrid model has been the subject of discussion and global studies by researchers for the past ten years. Still, this global phenomenon began to progress with the emergence of the COVID-19 pandemic and became an alternative strategy for many organizations worldwide (Mustajab et al., 2020; Turnea et al., 2022), including the Czech Republic. Workers were told to work remotely or in a hybrid model, depending on whether they liked it. The authors agreed that remote work or working in a hybrid model became common and now represents a crucial dimension of the future of work (Bai et al., 2020).

Some people use the terms ʿremoteʾ, ʿvirtualʾ and work from home interchangeably, while others have their definitions of each. The authors are going to use the term ʿremoteʾ and define it as a situation in which someone works fully remotely (independently and in an environment where there are no co-workers) - this most often includes working from home, from cafés or restaurants or while moving from place to place (Dyer & Shepherd, 2021; Felstead, 2022).

The hybrid work model involves a flexible way of organizing work and combines both work in an office and remote work. Organizations can choose which hybrid model arrangement works best for them because different hybrid models bring their positives and negatives. An organization may offer employees maximum autonomy to design their work week with zero restrictions or commands. Another option is that the organization, for example, sets a certain number of days that employees must spend at the workplace, as management sees this arrangement as a way to increase productivity and employee satisfaction (Kirkham, 2022).

During the days before the pandemic, remote work or working in a hybrid model was a popular and desired benefit. However, during the pandemic, it became an absolute necessity for many companies and state institutions to ensure their operation, and with the ongoing pandemic, it has become an everyday routine (Profi HR, 2020a; Kvapil, 2021). However, long-term remote work or working in a hybrid model only suits a third of

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people, as shown by a survey conducted by Profesia in the spring of 2020 (Novinky.cz, 2021). If they work predominantly or entirely from home, they feel uncomfortable, less happy and satisfied, or even unhappy. Isolation is the biggest problem, with more than 70 % feeling less connected to their colleagues (Profesia, 2020).

Data from a global survey conducted by Wakefield Research showed that 77 % of companies have already chosen some form of hybrid functioning. More than half of these companies (56 %) allowed employees to determine when and how often they wanted to work from the office (Kirkham, 2022).

Across the Czech Republic, 60 % of employees in the business sector worked in a hybrid work model or fully remote work model at the time of the pandemic (Czech Statistical Office, 2022), 80 % or 60 % of employees in the public sector (depending on whether they were state organizational units or local authorities) and 60 % of employees in the voluntary sector. 50 % of public sector employees were satisfied with remote working or a hybrid model (Ministry of Labour and Social Affairs, 2021). We can expect that the number of e-workers who work remotely will increase every year, even after the pandemic (Novinky.cz, 2020).

2.2 Future of a hybrid model and remote work

Before the pandemic, about 20 % of Czech employees occasionally had the opportunity to work remotely or in a hybrid model – companies allowed this benefit only a few times a month, according to the research done by the company LMC (Černohlávková & Housková, 2021). The main reason was mistrust. However, the technical unreadiness of employers during the beginning of the pandemic played an important role, and the test of readiness was very tough during the pandemic. Nevertheless, thanks to this, the attitude of employers toward this issue has changed fundamentally, both for private and state institutions (Profi HR, 2020b). After the experience with the pandemic, half of the employers say that more frequent remote work or a hybrid model will become the new norm (Černohlávková & Housková, 2021). The authors would like to emphasize that in recent years, one-third of companies have implemented a hybrid model of work attendance, most often requiring their employees to attend the office at least three days a week. Another third offers a limited number of days to work from home per month. Some allow workers to choose their work schedule. The main reason is that employees have gotten used to more flexibility over the past few years, which has become their standard (HR News, 2022). Remote work and hybrid models place the highest demands on managers, who must learn how to assign tasks, manage employees, and check that work is performed correctly (Profi HR, 2020a; Androniceanu et al., 2023). While in the past it was enough to supervise the presence of subordinates in the office, with the absence of people in the workplace, it is essential to concentrate on outputs, not the activity itself, and to evaluate results regardless of the number of hours worked consciously. If managers do not want to lose track of their employees' work, the appropriately chosen project management technologies, advanced communication tools, or shared storage offer the latest information and enable insight into projects in progress. At the same time, the advantage of this approach is that employees are not so overwhelmed by communication and can focus on their work (Management News, 2023).

On the other hand, the employees should have sufficiently high self-motivation for work performance while working remotely or in a hybrid model (Frankovský et al., 2018). Only 16 % of Czech employees would like to work only remotely in the future, 72 % would like to switch between remote work and office according to their needs (hybrid model), 12 % of people would not want to work remotely at all (Hájková, 2021). Similar results were shown in research by the Institute of Technology and Business in České Budějovice, according to which over 22 % of workers wanted to continue to work remotely, over 35 % wanted to use this option more often than before Covid-19 (Novinky.cz, 2021).

A survey conducted by the company Profesia showed that the majority of employees in Czech companies and institutions (42 %) who worked thoroughly in remote work mode during the pandemic do not want to experience this situation in the future and prefer the hybrid model of work (Businessinfo, 2021). According to the study conducted by the company Ipsos, which surveyed more than 540,000 people from ninety-five countries, 68 % of respondents preferred hybrid work, and 24 % wanted to work outside the office. Less than a tenth wished to stay with the traditional model (Chlebek, 2023).

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2.3 Burnout syndrome

Minimizing the harmful effects of remote working and working in a hybrid model and generating solutions to decrease adverse factors associated with the disadvantages of remote working and working in a hybrid model is critical for maintaining the productivity and well-being of individuals (Okuyan & Begen 2021). Burnout syndrome was one of the significant adverse effects of remote work and working in a hybrid model during the pandemic. For example, 67 % of US employees of various age groups and industries think burnout syndrome worsened during the pandemic (Threlkeld, 2021). Many employees in remote work felt overworked because it was difficult for them to break away entirely from their working duties at the end of classic working hours. Burnout syndrome is a set of symptoms that develop gradually over time and can resemble some of the symptoms of depression and anxiety disorders. Burnout syndrome manifests itself on both a physical and psychological level. Since it results from long-lasting stress, it can be experienced by anyone exposed to it. The common signs of burnout syndrome include general physical and mental exhaustion, negative thoughts about work and employer, feelings of inferiority, loss of interest and cynicism, unpleasant work and time pressure, etc. (Maslach & Jackson, 1981). All these manifestations lead to lower or very low productivity for an employee. Even the least severe symptoms of burnout must be recognized and addressed immediately to prevent further negative consequences on an individual's mental and physical state.

The most recent studies show that long-term remote work, to which many employers resorted during the pandemic, can lead to burnout syndrome (Gonzalez et al., 2021; Hayes et al., 2021; Parra et al., 2022; Zaharia et al., 2022; Yildirim & Ashraf, 2023; Moron et al., 2023; Costin, Roman & Balica, 2023). Regular work in the office or a hybrid model may appear less detrimental (Medical Facilities of the Ministry of the Interior, 2021; Stasila-Sieradzka, Sanecka & Turska, 2023). Suppose a hybrid model work system is set up appropriately, maximizing all the positives and eliminating the negatives. Managers make sure that people work only within their set of working hours. In that case, people can achieve a sustainable balance between productivity and healthy well-being and are less at risk of burnout syndrome than remote workers (Chafi, Hultberg & Yams, 2022). While 20 % of Czech citizens suffered from burnout syndrome before the pandemic (CT, 2018), this figure doubled to 40 % during the pandemic (Deník, 2021). According to a survey conducted by The Office Group, more than half of the respondents (52 %) saw the cause in trying to do too much whilst in a remote work mode. Approximately 58 % of respondents believed their typical remote working hours were too long, 39 % of respondents did not take enough time off, and just under half (47 %) felt they had to be available all the time. Two out of five workers thought they were under pressure to do some extra work more often in remote work mode. Less than half of the respondents struggling with burnout syndrome left their jobs due to exhaustion. Another third said they would consider taking unpaid leave next time in such a condition (IDnes.cz, 2020; Chafi, Hultberg & Yams, 2022).

Since none of the above-described studies concerning the Czech Republic have addressed the examination of the relationship between different work modes during the pandemic, as well as the preference for the work mode in the post-pandemic period and the degree of perceiving burnout syndrome specifically among public sector employees (but generally among all employees in the Czech Republic regardless of sectors), the authors decided to fill this research gap and carry out such research.

3. Methodology and methods

The starting focus point sector of the article was the public sector, which is the set of organizations and institutions that are directly or indirectly controlled by the state. The public sector was chosen because overall, the Czech public sector employs about 293,000 people, almost one-fifth of the workforce in the Czech Republic, according to a study of data from the Czech Statistical Office (E15, 2020).

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3.1 Research questions and hypotheses formulation

For the area of the future of a hybrid model and remote work:

Research question Q1: Did the work mode during the pandemic influence the preference of the work mode of public sector employees in the Moravian-Silesian Region in the post-pandemic period?

The first research question was answered by formulating and disproving/confirming hypothesis 1.

H1: Most public sector employees in the Moravian-Silesian Region would prefer a hybrid model in the post-pandemic era.

For the area of burnout syndrome:

Research question Q2: Did public sector employees of the Moravian-Silesian Region working in different work modes during the pandemic experience various levels of burnout syndrome (where the level is understood as the frequency of burnout syndrome symptoms)?

Answering the second research question was done by formulating and disproving/confirming hypotheses 2 and 3.

H2: More public sector employees in the Moravian-Silesian Region working remotely or in a hybrid model during the pandemic often or constantly experienced burnout symptoms than employees in the Czech Republic.

H3: The mode of work during the pandemic that least led to the experiencing symptoms of burnout syndrome for public sector employees in this region was the hybrid model.

3.2 Instrument development

In the part where the questionnaire refers to **H1,** the authors once again relied on theoretical assumptions and various studies, in particular, a study by Profesia regarding the preference of a specific work mode in the post-pandemic period based on the pandemic experience (Businessinfo, 2021), which is presented in chapter 2. This hypothesis was formed based on the quantitative content analysis of these studies. Confirming or disproving this hypothesis provided insight into how the experience of working during the pandemic affected the work mode preference of the Moravian-Silesian Region public sector employees in the future.

In the next part, where the questionnaire refers to **H2 and H3**, the authors once again relied on theoretical assumptions, mainly the Maslach Burnout Inventory - Human Services Survey (MBI-HSS), and various studies, in particular the study that looked at the relationship between long-term remote work and hybrid model work and burnout syndrome (Medical Facilities of the Ministry of the Interior, 2021), presented in chapter 2. These hypotheses were formed based on the quantitative content analysis of these studies. The confirming or disproving of these hypotheses provided an insight into how remote work or work in a hybrid model affected the perceived level of burnout syndrome by public sector employees of the Moravian-Silesian Region and which mode of work during the pandemic was least conducive to experiencing symptoms of burnout syndrome.

Within the creation of the questionnaire, the authors, besides relying on the above-mentioned theoretical assumptions, also relied on the conclusions of a meeting with 42 HR specialists, managers, and employees of public sector organizations operating within the Moravian-Silesian Region of the Czech Republic. This meeting was organized to understand their experiences and views better and took place in May 2022.

The formulation of the individual questions was then validated by a focus group attended by 18 representatives of future respondents in May 2022. Approximately half of them had participated in the previous meeting; the other half were approached for a broader perspective and clarification of the issues. The authors of the article also attended this focus group. Focus groups were identified to capture participant's experiences, opinions, and perspectives (Kitzinger, 1995). How focus group participants responded to the questionnaire was determined, whether the questions were well formulated, whether they understood them, and whether the offered answering

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options were appropriate. Based on the outputs of the focus group, one question was slightly reformulated, and one was deleted. The result of the focus group meeting was the final questionnaire, which experts within that field later validated — the experts also commented on the extent to which individual questions and proposed answers described individual areas. The authors also evaluated the content validity using the Content Validity Ratio (CVR). CVR = [(E=(N/2))/(N/2)], where N is the total number of experts, and E is the number of those who rated the object as essential. CVR ranged between 0.85 to 1.00 for each topic and 0.75 to 1.00 for each item. Therefore, the questionnaire was considered valid from a quantitative point of view in terms of content.

The final questionnaire included six questions. In this article, the authors focus on the interpretation of only a selected part of the questionnaire due to its size.

The final questionnaire can be used in the public sector when working in three possible work modes as a tool to detect problems that should be addressed to avoid reducing employee productivity. This evaluation should be an internal activity of the public sector organizations carried out by responsible persons, most often by HR managers (Up, 2021). In addition, corresponding numerical values can be assigned to all difficulties or feelings related to burnout syndrome, and their time monitoring can then reveal improvement areas.

The final questionnaire (the authors can send a full version after request) was then used to conduct a survey that fulfilled the purpose of this paper.

3.3 Sampling and data collection

The next step was to decide on the respondents. Respondents came from public sector organizations operating in the Moravian-Silesian Region of the Czech Republic. These employees are funded from public budgets (Vavrek & Bečica, 2020). According to data from the Czech Statistical Office, as of 31 December 2020, 293,000 employees worked in the public sector in the whole Czech Republic, and 1,654 employees were within the Moravian-Silesian Region. Before carrying out the survey, a pilot survey was conducted with a sample of 30 respondents from the target group. The pilot test took place the same way as the expected full test, i.e., sending emails with a link to an online questionnaire with the possibility of commenting on individual items. Only minor changes were made based on the comments on individual items that were sent to the testers, along with the answers by some respondents participating in the pilot test.

The primary quantitative research was conducted in May 2022. The questionnaire was anonymous and was implemented by the CAWI (Computer-Assisted Web Interviewing method, which was based on a questionnaire provided to the respondent via a link, panel or website (IdSurvey, 2023)). This ensured that there were no possible conflicts of interest or potential distortions of the data by the researchers; the results were not dependent on the persons who analyzed them, and this ensured objectivity.

The final result was, from the 1654 respondents, 492 fully and correctly completed questionnaires were received (29.8 % return rate).

The data was processed using statistical methods from May and June 2022. Based on the overall evaluation of the acquired data, the result of the survey was to answer the research questions, disprove/confirm formulated hypotheses, and develop more general conclusions in the research area as a basis for further directions of possible research on this issue.

3.4 Data analysis methods

The data was first examined for its completeness before analysing the data from the anonymous electronic questionnaire survey implemented by the CAWI method. Subsequently, all the questions and responses were decoded. Afterwards, descriptive statistics were calculated for each question, which helped better understand the respondents and the distribution of responses. Since the authors dealt only with nominal variables in the survey, a contingency was implemented to show the dependence between variables. This was followed by hypothesis testing conducted using Pearson's Chi-square test, where the p-value decided whether to confirm or reject the stated hypotheses. Finally, Cronbach's alpha coefficient was calculated to determine the reliability of the research; in other words, the coefficient was used to assess the reliability and quality of the measurements

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of the questionnaires and scales created. All calculations were done with the help of IBM SPSS Statistics 28.0 software.

4. Research results

A total of 492 respondents were included in the results of the survey.

4.1 Sample characteristics

Of the 492 respondents, all respondents were employees of public sector organizations operating in the Moravian-Silesian Region of the Czech Republic. The research did not consider any other characteristics, such as the number of employees in the public sector organization, gender and age of respondents, etc. All respondents answered all questions.

4.2 Working mode preferences after the pandemic

The question "Did the working mode during the pandemic affect your preference for your working mode in the post-pandemic period?" was asked in the questionnaire to investigate how the working mode in which public sector employees in the Moravian-Silesian Region worked during the pandemic influenced their view on the working mode they would like to work in after the pandemic. The responses to this question can be seen in Table 1.

Table 1. Working mode preferences after the pandemic

		Working mode preferences after the pandemic			
		Office work only	Hybrid model	Remote work	Total
Working mode during the pandemic frequency (%)	Office work only	70 (14.2)	14 (2.9)	4 (0.8)	88 (17.9)
	Hybrid model	64 (13)	262 (53.2)	28 (5.7)	354 (72)
	Remote work	6 (1.2)	20 (4.1)	24 (4.9)	50 (10.2)
Total		140 (28.4)	296 (60.2)	56 (11.4)	492 (100)

Source: Own research

Table 1 shows that 60.2 % (296) of the respondents working in all three modes of work during the pandemic would prefer a hybrid model after the pandemic. This group is most represented by those already working this way during the pandemic (262; 53.2 %). This group was then increased by 14 (2.9 %) of those working only full-time in the office at the time of the pandemic and 20 (4.1 %) working entirely remotely at the time of the pandemic. From those working in a hybrid model at the time of the pandemic, 64 (13 %) would prefer to return to only full-time office work; conversely, 28 (5.7 %) would like to work remotely after the pandemic. Furthermore, we can also see from the table that although respondents prefer the mode of work they worked in during the pandemic, the hybrid model is the most preferred mode in the post-pandemic period, thus confirming hypothesis **H1:** Most public sector employees in the Moravian-Silesian Region would like a hybrid model in the post-pandemic era. According to a survey of HR professionals in Czech companies and institutions, in the future, more than two-fifths of employees expect a hybrid model of work in the post-pandemic era (Novinky. cz, 2021). It also corresponds with Hájková's claim that 72 % of employees would like to switch between remote and office work in the future according to their needs (hybrid model) (Hájková, 2021) – see subchapter 2.2.

The independence test for the two variables was performed via Pearson's goodness-of-fit test, where Pearson's chi-square test statistic was used as a test criterion for disproving/confirming hypothesis H1. The Pearson Chi-Square test value is 93.106 with 6 degrees of freedom (df). The P-value is .000, which indicates that there is a statistically significant association between the variables examined. Thus, we confirm that most public sector employees would prefer a hybrid model in the post-pandemic period. Moreover, this test found that no cells (0 %) have an expected value of less than 5, while the minimum expected value is 0.53. This aspect is essential for the validity of the test because the Chi-Square test is sensitive to low expected values in cells.

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4.3 Burnout syndrome perception rate

The question "Did public sector employees working in different work modes during the pandemic experience different rates of burnout syndrome?" (where the rate is understood as the frequency of burnout syndrome symptoms) investigated whether the work mode affected experiencing burnout syndrome symptoms. First, it was necessary to determine the frequency of burnout syndrome symptoms from public sector employees working in all three work modes during the pandemic. The responses to this question can be seen in Table 2.

Table 2. Frequency of experiencing burnout syndrome symptoms

	Symptoms							
	I felt exhausted physically or emotionally	I had negative thoughts about my job	I got easily upset by minor problems or my co-workers	I felt under immense pressure to succeed	I felt like I was in the wrong organization or profession	I felt like organization policy or bureaucracy was hindering my ability to do a good job	I felt like I did not have time to do many of the things that are important for doing a good job	I found that I did not have time to plan as much as I wanted to
	Frequency (%)							
Never	74 (15)	171 (34.8)	144 (29.3)	160 (32.5)	246 (50)	171 (34.8)	156 (31.7)	140 (28.5)
Almost never	124 (25.2)	168 (34.1)	196 (39.8)	190 (38.7)	120 (24.4)	106 (21.5)	170 (34.6)	176 (35.8)
Sometimes	216 (43.9)	108 (22)	134 (27.2)	102 (20.7)	86 (17.5)	143 (29.1)	116 (23.6)	132 (26.8)
Total	**414 (84.2)**	**447 (90.9)**	**474 (96.3)**	**452 (91.9)**	**452 (91.9)**	**420 (85.4)**	**442 (89.9)**	**448 (91.1)**
Frequently	68 (13.8)	37 (7.5)	15 (3.1)	37 (7.5)	32 (6.5)	60 (12.2)	42 (8.5)	41 (8.3)
Constantly	10 (2)	8 (1.6)	3 (0.6)	3 (0.6)	8 (1.6)	12 (2.4)	8 (1.6)	3 (0.6)
Total	**78 (15.8)**	**45 (9.1)**	**18 (3.7)**	**40 (8.1)**	**40 (8.1)**	**72 (14.6)**	**50 (10.1)**	**44 (8.9)**

Source: Own research

Table 2 shows that the majority of public sector employees in the Moravian-Silesian Region working in all three work modes during the pandemic never or almost never, or only sometimes experienced symptoms of burnout syndrome; only a smaller number of respondents experienced symptoms of burnout syndrome frequently or constantly, thus not supporting hypothesis H2: More public sector employees in the Moravian-Silesian Region working remotely or in a hybrid model during the pandemic often or constantly experienced burnout symptoms than employees in the Czech Republic as a whole. According to the findings of the company Profesia, 40 % of Czech employees experienced the symptoms of burnout syndrome during the pandemic – see subchapter 2.3. This is a very positive outcome of the survey.

Although the majority of public sector employees working in all three modes of work during the pandemic never, or almost never, or only sometimes experienced symptoms of burnout syndrome, a smaller number of those experienced symptoms of burnout syndrome frequently or constantly. Consequently, the relationship between the frequent or constant experience of burnout syndrome symptoms and work mode during the pandemic was examined only for those employees who experienced these feelings. The responses to this question can be seen in Table 3.

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Table 3. Relationship between work mode and experiencing the symptoms of burnout syndrome

		Office work only	Hybrid model	Remote work	Total
Symptoms					
I felt exhausted physically or emotionally	Frequently	10 (14.7)**	12 (17.7)	46 (67.6)*	68 (100)
	Constantly	3 (30)	2 (20)**	5 (50)*	10 (100)
I had negative thoughts about my job	Frequently	4 (10.8)**	7 (18.9)	26 (70.3)*	37 (100)
	Constantly	6 (75)*	2 (25)	0*	8 (100)
I got easily upset by minor problems or my co-workers	Frequently	2 (13.3)**	4 (26.7)	9 (60)*	15 (100)
	Constantly	3 (100)*	0**	0**	3 (100)
I felt under immense pressure to succeed	Frequently	6 (16.2)	4 (10.8)**	27 (73)*	37 (100)
	Constantly	0**	1 (33.3)	2 (66.7)*	3 (100)
I felt like I was in the wrong organization or profession	Frequently	6 (18.8)**	6 (18.8)**	20 (62.4)*	32 (100)
	Constantly	2 (25)**	2 (25)**	4 (50)*	8 (100)
I felt like organizational policy or bureaucracy was hindering my ability to do a good job	Frequently	16 (26.7)	2 (3.3)**	42 (70)*	60 (100)
	Constantly	2 (16.7)**	2 (16.7)**	8 (66.6)*	12 (100)
I felt like I did not have time to do many of the things that are important for doing a good job	Frequently	8 (19.1)	4 (9.5)**	30 (71.4)*	42 (100)
	Constantly	2 (25)**	2 (25)**	4 (50)*	8 (100)
I found that I did not have time to plan as much as I wanted to	Frequently	6 (14.6)	2 (4.9)**	33 (80.5)*	41 (100)
	Constantly	3 (100)*	0**	0**	3 (100)

Note: The * symbol for each symptom always indicates the worst performing model(s) of the work mode for both intensities of its perception. Conversely, the ** symbol for each symptom always indicates the best-performing model(s) of the work mode for both intensities of its perception.

Source: Own research

Table 3 shows that those employees who worked entirely remotely at the time of the pandemic frequently (8 out of 8) or constantly (5 out of 8) experienced more symptoms of burnout syndrome than the employees who only worked in the office during the pandemic (frequently none of the respondents, 3 out of 8 constantly); respondents who worked in the hybrid model at the time of the pandemic experienced these symptoms the least (5 out of 8 frequently, 6 out of 8 constantly), thus confirming hypothesis **H3**: The work mode during the pandemic that lead least to experiencing symptoms of burnout syndrome was the hybrid model. The findings were consistent with the propositions that the work mode at the times of the pandemic that least led to experiencing symptoms of burnout syndrome was the hybrid model or that working partly from home had a preventive effect against burnout syndrome (Chafi, Hultberg & Yams, 2022).

The majority (404; 82.1 %) of public sector employees in the Moravian-Silesian Region of the Czech Republic worked remotely or in a hybrid model during the pandemic. In the time after the pandemic, an absolute majority (296; 60.2 %) of respondents working in all three work modes during the pandemic would prefer the hybrid model. In terms of the effect of the pandemic work mode on experiencing symptoms of burnout syndrome, the majority of employees (414; 84.2 % to 474; 96.3 %) never or almost never experienced or only sometimes experienced these symptoms; only a low number of respondents (40; 8.1 % to 78; 15.8 %) experienced symptoms of burnout syndrome frequently or constantly.

Finally, Cronbach Alpha calculated the internal consistency of the survey. The value of Cronbach's alpha 0.743 indicates the measurement's good reliability (internal consistency). This means that the items (questions) in the examined questionnaire had a solid level of correlation and were consistent in measuring the same construct.

Regression analysis was not used here because several assumptions were not met. For proper use and interpretation of the results of a regression model, the following assumptions should be satisfied: a linear relationship between the independent variables and the dependent variable, independence of observations in the sample, homoscedasticity, normality of errors, and absence of multicollinearity.

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Conclusion and limitations

The article aimed to determine whether there was a direct link between the different work modes during the pandemic, the preference of the work mode after the pandemic and the level of perceived burnout syndrome.

Since there has been no research to date that has provided results examining the relationship between different work modes during the pandemic, as well as the preference for the work mode in the post-pandemic period, and the degree of perceiving burnout syndrome specifically among public sector employees, the authors conducted this research in one of the regions of the Czech Republic, which is where the novelty of this research lies.

The first step within the paper's methodology was to conduct a vast literature review. This resulted in meeting the aim of this article (based on the questionnaire survey done by the authors). In the next step, the stated aim resulted in formulating two research questions and corresponding hypotheses.

Subsequently, in May 2022, a survey was conducted in the form of an online questionnaire survey based on a structured questionnaire. The initial population for the sample selection included 1 654 public sector employees in the Moravian-Silesian Region, where the return rate was 29.8 %. A total of 492 questionnaires were returned. The survey results were first compiled using Microsoft Excel, the data was collected, and faulty results were eliminated to ensure only relevant data was used for further analysis. Basic descriptive statistics (absolute and relative frequencies) were computed. Statistical analysis was computed and evaluated using IBM SPSS Statistics 28.0 software. Specifically, a goodness-of-fit test was used, with Pearson's chi-square test statistic as the test criterion.

The survey results were analyzed and commented on in detail compared with the results of various surveys dealing with the issue. The following conclusions were made in the research area, which became the starting point for formulating further directions for possible research on this issue.

The questionnaire survey results and hypotheses disproving/confirming answered the formulated research questions in the following way. **Q1** is: employees would prefer a hybrid model in the post-pandemic era. The answer to research question **Q2** is that the rate of experiencing symptoms of burnout syndrome among employees working in different modes varies but is generally low among these employees. Nevertheless, there is a lower number of those who experienced symptoms of burnout syndrome frequently or constantly. It is in the interest of employers and the affected employees to try to create such conditions and behave in a way that does not put them at risk of burnout syndrome. There is a fully extensive informational database on this topic that both employers and employees can now use.

The limiting conditions of the survey can be seen in the return rate of the questionnaires, which was only 29.8 %. Generalizing the findings of this study must be taken with care, as the findings are based on a sample in one region of the Czech Republic. Future research can build on the findings of this research, which can be considered pilot research.

A limitation of the survey can be that respondents' answers might have been influenced by the fact that public sector employees in the Moravian-Silesian Region needed to be sufficiently prepared for the instant transition to remote work or a hybrid model and had to implement new measures. The main challenge for public sector organizations was often how to technically provide employees with the possibility to work remotely or in a hybrid model. Suppose people could work on their computers if it were necessary to provide them with a company laptop or if they had the software required to do their work and to communicate with colleagues.

Another limitation of the survey may be the fact that the authors of the article did not have available pre-pandemic measures of the level of burnout syndrome not only for public sector employees in the Moravia-Silesian Region but also for public sector employees of the whole Czech Republic, no such study exists. Therefore, they based their hypothesis on the results of surveys on burnout syndrome throughout the Czech Republic across all sectors.

The authors see further direction in the research, focusing on the public sector throughout the Czech Republic. Another possible direction of the study could be to analyze the results based on gender, age, or job profession or position and to analyze in detail why the public administration employees of the Moravian-Silesian Region (or the whole Czech Republic) were identified as experiencing lower levels of burnout syndrome symptoms than other professions.

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ANALYZING THE IMPACT OF ORGANIZATIONAL TRUST ON JOB ENGAGEMENT: A MEDIATING ROLE OF EMPLOYEE LOYALTY*

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Abstract. This research aimed to investigate the mediating role of employee loyalty in the relationship between perceived organizational trust and job engagement. The study utilized data from 268 employees across two private banks in Mongolia and conducted thorough analyses to evaluate the reliability and correlation of the variables via structural equation modelling (SEM). The study revealed that organizational trust had a positive impact on both employee loyalty and job engagement. These findings underscore the critical importance of organizational trust in fostering employee loyalty and promoting increased engagement in one's work. Additionally, the study identified a positive influence of employee loyalty on job engagement, indicating that loyal employees are more likely to be engaged in their roles. The research determined that employee loyalty fully mediated the connection between organizational trust and job engagement. While organizational trust directly affects engagement, its impact is also channelled through enhanced employee loyalty. This highlights the intricate relationship between organizational trust, employee loyalty, and job engagement in the workplace. The results of this study deepen the understanding of organizational trust and have important practical implications for improving employee loyalty and engagement. Specifically, the findings suggest that fostering transparency and open communication between management and employees can increase trust, leading to higher retention rates and greater willingness to go above and beyond job duties.

Keywords: organizational trust; employee loyalty; job engagement; bank employees

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1. Introduction

In today's fiercely competitive environment, manufacturing and service demand are undergoing continuous rapid transformations, and organizations face an ethical crisis and many complex dilemmas. Advancements in information technologies have significantly accelerated the digital transformation of businesses (Ližbetinová et al., 2021; Krajčík, 2022; Civelek et al., 2023). In particular, the financial sphere's technological shifts grapple with formidable obstacles, including issues related to integrity, trust, transparency, and the looming threat of financial scandals (Srivastava & Mohaley, 2022; Sun et al., 2022a; 2022b). Today, more than ever before, business success is more dependent on organizational trust. In the financial sector, trust holds particular significance and serves as a cornerstone for its effective functioning, and organizational confidence acts as the bedrock, enabling the industry's smooth operation (Hurley et al., 2013). Given the rising significance of proficient human resource management in navigating the complexities of Industry 4.0 (Turek et al., 2023; Lewandowska et al., 2023), this subject has emerged as especially crucial (Szostek et al., 2020).

Organizational trust is the cornerstone of an organization's long-term success and survival while also being the key driver of employee performance, organizational commitment, engagement, and collaboration (Mishra, 1996; Mishchuk et al., 2023). Employees with a high level of organizational trust are more productive, engaged, collaborative, and likely to stay at their current company longer than employees with low trust. When employees trust their leaders and the organization, they tend to be more productive, dedicated, and willing to go above and beyond. Organizational trust also facilitates effective teamwork, information sharing, and relationships with clients and partners. For these reasons, establishing a high-trust culture is fundamental to an organization's long-term success and survival. Employees who trust their leaders and colleagues typically exhibit superior performance, greater loyalty, and a heightened commitment to their organization. Engaged, talented, and loyal employees are fundamental to the success of a business, as they play a pivotal role in wealth creation and drive organizational development. Hence, to heighten competitiveness, organizations focus on developing and retaining top talent, forging employee loyalty, and enhancing employee engagement alongside trust in the organization. However, further research into the causative factors is still needed to fully establish the degree and pathways through which organizational trust increases employee loyalty and engagement.

This study delved into the relationship between organizational trust, employee loyalty, and job engagement among Mongolian bank employees.

2. Theoretical background

2.1 Organizational trust

Trust has long been acknowledged as a critical determinant of organizational efficiency and stability (Artar & Erdil, 2017). Organizational trust is a complex social and psychological phenomenon, and scholars have approached the interpretation of organizational trust from diverse perspectives (Kmieciak, 2021; Olah et al., 2021).

In 1990, Podsakoff et al. defined organizational trust as a measure of the level of trust that employees hold in their supervisors and co-workers (Dai et al., 2022). As Mishra (1996) asserted, organizational trust constitutes a vital foundation for contemporary business resilience and competitiveness within an increasingly dynamic global climate. Organizational trust begets enhanced information sharing, collaboration, risk-taking, agile execution, and willingness to exert discretionary effort toward shared goals (Fulmer & Gelfand, 2012). Sousa-Lima, Michel, and Caetano (2013) argued that building organizational trust is critical in developing social exchange relationships. Organizational trust reflects the trustworthiness of the organization. When employees have confidence in their organization, they tend to invest more effort and adopt a positive attitude toward their work (Cohen, 2015).

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Organizational trust is a critical factor influencing employee performance, organizational commitment, and loyalty to one's work (Alfes et al., 2016) and is a crucial component of establishing effective work relationships (Colquitt et al., 2007; Rózsa et al., 2023). Organizational trust can be defined as the positive expectation that individuals hold regarding the intentions and behaviour of numerous members within the organization. This expectation is rooted in the roles, relationships, experiences, and interdependence inherent in the organizational context (Shockley-Zalabak et al., 2000). In other words, organizational trust is essentially the confidence of employees in the actions and initiatives undertaken by the organization. Organizational trust is crucial in how organizations strengthen their relationships with their members. Employees who trust their colleagues and management tend to exhibit higher performance levels and demonstrate greater loyalty to their organization. Organizational trust emphasizes cooperation and teamwork in well-established organizations. Employee trust in the organization is a vital foundation enabling superior execution, innovation, and financial performance. As Hoppes and Holley (2014) established, perceptions of organizational integrity, benevolence, competence, openness, and reliability allow employees to focus on value creation rather than self-protection. By signalling care for workforce well-being and dependability in upholding ethical practices, trust-based company cultures benefit from reduced turnover, enhanced collaboration, knowledge sharing, and increased employee effort (Colquitt et al., 2007; Kuzmenko et al., 2023). Over time, the resulting benefits in innovation, customer orientation, product quality, and employee retention compound to reveal vast performance differences between trusted organizations and less reputable competitors (Gavurova et al. 2022). Furthermore, in periods of deep uncertainty wrought by technological shifts, economic fluctuations, or disruptive events, organizational trust sustains cooperativeness, adaptation, and rational decision-making to enable survival and renewed growth (McEvily et al., 2021). Thus, regular diagnostics via enterprise-wide surveys combined with responsive communication and policies reinforcing organizational trust constitute crucial strategies for contemporary executives.

2.2 Employee Loyalty

An individual's loyalty reflects a psychological bond and willingness to expend effort based on a convergence of interests, values, or social belonging. As Rosanas and Velilla (2003) discussed, loyalty signals an underlying motivation to join an organization or group. Moreover, loyal individuals may sacrifice their narrow self-interest to achieve superordinate goals they care deeply about (Hajdin, 2005; Elegido, 2013). Employee loyalty can be assessed by attitude, personality, and psychological characteristics. It serves as an essential factor for gaining a competitive advantage for the organization (Dutta & Dhir, 2021; Mehmood et al., 2023) that promotes organizational interests and images of the external environment and expresses organizational citizenship (Bettencourt et al., 2001). It can be concluded that loyalty is a commitment to organizational success and employees' belief in their good choice to work for the business (Trinh et al., 2023). Employee loyalty is expressed by their determination to contribute to organizational goals, increase productivity, and endeavour to provide excellent customer service. Loyal employees try to use their knowledge and expertise to add to the organization, directly impacting its operations (Tomic et al., 2018). Yee et al. (2010) found that employee loyalty knowingly impacts corporate incomes through quality service, satisfaction, and customer loyalty. Employee loyalty supports corporate growth and sustainability and reduces financial burdens and investments in recruiting potential new employees (Skare et al., 2023). Improving corporate reputation is closely linked to organizational performance, trust, employee loyalty, and job satisfaction (Ruschak et al., 2023; Xu et al., 2020). Nurturing employee loyalty requires continuous care and communication (Chang et al., 2010).

2.3 Job engagement

The concept of job engagement is a popular management concept that is widely studied from multiple perspectives and has become a hot research area in recent years ((Bedarkar & Pandita, 2014; Navickas et al., 2023).

Employee engagement embodies the profound commitment of an employee's heart and mind to the organization, evident in the effort invested in their work. Put differently, it serves as a manifestation of belief in the organization's values, coupled with a genuine eagerness to contribute to achieving the overarching business objectives (Borisov & Vinogradov, 2022). Employee engagement is characterized by an employee's inclination to channel his or her energy and strength wholeheartedly toward goals and values. This impacts an organization's

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development and adaptability and plays a pivotal role in shaping morale, productivity, initiative, and loyalty among employees, thereby impacting internal and external stakeholders (Rollnik-Sadowska et al., 2023). Employees become engaged when they are ready to pay for hard work, enthusiastic about the job, motivated to work, and concerned about the positions they hold within the organization (Horváthová et al., 2019). Job engagement can be assessed by how loyal employees are to the organization, their enthusiasm, and their match of personal values with the organization's mission statement and goals.

Relationship between Organizational Trust and Employee Loyalty

Organizational trust is a pivotal factor that substantially impacts employee loyalty and encompasses the organization's credibility, integrity, and trust. Employees who have faith in their organization tend to foster loyalty and commitment. Both employee trust and job satisfaction positively influence loyalty (Pham & Tran, 2023). Organizational trust has been shown to play a vital role in multiple organizational activities and outcomes. For example, high organizational trust fosters excellent entrepreneurial behaviour, loyalty, and employee performance (Baştuğ et al., 2016). Trust-driven loyalty further enhances employee participation, satisfaction, commitment, and positive workplace attitudes and behaviours (Shalabi, 2019; Alshaabani et al., 2022). Researchers suggest several mechanisms underlying these observed effects. As employees perceive an organization to be reliable, honest, and caring toward their well-being, they feel a sense of reciprocal psychological contract, which deepens their engagement and willingness to exert effort toward collective objectives (Matzler & Renzl, 2006). Many researchers, including Kalhor et al. (2020), Melian-Alzola & Martín-Santana (2020), Paliszkiewicz (2011), and Paparoidamis et al. (2019), have confirmed that organizational trust has a positive impact on employee loyalty. Given these consistent findings, it is reasonable to hypothesize that as organizational trust increases, so does employee loyalty. Based on the results and evidence of previous studies, we support the abovementioned circumstances and propose the following hypothesis:

H1: There is a positive relationship between organizational trust and employee loyalty.

Relationship between Organizational Trust and Job Engagement

Employee engagement is a pivotal factor in the success of any organization and is intricately linked to trust and psychological safety in the workplace. The presence of trust among employers and coworkers fosters increased engagement (Tan & Tan, 2000). Wong et al. (2010) discovered that employee engagement can be enhanced through organizational trust and confirmed a direct and positive relationship between organizational trust and employee engagement. Numerous studies have demonstrated that organizational trust exerts a positive influence on employee engagement by fostering a positive workplace environment (Bulińska-Stangreck, 2020; Chughtai et al., 2015; Jankelová & Joniaková, 2022; Lin, 2010). Most researchers explain this relationship through the lens of social exchange theory. A central tenet of social exchange theory posits that associations evolve, progressing toward a state of trust, loyalty, and reciprocal obligations, as both parties adhere to specific rules of exchange (Mubashar et al., 2022). Employees who perceive that the organization treats them fairly are inclined to reciprocate positively. It can be concluded that organizational trust is crucial for employees to focus on their work, engage with organizational issues, and feel motivated to actively contribute to their tasks (Ugwu et al., 2014). Hence, we argue that organizational trust directly influences job engagement. In light of this, we introduce the following hypothesis:

H2: There is a positive relationship between organizational trust and job engagement.

Relationship between Employee Loyalty and Job Engagement

Job engagement refers to a positive and fulfilling work-related state of mind. Engaged workers demonstrate enhanced in-role task performance, driven by their dedication and focused commitment to their work (Zahra & Kee, 2022). In the work of Turkyilmaz et al. (2011), loyalty is defined as a psychological state that characterizes the relationship between employees and their organizations. This relationship has substantial implications for employees' decisions regarding their retention within the organization and their level of job engagement. There is a relationship between employee engagement and employee loyalty, and employee loyalty positively affects job engagement (Ludviga & Kalvina, 2016; Ensai et al., 2022).

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A reciprocal relationship exists between employee engagement and loyalty, where each influences the other (Milliman et al., 2018). Employee loyalty, in particular, directly impacts sustaining and enhancing employee engagement. Syahrizal, Patrisia, and Abror (2019) discovered in their study that employee loyalty significantly impacts job engagement. Consequently, they concluded that organizations should direct their attention toward fostering employee engagement as a means to augment loyalty. Researcher Soliman (2023) demonstrated a positive relationship between employee engagement and loyalty. Numerous studies have consistently affirmed the positive impact of employee engagement and loyalty (Nguyen & Ha, 2023). Based on the results of these studies, we propose the following hypothesis:

H3: There is a positive relationship between employee loyalty and job engagement.

The mediating role of employee loyalty

As the war for talent intensifies across industries, talent retention and engagement initiatives have become imperative for organizational success. The costs associated with turnover due to dissatisfied or distrusting employees are steep, with estimates of replacing an employee with an average salary of 6-9 (Beehner & Blackwell, 2016). Employees' trust in an organization significantly influences their loyalty and commitment, ultimately decreasing turnover (Ferres et al., 2004). This enhanced trust fosters improved performance and increases employee engagement (Phuong & Vinh, 2020). Within banking specifically, nurturing loyalty and commitment across the workforce allows for superior mobilization of skills, knowledge sharing, accountability, and performance that directly impact operations and the bottom line (Tomic et al., 2018). Employee trust and belief in an organization enable more significant discretionary effort and commitment toward collective objectives. Shalabi (2019) found that more profound psychological attachment develops when workers perceive their organization to be aligned with their values and demonstrate integrity, benevolence, and competence in upholding its mission. This organizational trust contributes to heightened employee loyalty, fostering more active and engaged participation in their work. The following hypothesis has been proposed.

H4: Employee loyalty significantly mediates the relationship between organizational trust and job engagement.

Research objectives, methodology and data

This research aimed to investigate the mediating role of employee loyalty in the relationship between perceived organizational trust and job engagement.

3.1 Data collection and sample size

The survey was administered online by employees of two private banks between 02 October and 25 November 2023. When selecting the survey sample, a minimum confidence level or acceptable level of 95% was chosen, with a confidence interval of 5%. The target population consisted of 519 employees from two private banks. The sample size was determined to be 221 participants. As the survey collected responses from 268 participants, it can be concluded that the sample was representative of the original population.

The sample consisted of 268 employees (n = 91 males, n = 177 females) from two private banks. Regarding educational qualifications, 1.5% of the workforce held a high school diploma, 73.1% possessed a bachelor's degree, 0.4% had a professional degree, 24.6% had a master's degree, and 0.4% held a doctorate. Regarding employment distribution, 127 participants, constituting 47.4%, were employed in the central bank, whereas 141 participants, representing 52.6%, worked in branches. Regarding tenure, 23.1% of the respondents had worked for up to 1 year, 37.3% had worked for 1-5 years, 19.4% had worked for 6-10 years, 10.4% had worked for 11-15 years, 7.8% had been employed for 16-20 years, and 1.9% had a work history exceeding 20 years. Position-wise, 0.7% held executive management, 3.4% were departmental directors, 9.0% served as branch directors, 9.7% were senior managers, 14.9% were managers, 4.1% were senior specialists, 32.1% worked as specialists, 20.5% were branch employees, 0.4% served as credit risk analysts, and 5.2% held roles such as security guards, drivers, mechanical dispatchers, cashiers, customer service officers, and receptionists.

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3.2 Instruments and Data Analysis

Organizational trust: This concept was measured using 12 items developed by Cummings and Bromiley (1996). The scale demonstrated excellent reliability (Cronbach's alpha = 0.955) and validity (KMO = 0.933; Bartlett's test $p < 0.05$).

Employee loyalty: Four items from Bettencourt et al. (2001) were used to evaluate employee loyalty. The scale showed high reliability (Cronbach's alpha = 0.860) and validity (KMO = 0.933; Bartlett's test $p < 0.05$).

Job engagement: Nine items developed by Crawford et al. (2013) were used to assess job engagement. The scale exhibited strong internal consistency (Cronbach's alpha = 0.929) and validity (KMO = 0.929; Bartlett's test $p < 0.05$).

All the questionnaires were scored on a 5-point Likert scale. Statistical data analysis tools such as SPSS 23.0 and Smart PLS version 4.0.9.8 were used to analyze the research results. The reliability and correlation of the variables were analyzed in the study to ensure the quality of the measurements. Structural equation modelling (SEM) was employed to examine the relationships and obtain the results.

4. Results and discussion

Results

4.1 Reliability analysis of variables

A factor loading analysis was also conducted to determine the correlation coefficients between the measurement variables. Internal consistency and reliability tests were also performed, including calculating Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). The results of these analyses are presented in Table 1 to demonstrate the underlying relationships between the measures.

Variables	Number of questions	Factor loading	Cronbach's α	CR	AVE
Organizational Trust -OT	9	0.777-0.906	.955	.961	.734
Employee loyalty-EL	4	0.765-0.906	.860	.906	.707
Job Engagement -JE	9	0.749-0.854	.929	.941	.639

Table 1. Results of the reliability analysis of the variables.
Source: authors

The analysis yielded strong consistency and reliability across the factors and measurement variables. Specifically, the internal consistency values ranged from 0.749 to 0.906, indicating a good level of consistency among the questions used to measure each factor. The Cronbach's alpha values ranged from 0.860 to 0.955, surpassing the 0.70 threshold for adequate reliability (Nunnally, 1978). The composite reliability (CR) ranged from 0.906 to 0.941, exceeding the 0.70 guideline (Hair et al., 2014) and demonstrating high reliability. Finally, the average variance extracted (AVE) values ranged from 0.639 to 0.734. Since these AVE values surpass the recommended 0.50 level (Awang, 2014), they signify practical significance and the ability to discriminate between factors. Additionally, we excluded questions OT4, OT6, and OT12, which had values less than 0.7, from further analysis.

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4.2 Correlation analysis

Table 2 outlines the descriptive data and pairwise correlation coefficients for all quantified variables. Our analysis indicates negligible multicollinearity concerns, as the interrelationships between model constructs sit below the 0.8 best practice cut-off (Gujarati & Porter, 2003).

	Mean	OT	EL	JE
Organizational Trust -OT	4.1828	**(0.857)**		
Employee loyalty-EL	4.3442	0.531	**(0.841)**	
Job Engagement -JE	4.3093	0.436	0.473	**(0.799)**
***Significant at the 0.001 level; **significant at the 0.01 level; * significant at the 0.05 level. Diagonal elements (bold) in brackets are the square roots of AVEs. Below the diagonal elements are the correlations between the constructs.				

Table 2. Results of Discriminant Validity Determination Using the Fornell–Larcker Criterion
Source: authors

4.3 Structural equation modeling (SEM)

The present study used PLS-SEM to test the hypotheses. The correlation between independent and dependent variables was reviewed during the analysis. The analysis results supported all three assumptions, and all the regression weight values were positive and significant ($p < 0.01$). The results of the survey are shown in Table 3.

Hypothesis	Path	Standardize Beta	Standard Error	T statistics	P value	Remarks
H1	OT →EL	0.541***	0.064	7.288	.000	Supported
H2	OT →JE	0.258***	0.072	3.968	.000	Supported
H3	EL→JE	0.342**	0.061	8.727	.000	Supported
Note: ***:p<0.001; **:p<0.01; *:p<0.05, significance levels are two-tailed Variable definition: OT, Organizational Trust; EL, Employee loyalty; JE, Job Engagement;						

Table 3. Research results in PLS-SEM
Source: authors

Having established the validity and reliability of the measurement model, the next step was to test the hypothesized relationship by running the PLS algorithm and bootstrapping algorithm in PLS 4.0.9.8.

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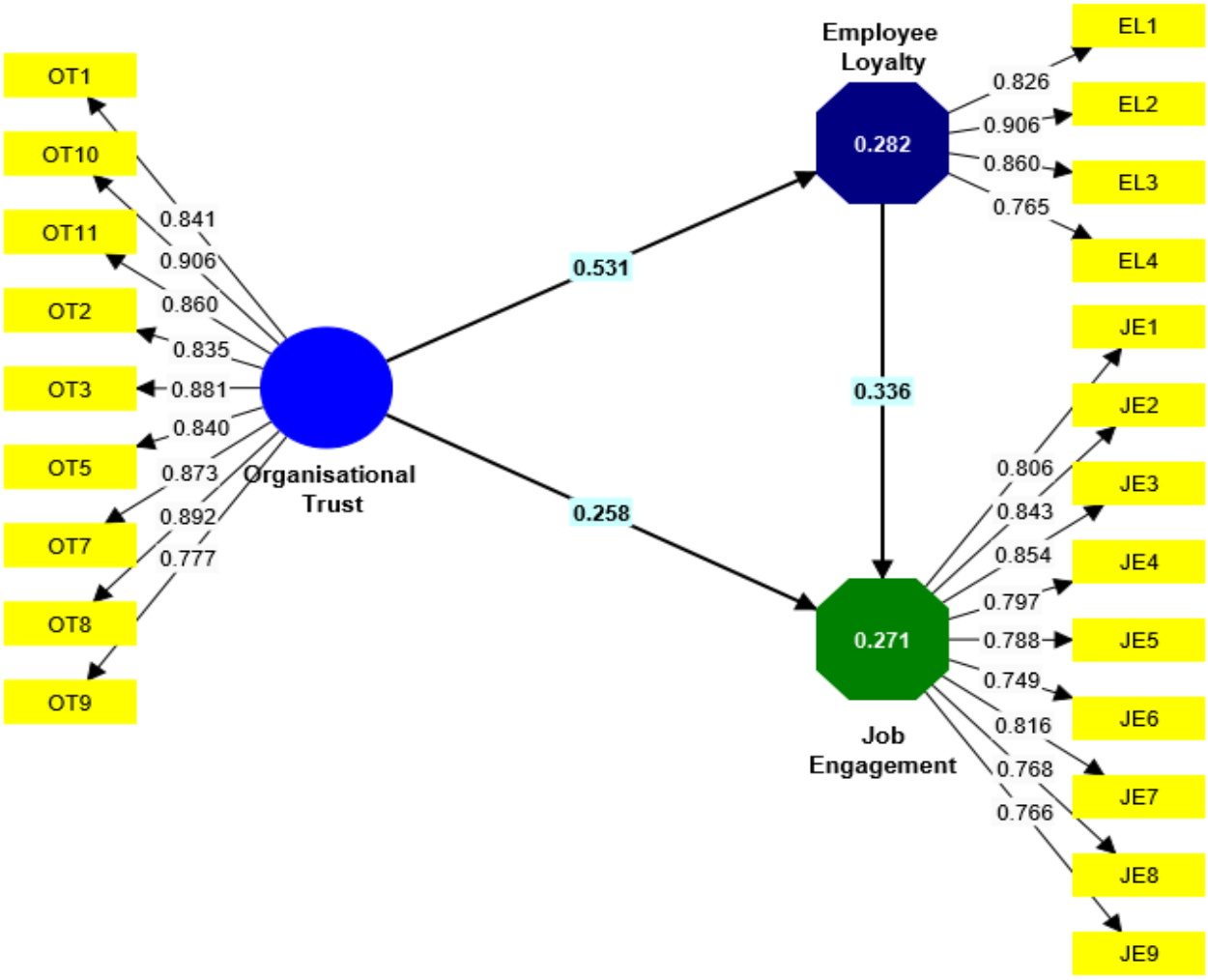


Fig. 2. Item loadings and path coefficients
Source: authors

As depicted in Figure 2 and Table 3, the study's results confirmed all the research hypotheses about the direct effect of organizational trust (OT) on employee loyalty (EL) and job engagement (JE).

According to the results of the analysis, for the participants of the study, it was observed that organizational trust in employee loyalty (β = 0.531) has a positive and moderate effect and that job engagement (β = 0.258) has a positive and weak effect. Additionally, the research results indicated that employee loyalty (β = 0.336) has a positive weak effect on job engagement. All of the hypotheses in the study were confirmed, as the effects of the associated regulatory variables (beta coefficients) were all positive and statistically significant ($p < 0.01$). Additionally, we propose examining the mediating role of the relationship between employee loyalty and organizational trust, and job engagement. Bootstrapping was employed to further test the mediating effect, and the results are shown in Table 4. The mediating effect of employee loyalty is significant, and the total mediating effect is 0.436. The indirect effect value of the OT → EL → JE process is 0.178. The upper and lower limits of the 95% confidence interval obtained via the bootstrap method do not contain 0. Employee loyalty has a strong mediating effect on the relationship between organizational trust and job engagement, which fully supports hypothesis H4.

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Hypothesis	Path	Direct effects	Indirect effects	Total effects
H4	Organizational Trust → Employee loyalty → Job Engagement	0.258***	0.178***	0.436***
***:p<0.001; **:p<0.01;*:p<0.05				

Table 4. The Mediating Effect of Employee Loyalty and Job Engagement
Source: authors

Our study verified all four hypotheses, as the impacts of the associated independent variables proved positive and significant at the p<0.01 level.

Discussion

An organization's ability to sustain its competitive edge and fortify its market standing hinges on retaining engaged, dedicated, and loyal employees who believe in its mission. Boosting employee loyalty and engagement is one of executives' most difficult yet critical tasks. This study analyzed the connections between organizational trust, employee loyalty, and job engagement at two private banks in Mongolia. The results of this study provide several meaningful insights into the relationships between organizational trust, employee loyalty, and job engagement in the banking sector.

- First, organizational trust was found to have a significant positive influence on employee loyalty (β=0.531, p<0.001). This finding suggests that when employees perceive their organization to be trustworthy, open, and reliable, they are more likely to feel a sense of loyalty and commitment to the organization. Strategies to build trust through transparent communication, showing care for employees, and fulfilling promises could strengthen loyalty. Our study's first finding is in line with the findings of Alshaabani et al. (2022), Baştuğ et al. (2016), Kalhor et al. (2020), Melian-Alzola & Martín-Santana (2020), Paliszkiewicz (2011), and Paparoidamis et al. (2019) reinforce the consensus among various researchers that organizational trust consistently has a positive impact on employee loyalty.
- Second, organizational trust was also found to weakly but positively impact job engagement (β=0.258, p<0.001). Fostering organizational trust could be an avenue to enhancing employee engagement. The second finding of our study aligns with the findings of Bulińska-Stangreck (2020), Chughtai et al. (2015), Jankelová & Joniaková (2022), Lin(2010), Ugwu et al.(2014), and Wong et al.(2010) support the findings among various researchers that organizational trust plays a pivotal role in increasing employee engagement.
- The third major finding demonstrates that loyal employees also tend to be more engaged in their jobs (β=0.336, p<0.001). Employees who feel committed to and identify with the organization are more motivated to devote greater effort and become immersed in their roles. Bolstering ties binding staff and organizations could ignite heightened participation. The third finding of our study corresponds with the findings of Ensai et al. (2022), Ludviga & Kalvina (2016), Soliman (2023), and Zahra & Kee (2022), who support the findings of various researchers that a positive relationship exists between employee engagement and loyalty.
- Employee loyalty fully mediated the link between organizational trust and job engagement. While organizational trust directly affects engagement, its influence is also transmitted through enhanced loyalty. Nurturing trust serves to deepen employees' loyalty and commitment, which in turn drives greater work engagement. The last finding from our study aligns seamlessly with the research results of Ferres et al. (2004), Phuong and Vinh (2020), and Shalabi (2019). This strengthens the consensus among diverse researchers that employee loyalty is a pivotal mediating factor in the correlation between organizational trust, work engagement, intention to quit, and employee performance.

Overall, the results emphasize the vital role that organizational trust plays in securing employee loyalty and spurring greater involvement in one's work. Initiatives to cultivate transparency, deliver on promises, show care for employees, and support their needs could strengthen trust bonds, loyalty, and engagement, positively impacting employee and organizational outcomes.

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5. Conclusions

This study makes significant contributions to both theoretical understanding and practical applications in organizational dynamics, specifically focusing on the intricate connections among organizational trust, employee loyalty, and job engagement. Drawing from survey data collected from 268 employees spanning two private banks, the results distinctly reveal that organizational trust not only exerts a direct positive influence on employee loyalty but also, directly and indirectly through loyalty, significantly impacts job engagement.

From a theoretical standpoint, these findings align with established organizational behaviour theories, suggesting that employees cultivate a stronger sense of connection and commitment when they perceive their organization as trustworthy, open, and reliable. This heightened loyalty, in a reciprocal manner, propels increased motivation and active participation in their respective roles. Strategic initiatives geared toward fostering transparency, fulfilling promises, demonstrating care and support for employees, and meeting employees' needs emerge as pivotal in fortifying trust within the organization.

In summary, this study provides valuable insights by shedding light on the indispensable role of organizational trust in cultivating employee loyalty and enhancing job engagement.

Limitations of the research

Recognizing specific limitations within this study is crucial. First, the data were exclusively sourced from employees within two private banks, thereby constraining the generalizability of the findings to a broader context. Furthermore, the reliance on self-report surveys introduces the potential for response biases, influencing the accuracy of the gathered information. To overcome these limitations and enrich the depth of understanding, future research could extend its scope to encompass a more diverse array of organizations and industries. Utilizing multisource data collection methods would offer a more comprehensive and nuanced perspective.
Despite these limitations, it is crucial to underscore that this study significantly contributes to theoretical and practical realms by revealing the intricate dynamics of organizational trust and loyalty to heightened employee engagement.

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SUSTAINABLE PRODUCTS AND THEIR PERCEPTION BY CZECH CONSUMERS*

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Abstract. This article aimed to determine whether Czech consumers buy more sustainable products in relation to their income level and the fact that they trust the certificates awarded to sustainable products. To achieve the goal, a quantitative data collection method was used, a questionnaire survey in which 997 respondents participated (quota sampling) and was implemented from June to September 2020. Subsequently, correlation analysis and Pearson's chi-square were used to process the primary data obtained. The correlation analysis method was used to determine whether a higher income means that consumers tend to buy sustainable products. The research results showed that the level of consumer income does not affect the preference for purchasing a sustainable product. Using the second Pearson chi-square method, it was found that consumers who believe in certificates buy more sustainable products, but the dependence appeared very weak, according to the result of the contingency coefficient. The research limits can be seen in the fact that only one research method was used for data collection: a questionnaire survey. For a better and deeper understanding of the consumption behaviour of Czech consumers in the case of buying/not buying sustainable products, qualitative methods of data collection, e.g., focus groups, and guided in-depth interviews.

Keywords: sustainability; eco-friendly product; fair-trade product; price; certification; supporting the sale

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1. Introduction

In general, sustainable development can be understood as the ability of the present generation to satisfy its own needs without endangering future generations in meeting its consumption (World Commission on Environment and Development, 1987).

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Related to this is that we should think about how our consumption affects, for example, the environment. One thing that negatively impacts our environment is the excessive production of waste. 38,504 thousand tons of waste was produced in the Czech Republic in 2020, of which 1,781 thousand tons (4.63%) were hazardous, and 36,721 thousand tons (95.37%) were other waste. If we were to apply these data to one resident of the Czech Republic, then 3,598 kg of all waste would be accounted for. Of this, 166 kg was hazardous waste and 3,431 kg other waste (Ministry of the Environment of the Czech Republic, 2021a). As for municipal waste in 2020, it accounted for 14.9% (5,730,000 tons) of total waste production and 536 kg per inhabitant of the Czech Republic (Ministry of the Environment of the Czech Republic, 2021b).

Due to the excessive waste production in the Czech Republic, it is necessary to find ways to reduce waste production. One of the ways could be a change in consumer behaviour in such a way that consumers would focus more on the consumption of sustainable products.

According to Frans Timmermans, Executive Vice-President of the Green Deal for Europe, "It is time to put aside the "take, make, break and throw away' model that is so damaging to the planet, our health, and the economy. With sustainable products, consumers will save energy, have broken products repaired instead of having to replace them and be able to make smart, environmentally conscious decisions when purchasing new products. This will restore the balance in relation to nature" (European Commission, 2022a). This idea is also presented in the Green Paper for Europe, which should ensure a longer life of products, achieved by being able to repair, recycle and use them again (European Commission, 2022b).

Textile products are one of the two groups of products that have a significant negative impact on the environment. Between 2000 and 2015, the production of textile products doubled, thanks to the "phenomenon of fast fashion" (faster change of new fashion styles, increasing offers of collections during the year, lower prices). The demand for clothing is accelerating, mainly driven by markets such as Asia and Africa. In 2050, clothing sales are expected to reach 160 million tons, more than three times that of nowadays. This would lead to an increase in adverse environmental impacts, precisely through the textile industry. This could be reflected in an increase in oil consumption to 300 million tons in 2050 and an increase in the share of CO2 production to 26%. Between 2015 and 2050, the number of microplastics accumulated in the oceans could be more than 22 million tons, approximately two-thirds of the plastic-based fibres used annually to make clothing (Ellen Macarthur Foundation and Circular Fibers Initiative, 2017). The negative impacts of fast fashion are rooted in a linear model. The essence of this model is the low rate of use, reuse, repair, and recycling of textile fibres into new fibres. In addition, releasing microplastics from synthetic textiles and footwear at all stages of their life cycle also negatively influences the environment (European Commission, 2022c).

In the case of food, it is interesting to see how consumer choice regarding food can reduce greenhouse gas emissions. The current value of the average UK diet was found to contain 8.8kg of CO2 per person per day. This number includes both food eaten and food wasted (after purchase). If meat were excluded from the diet, the amount of greenhouse gas emissions would be reduced by 35%, if lamb and beef were replaced by pork and chicken, it would be by 18%, and not consuming food grown in a greenhouse or transported by air brings a saving of 5% (Hoolohan et al., 2013).

If some products are environmentally friendly, they can be marked with the so-called eco-label after meeting specific rules and implementing the certification process. These labels are essential for informing consumers that the properties of the products are compatible with the environment. On the other hand, the many brands that consumers encounter can lead to different perceptions, understanding, and evaluations of the quality associated with each brand (Gavurova et al., 2018; Brécard, 2017).

In the case of companies, those that combine economic prosperity, social justice, and environmental quality are considered sustainable (Ahmad et al., 2022). One of the models that help companies identify, measure, and integrate social, environmental, and economic impacts into corporate strategy and managerial decisions to increase profitability successfully is the model of Epstein et al. (2017).

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The activity of sustainable companies is characterized as a sum of procedures, policies, and strategies that are linked to the above-mentioned social side and benefits supporting the environment, which companies try to implement to serve the interests of multiple stakeholders at once (Mosca and Civera, 2017; Skare et al. 2024a,b). The fact that they include sustainability and social responsibility in their business strategies is a necessity for the survival of any company in the future (Buzzi, 2021; Wei et al., 2021).

Nowadays, companies in the field of their environmental policy are moving to a strategy in which they emphasize the recycling and reuse of products or revise their production and distribution strategies in such a way as to use natural resources as efficiently as possible (Krzywda et al., 2021; Yanginlar et al., 2022; Skare et al., 2023). Environmental innovation improves not only the competitive position of the firm, which is based on the knowledge and novel activities they offer, but it can also help increase social and environmental responsibility (Fernando et al., 2019).

Employees represent the social aspect of sustainable development. In this context, the debate about the ideal development of the quality of the working life of employees and the effort to support the quality of working life and a healthy lifestyle is being developed in recent times (Sanusi and Johl, 2022; Simionescu et al. 2021).

The fact that the given product was manufactured in accordance with the social aspect aimed at the employees can be declared on the products through brands such as Fairtrade.

The activities that the company implements within the framework of sustainable development and social responsibility have a significant and positive effect on the company's reputation, satisfaction, and trust of the company's customers, and that the company's reputation, trust, and customer satisfaction creates a relationship between the company's social responsibility and customer loyalty (Islam et al., 2021; Gavurova et al., 2022).

According to Lentjushenková et al. (2019), reputation is a basic element of intellectual capital and an important part of a company's value. Intellectual capital includes four parts, namely human capital, business processes, technology, and intangible assets. Based on the above, the research goal was determined to find out whether Czech consumers buy more sustainable products in relation to their income and the fact that they believe in the certificates awarded to sustainable products.

The results of research carried out by the ŠKODA AUTO University in 2019 and involving more than 1,000 respondents showed that the higher price of ecologically produced products is the reason for not purchasing them 10% of respondents. More than half of the respondents cannot clearly answer whether the reason for not purchasing environmentally friendly products is that the products produced in this way are expensive. With these two groups of respondents, it is interesting to find out whether the decision to buy or not to buy environmentally friendly products depends on the amount of their income. Therefore, the research question was set:
1. Does the level of income of consumers influence their preference for purchasing sustainable products?

The same research also showed that less than 4% of respondents purposefully buy products marked with a sustainability certificate, and more than a third of respondents buy them if the retail unit has them in its assortment. Based on these results, it would be appropriate to focus on how much consumers trust certificates guaranteeing sustainability in relation to the decision to purchase these products. Here, the second research question was asked:
2. The more consumers believe in sustainability certificates, the more they tend to buy them.

2. Theoretical background

The literary research is devoted to sustainable products, both environmentally friendly products (green products, eco-friendly products) and also fair-trade products (Fairtrade products). In addition, the literature review deals with the issue of insight into certificates for sustainable products.

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The Industrial Revolution 4.0 currently underway means that companies face new opportunities and challenges related to identifying their roles in the emerging modern smart world (Lewandowska et al., 2023). Thanks to their unique characteristics, these so-called intelligent companies are better able to cope with technological innovations and social and cultural problems, as well as compete effectively and develop towards sustainability (Adamik and Sikora-Fernandez, 2022), which represents both the area of environmental protection and social area and economic prosperity.

In the case of the environment, some companies use so-called greenwashing. This is the behaviour of companies that use practices to deceive consumers through legal means of green marketing and production, but in reality, it is not so. The reason is that these companies are trying to become famous and increase their market share, sales, and positive perception of them by consumers. On the other hand, fortunately, it seems that consumers are increasingly aware of these unfair practices of greenwashing companies (Hameed et al., 2021; MacGregor Pelikánová and Sani, 2023)

Ideas promoting environmental protection are implemented in the marketing strategies of companies in the form of so-called green marketing. It uses the classic "4P" concept, with pro-environmental social responsibility (CSR) as a specific brand promotion tool. One of the elements of the 4Ps is price. The research, which was carried out among 220 Polish respondents, showed that the young generation between the ages of 18 and 34 pay attention to, e.g., recyclable packaging when purchasing, but on the other hand, the price of these products is a decisive factor for them in their purchasing decisions. In other words, the importance of the costs associated with purchasing environmentally friendly products exceeds the benefits of purchasing these products (Siuda, 2022).

In most cases, the price of green products is higher than that of traditional products, which means that these are premium prices. Pricing strategies used in green marketing are based on a balance and combination of consumers' price sensitivity and environmental conciseness. Consumers will be willing to pay a higher price if the perception of the added value of the product is manifested in better performance, function, design, visual appeal, etc. (Fan and Zeng, 2011), but also in the availability and quality of the products (Biswas, 2016). The willingness to pay a higher price for environmentally friendly products was confirmed, for example, in the case of a questionnaire survey, which was addressed to academic staff and students of Sanaa University. This survey showed that 133 out of 200 respondents are willing to pay more for environmentally friendly products (Al-Dubai and Develi, 2022).

This attitude of consumers to pay a higher price to buy more environmentally friendly products is sometimes called green consumerism (Ambec and De Donder, 2022; Dabija et al., 2022). According to the authors Kaviya and Priyadarshini (2022), this phenomenon is also explained by the fact that consumers, due to environmental concerns, look for environmentally friendly products that do not harm society.

The essence of the green consumer way of life was also investigated within the framework of research in which 705 consumers from Slovenia took part. This research showed that the consumer's affection for the environment and the perception of eco-products positively affects the intention of a green purchase (green purchase), which immediately positively and substantially affects the consumer's purchase of eco-products (Hojnik et al., 2020).

Furthermore, consumers' ethical actions focused on the environment, their moral principles, and green attitude" have a significant influence on consumer willingness to consume green products, which can subsequently have a substantial impact on current consumer green consumption (Akhatar et al., 2021; Gallardo Vázquez, 2023).

Another essential element is consumer trust, which influences consumers' decisions to purchase green products and is a crucial prerequisite for creating a market for these products (Nattaavuthisti and Thogersen, 2017). According to Ansar (2013), age and education positively affect whether consumers buy green products compared to socio-demographic variables.

From the point of view of marketers, in addition to price and advertising, product packaging influences whether the consumer decides to buy green products. In the case of the packaging of any products that are ecologically

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friendly to the environment, the green colour is primarily associated. On the other hand, research by Samaraweera et al. (2021) found that consumers are, on the contrary, willing to pay more for a product with a white-toned label.

It could be said that consumer purchasing behaviour is considered green when consumers are willing to purchase sustainable products. These are those products where the processes involved in their creation are considered green, the supply chain tries to minimize carbon emissions, the packaging of the products is degradable, and the disposal of the products itself is ecological because it does not have to increase the amount of waste.

In the case of retailing companies, some consumers tend to choose those that focus on selling environmentally friendly products and various green strategies aimed at waste disposal and recyclable packaging, etc. (Dabija et al., 2017).

In connection with consumers' green purchasing behaviour, we can mention, for example, the LOHAS group, which pays attention to the environment and tries to ensure that its behaviour is in harmony with the environment. The term LOHAS is currently being used for both products and consumers that are environmentally friendly. For example, this group's consumers buy food in packaging that protects the environment more than other consumers (Matharu et al., 2020). According to Chirilli et al. (2022), the packaging is the main factor determining the overall impact of food products on the environment.

Various eco-labels are displayed on the packaging of products that claim to be environmentally friendly. And precisely, the eco-labelling of products and the promotion of environmentally friendly products are the basic prerequisites that can affect the consumer's purchasing behaviour (Sedky and AbdelRaheem, 2021). The eco-label itself is one of the essential tools of green marketing, which helps to distinguish between green (environmentally friendly products) and "non-green" products. A study by Sharma and Kushwaha (2019) shows that eco-labelling is an essential criterion for creating consumer trust and their intention to make a green purchase through the information and knowledge gained by consumers themselves.

Certificates, which are supposed to guarantee that the given product is ecologically friendly to nature, should affect the consciousness and the consumer's subconscious. Certificates thus become a kind of suggestive method (means of communication), resulting in the purchase of ecologically certified products (Chaikin, 2015). According to Majeed et al. (2022) state that among environmentally oriented consumers, there is a noticeable relationship between ecolabelling and the intention to purchase environmentally friendly products.

More and more consumers have recently chosen food products based on their local or traditional attributes and whether these products are sustainable and environmentally friendly. Specifically, the food industry has introduced several strategies to guarantee product quality and sustainability (quality systems and quality marks) (Jakubowska, 2021).

Furthermore, for a favourable consumer decision to purchase sustainable food, the producer's statements about sustainability and socially responsible agricultural methods must be included on the labels of agricultural products (dos Santos et al., 2021).

Fairtrade is a transnational voluntary labelling initiative that aims to improve producers' social, economic, and environmental conditions in developing countries (Mook and Overdevest, 2020). In other words, Fairtrade and other voluntary sustainability standards could improve the socio-economic well-being of small farmers in developing countries and help reduce the negative impacts of agricultural production on health and the environment (Sellare et al., 2020). Fairtrade brings income to farmers by setting a minimum price, an alternative form of distribution without intermediaries between commodities and the world market (Podhorsky, 2015)

According to Becchetti and Michetti (2008), Fair Trade is an innovative value chain that aims to provide primary producers with higher economic value and social benefits.

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Fairtrade certificates (one of the most popular third-party certifications in the agri-food sector) (Reynolds, 2014) are often assumed to lead to poverty alleviation in developing countries. The main determinants of economic growth in poor areas (pro-poor economic growth, i.e., economic development that is directly addressed to the poor) are trade, investment in human capital, health, and financial development. Fairtrade food certification highly influences Some of these determinants (Bissinger, 2019).

Fairtrade was created as a reaction of consumers, society, and companies to the production conditions of imported food. Many studies have focused on investigating the welfare implications of smallholder farmers' participation in the Fairtrade system and consumers' willingness to pay for Fairtrade products (Van den Broeck et al., 2017).

Fairtrade can potentially increase market efficiency through linkages between farmers and altruistic consumers willing to pay a "premium" for certified sustainable products (Durevall, 2020). Research by Bissinger (2018) regarding the price comparison of fair-trade products and conventional products of producers shows that fair-trade prices are twice as high as the traditional equivalent.

Another research related to wine carried out by the authors Niklas et al. (2017) associated with the analysis of the price dispersion of this food in the United Kingdom, i.e., it investigated whether fair trade wines differed from "non-fair trade" wines. The analysis showed that fair trade wines show less price dispersion than their counterparts.

The research with 200 millennials from Turkey aimed to find out what influences their willingness to pay "premium prices" for fair trade products. The study did not show a significant relationship between knowledge of Fairtrade and the desire to buy these products. On the contrary, it was shown that the willingness to pay for Fairtrade products was positively influenced by trust in Fairtrade and enthusiasm (like) for these products (Aksoy and Özsömez, 2019).

Research by the authors Ruggeri et al. (2021), in which shoppers of a well-known Italian retail chain were involved, showed that the respondents positively evaluated the introduction of certification on products, as well as being willing to pay a "premium" price for certified products, and this willingness increased by being given additional information regarding the Fairtrade system.

The following data collection and data processing methods will be used to answer the above research questions.

For the first research question, a quantitative data collection method, namely a questionnaire survey, will be used. The correlation analysis method will be chosen to process the obtained primary data.

As with the first research question, the second research question will use a questionnaire survey for data collection. The method that will be used for data processing will be Pearson's chi-square goodness-of-fit test.

3. Research objective and methodology

A quantitative research method was chosen to answer both research questions: a questionnaire survey. This was implemented as part of the SGS Jaderná project at the ŠKODA AUTO University's Department of Marketing and Management in cooperation with the BehavioLabs research agency. Data collection took place from June to September 2020 via the Trendaro platform. A total of 997 respondents answered the questionnaire from the panel of respondents that the research agency has. The sample of respondents was representative, as quota sampling was used. This guarantees that the distribution of relative frequencies of auxiliary statistical characters in the sample set corresponds to their distribution in the base set.

After data collection, the data was transferred to Microsoft Excel and coded into statistically measurable quantities. Afterwards, the data were statistically evaluated using IBM SPSS Statistics.

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The data processing method correlation analysis was used to answer the first research question. Correlation analysis deals with interdependencies, where the emphasis is primarily on the intensity of the mutual relationship rather than on examining quantities in the direction of cause and effect. The correlation coefficient can take on values from – 1 to 1. If its value is equal to – 1, then it is a perfect negative linear relationship. If the value of the correlation coefficient is equal to zero, then there is no linear relationship. Finally, if the value of the correlation coefficient is equal to 1, then it is a perfectly pure linear relationship. In this context, it is also necessary to find out the so-called p-value to test the significance of the correlation coefficient. If this value is less than 0.05, the correlation coefficient is statistically significant, and the investigated variables have a linear relationship.

Using the correlation coefficient makes it possible to determine the relationship between two properties.

Even if the correlation coefficient is closer to +1 or -1, it indicates a positive (+1) or negative (-1) correlation between the matrices. A positive correlation means that as the values in one matrix increase, so do the values in the other matrix. A correlation coefficient that is closer to 0 indicates no or weak correlation. The test in MS Excel was used in the following way.

The correlation coefficient equation is:

$$Correl\,(X,Y) = \frac{\sum(x-\bar{x})\,(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2 \quad \sum(y\ -\bar{y})^2}}$$

where x and y are the mean values of the sample.

The Pearson chi-square data processing method was used to evaluate the second research question through the CHISQ.TEST function in MS Excell, and also according to the calculation of the test criterion, the critical field, their comparison, and the Pearson contingency coefficient.

For both procedures, a contingency table of trust values in sustainability certificates and the purchase of sustainable products were first created in MS Excell. Then, hypotheses H0 and H1 were established.

The CHISQ.TEST function returns the value of the chi-square ($\chi 2$) distribution for the given test criterion and the corresponding degrees of freedom. Using $\chi 2$ tests, it is possible to determine whether the experiment confirms the predicted results.

When calculating this probability the CHISQ function, THE TEST FUNCTION, uses the $\chi 2$ distribution with the appropriate number of degrees of freedom, df. If r > 1 and c > 1, then df = (r - 1)(c - 1). If r = 1 and c > 1 then df = c - 1 or if r > 1 and c = 1 then df = r - 1. r = c= 1 is not allowed and #N/A is returned.

If the resulting value of the CHISQ.TEST function would be less than 5%, the hypothesis H1 is confirmed.

In the case of the second procedure, the first step was to calculate the test criterion G using the formula:

$$G \;=\; \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\left(A_{ij}\;-\;E_{ij}\right)^2}{E_{ij}}$$

where:
A_{ij} = current frequency in i-th row and j-th column
E_{ij} = expected frequency in i-th row and j-th column
r = number of rows
c = number of columns

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This was followed by the determination of the critical field according to the formula:

$$W \equiv G; \{G \geq \chi 2_{1-\alpha}(r-1)(c-1)\}$$

where:
G = test criterion
$\chi 2$ = significance level
r = number of rows
c = number of columns

If the critical field were not fulfilled (the value of the test criterion would not be greater than or equal to the chi-square at a significance level of 5%), then the established null hypothesis would not be rejected and vice versa.

Pearson's contingency coefficient was used to assess the strength of dependence:

$$C = \sqrt{\frac{G}{G+n}}$$

where:
G = test criterion
n = number of measurements

If the value of C is less than 0.3, then this is a weak dependence. If the value of C is greater than 0.3 but less than 0.8, then the dependence is moderate. In the case of a value of C higher than 0.8, this is a strong dependence.

4. Results

This chapter will present the results based on the above-mentioned methodology and related to individual research questions.

To answer the first research question, a question was first asked to the respondents as part of the survey, which had the task of finding out the knowledge of the respondents about the term sustainable product, in other words, what comes to mind first when the sustainability of the product is mentioned. Respondents had the option to choose one of the offered answers or to skip the question. This question was followed by a question that asked whether the respondents bought these products. Only one answer could be selected from the possible answers. The responses are recorded in Table 1. This table shows that more than half of the respondents (58%) answered that they sometimes buy them. 31% of respondents do not deal with it, and the rest directly search for them (11%).

Table 1. Buying preference for sustainable products by Czech consumers

Do you buy sustainable products?		
Yes, I am looking for them.	109	11 %
Sometimes.	582	58 %
I don't deal with it.	309	31 %

Source: own processing

From earlier investigations by researchers at the ŠKODA AUTO University (Jaderná, 2019) and studies from around the world, it is clear that the most significant reason consumers do not buy sustainable products is their higher price. Therefore, attention was focused on the level of income and its influence on the purchase of these products.

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In this context, a correlation analysis was conducted to determine the interdependence of these two variables, i.e., whether higher income means consumers tend to buy sustainable products. The value of the correlation coefficient was 0.03. A correlation coefficient that is closer to 0 indicates no or weak correlation.

An important external stimulus for purchasing a sustainable product is the mark with a sustainability certificate, which is very important for Czech consumers. Research question #2 related to the dependence of the purchase of a sustainable product on the answer to the question: "Do you trust such certificates?". To this question, the respondents had the option to answer one of the following options, which were modified for easier interpretation within the Pearson chi-square test (indicated after the slash):

Yes, most of them guarantee the quality and origin of the product / yes
You can rely on the part of it / partly
No, most certificates say nothing / no

The second question from the questionnaire survey for the need to use Pearson's chi-square was the above question, which related to the purchase of sustainable products. The possible answers offered have been modified as follows:

Yes, I'm looking for them / yes
Sometimes yes / sometimes
I don't deal with it / no

The next step for testing needs was to add up the answers "yes" and "sometimes" to the question of whether consumers buy these products, followed by "yes" and "partly" to the question of whether consumers believe in sustainability certificates. The given values are shown in Table 2, to which the expected values for further testing have also been added.

Table 2. Actual and expected values

Actual values			
	Answer to question No. 1: yes + partly	Answer to question No. 1: No	
Answer to question No. 2: yes + sometimes	277	138	415
Answer to question No. 2: No	516	66	582
	793	204	997
Expected values			
	Answer to question No. 1: yes + partly	Answer to question No. 1: No	
Answer to question No. 2: yes + sometimes	357,557673019057	84,9147442232698	
Answer to question No. 2: No	501,442326980942	119,0852255767301	

Notes: Question No.1: Do you believe in certificates?
Question No.2: Do you buy these products?

Source: own processing

Subsequently, the following hypotheses were established:

H0: If consumers believe in sustainability certificates, they are less inclined to buy them.
H1: If consumers believe in sustainability certificates, they tend to buy them.

The test criterion was calculated with a value of 70.8. The critical area was determined based on the calculation of $\chi 2_{1-0,05}$ [(2-1)(2-1)], which was 3.84. Since 70.8 > 3.84, it can be concluded that the null hypothesis is rejected.

To assess the strength of dependence, Pearson's contingency coefficient was used, the value of which was 0.066. Since C < 0.3, this is a weak dependence.

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The calculation in MS Excel (CHISQ.TEST) gives the value p = 3.79919E-18, i.e. the dependence is also proven ($p < 0.05$).

5. Discussion

At the beginning of this article, two research questions were presented, which are based on the goal of the research, which had the task of finding out whether Czech consumers buy more sustainable products of their income level and also the fact that they believe in certificates awarded to sustainable products.
To answer the first research question, "Does the level of income of consumers affect their preference to purchase sustainable products?" the data processing method correlation analysis was used. The relationship was investigated to determine whether higher income means consumers tend to buy sustainable products. Since the calculated value of the correlation coefficient is close to 0, there is no weak correlation. It follows that the relationship between these variables cannot be confirmed. The answer to research question #1 is that the level of consumer income does not affect the preference to purchase a sustainable product.

To determine this research question was based on the fact that the prices of sustainable products are higher than those of conventional (traditional) products. One of the studies mentioned in the literature review found that the price of these products is an important factor in consumers' buying decisions. These were respondents aged 18-34 (Siuda, 2022), a young generation, and it is possible to assume that they do not yet have the same level of income as, for example, their parents. On the other hand, research involving students and academics found that more than 60% of respondents said they were willing to pay more for environmentally friendly products (Al-Dubai and Develi, 2022).

In any case, it is not possible to clearly state whether it is always true that the amount of consumer income does not influence the preference to purchase a sustainable product, as it turned out in the research we carried out in relation to the research mentioned in the literature review.

In the case of the second research question, "The more consumers believe in sustainability certificates, the more they tend to buy them," the Pearson chi-square test was used, and the following hypotheses were posed:

H0: If consumers believe in sustainability certificates, they are less inclined to buy them.
H1: If consumers believe in sustainability certificates, they tend to buy them.

Since the calculated value of the test criterion was higher than the critical field, it can be stated that the null hypothesis is rejected. In other words, it can be said that at the significance level of 5%, it was proven that consumer trust in sustainable product certificates and the tendency to purchase them depend together, and according to Pearson's contingency coefficient, this is a weak dependence.

Dependence was also demonstrated using a calculation in MS Excel (CHISQ.TEST).

When evaluating the second research question, it can be summarized that consumers who believe in certificates buy more sustainable products. However, the proven dependence is very weak, according to the result of the contingency coefficient.

This positive evaluation of the research question fully corresponds with the opinion that there is a noticeable relationship among environmentally oriented consumers between ecolabelling and the intention to purchase environmentally friendly products (Majeed et al. (2022).

In the case of the Fairtrade certificate, it can be stated that consumers positively evaluate when the certification is indicated on the products. Moreover, they will pay a "premium" price for such certified products (Ruggeri et al., 2021).

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Based on the research and the research mentioned in the literature searches, the more consumers believe in sustainability certificates, the more they buy.

Conclusions

Today's society is increasingly thinking about what to do so that its behaviour, which satisfies its own needs, does not endanger the lives of future generations. It is thinking about, for example, how to achieve that it does not produce an unnecessarily excessive amount of waste, does not increase greenhouse emissions, strives to ensure suitable working conditions for employees mainly working in developing countries, etc. In this context, our company is increasingly leaning towards consuming sustainable products. But what leads her to prefer these products over conventional ones? What influences her when buying sustainable products? The answers to these questions will undoubtedly benefit retailers with these products in their assortment. Based on the above, the aim of this article was determined, namely, to determine whether Czech consumers buy more sustainable products based on their income level and whether they trust the certificates awarded to sustainable products.

The research results in part of this article showed that the given product received a certificate declaring sustainability and not the amount of the consumer's income, which is of fundamental importance for the consumer's decision to buy a sustainable product. From this research result, retailers can recommend that they be bold in having products marked with sustainability certificates in their assortment and, in this context, to use various marketing communication tools intended for consumers supporting sustainable products.

It can be about supporting the sale of sustainable products in the form of in-store, in the form of tastings and demonstrations, consumer competitions, sampling in the form of inserted advertising in magazines intended for consumers, as well as a suitable form of merchandising (modification of goods on shelves, fastening of banners, installation of posters, an appropriate type of presentation, etc.), by placing suitable POP and POS, means on the sales floor (shelf wobblers, plastic visuals of products, illuminated advertisements, merchandising accessories) and also by using event marketing. Another marketing communication tool that could be used is advertising for sustainable products, whether in the media or printed advertising. Furthermore, it could be personal selling in the form of face-to-face.

The limitation (limits) of the aforementioned research can be seen in the fact that only one quantitative data collection method was used, namely a questionnaire survey. For a closer understanding of consumers' opinions and attitudes towards sustainable products, the qualitative method of focus group data collection or guided in-depth interviews could be used as part of further research. The topic of these data collection methods could be, for example, what other incentives/motives besides certificates can lead Czech consumers to buy these products. It can be their belief that these products' production leads to sustainable development, or it will result from their lifestyle supporting sustainable development, positive experiences, and the availability of these products, etc. In addition, it is also possible to find out how attitudes have changed after the coronavirus pandemic and consumers' opinions on whether they will buy and consume sustainable products.

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ECO-MARKETING AND THE COMPETITIVE STRATEGY OF ENTERPRISES – REVIEW OF THE RESEARCH RESULTS OF ENERGY COMPANIES

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Abstract. This study examines the significant impact of eco-marketing in the energy sector when environmental sustainability is paramount. By implementing a diagnostic survey approach, we examined the feedback provided by 1025 firms pertaining to eight crucial energy sectors. The results of our research show that incorporating eco-marketing into competitive tactics is acknowledged and has a considerable and varied effect on pricing, sales, and operational expenses. These observations emphasise the dual function of eco-marketing in enhancing industrial competitiveness and promoting sustainability objectives. It provides a strategic framework for energy companies as they shift towards environmentally friendly practices.

Keywords: eco-marketing; competitive strategies; energy companies; company's costs

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1. Introduction

The term eco-marketing is a concept introduced previously in the literature. However, due to the permanent nature of pro-environmental activities, it is still vital and up-to-date. This study draws attention to the fact that the company's management staff still needs to recognise eco-marketing. This results from the research in which 1025 companies were analysed, and it was noted that, in advertisements and social media, energy companies are eager to emphasise their eco-marketing approach, which is based on increasing performance without harming the environment (Ziyadin et al., 2019). However, the research indicates that these companies' management staff need to gain knowledge of the impact of eco-marketing on the development of competitive strategies (Tauron, 2023). Based on the above, the study raised the research question: How does eco-marketing shape the competitive strategy of energy companies? The hypothesis (H1) was formulated to answer the research question that introducing eco-marketing in enterprise management and offering products allows for building a competitive advantage strategy in energy enterprises. This study sets itself apart from current literature by comprehensively examining eco-marketing within energy businesses, specifically from a managerial standpoint. This perspective needs to be thoroughly addressed in previous research. Our research focuses on the

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strategic implications of eco-marketing at the organisational level rather than consumer behaviour or macro-environmental impacts. By doing so, we aim to expand existing knowledge and provide new theoretical and practical insights. Our research aims to enhance the theoretical framework of eco-marketing by clarifying its strategic dimensions and ramifications, specifically in the energy industry. This study aims to go beyond conventional perspectives on eco-marketing, which consider it a tactical means for meeting environmental regulations or standing out in the market. Instead, it emphasises eco-marketing as a crucial component in the strategic framework for gaining a competitive edge for energy companies. To accomplish our goals, we utilised a diagnostic survey approach, supplemented by a thorough examination of relevant literature and a rigorous analysis of survey data. This extensive methodology guarantees a meticulous topic examination, establishing a solid basis for our discoveries and conclusions.

Theoretical context of eco-marketing in enterprises

Economic trends indicating the direction of management in modern enterprises consider the level of environmental awareness represented by customers (Croitoru et al., 2021; Simionescu et al., 2022; Ruschak et al., 2023; Ogutu et al., 2023). According to Dong (2023), enterprises focusing on eco-innovation play an essential role in development and operation. According to Civelek et al. (2021), marketing communication positively affects the innovativeness of activities within an organisation. With the rapid growth of the economy, there is a need for continuous development of the environmental direction and transformation from a resource-based economy to a green economy (Zhang, Gao & Liu, 2022) and a focus on the most environmentally friendly return of raw materials back to the economy and secondary use of raw materials in the production process (Šimková et al., 2023; Jakubelskas & Skvarciany, 2023; López-Serrano et al., 2023). This means that customers evaluate companies and their products through a pro-environmental orientation. This is because customers are increasingly interested not only in the quality, price, and time of fulfilling their needs but also in the conditions (Pilarczyk & Nestorowicz, 2010; Androniceanu & Sabie, 2022; Jagoda et al., 2023) in which the products satisfying their needs were manufactured, although it should be noted that there are still companies that do not act fully ethically towards the environment (Podda & Harold, 2019).

In the literature on the subject, eco-marketing is understood as offering and selling ecological or environmentally friendly products addressed to customers with a higher level of environmental awareness (Kronenberg, 2007), and the production and sale of products and services are less harmful to the environment (Maksudunov & Avci, 2020). According to Li and Evans (2019), environmental performance is a valuable concept that combines business activities with sustainable development and achieving long-term profits. Thus, eco-marketing is an element of the business management process. It aims to recognise and forecast customer needs for green products and satisfy them by creating a supply of environmentally friendly products (Zaremba, 2009). According to Ali (2021), customers from less developed countries have less knowledge than customers from developed countries, so choosing the right environmental strategy is necessary. Eco-marketing reflects the company's activities focused on identifying customer needs to obtain their satisfaction, which contributes to sustainable development due to consumers' growing interest in sustainability (Correia et al., 2023; Skare et al. 2023a,b). In this approach, eco-marketing becomes the pursuit of reducing the negative impact of the enterprise on the natural environment, which means that eco-marketing involves the promotion of products and technologies that are consistent with the concept of sustainable development (Klikovac-Katanić & Kosanović, 2012), which forces enterprises to deal with this problem (Shi et al., 2022; Chen, Wu & Jiang, 2022). In this context, eco-marketing becomes an instrument of the policy of sustainable development and corporate social responsibility (Biernacki, 2017; Chowdhury, 2021; Skare et al. 2024a).

Pro-environmental activities undertaken by enterprises, on the one hand, help build relationships with customers and, on the other hand, improve the company’s image (Kot, Ul & Kozlovski, 2019) through green marketing tactics to enhance the purchasing intentions of their customers (Jabeen et al., 2023). Moreover, eco-marketing makes it possible to reorient the traditional approach to enterprise management to an approach directed at the launch of green product solutions. Therefore, environmentally responsible companies concentrate their activities on satisfying the environmental needs of customers, which is why they are perceived as ethical, yet the principles of sustainable development are still implemented only in a small proportion of enterprises (Skare et al. 2024bc; Karaeva et al., 2023). Therefore, pro-environmental activities become a factor in the market's

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competitive advantage (Wojnarowska, 2011; Małys, 2023), and thus environmental and social wealth (Maassen et al., 2023). Customers are increasingly choosing products from companies promoting environmental values, which is why they are willing to accept a higher price for the products of companies that disseminate their orientation using eco-marketing tools due to environmental protection (Reddy et al., 2023; Skare et al. 2024b). Additionally, eco-marketing focuses on information activities addressed to customers and business partners (Rosca, Tanase & Morar, 2012) regarding strategic, tactical, and operational activities (Vilkaite-Vaitone & Skackauskiene, 2019). Therefore, the primary objective of eco-marketing, implemented through tools such as environmental campaigns, should be to improve the environmental awareness of society by comparing business processes, transforming markets, and thus balancing the social, environmental, and economic dimensions, which is intended to educate global society towards responsible and conscious actions for the already degraded environment (Czerwińska & Jaśkiewicz, 2009; Solaiman et al., 2015).

To summarise the review of the literature on the subject in terms of defining eco-marketing, it should be emphasised that it is a marketing concept directed to the use of interest in environmental protection needs when selling the offered goods and services (Kokoszka, 2008) and promoting a more responsible approach that builds a sustainable society (Sheth & Parvatiyar, 2021). The eco-marketing issue is becoming increasingly important since it responds to customer needs resulting from concern for the environment, especially since it becomes an instrument for creating needs, the satisfaction of which brings results for both customers and enterprises. However, all parties involved must cooperate (Hodson, 2019). Explaining how eco-marketing shapes the competitive strategy of enterprises is essential not only for building the theory (Skowron-Grabowska, 2023) but also for the practice of management of modern enterprises since the development of eco-marketing is the basis for activities of the environmental protection movement, which becomes a factor in the competitiveness of enterprises, mainly due to the intensifying social and environmental crises (Akbulut, 2020; Ahmad et al. 2022).

Competitive strategy of enterprises in the context of eco-marketing

The functioning of enterprises in the competitive market requires entrepreneurs to apply operation principles and concepts to implement competitive strategies, which are critical factors related to the performance of the organisation (Gonzalez-Benito, Suarez-Gonzalez & Gonzalez-Sanchez, 2022), primarily through marketing operations that develop competitive business strategies (Hosseinzadeh et al., 2021; Urban et al., 2023). In the literature on the subject, this operation concept is referred to as a competitive strategy (Cooke, 2008), which should be understood as a development model to create long-term advantages for all entities in the competitive environment (Faulkner & Campbell, 2006). According to Amer and Abdulwahhad (2020), a significant and positive correlation exists between competitive advantage strategies and customer satisfaction and value. The forerunner of the competitive strategy theory was Porter, who significantly contributed to the development of knowledge in the field of strategic management, assuming that "competitive strategy assumes the search for a privileged competitive position in the industry, which is the most important area from the point of view of competition (Talíř & Straková, 2023). According to Wanyonya et al. (2020), the key to increasing competitiveness is applying the competitive strategy Porter described. This strategy includes a differentiation, focus, and low-cost strategy (Islami, Mustafa & Topuzovska Latkovikj, 2020). The competitive strategy is to enable the development of a solid and favourable position in relation to those forces that determine the nature of competition in the industry" (Porter, 2006), which involves creating a sustainable competitive strategy (Hayati et al., 2021). In the literature on the subject, competitive strategy is understood as the objectives and actions undertaken by the company that are aimed at achieving a sustainable competitive advantage (Madsen & Walker, 2015; Wang et al., 2021). Moreover, the competition strategy includes striving to meet best customer needs and activities aimed at weakening or eliminating a specific competitor from the market (Spulber, 2007; Ardley & Naikar, 2021).

The most famous division of competitive strategies was developed by Porter, who distinguished three basic competitive strategies: cost leadership, differentiation, and focus (Porter, 1998). According to Suleman, Rashidirad & Suleman (2019), it is essential to remember that although the cost leadership strategy may lead to increased performance, it may be more beneficial and sustainable for online-only companies to pursue the differentiation strategy than the cost leadership strategy. The competitive strategy regarding cost leadership is distinguished by the fact that the company using this strategy strives to achieve the lowest level of costs in the

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industry in relation to competitors (Gomes, Okano & Otola, 2020). However, it should be noted that most companies currently use this competitive strategy, competing with other entities in terms of cost optimisation (Alkhanak, Lee, Rezaei & Parizi, 2016). In this context, organisations need to use cost management systems with a strategic orientation; only then can a competitive advantage be achieved (Adigbole et al., 2023). When considering the competitive strategy in terms of cost leadership in the context of eco-marketing, it should be admitted that implementing eco-marketing projects is usually associated with higher costs (Hennart, 2005). An example is green marketing leader Starbucks, which invests heavily in environmental and social initiatives (Fernando, 2023). However, the eco-marketing preferences of customers can be satisfied by searching for optimal solutions for production in pro-environmental conditions and maintaining the required cost regime, which later pays off in the form of income and sales. (Ullah et al., 2022).

In the case of differentiation, the competitive strategy involves offering customers a wide range of manufactured products or services and, above all, standing out from competitors in the market (Lauga, Ofek & Katona, 2022). This range of offers allows for meeting the diverse needs of different customer groups, which is reflected in the level of sales. On the other hand, not every company can provide and maintain a broad and balanced product offer. However, the differentiation strategy allows the company to fill market gaps, thereby preventing competitors from entering the market in various ways, which include, e.g., the low-cost strategy (Mongkol, 2021). In relation to eco-marketing, the differentiation strategy may be distinguished by the fact that entrepreneurs can expand their commercial offers with items created in a sustainable, environmental, and economical manner (Ahmed, Streimikiene & Zheng, 2021).

The concentration strategy involves focusing on a narrow market offer dedicated to a specific customer and supplier (Ahsan et al., 2023), which may increase the innovativeness of suppliers (Lin, Xue & Wang, 2021). Unlike the differentiation strategy, the concentration strategy is directed at opposite actions, which may cause these concepts to be mutually exclusive (Ali & Anwar, 2021) and contradictory (Xu et al., 2023). When analysing the competition strategy regarding concentration in the context of eco-marketing, it should be stated that this is a widespread activity in enterprises and involves them changing their production processes to manufacture products compliant with the principles of respect for natural resources and environmental protection (Wang & Wang, 2019). This competitive strategy, which focuses on eco-marketing, is addressed to recipients with high requirements who need to purchase products and services manufactured in a way that does not have a negative impact on the natural environment because harmony between man and nature has become a common choice of all countries in the world (Yuan, Wang & Yin, 2021).

To sum up, common competitive strategies regarding cost leadership, differentiation, and focus take on a new dimension when considering eco-marketing (Crespo, Simões & Fontes, 2020). Looking at the company's competitive strategies through the prism of eco-marketing increases the company's attractiveness in the eyes of potential customers and helps expand into new markets (Rajput et al., 2022).

2. Methodology

The diagnostic survey method was used in the research (Apanowicz, 2002). The research tools used include literature studies, the survey questionnaire (Vogel, Koutsombogera & Costello, 2020) and its verification, descriptive analysis, and statistical analysis. The work was divided into two main parts: the theoretical part and the empirical part. In the theoretical part, a review of the literature on eco-marketing and competitive strategies of enterprises was conducted. On the other hand, in the empirical part, there were characterised energy companies constituting the research sample, verified later in the study with questions from the survey questionnaire. The survey was conducted on a sample of 1025 enterprises, 8 of which were energy enterprises, and the survey was conducted from January to March 2022. The selection of the research sample was purposeful since it was noticed that energy companies are eager to emphasise their eco-marketing approach in advertisements and social media.

In contrast, the research indicates that the management staff of these companies do not know the impact of eco-marketing on the development of competitive strategies of enterprises. The study was carried out using the computer-assisted telephone interview (CATI) technique (Hair et al., 2014), which is widely used despite the

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lack of conclusive evidence of representativeness (Hemsworth et al., 2021). The advantages of using the CATI method to achieve the objective of the study include a short period for conducting many tests, high-quality results, systematicity of stages occurring during the study, integrated data collection (Oláh et al., 2019), and low cost (Maffioli, 2020). The questions used a five-point rating scale. The respondents were asked to answer the question that best characterises the degree to which they agree or disagree with each statement by selecting one of five values on a Likert scale from 1 to 5. Answer 1 meant "I completely disagree", 2 "I disagree", 3 "I don't know", 4 "I agree", 5 "I completely agree".

The following hypothesis was put forward in this study: *There is a relationship between the implementation of eco-marketing and the company's competitive strategy*; 4 questions from the survey questionnaire were used to verify the hypothesis.

The results were subjected to a descriptive analysis (Kemp, Ng, Hollowood & Hort, 2018), comparing the results obtained in energy enterprises with those of the other surveyed enterprises. It should be noted that the descriptive method charcterrizes cognitive activities and their products (Popper, 2005), which do not lead to any conclusions and are based only on probability theory (Kaliyadan & Kulkarni, 2019). The descriptive method serves an idiographic function in empirical cognition by describing a single organisation or structure (Popper & Hansen, 2014) and improving business performance (Farrokhizadeh & Oztasyi, 2022). Therefore, the descriptive method can characterise an event, phenomenon, process, or precisely defined research problem. The discussed methodological approach enables the formulation of research questions and their verification in a further procedure (Schjoedt, Bird, 2014), and according to Subanja et al. (2021), three levels of descriptive methods, namely construction, imitation, and modification, are distinguished. Subsequently, the results were subjected to statistical analysis (Hedges & Olkin, 2014), where the non-parametric Mann-Whitney U test was used (Stanisz, 2006). However, it is a popular procedure (Fong & Huang, 2019), which does not require homogeneity of variances or normal distribution, which is its advantage, as well as the Wilcoxon W test (Dobosz, 2004) and asymptotic (two-sided) significance was determined. In all calculations, the level of significance of $p < 0.05$ was assumed (Pułaska-Turyna, 2005).

3. Results

Characteristics of the energy companies constituting the research sample

Enterprises participating in the electricity market can be divided into the following four groups:

1. Electricity manufacturers.
2. Energy trading companies - i.e., intermediaries that buy energy for further resale.
3. Companies dealing with energy transport - i.e., companies dealing with the distribution of energy to the final customer.
4. Customers are divided into two main groups: households and institutional customers.

The energy companies constituting the research sample were selected from 1025 enterprises, most of which are companies from the following sectors: Construction, Energy, Gastronomy, Trade, IT, Marketing, Media, Medical, Transport and Insurance.

The population of the surveyed energy enterprises was diverse, with a slight dominance (37.5%) of small enterprises hiring from 10 to 49 employees annually. The respondents held mainly top management positions (37.5%) and middle management positions (37.5%). It is worth noting that 50.0% of the respondents believe that the position of their company on the market is favourable, 37.5% of the respondents assess the company's position as dominant. In comparison, 12.5% of the respondents describe the company's position on the market as average. The surveyed companies have been operating on the market for 6 to 20 years (37.5%) and over 20 years (37.5%). The dominant activity profile of the surveyed enterprises is service companies (62.5%). The dominant age range of the respondents is 36-50 years (87.5%). The respondents' work experience in each company ranges from 6 to 20 years (37.5%) and over 20 years (37.5%). The main products of the surveyed companies are energy services (62.5%). The structure of the research sample is presented in Table 1.

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Table 1. Structure of the research sample

Characteristics of enterprises	*Category description*	*% of respondents*
Company's size	*Micro-enterprise (hiring 1 to 9 employees on an annual average)*	*25.0%*
	Small enterprise (hiring 10 to 49 employees on an annual average)	*37.5%*
	Medium-sized enterprise (hiring 50 to 250 employees on an annual average)	*25.0%*
	Large enterprise (hiring more than 250 employees on an annual average)	*12.5%*
Position held in the company by the respondent	*Top management position (strategic level)*	*37.5%*
	Middle management position	*37.5%*
	Management position at operational level	*12.5%*
	Employee	*12.5%*
Territorial scope of the business	*A global enterprise*	*25.0%*
	A European-scale company	*25.0%*
	A national company	*25.0%*
	A local company	*25.0%*
Company's position in the market	*Dominant*	*37.5%*
	Favourable	*50.0%*
	Average	*12.5%*
Company's operating time on the market	*up to 5 years*	*25.0%*
	6-20 years	*37.5%*
	more than 20 years	*37.5%*
Dominant business profile of the company	*Production company*	*25.0%*
	Service company	*62.5%*
	Trade company	*12.5%*
Respondent age range	*up to 35 years*	*12.5%*
	36-50 years	*87.5%*
Respondent's work experience in the company	*up to 5 years*	*25.0%*
	6-20 years	*37.5%*
	more than 20 years	*37.5%*
Company main products	*cables, lighting, automation*	*12.5%*
	heat pumps	*125%*
	Construction projects and supervision	*12.5%*
	Energy services	*62.5%*

Source: Own study based on the conducted research

Comparative analysis of energy companies against other enterprises in the context of building a competitive advantage strategy, considering eco-marketing activities

The research objective was to examine and assess eco-marketing as a factor in building the competitive strategy of energy companies. The survey research results on eco-marketing issues in the context of the competitive strategy obtained from 1025 enterprises were subjected to a descriptive analysis, comparing the results obtained from energy companies with those for the other surveyed enterprises. The first statement analysed was: *Eco-marketing is included in the company's competitive strategy*, and Figure 1 presents the detailed results from the surveyed companies.

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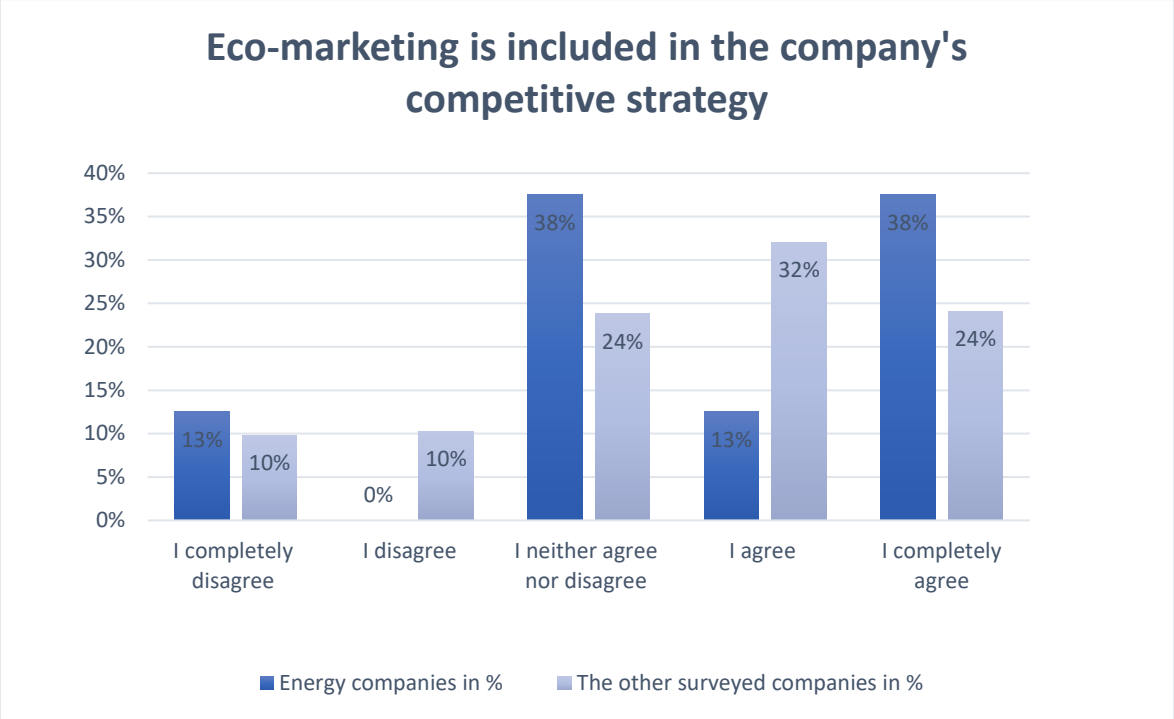


Figure 1. Verification of the statement: Eco-marketing is included in the company's competitive strategy
Source: Own study

The analysis of the information obtained based on the first survey statement allows for the conclusion that 50% of the respondents from energy companies believe that eco-marketing is included in their competitive strategy. When comparing the results obtained with those for the other surveyed enterprises, it is noted that 56% of enterprises believe that eco-marketing is included in their competitive strategy, i.e., it can be concluded that energy industry enterprises have a similar position on this issue as the other surveyed enterprises. According to 37.5% of the respondents from energy companies, they cannot take a position on whether eco-marketing is included in their competitive strategy. When comparing the obtained results with those obtained from the other surveyed enterprises, it is noted that 24% of the respondents cannot clearly answer whether eco-marketing is included in the strategy of their competitors or not. It is worth noting that only 12.5% of the respondents from energy companies indicate that eco-marketing is not included in their competitive strategy. In contrast, in the case of the other surveyed companies, this answer was chosen by 20%. Based on the research findings, eco-marketing has a role in shaping the competitive strategy of businesses, especially energy corporations.
The second analysed statement was: *The use of eco-marketing increases the price of the product*, and Figure 2 presents the detailed results from the surveyed companies.

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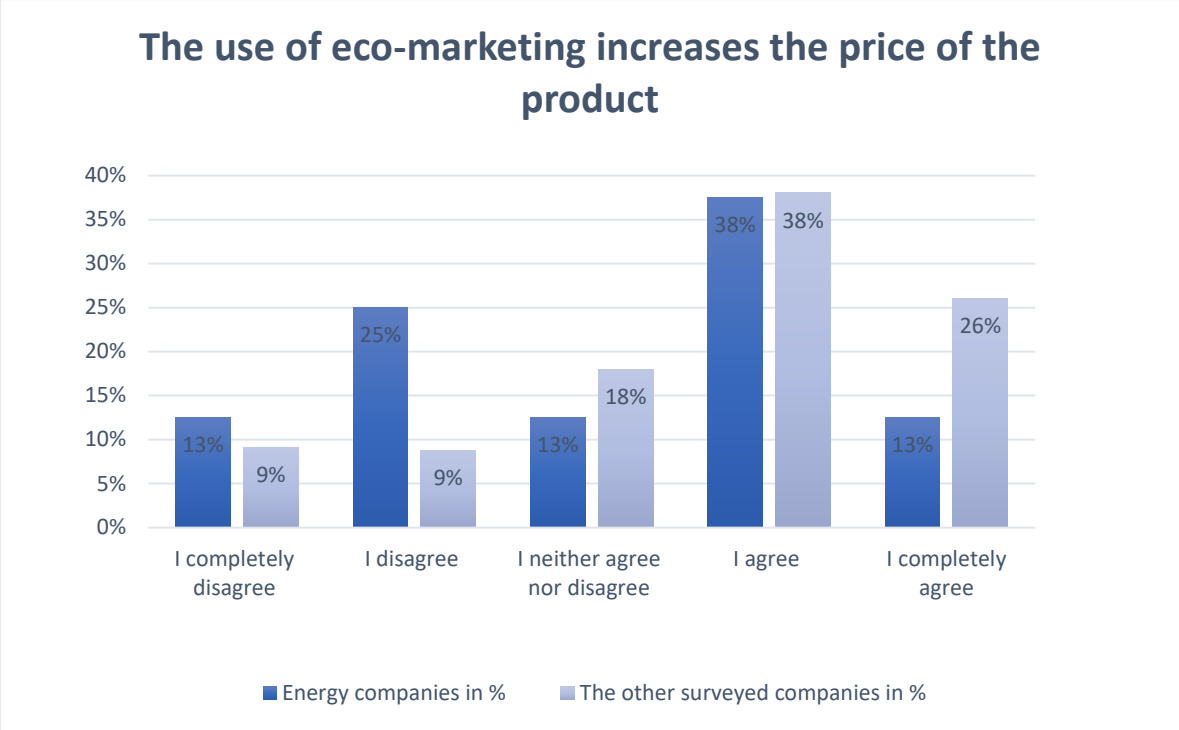


Figure 2. Verification of the statement: The use of eco-marketing increases the price of the product
Source: Own study

When analysing the responses regarding the impact of eco-marketing on the increase in product prices, it can be noticed that 50% of the respondents from energy companies confirm that the use of eco-marketing is a factor causing an increase in the price of the product. Regarding the responses obtained from the other surveyed enterprises, such an answer was declared by 64% of the respondents, i.e., in this respect, the responses of energy industry enterprises differed partially from the answers of the other respondents. This may be because undertaking eco-marketing activities generates additional costs. Notably, 37.5% of the respondents are from energy companies, and 18% are from other companies, and they do not notice any impact on the increase in product prices. This may suggest that eco-marketing activities do not generate additional costs that increase the price of the product or that these costs are so low that they do not significantly impact the product's unit price. As in the case of the previous statement, 12% of the respondents from energy enterprises and 18% from other companies cannot assess whether eco-marketing influences the increase in product prices. This may mean that these entities do not undertake eco-marketing activities. When summing up the research results referring to the second statement, it can be assumed that eco-marketing is a factor affecting the increase in product prices. On the one hand, this may result from the fact that eco-marketing generates operating costs for enterprises and, on the other hand, from the fact that customers are willing to pay a higher price for products that meet pro-environmental requirements.

Another analysed statement was: *The implementation of eco-marketing in the competitive strategy translates into an increase in sales*, and Figure 3 presents the detailed results from the surveyed companies.

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Figure 3. Verification of the statement: The implementation of eco-marketing in competitive strategy translates into an increase in sales
Source: Own study

When considering the answers provided by the respondents from energy companies, it is noted that, according to 50% of the respondents, implementing eco-marketing in the competitive strategy does not translate into an increase in sales. 29.6% of the respondents from the other surveyed entities have the same opinion. A difference of 20 percentage points is the largest discrepancy in the responses obtained in the survey of energy companies against the other surveyed enterprises.

Implementing eco-marketing in the competitive strategy translates into an increase in sales, according to 37.5% of energy companies and only 48.4% of the other respondents. The analysis of the responses of 12.5% of the respondents from energy companies to the above statement indicates that they cannot take a position on the issue of whether implementing eco-marketing in the competitive strategy translates into an increase in sales. While taken as a whole, this answer was chosen by 22% of the respondents.

In conclusion, the results suggest that implementing eco-marketing in the competitive strategy does not translate into an increase in sales, according to half of the surveyed energy companies. However, in the case of the respondents from the other surveyed enterprises, this impact is noticeable by half of the respondents. This may mean that the management of energy companies does not analyse eco-marketing as a factor causing the increase in product sales, unlike the other surveyed entities. When comparing the responses to the question about sales with the responses to the question about price, it should be noted that assuming that sales are the product of price and quantity, the increase in price translates into an increase in sales unless there is a decrease in the quantity of the products sold.

Because there were doubts about eco-marketing's impact on shaping the competitive strategy of energy companies, the respondents were asked whether *The implementation of eco-marketing results in an increase in the company's costs*. Figure 4 presents the detailed results from the surveyed enterprises.

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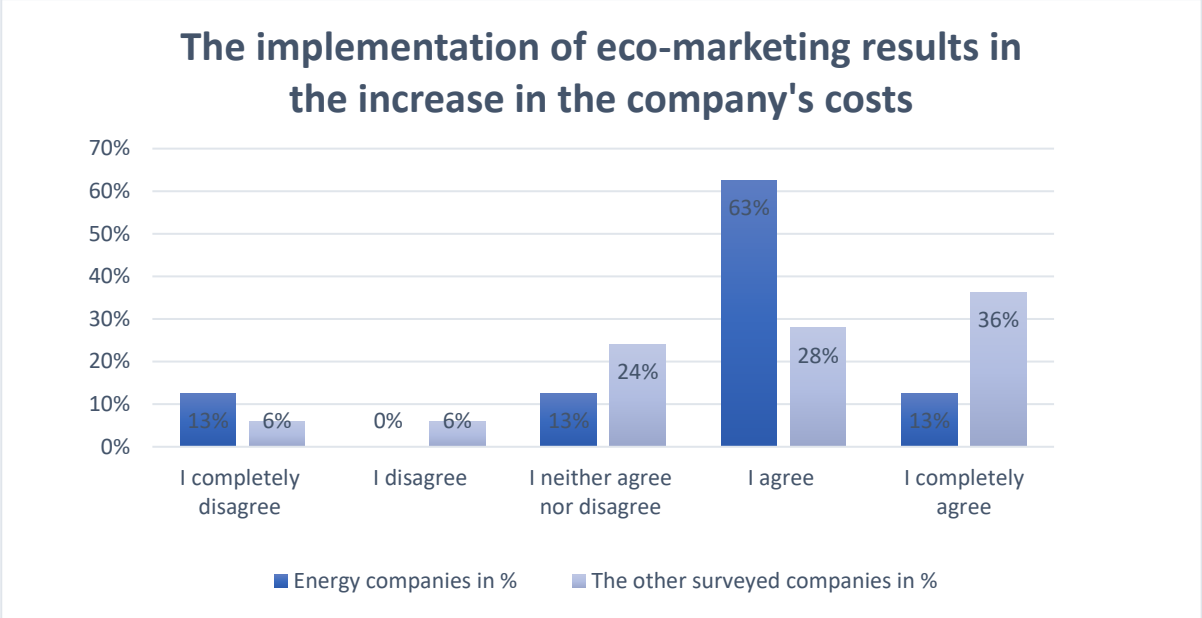


Figure 4. Verification of the statement: The implementation of eco-marketing results in an increase in the company‘s costs
Source: Own study

Based on the research results, 75% of the surveyed energy companies agreed that implementing eco-marketing increases costs. This was confirmed by 64.1% of the respondents from the other surveyed enterprises. In turn, 12.5% of the respondents from energy companies believe that implementing eco-marketing does not increase the company's costs. In comparison, this answer was given by 12% of the respondents from other enterprises. Moreover, 12.5% of the respondents from energy companies could not take a position on the verified statement. In comparison, as much as 24% of the other surveyed entities chose the response that *I neither agree nor disagree with*. To sum up, it can be concluded that many of the respondents from energy enterprises and the other surveyed enterprises believe that eco-marketing is a factor causing the increase in operating costs.

The results obtained from the last verified statement reveal discrepancies between the energy industry and the other surveyed enterprises. About 75% of the respondents from energy companies believe that implementing eco-marketing increases the company's costs, while 64% of the other companies confirm this. There are also discrepancies among entities that were unable to clearly state whether the implementation of eco-marketing results in an increase in the company's costs or not—taken as a whole, twice as many other entities could not take a position on this issue compared with entities from the energy industry, which proves that despite the increase in environmental knowledge in society, the knowledge of eco-marketing as a factor of competitive advantage is still underestimated in the company's strategic management.

Discussion

When considering the problem of whether the introduction of eco-marketing in enterprise management and offered products allows for building a competitive advantage strategy in energy enterprises based on the results of the conducted research, several observations come to mind. Analysing the responses obtained in relation to the first statement that *eco-marketing is included in the company's competitive strategy*, it should be emphasised that only 12% of the respondents from the energy industry and 20% from the other surveyed enterprises indicate that eco-marketing is not included in their competitive strategy. It can, therefore, be concluded that this is a desirable and acceptable state, which means that eco-marketing is a concept known and associated with enterprise strategies for most respondents, thus confirming the assumed hypothesis.

Concerning the second statement, it should be noted that approximately 64% of all the respondents believe that using eco-marketing increases the product price, which is an expected answer, as it is related to understanding eco-marketing activities as additional activities, i.e., generating additional operating costs.

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The third statement showed significant differences between the energy industry and other enterprises in assessing whether *implementing eco-marketing in the competitive strategy translates into an increase in sales*. The results obtained from the other enterprises were more diverse (i.e., 30% - negative answers; 22% - no position; 48% - positive answers), which proves that the management staff of energy enterprises have no knowledge of the impact of eco-marketing on the development of competitive strategies of enterprises.

When referring to the last statement, i.e., whether *the implementation of eco-marketing increases the company's costs*, some differences were also found between the energy industry and the other surveyed enterprises. This was the only statement for which the respondents from the energy industry gave such clear answers, i.e., 75% of them agreed with the verified statement. In comparison, 64% of the other respondents provided the same information. Significant differences were also noted in the case of undecided entities. It should be noted that, as in the case of the third statement, the answers are consistent with the attitude towards eco-marketing as a cost-generating factor.

To sum up, implementing eco-marketing results in an increase in costs but does not affect the increase in sales, which suggests that eco-marketing costs are a limiting factor in building the competitive strategy of energy companies. At this point, the question arises of whether costs are a barrier to implementing eco-marketing or perhaps lack of knowledge because the answer to which *I neither agree nor disagree* occurs frequently.

To deepen the considerations so far, the analysis of the frequency of selected answers was also conducted in the study, which shows that the response *I agree with* was the most frequently selected by the respondents (energy companies - 34%; the other surveyed enterprises - 33%). However, the least frequently occurring response was that *I completely disagree* (energy companies - 9%; the other surveyed companies - 9%). The above is illustrated in Figure 5.

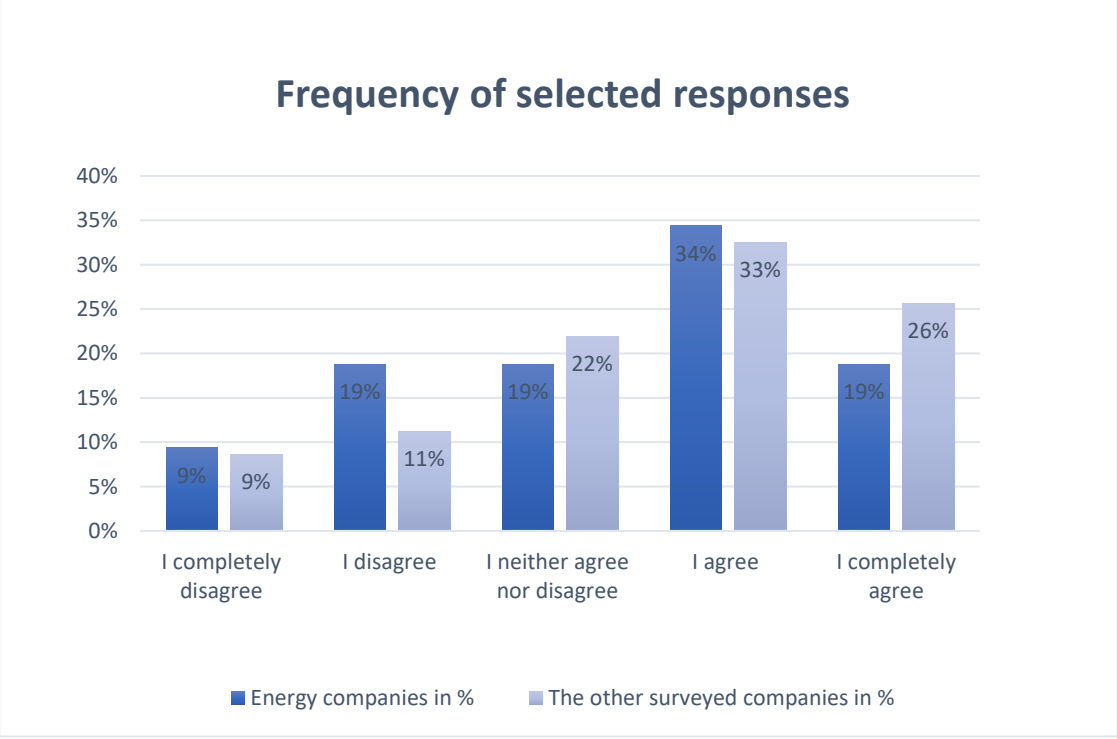


Figure 5. Verification of the frequency of selected responses
Source: Own study

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Statistical validation of the energy industry against other companies in terms of eco-marketing issues

Considering the proven differences in the respondents' attitudes toward the energy industry in relation to those from other companies in terms of eco-marketing issues, which were demonstrated in the previous part of the work, it was decided to verify the accuracy of the analysed statements using statistical tools. The results of the statistical verification are presented in Table 2.

Table 2. Results of statistical verification

	Eco-marketing is included in the company's competitive strategy.	The use of eco-marketing increases the price of the product.	The implementation of eco-marketing in the competitive strategy translates into an increase in sales.	The implementation of eco-marketing results in an increase in the company's costs.
Mann-Whitney U	3818.500	3155.000	3522.500	3641.500
Wilcoxon W	521471.500	3191.000	3558.500	3677.500
Z	-0.309	-1.141	-0.674	-0.534
Asymptotic significance (two-sided)	0.757	0.254	501	0.593

Source: Own study

The results of the Mann-Whitney U test and the Wilcoxon W test, which assess the impact of eco-marketing on society, are presented in Table 2. The table provides information on four important dimensions related to the impact of eco-marketing. The two-sided asymptotic significance of all the analysed variables exceeds the usual significance threshold of <0.05, indicating a lack of statistical significance. The Z-score values show a rather modest range, thus providing further evidence to support the lack of significance of the findings. The study results indicate no significant evidence supporting eco-marketing as an important part of the company's competitive strategy (p=0.757). Moreover, there is no significant correlation between eco-marketing and the increase in product prices (p=0.254), sales (p=0.501) or the company's costs (p=0.593). Based on the data presented, it can be concluded that the strategic impact of eco-marketing on the studied variables does not confirm clear statements.

In the face of the growing importance of eco-marketing as a mechanism for increasing competitiveness and promoting sustainable development, the statistics offered have extraordinary implications. The detected significance levels for all the analysed factors exceed the established threshold of $p < 0.05$. This suggests that, based on the sample data, there is insufficient statistical evidence to support the assumption that eco-marketing impacts the company's pricing strategy, sales performance, or the structure of costs. The above findings depart from previous research that showed favourable results from eco-marketing regarding market position and financial results (Wojnarowska, 2011). One likely explanation for this discrepancy can be attributed to the limited sample size or unique characteristics of the market or segment being studied. Further comprehensive quantitative and qualitative analysis should be performed before reporting the results, as it may reveal important moderating or mediating factors. This study, therefore, raises new questions about the complex impact of e-marketing on corporate strategy and highlights the need for further interdisciplinary research in this area.

Conclusions

This study has revealed a range of significant findings in our endeavour to assess the influence of eco-marketing on corporate management and product offerings. The replies obtained from participants within the energy business and several other sectors have been thoroughly analysed, providing valuable insights into the influence of eco-marketing on the development of competitive advantage strategies. Our study yields several significant observations.

Initially, it is encouraging to observe that a substantial majority of participants, specifically 88% within the energy business and 80% in other industries, acknowledge the involvement of eco-marketing in their

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competitive strategies. This finding indicates that eco-marketing is widely acknowledged and used as a concept closely linked to corporate strategy, confirming our initial prediction.

Furthermore, an agreement arises regarding the projected effects of eco-marketing. Approximately 64% of the respondents expect eco-marketing initiatives to result in a rise in product prices. The correlation between eco-marketing and increased operating expenses emphasises the widespread perception regarding the inherent characteristics of such endeavours.

A notable contrast becomes apparent when we examine the influence of eco-marketing on sales. This analysis observes notable inequalities between the energy industry and other sectors. Opinions among respondents from various industries exhibit a range of perspectives, with 30% expressing negative views, 22% remaining undecided, and 48% affirming a beneficial influence. In contrast to the energy industry, management personnel in this sector exhibit a somewhat lower level of awareness regarding the impact of eco-marketing on competitive strategies.

The issue of whether eco-marketing leads to a rise in company expenses remains a subject of contention, particularly when comparing the energy industry with other sectors. Notably, a significant proportion of respondents from the energy sector, specifically 75%, agree with this statement. Similarly, 64% of respondents from other sectors share a comparable viewpoint. The correlation between replies and the concept of eco-marketing as a factor that incurs costs is apparent.

In summary, our research indicates that implementing eco-marketing strategies may increase energy firms' expenses. However, it does not guarantee a corresponding rise in sales. This highlights the importance of eco-marketing as a constraining element in determining the competitive strategies of energy companies. The prevalence of responses indicating neutrality raises the question of whether the costs are a barrier to the broader implementation of eco-marketing or if there is a knowledge gap.

Our statistical analysis, which used the Mann-Whitney U and Wilcoxon W tests, supports the findings in this study. Unfortunately, the findings suggest that there is a lack of statistical significance observed in all the variables evaluated, which encompass the influence of eco-marketing on competitive tactics, product price, sales performance, and cost structure, thus failing to confirm hypothesis H1. The lack of statistical significance presented in this study challenges the prevailing beliefs about the impact of eco-marketing.

These findings hold significant implications given the increasing importance of eco-marketing in promoting competitiveness and sustainable development. The authors emphasise the necessity of conducting more quantitative and qualitative studies to potentially discover previously unexamined moderating or mediating elements. Consequently, our research presents significant inquiries regarding the complex impact of eco-marketing on business strategy and underscores the necessity of interdisciplinary investigation in this field (Foster, Saputra & Grabowska, 2020).

The absence of statistical significance in our findings, especially for the expected effects, highlights the intricate nature of eco-marketing's strategic consequences and presents opportunities for further investigation. Potential research endeavours may delve into the mediating and moderating variables that impact the efficacy of eco-marketing, such as industry-specific dynamics, regulatory frameworks, and consumer tendencies. An essential discovery of this study is the widespread acknowledgement of the impact of eco-marketing on the development of competitive strategies, as a considerable majority of companies in various industries are actively incorporating it. The widespread acceptance of eco-marketing demonstrates how it aligns strategically with business aims, confirming our premise and enhancing the theoretical knowledge of eco-marketing's role in strategic management frameworks.

The expectation of higher product prices and operating expenses resulting from eco-marketing campaigns highlights a fundamental difficulty in their execution: balancing environmental obligations and financial factors. These findings add to the current discussion on the economic aspects of sustainable business practices, emphasising the importance of strategic initiatives that reduce costs while increasing environmental advantages.

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THE COVID-19 PANDEMIC AND THE REAL ESTATE MARKET IN THE CZECH REPUBLIC

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Abstract. This paper aims to identify the critical factors that influence price changes in the real estate market before, during, and after the outbreak of the COVID-19 pandemic for the period 2016-2022. The first part of the contribution deals with the literature search that examines the issue in different parts of the world. Furthermore, methods of solving the problem were chosen. Time series and correlation analysis methods were chosen for this work. The data used was selected from the areas of developments in real housing price indices, developments in real property prices, from the real index, the index of the growth rate of completed apartments in Prague, real estate price indices for territorial comparison, residential construction of family and apartment buildings, construction production, unemployment rate, rate inflation, GDP development, interest rate, and construction index. The results showed that the correlation coefficient between inflation and the price of real estate in the years 2019-2022 was around 0.8. Furthermore, the correlation coefficient between GDP and the price of sold apartments in the same period was 0.63. The relationship between GDP and construction production also plays a significant role, where the correlation coefficient was 0.69. The correlation coefficient between construction output and the interest rate was 0.4. If you can focus on the real estate market as it grew, so did the asking prices. In the first quarter before the outbreak of the COVID-19 pandemic, the average selling price was around CZK 57,900 per m^2. At the end of the last quarter of 2022, prices reached an average of CZK 93,300 per m^2.

Keywords: Covid 19; real estate; prices; market analysis

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1. Introduction

Real estate markets have grown rapidly in recent years. Not only the sale prices but also the rental of real estate have increased. The global impact on the real estate market was the pandemic situation of COVID-19, which reflects the market both in the short term and in the long term (Wachter & Acolin, 2022; Tkacova & Gavurova, 2023). One of the effects of the pandemic was an increase in demand for housing associated first with pandemic public health measures such as social distancing and quarantine, then the adoption of working from home (Althoff et al., 2022; Navickas et al., 2022). A lasting effect of the pandemic situation may be some expansion of telecommuting that will persist even after the pandemic situation ends (Bailey et al., 2018; Grondys et al., 2021; Bloom et al., 2021; Davis et al., 2021; Gamber et al., 2023). Why did pandemic situations cause real estate prices to rise rapidly? A dramatic swing in uncertainty about health, macroeconomics (Gavurova et al. 2020, 2023; Kramarova et al., 2022; Valaskova et al., 2023), and social circumstances could predict a sharp decline in the housing markets (Brueckner & Sayantani, 2023). However, house prices rose by 10% in real terms

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in 2020 and 15% the following year. The demand for housing was affected by several factors that were related to the pandemic (Kmetz et al., 2022). While unemployment rose, mortgage interest rates fell (Goodman & Zhu, 2023; Belas et al. 2022). During the pandemic, demand for urban housing shifted away from urban centres and toward lower-density suburban areas (Gupta et al., 2022; Gavurova et al., 2022; Ramani & Bloom, 2021).

House prices and rents grew faster outside city centres (Gupta et al., 2022). From a long-term view of real estate prices in the Czech Republic, it can be seen that prices are constantly rising (*The Real Estate Market in the Czech Republic Is Reviving*, n.d.). In the years 1998–2019, according to data from the Czech Statistical Office, apartment prices rose an average of 4.25 times. During this period, the market experienced three significant peaks. Growth peaks were always interrupted by certain negative events. The first negative event that affected the whole world was in 2008, a financial crisis that was also reflected in the mortgage market crisis (*CBA Hypomonitor*, n.d.). By the end of 2009, according to available statistics from the Czech Statistical Office, apartment prices fell by 18.1%, and family house prices fell by 4.6%. This crisis lasted for approximately three years. Before the outbreak of the COVID-19 pandemic in the Czech Republic, the average purchase price of an apartment per square meter reached approximately 39 thousand crowns, and the purchase price of family houses exceeded 34 thousand crowns per square meter (Štěpánek, 2023). Two years later, the price of apartments per square meter rose to 54,000 Czech crowns, and the prices of family houses rose to 43,000 crowns per square meter (*Market News | Transaction Price Map*, n.d.).

This dynamic volume of real estate is behind even a far more developed country than the Czech Republic. In the Czech Republic, the overvaluation reached around 15-20% at the beginning of 2022 (*The Real Estate Market in the Czech Republic Is Reviving*, n.d.). This work aims to analyze the real estate market before the outbreak of the COVID-19 pandemic, mainly in the Czech Republic, during the pandemic, and subsequently after it. What are the most important factors driving price changes in the real estate market, pre-pandemic 2016-2020, pandemic 2022, and post-pandemic? What properties were prevalent during this time, and what will be prevalent now? The mortgage market is also connected to the real estate market and how the mortgage market developed during this difficult time. When will it be appropriate to get a mortgage for your own home? How the price of apartments, family houses, and residential buildings has developed since 2016. This article will be beneficial for those interested in the real estate field, mainly for developers, new builders, investors, and interested parties who are thinking about the future purchase of real estate.

The following research questions are set about the objective:

RQ1: Which factors had the most fundamental influence on the real estate market in the Czech Republic during the pandemic situation that affected the whole world in 2019?

RQ2: What can be expected in terms of real estate prices after the end of the pandemic in the real estate market in the Czech Republic?

2. Literature Review

The literature review deals with the most fundamental factors influencing the real estate market. The most important factors include interest rates on mortgage loans, the performance of the economy, gross domestic product, unemployment, developments in the construction industry, inflation, and many other factors. Attention is also paid to the methods of solving the investigated problem within the current research framework. The research looks at these factors from the perspectives of different countries, whether the American or Chinese markets. In these countries, we focus on what they researched in that country, what methods they used, and what conclusions they reached.

2.1 Perspectives on real estate markets in other countries

Here, the countries where they researched the real estate market, what methods they used, and what results they came to will be discussed.

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2.1.1 Chinese market

China's real estate market has expanded and developed rapidly since the 1990s. This market has become a fundamental pillar of the Chinese economy (Liu, 2022). Pirogova and Temnova (2021) studied the driving force of the coordinated growth of the real estate market under the conditions of digitization. Another experiment, where the main goal was to investigate the impact of cross-border labour mobility on real estate price trends, was conducted (Dumeignil, 2022). Compared to other more developed countries such as Europe or the United States, China's real estate market started relatively late, and its development was not perfect, and real estate prices show obvious volatility (X. Li & Zhang, 2021).

China's real estate market has also been affected by the COVID-19 pandemic situation (Li et al., 2018). In his article, Liu (2022) tries to analyze the real estate market in China using statistical data of the real estate market, and at the same time, the author analyzes the factors affecting the price of real estate (Liu, 2022). It introduces the so-called multiple linear regression model, then uses the method of least squares to solve the model's unknown parameters, and finally constructs a model to predict house prices and the real estate market analysis.

The result of this study, which Liu (2022) dealt with, summarizes the factors affecting the price of real estate, using a method that includes four main factors, namely: the amount monthly income of residents, the disposable income of residents, the expenditure of residents on housing, and the completed area of real estate. The results showed that there was a positive correlation between the level of monthly income of residents and the price of real estate, and there was also a positive correlation between disposable income and the price of real estate. A negative correlation arose between the finished area and the price of the real estate field (Liu, 2022).

2.1.2 American market

Due to the pandemic situation in the United States of America, large companies require their employees to work remotely from home (Aladangady, 2017). This shift has impacted commercial space markets, where companies have begun to question the need to own large commercial spaces (Bayer et al., 2021). This trend of people working remotely from home impacts investors in real estate markets (Beltratti & Morana, 2010; Black et al., 2006).

In his work, Chong uses stock market data to estimate the loss of commercial real estate values caused by the COVID-19 pandemic using a simple method. His work analyses traded REITs, which provide statistical estimates of the decline in commercial real estate values in the United States of America. It also uses commercial stock valuation models that use key economic factors to value stocks, evaluating the economic impact on commercial real estate values. In his work, Chong found that real estate markets likely would have seen a significantly larger decline if not for the extreme monetary and fiscal policies implemented during the early months of the pandemic.

2.1.3 Indian market

The pandemic, which brought the whole world to a standstill, unsettled various sectors of the economy and the real estate market. Due to a shortage of construction materials and labour in India, sales and purchases of industrial and residential properties have been affected. Furthermore, Indian real estate was dealing with the demonetization in November 2016 and other changes that were affected by this pandemic, whether it was construction development or real estate transactions.

In his work, Sanchaniya, (2021) discusses the pre-pandemic real estate market and the impact of COVID-19 on the real estate market and discusses the risks and prospects facing various participants in the real estate market, whether they are mortgage holders, builders, or the real estate workforce. JLL (2020) reports the global implications of COVID-19 in real estate. Furthermore, according to FICCI, (2020), 2019 was a challenging year for the real estate market, which, even as a result of the pandemic situation, is facing a lack of financing in this

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sector. Another research that dealt with the invention of the risk factor of COVID-19 was used to assess companies' susceptibility.

An article written by Gujral, (2020) commercial real estate should be able to respond to the coronavirus. Some studies (Tanrıvermiş, 2020; Uchehara et al., 2020) share the same opinion about the impact of the coronavirus on the Indian real estate market. This pandemic has had a disproportionate impact on Indian real estate. In the first months, the epidemic suspended construction and significantly reduced the interest of potential buyers in real estate. In his work, (Sanchaniya, 2021) concluded that the market value of real estate increased during the Covid-19 era. Home values fell as the supply of housing fell, reducing government revenue. Furthermore, due to the decrease in demand and the increase in bargaining power in the market with a short supply, locations with a lower growth rate began to be sought.

2.1.4 Vietnamese market

In recent years, Vietnam's economy has become the region's most dynamic economy. Along with the country's development, it played a big role in the construction and real estate industry, representing 6% of the GDP (Minh et al., 2021). As a result of the prolonged pandemic situation, investors have not invested in real estate markets. Thus, there was a sharp drop in demand in the housing market. Most countries believe that the real estate market can significantly support the positive impact on the economy. The author HA (2021) deals with the factors affecting the price of real estate during a pandemic situation; the author uses the following methods: correlation matrix analysis and regression model. The results of the research show that the area of the house, the number of beds, and the location of the plot have a positive effect on the price of the property. The distance of the plot from the centre of the district harms the price of real estate, which means that the further the plot is from the centre, the lower its price.

2.1.5 European market

In this section, attention will be focused on the following countries: Slovenia, Greece, France, Poland, and Norway. In his work, Grum and Govekar (2016) deal with factors influencing the price of real estate. He uses a multiple linear regression model for his work, where the author finds out with the help of monitored macroeconomic indicators: the unemployment rate, the current account of the country's stock index, gross domestic product, and industrial production. Furthermore, Grum & Govekar (2016) came to the following conclusions in his work: there are statistically significant correlations between residential real estate prices and some macroeconomic indicators. In these countries, France, Greece, Norway, and Poland, it has been proven that the price of real estate is statistically significantly related to unemployment. Regarding Slovenia, a mutual statistical relationship can be shown between the stock index and the price of real estate. The linear regression model in this study says that the higher the unemployment rate, the lower the price for residential property. The greatest impact on unemployment was recorded in Poland, while Greece had the smallest impact.

From the scientific questions asked, this problem can be solved using the following methods:

a) Analysis of the development of time series according to the static office,
b) Analysis of the development of the hedonic price index,
c) Correlation analysis,
d) Econometric analysis,
e) Panel regression analysis.

According to the considered methods, two methods were chosen, namely the time series method and correlation analysis.

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3. Methodological Approach

A procedure was chosen to process this work, which consisted of using professional resources, time series analysis, comparison, analysis, and synthesis.

Expert sources were used from professional scientific articles, statistics, empirical formulas, and secondary data of experts. The primary purpose of this method was to obtain an overview of the issue, both in the Czech Republic and abroad. The literature search focused on the factors that influence the real estate market. In particular, these are the factors of interest rates, mortgage loans, gross domestic product, unemployment, developments in the construction industry, and inflation.

A time series can be understood as a sequence of indicator values, measured in certain time intervals. These intervals are usually equidistant and can therefore be written as follows:

Line graphs are mainly used for displaying time series and their initial analysis, where time variables are recorded on the horizontal axis and the values of the time series indicator are displayed on the vertical axis. Another important chart is the so-called dot chart. When working with time series, it is necessary to define their characteristics. Averages can be included among the first characteristics. In time series you can meet simple arithmetic averages, weighted arithmetic averages, and weighted chronological averages.

The simple arithmetic mean is calculated:

$$y = \frac{\sum_{t=1}^{n} yt}{n}; \quad (1)$$

The weighted arithmetic mean is given by where vt is the weight of the indicator yt at time t;

$$y = \frac{\sum_{t=1}^{n} vt\ yt}{\sum_{t=1}^{n} vt} \quad (2)$$

Weighted chronological average: where dn is the length of time intervals.

$$y = \frac{\frac{y1+y2}{2}\,d2 + \frac{y2+y3}{2}d3 + \cdots \frac{yn-1+yn}{2}dn}{\mathrm{d2} + \mathrm{d2} + \cdots \mathrm{dn}} \quad (3)$$

Another important characteristic is variance and standard deviation. The variance is the arithmetic mean of the square of the deviations from the arithmetic mean:

$$sy^2 = \frac{1}{\mathrm{n}-1} \sum_{t=1}^{n} (y_t - y)^2 \quad (4)$$

The standard deviation is given by the square root of the variance:

$$\mathrm{sy} = \sqrt{sy^2} = x = \sqrt{\frac{1}{\mathrm{n}-1} \sum_{t=1}^{n} (y_t - y)2} \quad (5)$$

Correlation expresses the relative degree of dependence in the mutual development of two-time series, e.g., yt and xt is given by the relation:

$$sx_y = \frac{\sum_{t=1}^{n} (xt-x)\,.(yt-y)}{\mathrm{sx}\,.\mathrm{sy}} \quad (6)$$

y1, y2... yn where y denotes the analyzed indicator
t=1 where t is a time variable
n is the total number of observations.

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Correlation values approaching the limit value of -1 indicate that the two observed time series have opposite directions in their time development. Values approaching +1 mean that time values develop almost identically in terms of the same directions and movements and thus show the same relative rate about each other. In the time series analysis, either quarterly data from 2016-2022 or annual data will be used. This period was chosen for the given issue. Data that was tracked:

- Development of real housing price index, available from *OECD.*
- Development of real property prices in OECD; countries, available from OECD;
- Real index, real offer prices of apartments in the Czech Republic, available from the price map;
- Index of the growth rate of realized new apartments and family houses, available from the Czech Statistical Office;
- Index of the growth rate of completed apartments in Prague, available from the Czech Statistical Office;
- Real estate price index for the territorial comparison of the Czech Republic, available from the Czech Statistical Office;
- Residential construction of apartment and family houses, available from the Czech Civil Registry Office,
- Residential construction according to the number of rooms, available from the Czech Statistical Office;
- Completed apartments according to the main supporting structure, available according to the Czech Statistical Office;
- Single-family homes by construction type;
- Construction production, published at the Czech Statistical Office;
- Unemployment rate in the Czech Republic, available from the Czech National Bank;
- Inflation rate quarterly, published by the Czech National Bank;
- Development of GDP in the territory of the Czech Republic, accessible by the Czech National Bank;
- Annual and quarterly housing loan interest rates are available from Hypnomonitor.
- Index of building construction.

Comparison was used as part of the work, attention was paid to comparing the state of real estate prices in the monitored period, namely before the outbreak of the Covid-19 pandemic and during the pandemic. The work can also be found with other information about the development of real estate prices, not only during this period. The comparison was chosen to compare the development of real estate prices and identify what changes, growth, or decline could have occurred during this period.

Another investigated quantity was the correlation of two quantities using the Excel tool. The relationship between the two quantities was determined. To calculate the correlation coefficient, a method was chosen that includes the CORREL function, which is written using two matrices. In this respect, matrices are variables that examine given quantities. The first quantity (x) is a set of values representing the average prices for offered apartments in Prague. The second variable(s) is inflation, which is one key factor affecting the price of real estate. The time horizon is given from 01.01.2019 - 31.12.2022. Using the CORREL function, the correlation coefficient is calculated, which determines the mutual relationship of these quantities.

4 Results

The pandemic situation that occurred in 2019 caused a large reduction in consumption, an increase in unemployment, which reached up to 15% in some countries, and a decrease in income for many households. These influences then affect the macroeconomic situation and also the real estate market) (Giudice et al., 2020). If you can look at the Czech Republic, during the pandemic situation, the gross domestic product fell significantly while inflation gradually increased. A certain correlation can be seen between GDP and inflation. The correlation between GDP and inflation can be seen in Figure 1.

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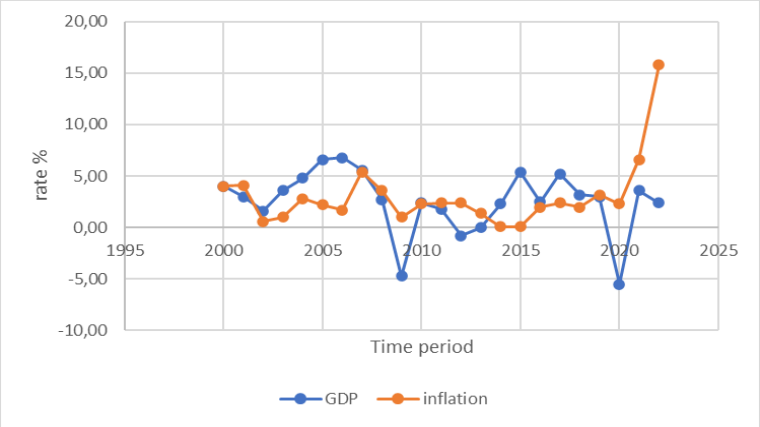


Figure 1. Correlation of GDP and inflation.

Source: own processing taken from the CNB.

The gross domestic product was 3% in 2019, the following year the loss was clear, and the gross domestic product fell to -5.5%. Which only confirms the pandemic situation. The inflation rate was around 2-3% in the years before the pandemic. In 2019, the inflation rate increased slightly to 3.2%; a large increase in inflation occurred in 2021, when the inflation rate was 6.6% in the last examined year; therefore, in 2022, inflation amounted to 15.8%. A certain correlation can be seen between these two factors that influence the price of real estate. The largest correlation coefficient came from the years 2019–2022. When the correlation coefficient was 0.42. If you look at the data from 2000 to 2022, you don't see much correlation here; the correlation coefficient came out to be 0.08.

Another important role in the area of GDP is the relationship between construction production. There is, again, a high correlation in this relationship, where the correlation coefficient is 0.69. This correlation originated from the period 2015-2022. How GDP and construction output developed can be seen in Figure 2.

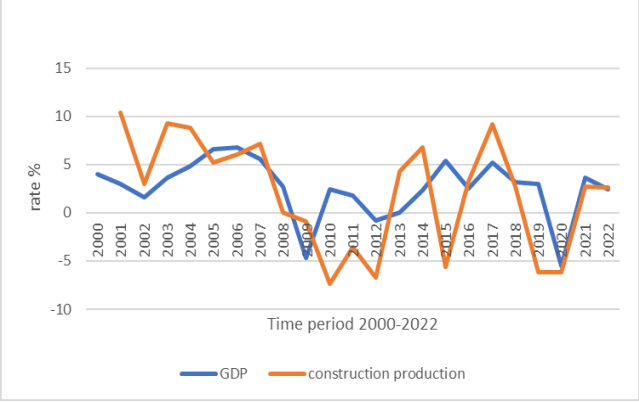


Figure 2. Correlation between GDP and construction output.

Source: own processing, taken from the CNB.

The real estate market is largely influenced by construction production; during the pandemic situation, construction production was very limited as there was not enough labour, and there were suspensions of contracts at this time, which led to the fact that construction production decreased. The correlation coefficient, in this case, was 0.69. This could already be considered a high degree of correlation. A certain correlation can be seen between construction output and interest rates. The construction output and interest rate development can be seen in Figure 3.

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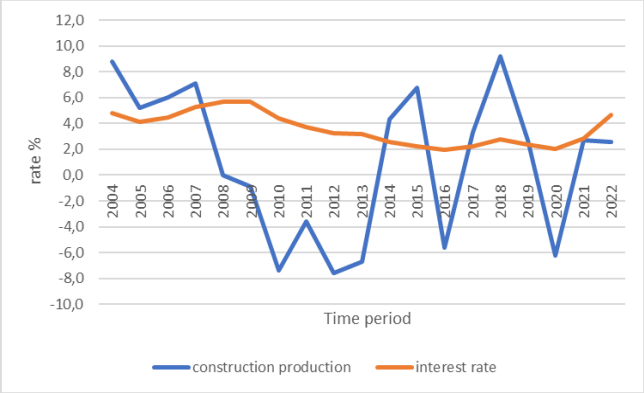


Figure 3. Correlation between construction output and interest rates during 2004-2022.

Source: own processing, taken from the CNB.

Construction output before the outbreak of the pandemic reached around 3%; during the pandemic, construction output fell to -6%. After the pandemic ended, construction production rose again and reached values similar to those before the pandemic. Interest rates have been around 2.22% since 2015; in 2021, the interest rate was just under 2%, so there was a great demand for a mortgage loan for housing. The year 2022 saw an increase in interest rates to 4.68%. During the pandemic, most of the population decided to protect their savings against inflation and invest in real estate. The beginning of 2022 brought an increase in mortgage interest rates, which reduced the demand for housing. If one can look at a certain correlation between construction production and the interest rate can be determined in the ranges of medium values, the range of these values is 0.4-0.7. The largest correlation coefficient calculated using the CORREL function was found in the data between 2019-2022, when the correlation coefficient was 0.53. Another high correlation coefficient that came out of the calculation occurred between 2016-2022; here, the correlation coefficient is slightly smaller and reaches a value of 0.4.

Another correlation that came out with a high value is given between the interest rate and inflation. The correlation coefficient, which measured data from 2015-2022, was 0.94. The interest rate and inflation development can be seen in Figure 4.

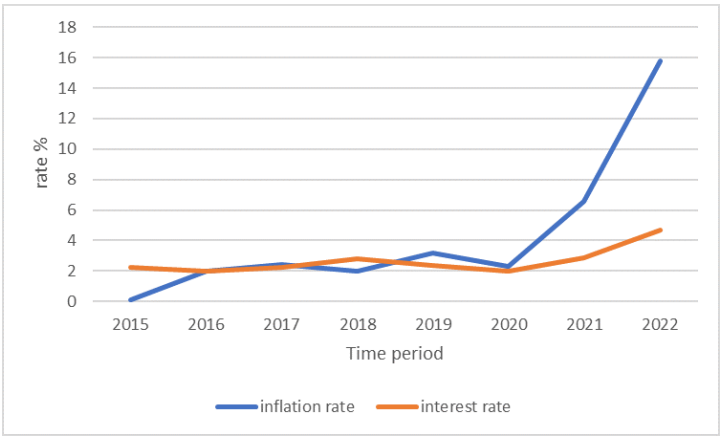


Figure 4. Correlation between inflation and interest rates in 2015-2022.

Source: own processing.

The increase in real estate prices did not correspond to the original estimates of the impact of the pandemic situation. At first, the entire economy was expected to collapse; fortunately, that did not happen. Further, property prices were expected to reach a price ceiling, but property prices continued to rise and rise. In 2021, a slowdown in real estate price growth was expected; on the contrary, in 2022, it was proven that the prices of

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new apartments in Prague increased by almost a quarter (Svoboda, 2022). Figure 5 shows the price indices of new apartments.

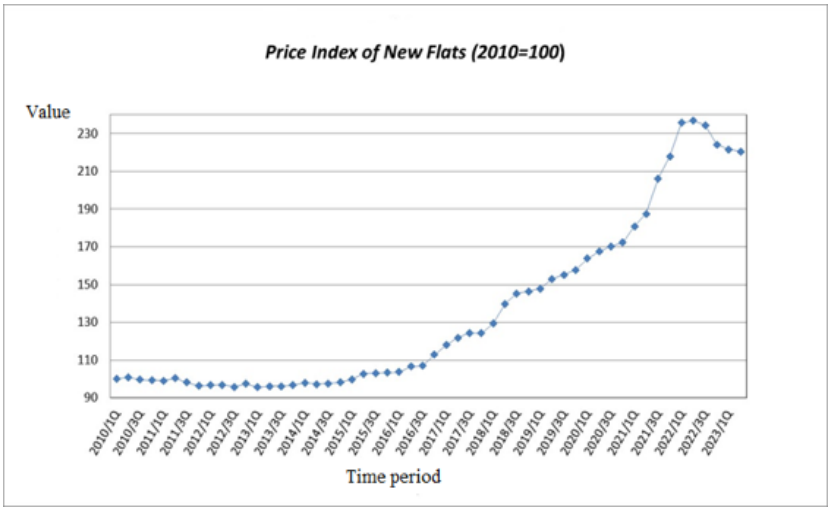


Figure 5. Price index of new apartments quarterly in 2010-2022.

Source: own processing, taken from the Czech Statistical Office.

As can be seen from the picture, during the pandemic, the housing price index increased rapidly; this growth lasted until 2022; in the first quarter of this year, there was a slight decrease.

Price changes in the real estate market are monitored in the Czech Republic by the Czech Statistical Office. In the thesis, the results can be presented during the years 2010-2023. The indicator of the average offer price index of apartments, which is recorded in Table 1, can be seen in the increase. In 2010, the average bid price index was 100; if we look at the year 2022, we can see a value of 216.8, which is a 141% increase if we focus on the set period from 2016-2022. In 2016, the average offer price index for apartments was 117.6; in 2022, it was already the mentioned 216.8, which is once as much. Table 1 shows how the average indices of offer flats developed.

Table 1. Indices of apartment prices in the Czech Republic

	Average indices (2010 = 100) offer prices of apartments			average growth rate offer prices of apartments		
year	Czech republic	CR out of Prague	Prague	Czech republic	CR out of Prague	Praha Prague
2010	100.0	100.0	100.0	99.2	99.6	98.8
2011	95.1	96.6	93.6	98.7	98.7	98.6
2012	96.1	92.5	99.6	100.8	99.1	102.3
2013	97.2	91,3	103,1	100,5	100,1	100,9
2014	100.7	93.0	108.5	100.7	100.1	101.3
2015	106.9	97.7	116.1	102.3	102.5	102.1
2016	117.6	107.1	128.2	102.4	102.1	102.7
2017	130.7	112.1	149.2	103.0	101.2	104.4
2018	144.6	121.9	167.2	102.1	102.0	102.1
2019	153.2	131.0	175.3	101.4	102.2	100.7
2020	164.3	144.3	184.2	101.9	102.6	101.3
2021	179.7	163.7	195.6	103.0	103.9	102.2
2022	216.8	205.0	228.6	104.3	104.7	104.0
2023	217.8	204.0	231.6	98.7	98.6	98.8

Source: own processing, taken from the Czech Statistical Office

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The so-called Real index of the Czech Republic can be used to compare the development of prices during the pandemic situation in the territory of the Czech Republic. The Real Index of the Czech Republic indicates the change in the average price of realized apartment sales compared to the previous period in regional cities. Data on this index is published by the price map on Deloitte. Figures 6 and 7 below show how the situation developed during the pandemic.

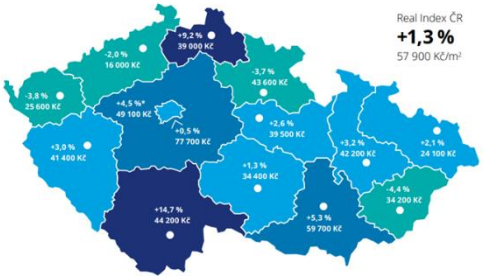


Figure 6. Price map of realized apartment sales in the Czech Republic, in the first quarter of 2019.

Source: Deloitte.*2019*

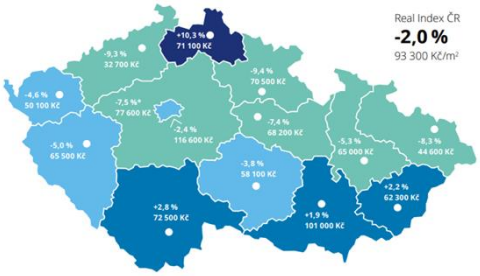


Figure 7. Price map of completed apartment sales in the Czech Republic, at the end of the fourth quarter of 2022

Source: Deloitte.2022

As can be seen from the price maps, average selling prices in the Czech Republic increased by thirty-five thousand four hundred Czech crowns over three years. For a better understanding of how the average price of realized apartment sales in the Czech Republic developed, you can see by region in Figure 8. In each region, the price of apartments for sale is influenced by various factors. The highest sales prices can be seen in the capital, further in the South Moravian region. The lowest values are in the Ústí Region and the Moravian-Silesian Region. How the real index developed worldwide can be seen in Figure 9.

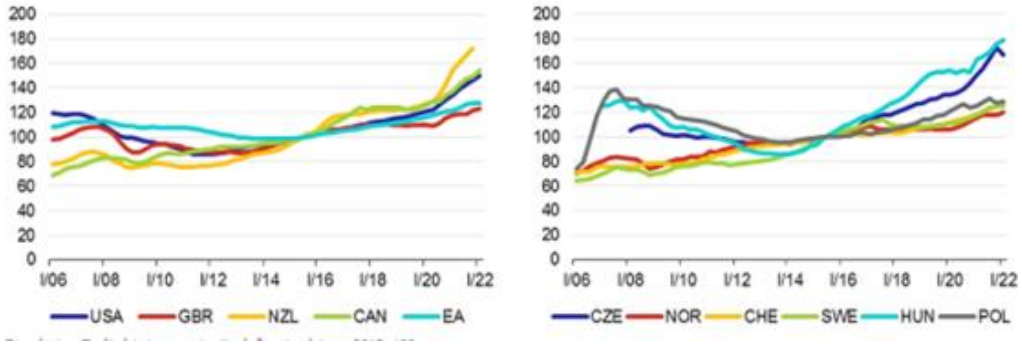


Figure 8. Development of the real housing price index in the world.

Source: taken from OECD.

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As can be seen from the figure, the real index grew not only in the Czech Republic but also in other countries. The biggest increase can be seen in the Netherlands and Hungary.

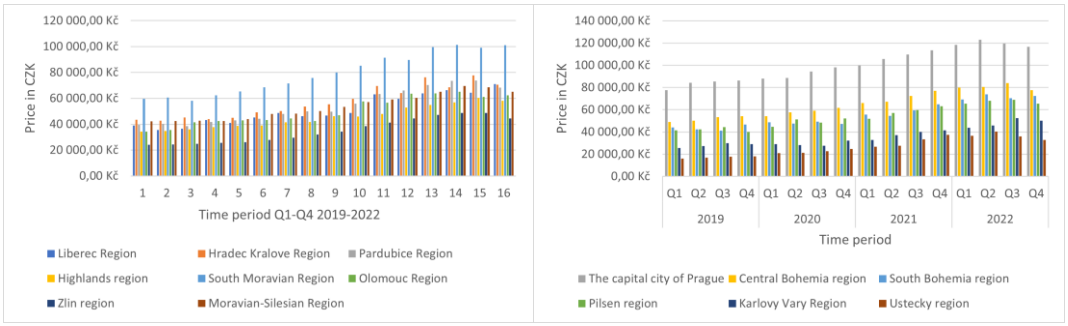


Figure 9. Actual prices of sold apartments in the Czech Republic in 2019-2022.

Source: own processing, taken from Deloitte.

Another correlation arose from the relationship between the prices of apartments for sale in Prague in 2019-2022 and one of the most important factors that influence the price of real estate, namely inflation. Using the CORELL function, it is possible to obtain a correlation coefficient, the calculated value of which tells the mutual relationship between the two quantities. The correlation coefficient belongs to these intervals 〈-1;1〉 . The calculated correlation coefficient from these values was 0.80. The closer the calculated value is to +1 or -1, the stronger the dependence on the behavior of both quantities in real time. How such a representation looks like can be seen in Figure 10.

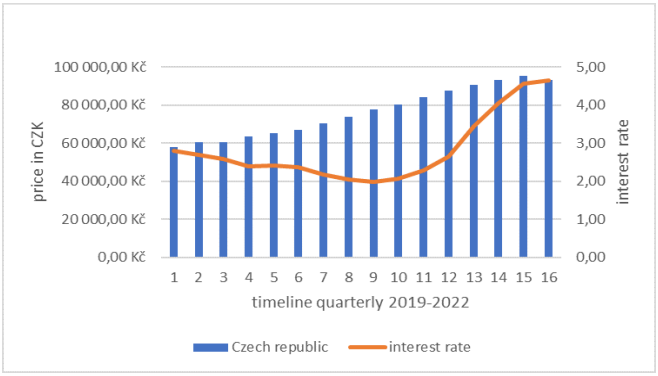


Figure 10. Correlation of inflation and property prices in 2019-2022.

Source: own processing.

It is clear from the figure that the increase in inflation started in 2021 and the most significant increase was recorded at the end of the 2022 period. The correlation between inflation and the real estate market during COVID-19 is minimal, while the effects of the pandemic on the growth of real estate prices are apparent. Empirical studies also prove the correlation between real estate prices and the inflation rate. An empirical study by Laurinavičius et al. (2022) confirms that the inflation rate is one of the macroeconomic indicators that affect the price of real estate, especially if unemployment is lower and GDP is higher.

Another correlation that is related to the real estate market is between GDP and real estate prices. This correlation has a high degree of positivity, confirmed by Li et al. (2018) his work. The similar existence of influence between real estate price and the gross domestic product is confirmed by empirical studies (Chan & Woo, 2013; Vogiazas & Alexiou, 2017; Laurinavičius et al., 2022). The correlation in this work took data from 2019-2022. The correlation coefficient was 0.30. Figure 11 shows how GDP and real estate prices look like.

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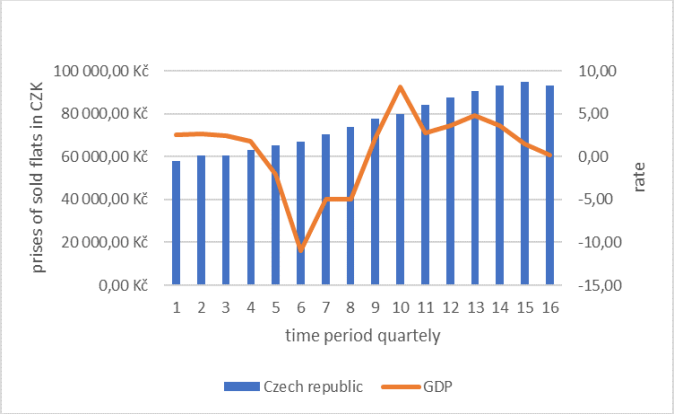


Figure 11. Correlation of GDP and housing prices in 2019-2022.

Source: own processing.

Several empirical studies show another correlation between the interest rate and real estate prices. In his work, (Yiu, 2021) quantifies the correlation, stating that just a 1% drop in interest rates causes a 1.5% increase in property prices. A drop in the real interest rate will significantly increase the real estate price in real terms. The development of interest rates can also be affected by Covid 19, which has just been confirmed. Our correlation was based on the period 2019-2022 every quarter. The correlation coefficient was 0.63. Figure 12 shows this relationship.

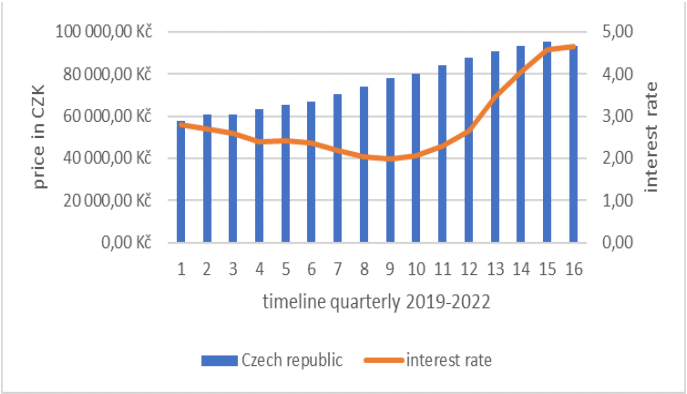


Figure 12. Correlation between property price and interest rate in 2019-2022.

Source: own processing.

Factors that can affect the real estate market are presented in time series. Overall, how these factors develop over time can be seen in Figure 11.

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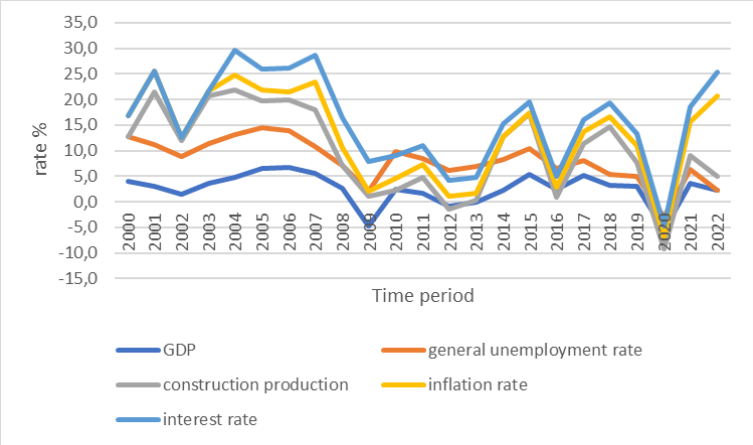


Figure 11. Factors affecting the real estate market from 2000-2022.

Source: own processing, taken from the Czech Statistical Office, hypomonitor.

If we focus on the time area from 2016-2022, the following can be seen: In 2016, there was a big break in the following factors: interest rates, inflation rate, and construction output. There was a slight decrease in unemployment and gross domestic product. For which there was a big break in 2016, they subsequently grew and reached around 20%; they maintained this growth until 2019, when the big break occurred. This is where the pandemic situation comes in. This situation affected all factors and the real estate market itself. It can be assumed that factors such as the interest rate and inflation rate will continue to rise until the end of 2023. From 2024, these factors should decrease, and thus, the real estate market should revive.

5 Discussion of results

The COVID-19 pandemic has significantly impacted the real estate market globally. This hypothesis was only confirmed. In most cases, property prices have risen as a result of the pandemic. If the pandemic situation had not occurred, it is not clear whether the increase in real estate prices would have increased. Prices would probably continue to rise in the Czech market as there is a lack of real estate. As for other countries, there is no clear prediction. The pandemic created the conditions for determining real estate prices, not only determining the state of supply and demand but also determining a number of factors. Real estate prices in the Czech Republic and other countries were different during the pandemic than before the pandemic. This hypothesis was not confirmed. This trend towards real estate growth started even before the pandemic situation. In the Czech Republic, there has been a continuous increase in real estate prices in all regions in recent years. The largest increases were recorded in regions with a high number of inhabitants, whether it was Central Bohemia, South Moravia, or South Bohemia. As empirical and statistical patterns show, this rise in house prices continued during the pandemic. The research questions posed can now be answered.

Which factors had the most fundamental influence on the real estate market in the Czech Republic during the pandemic situation that affected the whole world in 2019?

As part of the work, it is impossible to determine the price of real estate using one factor; several different combinations of factors contribute to the price of real estate. The following factors emerge from the work: development of mortgage loans, development of gross domestic product, costs associated with building materials, unemployment, inflation, and construction production. Furthermore, this work should have considered many factors, such as the type of apartment, region, size of the village, household income, education, and others. During the pandemic, it was necessary to define the most important factors that impacted the real estate market in the Czech Republic. These factors were selected from secondary data and their analyses. Based on various experts, it has been concluded that the key factors that have caused real estate growth include mortgage interest rates, gross domestic product, and inflation.

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What can be expected in terms of real estate prices after the end of the pandemic situation on the real estate market in the Czech Republic?

None of us can accurately say what the real estate market will bring in the coming years. The likely development of the real estate market will vary depending on the location and type of property. The situation in the Czech Republic is not simple; as energy prices continue to rise, so do mortgage interest rates. Therefore, the development of the mortgage market will be crucial; if interest rates fall, there will be more demand for housing, and the real estate market will revive again.

6 Conclusion

This work dealt with the impact of the COVID-19 pandemic situation on the real estate market. As is known, the real estate market is a very significant element in every economy, and it is usually associated with the country's economic development. The real estate market is very important for businesses and citizens. Because the real estate market still faces supply and demand. This information is important for the possible sale or purchase of the real estate or whether it is appropriate to obtain a possible loan, so it is necessary to monitor price changes. It is also essential to monitor the so-called price bubbles the real estate market deals with. If a buyer were to purchase a property before this price bubble burst, they would be exposing themselves to huge risks of losing their investment in the purchased property. This work examined how the real estate market developed, the price changes associated with the real estate market, and how the pandemic affected the real estate market. Professional and empirical sources confirmed that COVID-19 affected the real estate market. If there is a global crisis, whether it is the mentioned pandemic, there is usually a drop in real estate prices; in this case, there was no price drop. The pandemic created an unprecedented situation in which conditions were created, and the price of real estate could continue to rise even though the economy was experiencing a crisis.

The main objective of the work was to identify the most important factors that influence price changes in the real estate market. And that in the periods before the pandemic, i.e., from 2016 to the 2020-2022 pandemic. The following essential factors emerge from the work: GDP, inflation, construction output, and mortgage interest rates. A comparison was made between these factors; it is clear that their effect on the real estate market is long-term, and each factor influenced the real estate market even before the pandemic outbreak. For a long time, it was possible to observe a decrease in mortgage loan rates worldwide; after the pandemic outbreak, this interest rate decreased even more, thanks to which the demand for real estate purchases increased. As a result, real estate prices increased. Before the outbreak of the pandemic, there was economic growth, which was also reflected in the rise in real estate prices.

By working out the work, it confirmed that COVID-19 had an effect on the real estate market on a global scale. This consequence caused prices to rise rather than fall. The real estate market recovered relatively quickly from the pandemic, and a continuing real estate price growth trend was noted. Therefore, it is necessary to monitor critical factors in the future. According to these factors, the buyer can track well when the right time to buy is so that losses are as low as possible.

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EXPLORING THE DEVELOPMENT OF ORGANISATIONAL AND MANAGEMENT STRUCTURES IN THE CZECH REPUBLIC AND THE NETHERLANDS*

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Abstract. The paper aimed to examine the changing organisational and management structures in Czech and Dutch companies, emphasising the importance of adaptability and resilience today. The research methods used in the study used a strong comparative approach to analyse the detailed differences and statistical significance between the organisational and management frameworks of these two locations, utilising Chi-Square and ANOVA One-Way analyses. This analytical method enables us to accurately measure the frequency and effects of different management approaches, establishing a solid statistical foundation for our comparison analysis. The research shows a clear shift towards using agile and hybrid models in these companies, emphasising these structures' vital role in improving operational flexibility and market adaptability. This transition is not just a reaction to present market forces but a deliberate repositioning to safeguard companies against global economic risks in the future. The study has consequences that go beyond regional borders and provide significant insights for businesses globally. The study's results demonstrate how agile and hybrid frameworks can effectively promote resilience and responsiveness in businesses facing rapid change and global market challenges. This study emphasises the importance of strategic adaptation for modern corporate performance and offers a guide for companies aiming to navigate today's complex economic environment. This study adds to the overall discussion on organisational strategy by providing practical insights for companies seeking to stay competitive in a constantly changing environment.

Keywords: Organisational agility; organisational and management structure; cross-cultural analysis; management resilience; strategic corporate adaptation

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1. Introduction

Businesses must adjust to keep up with the ever-shifting nature of the global economy and remain positioned to compete. Companies worldwide, but particularly in the Czech Republic and the Netherlands, have been undergoing significant organisational and management structure shifts over the past few years. According to a study by Michna and Vaková (2020), the Czech Republic has transitioned away from traditional hierarchical structures and toward more adaptable and forward-thinking systems, such as flat structures and network structures. On the other hand, there has been a rise in the use of hybrid construction in the Netherlands. These structures blend aspects of both classic and contemporary architecture (Van Wijngaarden et al., 2019). This change in organisational and management systems has enormous repercussions for companies, their employees, and society. For instance, Pencak and Zolnierczyk-Zreda (2018) discovered that businesses with more flexible structures have greater employee happiness and productivity levels. These findings were based on an analysis of a total of 450 companies. In addition, as businesses become more adaptable and innovative, they can better adjust to shifting market conditions, ultimately leading to increased success and economic growth. Within today's modern corporate environment, the discussion of shifts in organisational and management structures is of the utmost importance. Businesses need to comprehend and implement efficient organisational and management structures to continue to succeed in the face of rising demand, remain competitive, and adapt to shifting market conditions. To inform and direct businesses in their strategic decisions, the purpose of this article is to provide insightful information regarding the changes that have taken place in the organisational and management structures of companies in the Czech Republic and the Netherlands. In addition, it is essential to investigate how these shifts show themselves in various industries and the sizes of companies and how the architecture of these businesses can be optimised to produce the best possible outcomes.

This article aims to help businesses understand and implement effective organisational and management structures that will allow them to remain competitive and thrive in the face of rising demand and shifting market conditions in the Czech Republic and the Netherlands. The article's findings could have a few consequences, including a greater propensity for businesses in the Czech Republic to adopt flexible structures like flat structures and network structures and a greater propensity for firms in the Netherlands to implement hybrid structures to reap the benefits of both traditional and modern architecture (De Waal, Hermkens, 2017; Halk, Viturka, 2019). In addition to fostering a more agile and adaptable work environment, the article may encourage businesses to investigate the benefits of flexible structures in employee happiness, productivity, and innovation.

Furthermore, the article may be helpful for businesses across industries and sizes by shedding light on optimising their organisational and managerial structures through a comparison of the changes in organisational and management structures of companies in the Czech Republic and the Netherlands. Moreover, by contrasting these shifts with those in other countries and regions, businesses can gain insight into the global economy's broader evolution of organisational and management structures and adapt accordingly.

This study aims to investigate and contrast the shifts that have taken place in the organisational and management structures of businesses in these two nations. In sum, this study can be a helpful reference for companies enhancing their management and organisational structures to remain competitive in today's swiftly evolving global economy. Companies in the Czech Republic and the Netherlands can learn from each other's experiences by sharing their successes and failures in these areas.

This issue leads to the formulation of the following hypotheses:

H1: The organisational and management structures of companies in the Czech Republic differ significantly from those in the Netherlands.

The Netherlands emphasises education and manager training to increase service quality and reduce research and innovation costs. Placek, Ochrana, and Pucek (2017) attribute this to a lack of trust in strategic governance and management and a low competence of Czech governments for strategic governance.

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H2: The size of a company affects the speed and flexibility of its decision-making processes, which in turn affects its organisational and management structures.

To maximise the effectiveness of assessment groups and, by extension, the organisation's competitiveness, Korshunov, Kabanov, and Cehlar (2020) state that managerial decisions might serve as the foundation of an occupational risk management system.

H3: Differences in cultural and business practices between the Czech Republic and the Netherlands affect the management and organisational structures of companies operating in these countries.

Interdependence among social cultures, economics, and policies is a hallmark of globalisation. However, it can affect a nation or community positively or negatively (Antalova, 2020; Androniceanu, 2021). Skare and Soriano (2021) state that people have more trade options and more significant connections with foreign business partners because globalisation positively improves technology transfers.

2. Literature Review

According to Cardinale and Scazzieri (2019), theories of structural change determine the extent of transformations that can be made within given economic structures. However, for these theories to occur and be applicable, they must contain explicit or implicit assumptions about the activities within the structures. According to van Neuss (2019), four factors determine structural change. These factors include changes in sectoral prices, changes in income, changes in the interrelationships between inputs and outputs, and comparative advantage. For a developing and transforming market, great care must be taken with technological innovation and structural changes leading to economic growth (Zhou et al., 2021). According to Lee (2021), incomes play an essential role in economic growth due to rapid structural changes and export demands that have grown faster than import demands, while exports have also changed from primary products to more technology-intensive products. Dobrzanski (2019) concluded that technological change and structural labour productivity, i.e., the shift of labour from low productivity to higher productivity sectors, improved both productivity outcomes examined and thus contributed to modernisation and economic growth based on research on structural change in the Czech Republic. Structural change is directly linked to the Fourth Industrial Revolution, which was associated with substituting new technology and capital for labour. From a financial point of view, the automotive industry may be dominant in the Czech Republic, as it is successful in economic growth. Still, in terms of performance indicators, the growth of this sector may only be temporary, as the world market is crowded with cars, and the pressure to reduce emissions is enormous. Therefore, due to the economy's cyclical nature, even the less critical sectors in the Czech Republic may be important and relevant to the Czech economy in the future (Hedvicakova and Kral, 2019). Structural transformation based on research has shown that if the long-run self-sufficiency of a country's interest rate is higher than its interest rates, the share of employment and value-added in the tradable sector is higher; otherwise, these shares decrease. Since each country's interest rate increases with technological progress, the patterns of structural change can vary significantly (Sinicakova and Gavurova, 2017; Kim, Oh and Song, 2019; Robescu et al., 2021). Nissanke (2019) defines how to approach fiscal, monetary, and financial policy debates to facilitate structural transformation, avoid the limitations of the standard macroeconomic literature, and use this agenda as a reference point. Differences in technological progress among the three sectors (agriculture, industry, and services) are the dominant force behind structural transformation. Still, differences observed in other technologies are not as important (Herrendorf, Herrington, and Valentinyi, 2015). The criteria for successful structural transformation of exports are increasing the share of exports of high-technology products, reducing export concentration, expanding export complexity, and, finally, increasing the proportion of exports of capital products (Gnidchenko, 2021; Hamulczuk and Pawlak, 2022).

We can look at expansion differently nowadays, but business expansion is becoming faster and more intense. In 2023, technologies such as artificial intelligence, blockchain, and machine learning will have a significant impact on businesses (Moravec et al., 2024; Bartosik-Purgat and Jankowska, 2020; Lăzăroiu et al., 2022; 2023; Andronie et al., 2023). Another opportunity for businesses to expand is that as the market and technology evolve, businesses have more and more opportunities to increase their competitiveness and expand their operations.

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Among these activities that will help companies grow in a competitive environment can include online marketing, social media, and online trading, so-called online trading (Hoi, 2020; Turek et al., 2023). This is also confirmed by Xu (2019), but he also adds that trading through online marketplaces has its downsides, namely the fact that they can be expropriated or attacked by hackers. Businesses may find it profitable in the future to educate their employees; there is a need to invest money and time in human resources because they are the ones who bring profits, performance, and, ultimately, market positioning (Duminica, 2019). According to Ismail et al. (2019), employee communication and training significantly impact the achievement of set goals and the well-being of all employees. Investments in research and development are significant for a company's growth, and it primarily depends on strategic decision-making on what and how much money will be invested to grow (Innocenti and Zampi, 2019). According to Korshunov, Kabanov, and Cehlar (2020), managerial decisions can form the basis of an occupational risk management system to optimise the use of assessment groups and thus help to make the organisation more competitive. According to Mastrostefano et al. (2020), companies can use funds to expand through investment funds and funds that support start-ups, i.e., emerging businesses that have a good idea and can develop. Not only can start-ups grow, but it is also one way to combat unemployment and create wealth, i.e., a stake in the start-up company. Companies today increasingly focus on personalised products and, more than ever, on the customer because the customer is the central aspect that can expand a business (Olah et al., 2021; Jiang, 2022).

Globalisation is a process where cultures, economies, and policies are intertwined, while social cultures are also intertwined. However, it can positively and negatively impact a country or society (Sinicakova et al. 2017; Antalova, 2020; Lv et al., 2023). According to Skare and Soriano (2021), globalisation positively affects technology transfers, so people have more opportunities in trade and can better connect with business partners from abroad. These processes of globalisation increase the efficiency of activities, but there is a need to continuously create an environment for institutional support and regulate rules in the information market. Like everything, globalisation has adverse effects. First, social inequalities in income between countries cause social tensions (Shopina, Oliinyk, and Finaheiev, 2017). According to Kassai (2017), globalisation has both positive and negative impacts on the country; foreign investment positively affects economic development; the negative consequences are mainly from an ecological point of view, but these can be prevented or at least eliminated through global cooperation and a focus on ecology through guidelines. Ultimately, globalisation can be beneficial if it is appropriately regulated. According to Tomljanovic, Cvecic, and Franc (2022), the SDGs must be followed. Still, it is also necessary to remember that each region and each country is based on different dynamics, so each country and region needs to be approached differently to meet the SDGs. Globalisation has also facilitated global networking, which means that all communication technologies have become interconnected and work together to enable the fast and efficient transfer of information worldwide, which can help companies grow (Grant and Jung, 2021). According to Schuh et al. (2020), the global network facilitates communication, saves time, and facilitates communication within a company if the communication medium is appropriate, which is essential for modern society to expand continuously. The global network is also reflected in business, whereby buyers and suppliers can communicate with each other and share information; however, according to Sterev et al. (2020), small businesses are not as shareable and have less trust due to the surrounding environment, mainly due to their more minor role in the market environment.

Companies use hierarchy management to organise and manage their employees at work. A hierarchical structure is integral to any company that wants to be competitive in a changing environment. Hierarchical power needs to be set up within the company so that it does not weaken the company's performance but strengthens it (Ji et al., 2019; Gavurova et al., 2022a,b). However, this finding contradicts the perspectives of De Waal and Hermkens (2017) and Halk and Viturka (2019), who suggest that Czech companies are more inclined to adopt flexible structures like flat and network structures, while Dutch companies tend to adopt hybrid structures combining traditional and modern elements. Bimpikis and Markakis (2019) say that a well-organised management hierarchy helps with staff management, communication, and follow-up. This is because all employees know their roles and responsibilities, and everyone knows who to contact for any questions or problems. Therefore, in managing innovative projects, group dynamics, conflict resolution, leader knowledge, and team-building processes are essential activities within the hierarchy of the organisation and the proper functioning of groups within the organisation (Soltes and Gavurova, 2015; Malec and Staňczak, 2022; Olah et al., 2021). Hierarchy can also bring weaknesses in that some employees of the company may feel marginalised

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compared to others, and there may also be situations where people with more power within the hierarchy abuse their position, a situation that does not help the company or workplace relationships (Rubineau, Lim, and Neblo, 2019). According to Li et al. (2020), organisational cohesion and good workplace relationships positively impact the firm's performance. This is also confirmed by Mikalsen et al. (2019), who state that in more extensive and complex organisations, there is a need to align with experts and other groups to create effective autonomous teams. According to Siekelov et al. (2020), revenue management involves good workplace relationships, a well-chosen product portfolio, and monitoring past weaknesses. According to Weerheim, Van Rossum, and Ten Have (2019), these are the factors of a successful team.

This field of study started in the 20th century. It looks at how to lead an organisation, manage and motivate employees, and use the enterprise's resources to reach its goals. It is used across all industries, and one of its main exponents is Henry Fayol, who focused on employee motivation (Hatchuel and Segrestin, 2019). According to Muldoon et al. (2021), Elton Mayo was also one of the leading exponents, but his theories are no longer essential to modern management theory. However, by far the most significant impact was the theory of Frederick Taylor, who contributed his theory to the organisation of work and thus higher efficiency, where each employee is given an activity and their performance is analysed (Paris, 2019). However, management theory nowadays includes modern approaches to help a company achieve its goals and be competitive. This also involves strategic management, which aims to plan, manage in the long term, and respond to crises that arise during the company's life cycle to minimise the impact on the company (Ansell and Boin, 2019).

Businesses that want to implement their decisions in the enterprise use business strategies which pair the objectives they want to achieve with the methods and actions they will use to reach them, according to Zapletalov (2021). The enterprise can achieve business success if the model is also set correctly. For emerging businesses needing more resources, choosing a business strategy that will effectively utilise the business's potential and resources is necessary. Strategies with differentiated products and minimal costs are the most effective. Other effective strategies include improving technology and product design (Kim et al., 2021). Financial planning is an essential business strategy that brings success to the business. With the financial plan, the company can anticipate and prepare for future problems, determine the situation of the business, and thus create a strategic plan for future development that will lead to the success of the organisational unit. According to Yeniaras, Kaya, and Dayan (2020), a business strategy should be responsive to change and flexible, as a flexible strategy positively affects business linkages and financial and non-financial performance. Companies should focus on the wants and needs of customers and on retaining existing customers or establishing relationships with customers in international markets (Tuominen et al., 2022).

The Netherlands is a developed country with an excellent legal and economic system. It can adapt to changes in the business environment, especially since there is a constantly growing number of entrepreneurs offering their services here (Jansen, 2020). The Netherlands is also good at strategic management, organisation, and planning. This is because business in the Netherlands comprises many different sectors and organisations. Managers tend to be consultants and try to create better systems and processes to make the company competitive in a dynamic environment (Filippov, Mooi, and van der Weg, 2010). In the Netherlands, there is a strong emphasis on education and a training system that helps managers, which allows companies to improve service quality as much as possible and minimises the cost of research and the innovation process. Allen and Belfi (2020), who claim that companies in the Netherlands are highly competitive due to educated employees, support this by stating that education in the Netherlands has expanded rapidly in recent decades, despite widespread concern, with no direct negative consequences.

The Czech Republic is less advanced than the Netherlands in terms of management and strategic management. According to Placek, Ochrana, and Pucek (2017), this is due to a need for more trust in strategic governance and management and the low capacity of governments in the Czech Republic for strategic governance. Even though the management level has yet to reach the level of world leaders, there has still been a lot of progress. In the Czech Republic, more and more companies are trying to evaluate quality and follow the trends already common in developed economies (Ondra, 2021). The number of students at universities is decreasing yearly, which can significantly impact the management of businesses and their ability to remain competitive. Managers should continuously educate themselves and manage the company based on practical and theoretical knowledge

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(Chladkova, Skypalova, and Blaskova, 2021). According to Caha (2017), managers' education is essential for the company's performance. It has been confirmed that in the Czech Republic, managers' education is related to the size of the company, i.e., the larger the company is, the more widespread the education is, and the more they focus on market trends, which affect the overall efficiency and performance of the company (Tothova et al., 2022).

3. Methods and Data

Chi-squared

The chi-square method is applied in situations where two variables are examined, and we examine whether there is frequency and statistical significance between the two scenarios. We derive the chi-square statistic using the formula below by comparing the observed and expected frequencies.
Where: χ^2 is the value of the test statistic; O_i is the observed frequency in the *i-th* category; E_i is the expected frequency in the *i-th* category.

ANOVA one-way

One-way ANOVA (Analysis of Variance One-way) is a statistical method used to compare means between three or more groups. The method tests whether there is a statistically significant difference between groups based on the variance in the data. According to Heiberger and Neuwirth (2009), it generalises the two-sample t-test to three or more samples. The formula for One-way ANOVA is:
F = (SSB / (k - 1)) / (SSW / (N - k)),
Where: *F* is the value of the test statistic, *SSB* is the sum of squares between groups, *SSW* is the sum of squares within groups, *k* is the number of groups, and *N* is the total number of observations.

Anova multi-way

According to Langenberg, Helm, and Mayer (2022), ANOVA Multi-way (Analysis of Variance Multi-way) is a widely used statistical method for data analysis that allows the examination of the effect of more than one factor on the dependent variable. This method tests whether there is a statistically significant difference between groups based on the variance in the data and determines whether there is an interaction between the factors. The formula for the Multi-way ANOVA includes the sum of squares (Sum of Squares) and the mean squares (Mean Squares) for each factor and the interaction between the factors. The exact formulas vary depending on the number of factors and their levels.

Dimensional analysis - scale reliable

Dimensional analysis - scale reliability is a statistical method used to assess the reliability of measurements in psychometric testing. This method is often used to assess the consistency and reliability of individual items or dimensions in questionnaires or scales. This analysis is used as a classical tool that has proven successful in converting difficult technical problems into more manageable ones (Mahoney and Yeralan, 2019).

We have individual functional units that are key to the smooth division of labour and, above all, to the creation of corporate value, whether in the form of a product or a service, within the corporate organisational decomposition. In this regard, we have identified a total of 12 groups that are mostly found in corporate practice. The research focuses on gaining knowledge, awareness, and type of organisational structure based on its characteristics, as well as its most appropriate structure depending on these differentiating parameters:

- Size of the company,
- Focus of the company, by sector,
- Focus of the company by nation,
- Number of organisational structure levels.

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3. Results

To investigate the inter-departmental linkages, a correlation analysis will be conducted as part of this study. The analysis will be specified to examine the correlations in the dataset collected in the Czech Republic and the Netherlands. Table 1 illustrates the results by examining correlation analysis and decoding the abbreviations. The results will offer a deeper understanding of the data samples from the Czech Republic and the Netherlands.

Table 1. Inter-Departmental Correlation Analysis between Czech and Dutch Companies

	A1(NL)	A2(NL)	A3(NL)	A4(NL)	A5(NL)	A6(NL)	A7(NL)	A8(NL)	A9(NL)	A10(NL)	A11(NL)	A12(NL)	NL
A1(CZ)	1,00	0,22	0,14	-0,02	0,33	0,36	0,17	0,62	0,09	0,04	0,29	0,28	**A1(NL)**
A2(CZ)	0,26	1,00	0,15	0,18	0,22	0,32	-0,12	0,21	0,11	0,22	0,18	0,55	**A2(NL)**
A3(CZ)	0,20	0,22	1,00	0,13	0,06	-0,07	-0,09	0,09	0,02	-0,10	0,00	0,16	**A3(NL)**
A4(CZ)	0,30	0,13	0,26	1,00	0,04	-0,04	0,22	-0,09	-0,02	0,08	0,06	0,04	**A4(NL)**
A5(CZ)	0,46	0,19	**0,52**	0,18	1,00	0,39	0,40	0,48	0,37	0,15	0,53	0,20	**A5(NL)**
A6(CZ)	0,21	0,08	0,24	0,31	0,33	1,00	0,22	0,66	0,40	0,18	0,42	0,20	**A6(NL)**
A7(CZ)	0,36	0,37	0,28	0,30	0,46	0,45	1,00	0,41	0,35	0,19	0,27	0,08	**A7(NL)**
A8(CZ)	0,44	**0,53**	0,36	0,24	0,49	0,34	**0,54**	1,00	0,29	0,21	0,36	0,30	**A8(NL)**
A9(CZ)	0,26	0,27	0,26	0,26	0,45	0,45	0,45	0,48	1,00	-0,03	0,35	0,06	**A9(NL)**
A10(CZ)	0,42	0,25	0,34	0,25	**0,57**	**0,55**	0,48	**0,59**	**0,57**	1,00	0,09	0,16	**A10(NL)**
A11(CZ)	0,28	0,05	0,24	0,17	0,39	0,39	0,33	0,38	0,38	0,47	1,00	0,23	**A11(NL)**
A12(CZ)	0,30	0,34	0,16	0,03	0,37	0,20	0,29	**0,51**	0,30	0,37	0,43	1,00	**A12(NL)**
CZ	**A1(CZ)**	**A2(CZ)**	**A3(CZ)**	**A4(CZ)**	**A5(CZ)**	**A6(CZ)**	**A7(CZ)**	**A8(CZ)**	**A9(CZ)**	**A10(CZ)**	**A11(CZ)**	**A12(CZ)**	

Legend			
A1	Purchasing	A7	Technical
A2	Manufacturing	A8	Quality
A3	Economic	A9	Development
A4	Business	A10	Controlling
A5	HR	A11	Marketing
A6	Investment	A12	Logistics

Source: Authors

Using the correlation coefficient, they are accepted as statistically significant, i.e., that two parameters are correlated with each other if the correlation coefficient is greater than 0.5. The first category that will be analysed in the results section are companies from the Czech Republic. Here, the area of control is correlated with the areas of HR, investment, quality, and research and development. This implies that companies with control are highly likely to have other departments. The results are also consistent with the fact that controlling work takes place not just at the investment level (0.550), in the quality area (0.593), but also in the development area, where development is one of the most expensive investment returns of companies and one of the riskiest areas. However, companies voluntarily take this risk, believing they will maintain or create a competitive advantage (development 0.575). Finally, there is the area of HR, where it is desirable to have the right people in the right jobs (0.571). The following correlations have been identified as accompanying statistically significant relationships: Quality in cooperation with logistics, which reflects the fact that both inbound and outbound logistics (0.512) are key elements for the company and are also a necessary means for a positively received input but at the same time a safely dispatched output. At the same time, quality correlates with production (0.528), indicating that the production process is also a necessary element that requires control during its transformation process. Last, it is entirely alone in the correlation between HR and economics (0.517). This

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result is related to the fact that businesses pay considerable economic units to their employees, so companies should evaluate the efficiency of their employees.

The results obtained in the Netherlands show that some correlations between departments were obtained. Examples are investment with quality (0.66), then quality with purchasing (0.62), manufacturing with logistics, and finally HR with marketing (0.53). The difference with the results from the Czech Republic is the measurement of negative reliability coefficients (R^2), which indicates an inverse relationship, e.g., technical with manufacturing (-0.12) or (-0.1) economic with controlling. The results are strongly influenced by the representation of the respondents in the territorial units of the Czech Republic and the Netherlands. The following graph demonstrates the percentage representation of the size categories of companies for both countries, which are determined by the number of departments in which each company operates within its organisational grouping.

It can be observed that the distribution of data is relatively normative, but in the case of the Netherlands, smaller departments (more departments) predominate, so the assumption of decentralised organisation of work is confirmed. On the other hand, the Czech Republic is represented by companies that centralise their organisational structures more and thus use larger departments (a smaller number of departments). The average among the countries we compare is a medium number of departments, where 20% of the companies surveyed are located (see Figure 1).

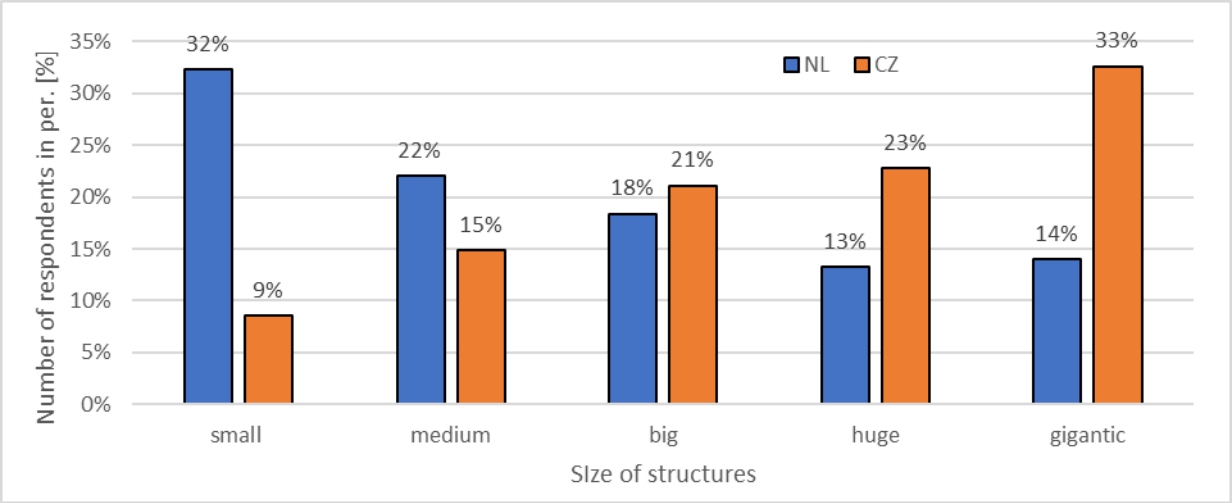


Figure 1. Organisational structure distribution by department size in the Czech Republic and the Netherlands
Source: Authors

To better understand the context of what has a clear impact on the choice of organisational structure, the choice of departments, or the number of departments, the statistical method of chi-square and the Pearson test were used to test the "legend of the structures" by the dependent variable within each differentiation, which can be seen in the following table. Table 2 shows the results for the Czech Republic.

Table 2. Pearson test results of the Czech Republic- Chi-square: testing for differentiation

CZ Pearson's Chi-squared test results: legend of the structure			
test file	**X-squared**	**df**	**p-value**
Focus of the company	24.38	8	**0,001979**
Size of the company	64,156	12	**0,3904E-08**
Financial balance of the company	11,772	8	0,1617
Type of organisational structure	28,644	36	0,8035
Number of levels/scopes of management	50,748	12	**0,1032E-05**

Source: Authors

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Using the Chi-square test, it was confirmed that the created parameter legend structure is significant with differentiation by focus, with a value of 0.001979. Furthermore, with size categorisation, where the value of the Pearson coefficient is 0.39 E-08, this result also determines the dependence on the parameter of number or range of degree of organisational management structure. The direct relationship of the parameter "legend structure" was confirmed, which is classified into 5 basic areas: [small, medium, large, gigantic]. This method was subsequently applied to the results from the Netherlands (see Table 3).

Table 3. Pearson test results of the Netherlands - Chi-square: testing for differentiation

NL Pearson's Chi-squared test results: legend of the structure			
test file	**X-squared**	**df**	**p-value**
Focus of the company	7,8732	6	0,2475
Size of the company	38,682	9	**0,00001315**
Financial balance of the company	5,5597	6	0,4743
Type of organisational structure	25,327	9	**0,00263**
Number of levels/scopes of management	27,282	9	**0,001256**

Source: Authors

When comparing the data from the Czech Republic and the Netherlands, there is a substantial difference in the significance of the size of structures and sectoral differentiation. This difference was not confirmed in the Netherlands (0.2475). The idea that the size of structures or the number of departments is directly linked to the type of organisational structure is indeed validated. These results prompt an examination of potential connections in philosophy among organisational groupings in the Czech Republic and the Netherlands. A link was verified in the Czech Republic between the size of companies (1.315E-5) and the number of management levels (0.001256).

The framework will consider the aspects determining whether the company is manufacturing or service-oriented. The sectoral distinction will be evaluated based on the various departments within the organisational structure. The results will be determined through dimensional analysis utilising the Scale reliable sensitivity analysis tool, presented in Table 4.

Table 4. Results of dimensional analysis Scale reliable - manufacturing sector CZ

MANUFACTURING SECTOR: 71 CZ				
	Alpha	**Std.Alph**	**r(item,total)**	
Controlling	0,8602	0,8576	**0,6821**	*
Economic	0,8699	0,8676	0,5209	
Investment	0,8718	0,8701	0,4856	
Quality	0,8555	0,8534	**0,7465**	**
Logistics	0,8723	0,8692	0,4872	
Marketing	0,8639	0,8612	**0,6246**	*
Purchasing and supply	0,8666	0,8645	0,5772	
Business	0,8797	0,8766	0,3655	
HR	0,8546	0,8526	**0,7612**	**
Technology	0,8618	0,8594	**0,6517**	*
Manufacturing	0,8779	0,878	0,3455	
Development and research	0,8673	0,865	0,5647	

Source: Authors

The results indicate that a collection of departmental organisational groups may be identified, which likely suggests that it is a manufacturing company. The quality department comes in second with a correlation value of 0.7465, and controlling comes in third with a correlation value of 0.6821. The human resources area has the highest correlation value of 0.7612. The technological area has a value of 0.6517, and the marketing area has a value of 0.6246, both being significant parameters. Here, the production unit reaches a minimum value of 0.3455. This could be attributed to manufacturing companies engaging in value-added production processes using their exclusive expertise, such as a distinctive or intricate technological production method. This analysis was conducted on service sector companies; the results are shown in Table 5 for comparison.

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Table 5. Result of the dimensional analysis: Scale reliable - service sector CZ

SERVICES (N): 57 CZ				
	Alpha	**Std.Alph**	**r(item,total)**	
Controlling	0,7225	0,7331	0,7469	**
Economic	0,7759	0,7878	0,2392	
Investment	0,7449	0,7602	0,4973	
Quality	0,7505	0,7614	0,4707	
Logistics	0,7666	0,7811	0,2915	
Marketing	0,7337	0,7518	0,5699	*
Purchasing and supply	0,7546	0,7713	0,4075	
Business	0,7697	0,7807	0,2905	
HR	0,7419	0,7623	0,5041	*
Technology	0,7435	0,7611	0,4951	
Manufacturing	0,7822	0,8033	0,0741	
Development and research	0,7523	0,7622	0,4866	

Source: Authors

With a smaller sample size of 57 service companies, the significance level of acceptance was lowered to >0.5. Like the prior scenario, the controlling, marketing, and people area criteria are the ones that achieve substantial values. The lowest-rated sectors are production and economics. A similar approach was used to analyse the data from the Netherlands. The tables below (Table 6 and Table 7) display the results for the manufacturing sector, followed by the service sector.

Table 6. Results of dimensional analysis Scale reliable - manufacturing sector NL

MANUFACTURING SECTOR: NL				
	Alpha	**Std.Alph**	**r(item,total)**	
Controlling	0,708	0,7394	0,3115	
Economic	0,7462	0,7758	0,0122	
Investment	0,7015	0,7261	0,4025	
Quality	0,6776	0,7039	**0,5998**	*
Logistics	0,6931	0,7192	0,4408	
Marketing	0,6778	0,7204	**0,5082**	*
Purchasing and supply	0,7072	0,7387	0,3226	
Business	0,7304	0,7594	0,1769	
HR	0,6733	0,7198	**0,5352**	*
Technology	0,6902	0,7329	0,4327	
Manufacturing	0,6975	0,7136	**0,502**	*
Development and research	0,7131	0,7456	0,2849	

Source: Own study

We implemented a similar methodology to that used in the Czech Republic to identify the specific departments characteristic of manufacturing companies within this sector. Using the scale reliability approach, we identified four statistically significant outcomes with values exceeding 0.5 based on the data's sample distribution. HR (0.5352), marketing (0.5082), and manufacturing (0.502) came in order of quality, with this ranking highest (0.5998). Next, we transition to the service sector, with the outcomes displayed in the subsequent table.

Table 7. Result of the dimensional analysis: Scale reliable - service sector NL

SERVICES (N): NL				
	Alpha	**Std.Alph**	**r(item,total)**	
Controlling	0,7509	0,7436	-0,0304	
Economic	0,7206	0,7042	0,2601	
Investment	0,6558	0,6439	**0,7145**	**
Quality	0,6643	0,6521	**0,6632**	*
Logistics	0,7345	0,7208	0,1487	
Marketing	0,6871	0,6765	0,5089	
Purchasing and supply	0,6722	0,661	**0,609**	*

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Business	0,739	0,7212	0,1264	
HR	0,6673	0,6531	**0,6487**	*
Technology	0,7223	0,7096	0,2539	
Manufacturing	0,7431	0,7283	0,0858	
Development and research	0,7116	0,6992	0,3356	

Source: Own study

Data with a correlation coefficient greater than or equal to 0.6 is considered significant. In this instance, the investment variable has a correlation coefficient of 0.7145, which is higher than quality's (0.6632), HR's (0.6487), and purchase's (0.609). Below is Figure 2 comparing the results obtained, showing data for different countries and specifying whether it pertains to the manufacturing or service sector.

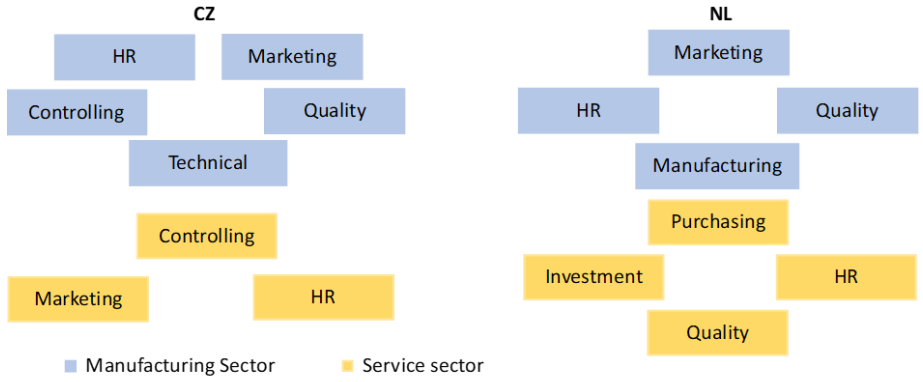


Figure 2. Visualisation of the comparison of the results obtained within the sectoral differentiation
Source: Authors

A visual comparison between the Czech Republic (CZ) and the Netherlands (NL) demonstrates the sectoral focus within the manufacturing and service industries. Both countries emphasise human resources and control in many areas, highlighting their essential significance in organisational and management structures. The CZ manufacturing sector prioritises technical and quality departments, emphasising production standards and innovation. In contrast, NL focuses on the manufacturing department, heavily emphasising production methods. NL puts a distinct stress on investment in services, reflecting a financial or growth-oriented approach, whereas CZ does not, suggesting potential variations in service sector dynamics or economic models. This comparison visualisation highlights the variations in organisational and management focus across regions and sectors, possibly indicating each country's distinct economic plans and industrial capabilities.

Discussion

This study focused on research on organisational and management structures in the Czech Republic and the Netherlands. The authors assume that differences in organisational and management structures may be due to the company's geographical location. These claims have been put forward in several studies, such as those by Allen and Belfi (2020) and Placek, Protection, and Pucek (2017). Based on these studies, the hypotheses in this research were proposed: H1: "The organisational and management structures of companies in the Czech Republic differ significantly from those in the Netherlands." This hypothesis was confirmed using various statistical methods. It has been shown that corporate governance in the Czech Republic is more centralised than in the Netherlands. Companies in the Czech Republic show a division into a smaller number of larger departments, whereas companies in the Netherlands focus on a more significant number of smaller departments. Both have advantages and disadvantages, but the Netherlands' organisational and management structures seem more appropriate, as confirmed by the studies of Halk, Viturka (2019) and De Waal, Hermkens (2017).

When researching organisational and management structures, it is necessary to include the relationship between the size of a company and the organisational structure. For this reason, the following hypothesis was developed:

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H2: "The size of a company affects the speed and flexibility of its decision-making processes, which in turn affects its organisational and management structures." This hypothesis was tested using the chi-square test, which showed the company's size dependence on the number of organisational structures. This result confirms that to manage larger companies effectively; it is necessary to divide the company into several departments and thus decentralise its management. A rise in the number of departments can increase the linkages between departments and, therefore, simultaneously increase the speed and flexibility of the company's management. The research of van Wijngaarden et al. (2019) and Pencak and Zolnierczyk-Zreda (2018) can support the confirmation of this hypothesis.

The next stage of this research was to determine the difference between the relationships between the different parts of the companies in the Czech Republic and the Netherlands, which corresponds to the following hypothesis: H3: "Differences in cultural and business practices between the Czech Republic and the Netherlands affect the management and organisational structures of companies operating in these countries." Using chi-square test statistical methods and dimensional analysis, some similarities but significant differences between the relationships of the companies' departments were identified. In the Czech Republic, a focus on the controlling area can be observed, which correlates with other departments. In the case of the Netherlands, it can be noted that the quality department showed the highest degree of correlation. However, it should be mentioned that the Netherlands also showed negative correlations. This finding and various correlations support H2's assertion that the interconnection in the different company departments depends on each nation's customs and business practices. The confirmation of this hypothesis is in line with the research of Jansen (2020).

Conclusions

The findings of the research that was conducted to compare the organisational and managerial structures of the Czech Republic and the Netherlands revealed valuable insights that characterise the contrasts between these two countries. In the sample that was examined, it was discovered that businesses in the Czech Republic have a higher degree of centralisation in relation to the larger size of the individual departments of the companies, which comes at the expense of the number of departments. On the other hand, business organisations in the Netherlands tend to decentralise certain aspects of their operations by separating the organisation into a greater number of smaller divisions. Subsequently, the variations in the organisational structures of the Czech and Dutch businesses were validated using additional statistical techniques to investigate the interdependencies between the various departments. It has been demonstrated that enterprises in the Czech Republic with a well-developed controlling system also have very mature human resources, investment, quality, and research and development departments. Based on these data, control plays a significant role in establishing a connection between strategic management and the investment plans and operational regions utilised by the corporation inside the Czech Republic domain. The negative association seen in the instance of the Netherlands was another factor that characterised differences during this study. After that, the research of businesses in both countries concentrated on conducting an in-depth investigation of the manufacturing and service sectors, during which particular connections of sectors were discovered. Based on the findings, the manufacturing and service sectors have very different concentration areas. A subsequent dimensional study proved a direct relationship between the company's size, the kind of organisational structure, and the number of management levels in the Czech Republic and the Netherlands. This research verified that countries have diverse organisational and managerial structures and gave new, previously unknown insights. This work provides a solid foundation for further research on organisational structures and the general functioning of companies, which also serves as a foundation for additional research.

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IMPACTS OF ECONOMIC CRISES ON E-COMMERCE IN CZECH REPUBLIC *

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Abstract. E-commerce has been undergoing intensive development every year to match the development of information and communication technologies. E-commerce has a significant, yet diverse, impact on the analysis of selected e-commerce segments during the COVID-19 pandemic between 2021 and 2022. Metadata evaluated our results using the tools of Google Analytics, Google AdSense, and Supermetrics tool. The research involved structured interviews to refine and improve the results obtained. We also analysed the turnover and year-on-year changes of selected e-shops in beauty products, food, fashion accessories, and luxury goods, exploring the development trends related to the pandemic and the ongoing war conflict. A part of the solution was also the analysis of the tested segments in terms of the NUTS 3 regions and the specification of the development of the business segment under review from the perspective of the geographical regional location. The obtained data will provide experts and the business sector with information about the development of e-commerce during times of crisis. They also apply to existing and potential business entities regarding their position in an increasingly challenging market environment. The first approximation of the results will be refined and validated in further research.

Keywords: digital marketing; advertising campaign; online marketing; e-shop; small and medium enterprises; Meta marketing

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1. Introduction

E-commerce is becoming one of Europe's most dynamically developing areas across all economic sectors and globally (Siegfried et al., 2021; Kolupaieva & Tiesheva, 2023). Various studies on this issue conclude that compared to brick-and-mortar stores, e-commerce is growing at an unprecedented rate (Liu et al., 2018), and its further growth will be at the expense of retail (Taher, 2021). E-commerce brings additional competitive advantages to SMEs, including increased business efficiency, reduction of costs, latest innovations, faster response and adaptation to changes, increased market share, etc. The advantages help SMEs to compete with large enterprises even in global markets (Hamad et al., 2018). A comparative analysis by Pacana et al. (2023) highlights the current approach of customers and SMEs from the V4 countries towards pro-environmental

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products, emphasising e-commerce's role in improving product quality and sustainability, aligning with global market demands. We can see this from the increasing volume of e-commerce transactions in individual countries or the worldwide market actively using the Internet compared to business transactions conducted offline.

Digitalisation, a key e-commerce component, is reshaping SMEs' operations and perceptions (Lewandowska et al., 2023; Civelek et al., 2023). Krajčík's investigation into the digitalisation of SMEs, particularly within the mining and iron industries, underscores the critical nature of public interventions and supports in facilitating this transition, thereby enhancing their competitive stance in the e-commerce landscape (Krajčík, 2022). This insight complements the view that e-commerce streamlines business transactions and necessitates a supportive ecosystem for SMEs to thrive. Furthermore, the role of social media in resolving financial challenges for European SMEs, especially those in the iron and mining sectors, is significant. Civelek's et al. (2022) international comparison reveals that social media usage can be a potent tool for SMEs to navigate financial obstacles, thereby contributing to their resilience and growth in the e-commerce domain. This perspective enriches understanding of e-commerce's multifaceted benefits, including market expansion and financial sustainability.

The online business environment aims to streamline business transactions in terms of their speed and accuracy (Mostafa et al., 2019). The costs reduced by e-commerce compared to retailing motivate SMEs to start a business, which is the primary reason for introducing e-commerce since its benefits do not exceed the costs of its implementation and running (Dahbi & Benmoussa, 2019; Gavurova et al. 2022a). However, SMEs are still afraid to start business in the e-commerce segment, lacking publicly available data and information. Another limitation is the budgetary constraints and the uncertainty concerning the expected return on investment (Gavurova et al. 2022b).

Many studies point to the importance of e-commerce and its positive impacts on the outcomes of companies or countries. The authors perceive e-commerce from three major perspectives (Jameel et al., 2018; Tran et al., 2021; Androniceanu & Georgescu, 2023) analyse e-commerce using internet applications, such as e-mail, websites, and intranet (Drew, 2003) Other authors study e-commerce from the perspective of business activities, i.e., the interaction of customers and suppliers, or B2C (Skare et al., 2023a; Daniel & Wilson, 2002; Stefko et al., 2022). From the third perspective, e-commerce combines Internet applications and business activities (Skare et al., 2023b; Kendall et al., 2001). E-commerce has advantages and potential benefits in related investments, such as the opportunity to attract new customers even in global markets (Tolstoy et al., 2001; Olah et al., 2021), the increased success rate of implemented business plans (Andonov et al., 2001), or gaining competitive advantage compared to ordinary retail (Xuhua et al., 2019), etc. The transition from traditional shopping to shopping in the online environment is a challenge for many companies (Costa & Castro, 2021). One of the optimal solutions for the business sector is the applicability of information technologies, i.e., the introduction of e-commerce with various technological modifications (Skare et al., 2024; Malitska & Melnyk, 2018; Jagoda et al., 2023; Kiba-Janiak et al., 2022). The main benefits of using e-commerce include its practical implementation, time flexibility, and low operating and management costs (Ghonyan, 2020).

The COVID-19 pandemic and other economic crises have affected global e-commerce in many ways. E-commerce is one of the rapidly growing segments, and in many cases, it helped or even replaced brick-and-mortar stores and helped the economy to survive. Customers had to adhere to strict pandemic measures, avoiding brick-and-mortar stores and crowded places; therefore, they preferred online shopping for food, clothes, household accessories, and other consumer goods. The average values of online orders increased by 10-20% in 2020 (Belair-Gagnon & Holton, 2018). Online shopping has been gaining popularity, witnessing the increasing number of e-shops in the Czech Republic, where total e-shops grew by 8% (46,000) in 2020 (International Trade Administration, 2021). Companies have gradually built a relationship with the online environment and realised the necessity of digitisation in various forms according to their needs, thus gaining a lot of experience in this area. The change forced by the pandemic has had a positive impact on the economy of the country as well as the whole society in many ways. The main positive effect was the development or increase in computer literacy, even among the older generation. The data from 2020 confirm a general satisfaction with supplying necessities and essential assortments. European e-commerce grew by more than EUR 633 billion compared to 2021, reaching EUR 718 billion, indicating a 13% increase (Lone & Weltevreden, 2022). The year-on-year turnover

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of Czech e-commerce increased to CZK 223 billion, showing a 14% increase. The Czech Republic is one of the European leaders in the e-commerce segment and has the most e-shops per inhabitant. E-shops grew by 3%, reaching 50,985 e-shops in the Czech market. However, the summer months will slow the year-on-year increase down to see the e-commerce turnover soar again in Christmas (Heureka.group, 2021; Heureka.group, 2022)

2. Research objective and methodology

To the issue discussed and the set goal of the solution, we collected primary data using the Google Analytics data collection method in the years 2021 and 2022, from January to June. The collected data allows real-time web traffic tracking in several formats compared to companies engaged in web analytics. Google Analytics, in particular, is one of the most commonly used tools, with approximately 28.1 million websites currently using the service. Google Analytics is linked to Google AdSense and allows for evaluating and measuring statistical data on how marketing, content, and products engage users. Their strengths complement each other and provide a complete picture of audience behaviour, including interests, preferences, and the time spent online. They can adjust when necessary and effectively modify ads in real-time, e.g., based on performance data, to increase traffic (Belair-Gagnon el at., 2019).

Our study involves four randomly selected Czech e-shops from different industries in the first two quarters of 2021 and 2022. Based on data analysis using Google Analytics, we weighed the sensitive data of the e-shops and preserved the companies' anonymity. The first selected e-shop is a Czech company focused on manufacturing and selling cosmetic products. The second e-shop is a Czech family-owned company producing unique food products, mainly for the children's segment. The following selected e-shop offers quality headwear and other fashion accessories. The last selected e-shop specialises in quality and original jewellery.

Table 1. Sales of selected e-shops in Q1 and Q2 / 2021 and 2022 in CZK.

E-shop	Year	January	February	March	April	May	June
1	2021	5 549 941	5 405 668	6 855 472	4 584 720	6 110 980	3 916 790
	2022	5 473 792	2 659 944	4 771 307	3 921 077	3 679 390	3 695 186
2	2021	2 015 408	1 492 736	2 501 648	1 126 396	1 859 244	1 955 125
	2022	1 544 468	680 367	983 898	1 475 888	2 160 431	3 951 858
3	2021	898 878	686 817	686 817	570 813	595 172	666 302
	2022	716 178	557 951	433 776	468 153	538 940	590 061
4	2021	2 151 040	2 119 729	2 015 849	2 115 185	1 903 302	1 352 837
	2022	1 820 818	1 181 891	1 496 414	1 422 055	1 154 697	1 071 699

Source: Authors

The data from Google Analytics, see Table 1, was further exported to Google Sheets using the Supermetrics tool. It is an automated tool to crawl sites and gather information. This tool is very useful in setting up metrics according to downloaded data. Linking the Supermetrics tool to Google Data Studio generates live reports and enables dashboards to track the progress of social campaigns as they are published (McDonald, 2020). Monthly marketing costs and sales are evaluated in Excel spreadsheet files to calculate an inverted cost-to-sales ratio, called PNO or ROAS (return on ad spend). The analytics also allow for comparing last year's sales with this year's sales, i.e., the year-on-year change. You can also track the daily trend of costs, sales, PNO or CPA (cost per acquisition).

The Google Analytics tool allows a visual comparison of the outputs from the analysis performed and the identification of their trends over the reference periods. Each report consists of dimensions (data attributes, e.g., city) and metrics (quantitative measurements) (Google Marketing Platform, 2022). The metrics allow you to compare sales over the two reporting periods and identify their trend, calculated by taking the arithmetic average of the data of the reference e-shops in the first six months of 2021 and 2022 and the consequent parallel average of all four companies being the selected representatives of each e-commerce segment.

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Guided interviews with the owners of the analysed companies were used as an additional method for detailed data analysis to clarify the analysed data.

4. Results and discussion

Tables 2-5 illustrate the data exported to Google Sheets using Supermetrics to compare the trend of sales/revenues in the first six months of 2021 and 2022 and the percentage year-on-year change.

Table 2 shows the cosmetics segment, suggesting the year-on-year change for all six months, i.e. the so-called "red numbers", that is a decline. In this case, the sharpest fall was recorded in February when the e-shop sales/revenues were lower by 50.79% than the previous year. Interestingly, in this month of 2021, brick-and-mortar stores had not been closed to the extent they were closed after announcing the lockdown on 26 February 2021. However, as noted by the e-shop owners in an interview, such a significant drop in February 2022 was still attributed to the COVID situation and other economic conditions in the Czech Republic, where people were reluctant to spend money on more expensive cosmetics. Thus, the most telling months are March to May, when most stores were closed in 2021, and people were left to shop online. For this reason, e-commerce performed significantly well. In 2022, according to the analysed data, the business already showed the expected decline, see Table 2.

Table 2. E-shop 1: Manufacturing and selling cosmetic products.

E-SHOP 1					
REVENUES 2021					
January	*February*	*March*	*April*	*May*	*June*
5 549 941CZK	5 405 668 CZK	6 855 472 CZK	4 584 720 CZK	6 110 980 CZK	3 916 790 CZK
REVENUES 2022					
January	*February*	*March*	*April*	*May*	*June*
5 473 792 CZK	2 659 944 CZK	4 771 307 CZK	3 921 077 CZK	3 679 390 CZK	3 695 186 CZK
ANNUAL CHANGE					
January	*February*	*March*	*April*	*May*	*June*
-1.37%	-50.79%	-30.40%	-14.48%	-39.79%	-5.66%

Source: Authors

Figure 1 line chart illustrates the trend in sales/revenues, which shows a considerable growth of 2021 sales. The blue peaks are interesting as they significantly outnumbered the orange curve three times. They show the values when the e-shop gives special offers to customers, thus sharply increasing sales. However, despite this rapid growth, sales were lower than in 2021, with an average year-on-year decline.

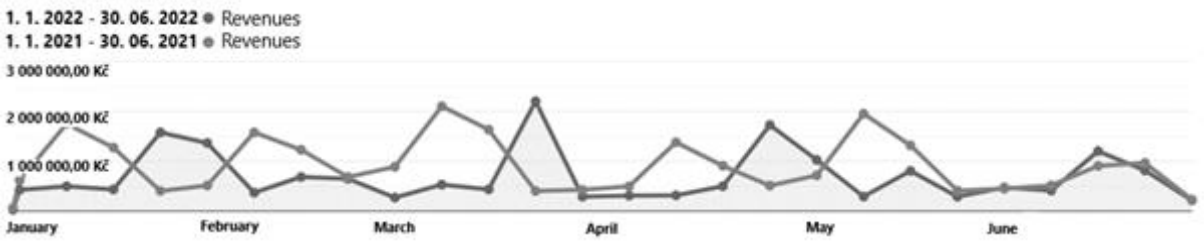


Figure 1. Sales/revenues trend: E-shop 1: Manufacturing and selling cosmetic products.

Source: Authors

The following data in Figure 1 compare the year-on-year number of transactions and sales/revenues for all the first six months of 2021 and 2022. It is also apparent from the figure that these data are partially correlated. The

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approximate 5% variation is mainly due to changes in average order value, e-commerce pricing policy, product portfolio, or conversion rate.

Figure 2 presents the transactions and generated sales/revenues by gender. A year-on-year decrease in sales was identified for women, reaching an above-average 35.24% and only 1.09% for men. According to the interview with the entrepreneur, women primarily indulge in this article, so they make up the majority of sales. Unlike women (personal consumption predominates), men motivate their purchases to obtain gifts, which explains the negligible decrease compared to 2021.

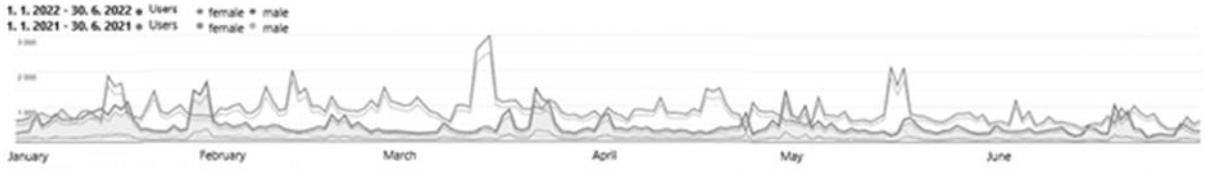


Figure 2. Sales/revenues trend by gender: E-shop 1: Manufacturing and selling cosmetic products.

Source: Authors

Figure 3 shows the year-on-year transactions and sales/revenues within NUTS-3 regions. For example, Prague, accounting for the largest share of sales, has only decreased by 15.21% year-on-year, indicating the smallest decline. The Vysočina Region saw the year-on-year trend plummet by 41.12%, implying the hugest slump. The year-on-year decrease values of the Central Bohemian Region, Moravian-Silesian Region and Zlin Region ranged from 22.85% to 28.64%. Year-on-year downturns ranging from 32.47% to 36.26% occurred in the remaining five Czech regions (South Moravian Region, South Bohemian Region, Plzen Region, Usti nad Labem Region and Olomouc Region).



Figure 3. Map Overlay: E-shop 1: Manufacturing and selling cosmetic products.

Source: Authors

The second analysed segment is the food sector, see Table 3. The table shows the year-on-year change in the so-called "red numbers" for the first three months (January, February and March). At the beginning of January-March 2022, the company faced a problem of insufficient turnover due to the unfavourable economic conditions manifested by the reluctance to spend money as it was in the previous year. In the second half of 2022, the online business was a going concern, and its sales increased significantly, given the temporary closure of brick-and-mortar stores. The collected data and data analysis suggest that the final sales/revenue result was affected by diversification between physical stores and e-stores. The month of June shows the highest increase in sales, with the e-shop achieving 102.13% higher sales than the previous year. The company responded to the slump in Q1 2022 by profitable promotional offers and new product portfolio launches. These activities strengthened purchase motivation, among other things, by having lower prices than competitors.

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Table 3. E-shop 1: Manufacturing and selling cosmetic products.

E-SHOP 2					
REVENUES 2021					
January	*February*	*March*	*April*	*May*	*June*
2 015 408CZK	1 492 736CZK	2 501 648CZK	1 126 396CZK	1 859 244CZK	1 955 125CZK
REVENUES 2022					
January	*February*	*March*	*April*	*May*	*June*
1 544 468CZK	680 367CZK	983 898CZK	1 475 888CZK	2 160 431CZK	3 951 858CZK
ANNUAL CHANGE					
January	*February*	*March*	*April*	*May*	*June*
-23.37%	-54.42%	-60.67%	31.03%	16.20%	102.13%

Source: Authors

The line chart in Figure 4 illustrates the trend in sales/revenues in the food segment. The year 2021 in this segment was less profitable than 2022, with a difference of about 150 thousand CZK. June saw the highest sales volume, where the blue peak exceeded the orange curve, caused by the change in the product portfolio and promotional offers, profoundly stimulating sales growth.

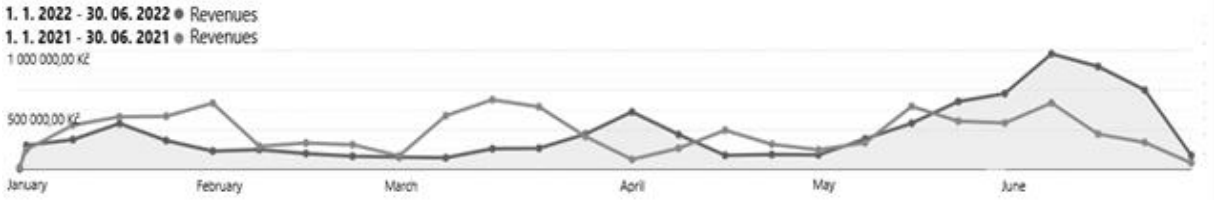


Figure 4. Sales/revenues trend: E-shop 2: Manufacturing and selling food products.

Source: Authors

Over the first two quarters of 2021 and 2022, the year-on-year comparison of the number of transactions and sales/revenues was a variance of approximately 12.94%, which is due to the same factors as the variance for E-shop 1, with the most significant factor being the increase in average order value by adding more expensive (and complementary) products to the portfolio.

Figure 5 shows a year-on-year decrease of 15.14% in sales/revenues for women and an increase of 38.81% for men. The company added more gift items for women sought-after by men to its product portfolio. These were mainly promotions to buy gifts on International Women's Day, Mother's Day, and others.

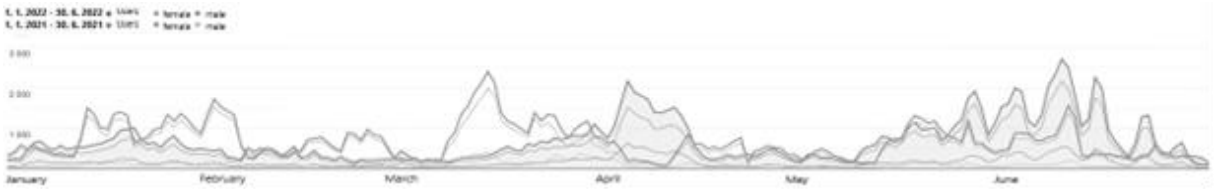


Figure 5. Sales/revenues trend by gender: E-shop 2: Manufacturing and selling food products.

Source: Authors

Figure 6 shows the year-on-year transactions and sales/revenues within NUTS-3 regions. The Zlín Region achieved the highest growth (30.40%), while the Hradec Kralove Region (-20.69%) and the Karlovy Vary Region (-24.71%) witnessed the sharpest slump. The Prague Region saw a significant sales increase of 8.01%. The Central Bohemian Region, the South Bohemian Region, the Liberec Region, the South Moravian Region

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and the Vysocina Region fluctuate between 4% and -4%. The remaining five regions (Plzen Region, Moravian-Silesian Region, Pardubice Region, Olomouc Region, and Usti nad Labem Region) oscillate from -14% to -19%.

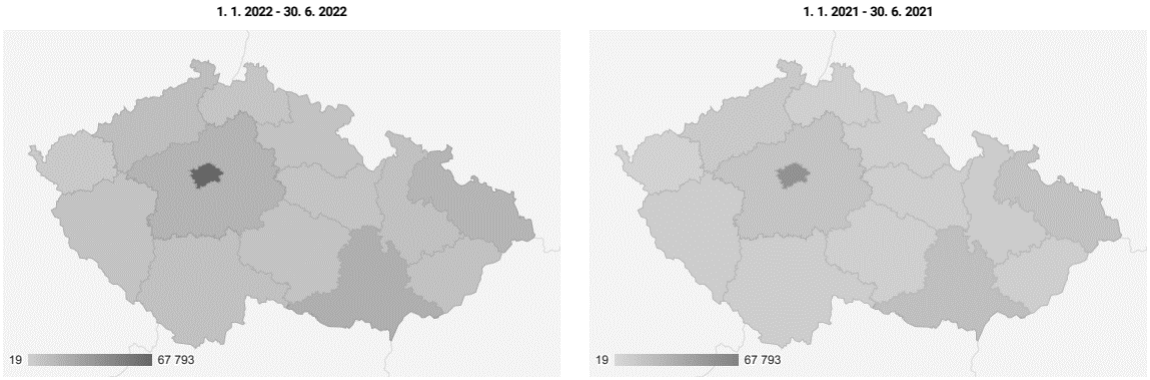


Figure 6. Map Overlay: E-shop 2: Manufacturing and selling food products.

Source: Authors

Another examined e-shop is a company that manufactures and sells headwear and fashion accessories. Table 4 shows the decrease in year-on-year change for all six reference months, referred to as 'red numbers'. The highest drop was recorded in March when the e-shop reached negative numbers, generating lower sales than the previous year, stemming from unfavourable economic conditions such as higher inflation, fear, and uncertainty about future developments when people were saving and hesitating to buy things. Also, the company did not benefit from the closure of brick-and-mortar stores in 2021 due to the change in the shopping environment from traditional brick-and-mortar stores to the online environment. As a result of these changes, there was an enormous increase in sales/revenues compared to 2022, when the brick-and-mortar stores reopened, and the business split back into two forms.

Table 4. E-shop 3: Manufacturing and selling headwear and fashion accessories.

E-SHOP 2					
REVENUES 2021					
January	*February*	*March*	*April*	*May*	*June*
898 878CZK	686 817CZK	686 817CZK	570 813CZK	595 172CZK	666 302CZK
REVENUES 2022					
January	*February*	*March*	*April*	*May*	*June*
716 178CZK	557 951CZK	433 776CZK	468 153CZK	538 940CZK	590 061CZK
ANNUAL CHANGE					
January	*February*	*March*	*April*	*May*	*June*
-20.33%	-18.76%	-36.84%	-17.98%	-9.45%	-11.44%

Source: Authors

The line chart of the e-shop sales/revenues 3 is, on average, 19.13% lower than in the first six months of 2022, see Figure 7. This sector is also affected by adverse economic conditions, where people prefer buying basic goods over superfluous ones, including fashion accessories.

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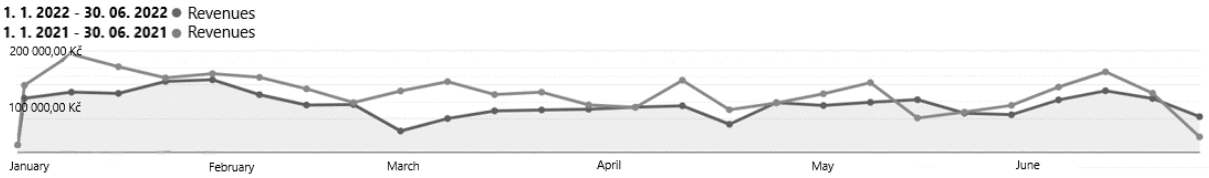


Figure 7. Sales/revenues trend: E-shop 3: Manufacturing and selling headwear and fashion accessories

Source: Authors

A comparison of the year-on-year number of transactions and sales/revenues over the whole reference period shows a correlated trend with a year-on-year variation of 4.4%. This deviation is mainly due to a decrease in the average value of orders caused by the preference for cheaper goods over luxury or premium goods. Another reason involves a change in the product portfolio caused by supply chain shortages, etc.

The sharpest decrease in sales/revenues, see Figure 8, can be observed in the women's segment, by an above-average 31.87%, and in the men's segment, by an overall decrease of 3.52%. The decline in women's interest in the goods is due to the poor choice of products, which means a drop in supply compared to 2021.

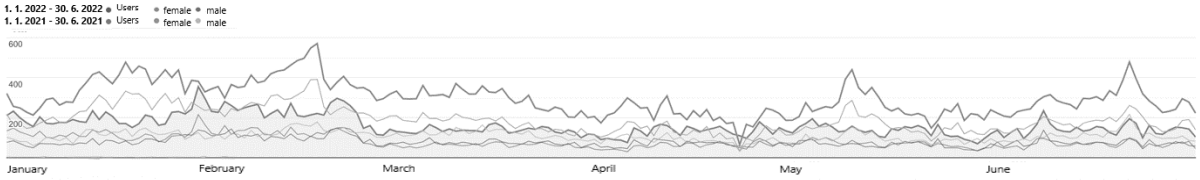


Figure 8. Sales/revenues trend by gender: E-shop 3: Manufacturing and selling headwear and fashion accessories.

Source: Authors

For the NUTS-3 regions, the steepest drop in sales/revenues was observed in the Hradec Kralove Region, whose values decreased year-on-year by 46.59% (see Figure 9). A high decline was also recorded in the Plzen Region (39.18%) and the Usti nad Labem Region (35.10%). Only the Karlovy Vary Region made an average year-on-year increase of 14.38%. The remaining ten regions experienced an annual decrease from 30% to 1% (Figure 9).

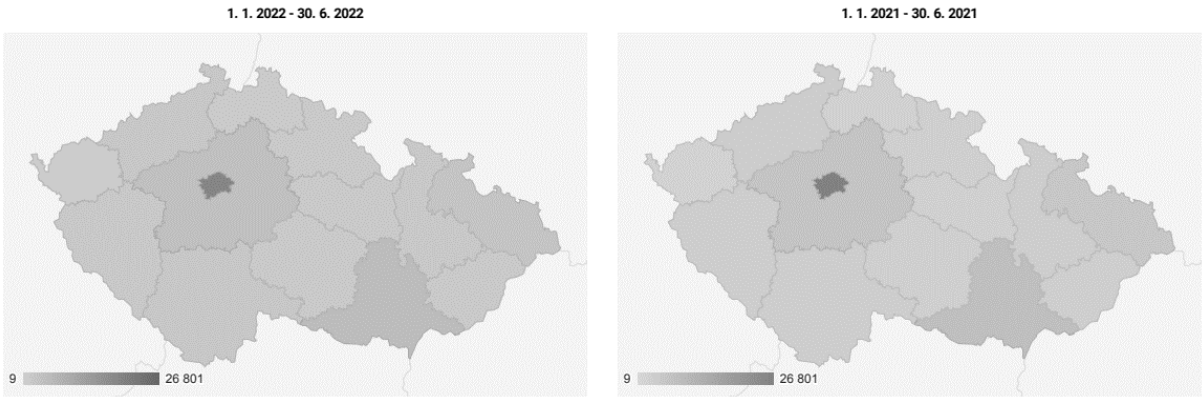


Figure 9. Map Overlay: E-shop 3: Manufacturing and selling headwear and fashion accessories.

Source: Authors

The last studied e-shop is the jewellery manufacturing and sales division, illustrated in Table 5. February recorded the sharpest decrease of 44.24% in year-on-year change, while January indicated the slightest downturn of 15.35%. The reason for such a decline is similar to E-shop 3, i.e., adverse economic conditions and closed brick-and-mortar stores where people preferred bread and butter stuff.

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Table 5. E-shop 4: Manufacturing and selling jewellery.

E-SHOP 4					
REVENUES 2021					
January	*February*	*March*	*April*	*May*	*June*
2 151 040CZK	2 119 729CZK	2 015 849CZK	2 115 185CZK	1 903 302CZK	1 352 837CZK
REVENUES 2022					
January	*February*	*March*	*April*	*May*	*June*
1 820 818CZK	1 181 891CZK	1 496 414CZK	1 422 055CZK	1 154 697CZK	1 071 699CZK
ANNUAL CHANGE					
January	*February*	*March*	*April*	*May*	*June*
-15.35%	-44.24%	-25.77%	-32.77%	-39.33%	-20.78%

Source: Authors

The sales/revenues in 2021 increased by CZK 3.5 million compared to the following year, see Figure 10. In the line chart, see Figure 10, the blue curve with an average decrease of 30% correlates with the orange. The comparison of the year-on-year number of transactions and sales/revenues for the whole reference period of 2021 and 2022 shows a deviation of about 12.34%, mainly caused by the change in the average value of orders that increased due to reframing the e-shop pricing policy and the product portfolio or the fluctuating conversion rate.

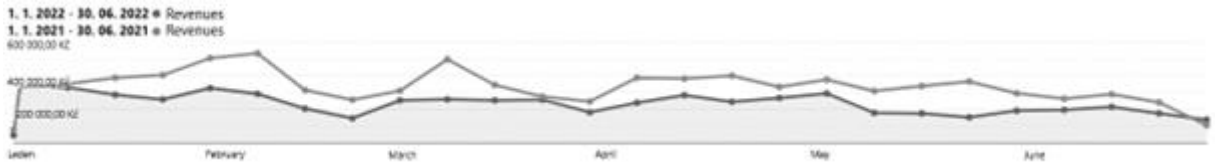


Figure 10. Sales/revenues trend: E-shop 4: Manufacturing and selling jewellery.

Source: Authors

This segment's sales/revenue trend reflects women's waning inclinations, as seen in Figure 11, which recorded a 40.95% year-on-year decline in sales. A year-on-year decrease also indicates the men's flagging interest, plummeting to 24.05%. For men, the decline in sales was less significant than for women, buying products only as gifts.

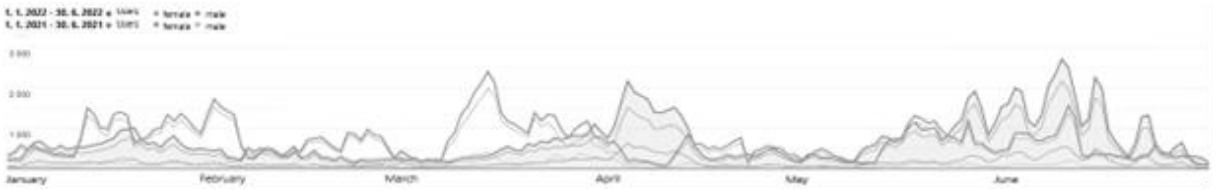


Figure 11. Sales/revenues trend by gender: E-shop 4: Manufacturing and selling jewellery.

Source: Authors

The South Bohemian Region recorded an increase of 18.94% in the year-on-year change of transactions and sales/revenues within NUTS-3 regions, see Figure 12. The steepest year-on-year decrease in sales/revenues was identified for the Vysocina Region (47.32%) and the Plzen Region (45.38%). A slide in sales/revenues ranged from 40% to 20% for the other remaining regions. Furthermore, we identified a non-detectable value in the measurement data, caused by different reasons, e.g., unconfirmed cookie bar, enabled incognito browsing mode, or third-party software, so-called "is not set", showing a year-on-year increase of 627.36%.

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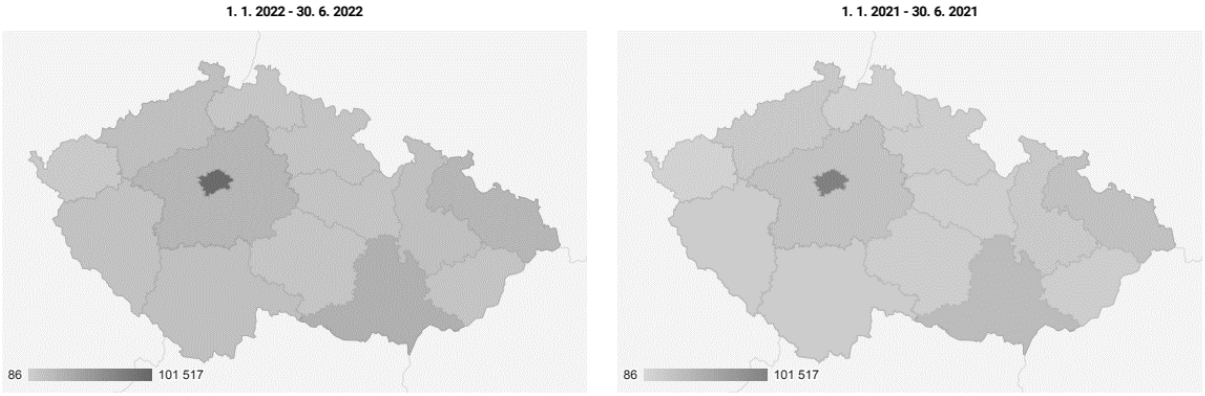


Figure 12. Map Overlay: E-shop 4: Manufacturing and selling jewellery.

Source: Authors

Discussion

The initial reference period defined by the COVID-19 pandemic gave way to another period of energy and resource crisis and the war in Ukraine. This reality shows both the necessity of the issues discussed and the all-society importance that continues to grow in the present time. We set two research questions, taking into account the outcomes of the solution and providing the following comments. The first question:

- Research question 1: Which segments were most adversely affected by the COVID pandemic and the Russia-Ukraine war in the first six months of 2021 and 2022?

The results showed that buying behaviour in 2022 suffered the consequences of the COVID-19 pandemic of previous years or the uncertain environment in segments such as the labour market, energy market, etc. These fundamental reasons have made customers think more about their purchase options. It is also important to mention that the year-on-year changes could reflect marketing events like a sale or a product discount. These events could distort the trend and temporarily increase the year-on-year turnover in this period, although the e-shop has been loss-making for a long time. It is essential to set the figures in the proper context. Pollak & Konecny (2021) also concluded that the global COVID-19 pandemic seriously disrupted traditional supplier-customer relationships, forcing e-shops to change their behaviour. Companies had to move their offline trading to the online environment. According to Švecová et al. (2020), the share of e-commerce was increasing, and buying food, ready meals or medicaments was growing. In general, many purchases would move more to the online environment, which is the case.

Figure 13 below illustrates the average year-on-year sales/revenues for each analysed e-shop. The curve indicates the overall average of all studied e-shops in terms of demographics. The percentages on the left represent the men's segment trend, while the right side refers to the women's preferences. The steepest decrease in sales/revenues can be observed for women, with an average value of 30.80%, while an increase is apparent for men (2.54%). The radical difference involves women boosting turnover, whereas men buy only gift items. For example, E-shop 3 saw its supply chain disrupted because of product shortages, especially the women's assortment. According to Švecová et al. (2020), consumers have also started to favour healthy, safe, and sustainable products, which was encouraged by the pandemic and the change in consumer thinking. Socio-economic crises will still have a long-term impact on shopping, including consumer behaviour. The typical new behaviour in a crisis period is saving money and reconsidering purchasing decisions, especially for luxury goods. On the contrary, buying sustainable or healthier products will be prioritised.

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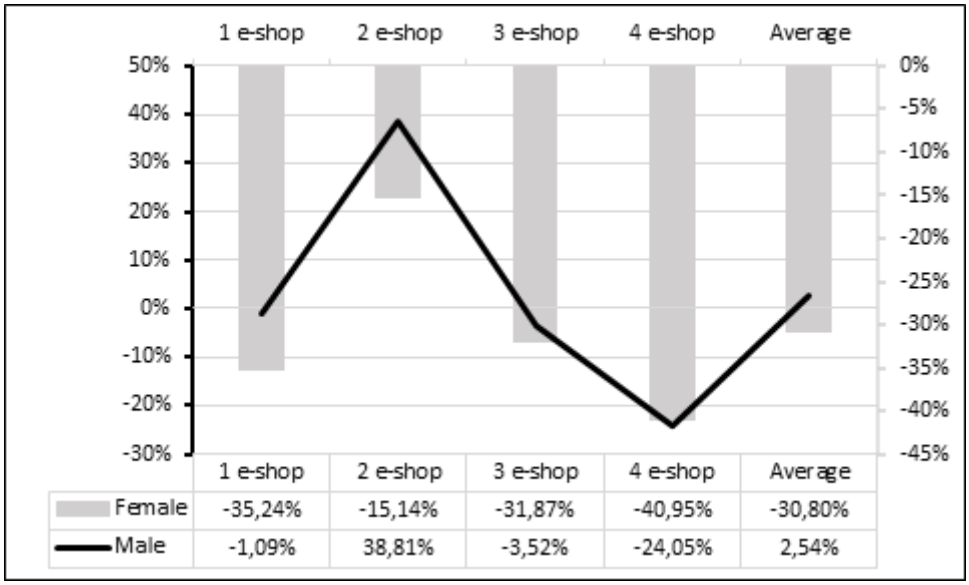


Figure 13. Impact of crisis situations on the demographic breakdown of the segments studied.

Source: Authors

In line with the research results, question 2 (below) can be answered as follows.

- Research question 2: Can a one-third drop in sales/revenues be expected in the e-commerce sector over the two quarters of 2021 and 2022?

The average decline in sales/revenues for the first two quarters of 2021 and 2022 were identified in the cosmetics segment, reaching 24%, followed by the fashion industry at 19% and the jewellery industry at almost 30%. On the other hand, an average year-on-year increase in sales/revenues was identified in the food industry (1.82%), see Table 6. E-shop 1 saw the sharpest average decrease in sales/revenues (cosmetics) due to the post-COVID crisis and other economic conditions. People did not spend money on more expensive high-quality cosmetics, preferring readily available products. E-shops 2 and 3 (fashion and jewellery) also witness an average decrease in year-on-year sales/revenue, affected by adverse economic conditions such as inflation, fear, and uncertainty about the future, making people resort to basic and life necessities. E-shop 2 (cosmetics) was the only one with increased average sales/revenues year on year. Sales in this segment involved physical stores and e-commerce, and the quick response of the e-shop owner and management to the slump in the first two quarters of 2022 affected the sales trend. The company has introduced attractive promotional offers, including new additions to its product portfolio. Lower prices have driven customers' motivation to make purchases.

Table 6. E-shop 4: Manufacturing and selling jewellery.

ANNUAL CHANGE							
	January	**February**	**March**	**April**	**May**	**June**	**AVERAGE**
E-SHOP 1	-1.37%	-50.79%	-30.40%	-14.48%	-39.79%	-5.66%	-23.75%
E-SHOP 2	-23.37%	-54.42%	-60.67%	31.03%	16.20%	102.13%	1.82%
E-SHOP 3	-20.33%	-18.76%	-36.84%	-17.98%	-9.45%	-11.44%	-19.13%
E-SHOP 4	-15.35%	-44.24%	-25.77%	-32.77%	-39.33%	-20.78%	-29.71%

Source: Authors

We argue (Agus et al., 2021) that none of the companies studied benefits from closing brick-and-mortar stores in 2021. There was a disproportionate growth in sales/revenues compared to the following 2022 (physical stores opened), and sales/revenues were split between the offline and online environments. The outbreak of the

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COVID-19 pandemic in the first quarter of 2020 significantly drove e-commerce growth. Lockdowns were introduced in many European countries, leading to a shift from physical to offline shopping. Consumer behaviour has changed, and businesses have responded by adopting more advanced technologies towards digital transformation. There has also been a significant change in the age structure of consumers, especially the older generation, and their preferences associated with digital literacy and marketing promotions, especially for healthy and sustainable goods (Gavurova et al., 2024). The research study by Stofkova et al. (2022) confirms the above conclusion but also points out that SMEs and the implemented measures related to the COVID-19 pandemic and other economic crises have affected both - businesses and consumer buying behaviour.

Conclusions

In line with the set objective of the paper and research questions, we formulate the following findings concerning the issue. The goal of the paper was to describe the development of selected Czech segments in e-commerce for the period from the first half of 2021 to 2022 and evaluate the adverse effects of the COVID-19 pandemic and other economic crises, which recently have shown the business sector that digitisation and shift to the online environment can play a leading role in maintaining and developing business activities. The research provided valuable data on the development of e-commerce. The selected method allowed answers to the research questions.

Besides making a profit, the main goal of all small and medium-sized enterprises is to optimise warehousing and logistics costs. The massive growth that e-commerce has achieved in recent years reflects the improvement in customer service and speed of delivery, which is the way to win customer loyalty. E-commerce personalisation enables the formulation of consumer preferences, pre-selection of their favourite categories, and selection of current offers and discounts. E-shops can use the obtained data for further analysis concerning the implementation of strategic marketing. Correct and systematic data analysis can help tailor offers, discounts and other additional services to potential customers.

Our research has the following limitations: applying the proposed methods to one selected country from the first half of 2021 to 2022; the study can fall into the category “is not set”, which appeared in the geographical breakdown of regions according to NUTS 3. It is an unmeasurable data point caused by an unconfirmed cookie bar, an anonymous mode enabled in the browser, or third-party software. The presented research is unique, as no other survey on NUTS 3 regions has occurred in the Czech Republic.

The pandemic taught the Czech public to largely use online shopping, which applies to older generations, too. With the opening of the retail market, online sales growth has slowed down slightly compared to previous months but will grow in the future. As part of their consumer behaviour, people increasingly prefer this form of shopping, and brick-and-mortar stores will see fewer customers than before the pandemic. A promising solution is to combine offline and online stores. Retailers without online businesses will be trying to launch or develop their e-shops. Existing e-shops will continue their activities by building distribution points (showrooms). For these reasons, the share of e-commerce in total retail sales will continue to grow in the following years. Online shopping is becoming increasingly popular even with the older generation, who had to change their consumer habits due to the pandemic, and their purchases consist mainly of medicines, food, and furniture.

The research implies that technological readiness, openness to innovation, information capabilities, and technology will convince small and medium-sized enterprises to adopt e-commerce. Small and medium-sized enterprises with higher levels of knowledge and practical skills, flexibility and varied business activities will gain significant competitive advantages by implementing e-commerce compared to enterprises that have not adopted this form of business. The paper also presents the outcomes from the first part of the research. The follow-up research will analyse selected Czech e-shops and their impact in the current, more challenging crisis than the COVID-19 pandemic.

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THE IMPACT OF INDUSTRY 4.0 ON BUSINESS RESULTS

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Abstract. The article aims to present the impact of Industry 4.0, which has developed worldwide as a new revolution in production and impacted manufacturing companies and changes in companies in the Czech Republic that apply it. Discussions in the engineering business emphasise the need to consider both the benefits and drawbacks of proposed modifications. In today's fast-paced environment, staying current with trends and continuing education is critical. Changes can be chaotic, affecting several industries. Businesses must change rapidly to stay caught up. The current trend is Industry 4.0, in which emphasis is placed on automation, digitisation, robotisation, artificial intelligence, etc., and this is an era of opportunities for digitalisation on a comprehensive scale. Employee change in response to new technology requires preparedness and skill development. Furthermore, business investment prioritises land and labour substitution for capital and technological equipment updates. The industry seeks to improve process quality and efficiency while promoting environmental sustainability and waste reduction in corporate production, emphasising the critical need for a comprehensive sustainable strategy. The study examines the influence of Industry 4.0 on corporate performance over five years, focusing on prospective transitions towards the new industrial age. The authors employed data collection, content analysis, and correlation approaches. The findings show varying added value patterns post-implementation, impacted mainly by firm size.

Keywords: Industry 4.0; enterprise; automation; robotization; digitalization

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JEL Classifications: M21, E31, E61

1. Introduction

Currently, Industry 4.0 is considered an industrial phase in which horizontal and vertical production processes ensure companies achieve higher performance with the help of technology (Dawale et al., 2023; Lewandowska et al., 2023; Song, 2023). With new technologies also come new opportunities in the field of work, and therefore it is necessary to prepare the current and future generations of workers for this situation Turek et al., 2023; Cramarenco et al., 2023). In developed countries, this transformation is led by digitising and integrating production processes throughout the value chain. It is therefore necessary to focus on implementation, especially in developing countries (Medić et al., 2020; Quyet, 2024). Understanding the characteristics and technical environment of Industry 4.0 is crucial for businesses, as they can formulate strategies dealing with digital transformations based on their development needs (Li, 2023). The goal is a paradigm shift from computer-controlled manufacturing to a smart factory concept in which machines, personnel, and materials are connected and adapted to digital change. It is a connection between information and operational technologies (Meyendorf et al., 2023).

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It is also necessary to prepare for this revolution, especially in education. Automation is effective only if understanding digitisation and using data to improve process quality and efficiency (Udvaros et al., 2023). Following today's increasing supply and demand in chains, planning tasks to provide flexibility and avoid complexities is essential. The most important prerequisite for developing networks and applications is the flexibility of the supply chain (ERDİL, 2023). Pursuing technical and economic progress, which must align with ethical considerations, environmental sustainability, and social responsibility, is central (Mhlanga, 2023). In this direction, robots and their cognitive functions have been improved, and dynamic capabilities have expanded. These are related to kinematics, self-control, and self-diagnosis (Barasa & Etene, 2023).

The essential technologies of Industry 4.0 are virtual and augmented reality, cyber-physical systems, blockchain technology, artificial intelligence, cloud computing, and additive manufacturing (Kolupaieva & Tiesheva, 2023; Lăzăroiu et al., 2022; 2023; Androniceanu, 2023; Hrab & Minculete, 2023).

The article aims to evaluate the impact of Industry 4.0 on selected manufacturing companies that operate in the Czech Republic, apply it, and indicate whether its effect on the company's added value and the economic result is proven.

RQ1: What is the tendency of the added value of the investigated companies after the application of Industry 4.0?

RQ2: Is there a proven correlation between the added value of the selected companies and their economic result after the application of Industry 4.0?

2. Literature Review

Researchers Kai et al. (2023), using a longitudinal case study and a qualitative analysis from the point of view of creativity, state that innovations related to Industry 4.0 are very investment-intensive and should be incredibly creative and subsequently lead entrepreneurs to success. Nimawat & Gidwani's (2023) questionnaire surveys revealed that companies are moving to Industry 4.0 to ensure competitiveness in developed countries.

According to Issa (2023), who based his study on qualitative analysis, the fourth industrial revolution is the integration of modern technologies and digitisation. He states that if companies understand the factors of Industry 4.0, they will secure a driving engine and effectively use their potential. Shadravan & Parsaei (2023) use interpretive structural modelling to illustrate relationships using different sustainability roles. The study's result points out the need to consider the concept of Industry 4.0 as a road map showing how to use technology for intelligent production. According to Labaran & Masood (2023), Green Supply Chain Management (GSCM) and renewable resources affect the sustainability of the supply chain and renewable energy. The authors stress the importance of business investments directed towards purchasing and sourcing, business relations, transport, logistics costs, sustainability, and waste reduction (Skare et al., 2023a,b; Gavurova et al., 2022a). In their study, Kılıç et al. (2023) used focus group methods and interval-valued spherical fuzzy IVSF-AHP. They concluded that a digital transformation is an effective tool for evaluating success and progress worldwide. The implementation of Industry 4.0 is necessary as a digitalisation infrastructure.

Wolniak & Grebski (2023) claim that Industry 4.0 tools are a strategic imperative leading to the continuous improvement of all business operations and will take a competitive position in a dynamic world. Using correlation and confirmatory factor analysis, Nitlarp & Kiattisin (2022) conclude that the conventional investment paradigm is no longer successful, and companies focus on environmental, corporate, and social investments. Kantar's (2022) study, which dealt with the logistics 4.0 process, shows that it is essential for companies to reduce working capital, inventory, and warehousing costs and to increase the services they provide to customers.

Andrusevich et al. (2022) solve tasks related to overviews of robots used in industry. They analyse risks and, using the method of system analysis and graphical generalisation and classification, perform an analysis of the

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current state of robotics in production, which results in economic, technological, environmental and financial uncertainties and challenges. Qammar et al. (2023) implemented a study, the originality of which lies in suggesting a specialised theory and creating a cyber-physical system that shows the positive impact of Industry 4.0 on waste management. Tsyba (2023) states that it is necessary to indicate steps that would allow to outline the innovative development via the revelation of decision-making capabilities of enterprises to analyse needs, define strategic goals, plan resources, and focus on financing and researching new technologies they want to implement.

Khan & Rizwan (2023), using descriptive statistics, correlation analysis, and diagnostic tests, found that corporate investment has a direct relationship with social responsibility and corporate efficiency. Therefore, managers should use their corporate resources to achieve company goals. However, some obstacles in this way are, for example, the complexity of data management, personal data protection, the high costs of implementing new technologies, and possible shortcomings and gaps in employees' skills (Gavurova et al., 2024). Based on quantitative research and interviews, Młody et al. (2023) concluded that Industry 4.0 technologies benefit from managerial decisions in the value chain through optimised business processes, eliminated errors, and reduced costs.

Wolniak & Grebski (2023) dealt with the investment in personalisation in the era of Industry 4.0. Their analysis of the literature showed that digitalisation and data employment effectively reduce waste (Gavurova et al., 2022b; Skare et al., 2024). Still, the company must plan carefully, comply with regulatory standards and ethical principles, and invest appropriately (Olah et al., 2021; Simionescu et al., 2021). The digital transformation of domestic companies should also focus on employees. Kablashova et al. (2023) point out that management must involve employees in business and organisational changes, primarily due to digital transformation, which can motivate employees to take the initiative and actively participate in projects. Mehmood & Farshchian (2023) conducted research related to information systems. Their study underlined the human factor as the cause of failure. Therefore, they assume that initiative workers are needed for digital transformation to be successful.

Pinto & Reis (2023) concluded that current and future generations should engage in hybrid-type learning. However, the technical equipment has limits, and the necessary depth in such teaching still needs improvement. Berthanila et al. (2023) used a quantitative approach and the Krijce table; hypotheses were tested via the Structural Equation Modelling analysis and came to the conclusion that employees who are more innovative and able to respond to changes quickly achieve better results; their motivation is related to their excellent performance. Udvaros et al. (2023) examined the needs of new employees who must be prepared to solve problems and develop the skills needed for the era of education 4.0, for which the infrastructure enabling virtual, digital, and technological development will be central. Using a questionnaire survey, Caha et al. (2019) found that corporate education in ICT (information and communication technologies) needs to be prioritised. This finding applies to the primary, secondary, and tertiary sectors and businesses of all sizes.

Dev (2023) used a questionnaire survey method in which almost 300 employees responded and applied multiple regressions; he found a significant influence of employees' physical, psychological, and functional comfort on their commitment and ability to engage in changes related to digitisation and automation. Deny's (2023) results show that organisational culture, digital transformation, and productivity positively affect employee performance. Business investments are also linked to storage and logistics (Tikwayo & Mathaba, 2023). In their publication, the authors employed Pareto analysis and concluded that implementing Industry 4.0 in the warehouse economy will improve efficiency and digital integration; data will be available in real time. Still, the obstacles are precisely high investment, insufficient support resources, and data security risks. Taş (2023) dealt with quantitative data analysis in a company's case study using Radio Frequency Identification (RFID) warehouse technology and came to the insight that applying Logistics 4.0 reduced the company's logistics operations costs by 13.37%.

The information security of the enterprise system is also related to the application of the new era of industry (Klishin & Chechulin, 2023). For their research, the scientists used the method of analysis of standards, studied selected models that ensured information security for companies and concluded that it is necessary to analyse

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the selection criteria and choose a relevant system for the corporate infrastructure, especially according to the size of the company, as the requirements will be different, and the investment impact vary significantly.

3. Methodological Approach

The methodology for the article was chosen to fulfil the research objective as best as possible. The literature search is based on professional articles from the websites Scopus and WOS, from which it is drawn. For the application part, the reports of the analysed companies will be used, and the results of this article will be derived with the help of statistical methods. Graphs and tables will be created and commented on based on the techniques used.

3.1 Data

The profit and loss statement values will be analysed, specifically the added value from the main activities of the selected companies - Vishay Electronic spol. s. r. o., Faurecia Automotive Czech Republic, s. r. o., Aisin Europe Manufacturing Czech, s. r. o., Motor Jikov Strojírenská a. s. and SINOP CB a. s. The economic results of the companies after taxes, which are recorded in the profit and loss statements, will also be examined. Data will be tracked in selected companies from 2018 through 2022, mainly due to their availability. These documents will be consulted using public internet portals on which companies publish their results so it can be concluded that the data will be reliable.

3.2 Methods

The obtained data will be processed using several statistical methods to answer the research questions. First, the data collection method will be applied. The content analysis of the documents will follow; specifically, each company's profit and loss statements from 2018 to 2022 will be evaluated. The monitored values in the statements will be sales revenue, material and service costs, added value, calculated as the difference between sales revenue and the cost of materials and services, and, finally, the economic result after taxes. The documents will be available on the public server, and the data will be recorded in Table 1 of the application section. Quantitative research will be used to compare a set of data or indicate any statistically significant differences. A comparison of the obtained data will also be applied, the results of which will be interpreted based on the created graphs. The obtained values will be correlated to determine the mutual relationship of the observed quantities and the subsequent impact on the concurrency of these values.

Here, higher values of one variable are associated with higher values of the other variable, but the reverse is also true. Therefore, if one of the monitored quantities changes, the other also changes, and the same applies in the opposite case. The correlation coefficient expresses the strength of the correlation. It can take on values from -1 to +1. If the value is +1, it means completely direct dependence; if -1, it means utterly indirect dependence, i.e., anti-correlation. The result can be interpreted so that the more the values in the first group of values increase, the more the values in the second monitored group decrease. If the result of the correlation coefficient is equal to 0, it is uncorrelated, meaning there is no statistically detectable linear dependence between the correlated values. If the value of the correlation coefficient is in the interval in absolute value from 0 to 0.3, the dependence is considered unproven. Suppose the correlation coefficient in the interval is more significant than 0.3 to 0.7 in absolute value. In that case, it is considered loosely dependent, and if it is more significant than 0.7 in absolute value and less than 1, it is considered tightly dependent. If the value of the correlation coefficient is in absolute value 1, it means functional dependence. According to the + sign, the dependence of the correlation coefficient is direct, and according to the - sign, it is indirect.

Equation 1 shows the formula for calculating the correlation:

$$\rho_{X,Y} = \frac{E(XY) - E(X)E(Y)}{\sqrt{E(X^2) - E^2(X)}\,\sqrt{E(Y^2) - E^2(Y)}} \quad (1)$$

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4. Results and Discussion

To compare the impact of Industry 4.0 on corporate investments, 5 companies operating in the South Bohemian region of the Czech Republic with a similar focus, which applies the new industrial era to their production, were selected. The research was directed to the profit and loss statement, from which the added value was calculated, relating to the products, not the companies' goods. 5 consecutive periods were analysed from 2018 to 2022. Production value added was calculated as the difference between the company's income from sales and the cost of providing materials and services. The first selected company is Vishay Electronic spol. s. r. o., branch in Přeštice. It is a global company with 23 production plants in Europe, 4 in the Czech Republic. It also employs approximately 1,800 employees here. It owns 17 branches in America, 21 in Asia and the Pacific. Their production focuses on components for cars, telephones, robots and appliances, resistors, capacitors, and inductors. The company aims to focus on technology and constantly develop, especially emphasising technology, which they perceive as a tool and driver of progress, innovation, and positive change.

The other company is called Faurecia Automotive Czech Republic s. r. o., which is based in Písek. It employs approximately 5,000 employees here. It is a leader in automotive technology and inspires the future of mobility. It has 8 branches in the Czech Republic but operates in 33 countries worldwide. The branch in Písek is focused on producing metal car seat structures, using classic welding methods and modern methods such as lasers. The company's goal is to be an example for other companies, to consider the exhaustibility of resources, and to be responsible for its decisions. The third selected company is Aisin Europe Manufacturing Czech, s. r. o., which also operates in Písek. It employs approximately 1,000 employees here. It is a leading manufacturer and supplier of auto components for customers such as Volvo, Toyota, Renault, Dacia, Nissan, and JTEKT. In its production, it uses automated and robotic workplaces mainly to produce gearboxes and engine castings, as well as for the assembly of plastic components. The company's production processes are machining, assembly, vibration welding, and pressure casting of aluminum. The fourth company is Motor Jikov Strojírenská a. s. Their production is focused on components for trucks, consumer equipment, handling equipment, hydraulic and filter systems, or woodworking. It employs approximately 1,000 employees. Their production lines are partly robotic and automated. Regular investments are aimed at new production technologies with a high degree of automation, process stability, and reliability. According to their studies, the investments in these projects are realised with a maximum return within five years. They also draw on subsidy sources from European programs. The company manufactures tools, casts semi-finished products and machines, and assembles and constantly optimises its production and technological processes. Their goal is to increase the utility value of products and services. The last monitored company is SINOP CB a. s., based in České Budějovice, which focuses on producing industrial cooling, air conditioning, cooling tap technology, and beverage technology. They employ approximately 700 employees here. They also provide components such as filters, regulators, air dampers, valves, and spare parts.

Table 1 shows selected companies' performance for 2018–2022. Values are given in thousands. CZK. Revenues from sales, costs of materials and services, and value-added are calculated as the difference between sales revenue and costs of materials and services, and finally, the economic result after taxes are captured. The mentioned values are influenced by applying Industry 4.0 to production, which all companies implement.

Table 1. Monitored companies

Monitored years	VISHAY ELECTRONIC spol. s r.o.			
	Sales revenue	**Cost of materials and services**	**Value added**	**Profit**
2018	1 944 840	1 146 074	798 766	75 814
2019	2 060 769	1 163 917	896 852	82 183
2020	1 818 429	931 563	886 866	71 619
2021	2 128 567	1 518 850	609 717	82 068
2022	2 519 790	1 695 072	824 718	103 588
	Faurecia Automotive Czech Republic s.r.o.			

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Monitored years	Sales revenue	Cost of materials and services	Value added	Profit
2018	11 833 450	11 302 235	531 215	230 169
2019	13 941 716	13 033 987	907 729	544 014
2020	13 400 718	13 000 035	400 683	293 460
2021	16 929 553	16 238 505	691 048	268 218
2022	17 974 781	16 974 382	1 000 399	404 762
Monitored years	**Aisin Europe Manufacturing Czech s.r.o.**			
	Sales revenue	**Cost of materials and services**	**Value added**	**Profit**
2018	2 390 387	1 919 323	471 064	17 550
2019	2 381 701	1 850 178	531 523	20 026
2020	2 201 707	1 669 841	531 866	9 846
2021	2 045 217	1 518 158	527 059	54 252
2022	2 295 116	1 703 820	591 296	53 383
Monitored years	**MOTOR JIKOV Strojírenská a.s.**			
	Sales revenue	**Cost of materials and services**	**Value added**	**Profit**
2018	985 720	900 125	85 595	-5 962
2019	938 903	833 266	105 637	1 543
2020	810 674	728 455	82 219	-20 637
2021	944 758	932 310	12 448	31 685
2022	1 092 316	1 048 964	43 352	39 983
Monitored years	**SINOP CB a.s.**			
	Sales revenue	**Cost of materials and services**	**Value added**	**Profit**
2018	516 655	459 454	57 201	64 063
2019	735 248	509 464	225 784	110 022
2020	625 035	468 458	156 577	95 162
2021	629708	445 571	184 137	60 775
2022	672 824	544 357	128 467	70 263

Source: Custom processing, 2023

The values shown in Table 1, i.e., the company's movements and results, were correlated according to the formula in the methodology for all the years listed so that their dependence was apparent. The given values are rounded to 3 decimal places. The results of the correlations at VISHAY ELECTRONIC s. r. o. were as follows: In the case of correlated values from sales revenue and material and service costs, the result was 0.929, which implies that the more the sales revenue grows, the more their material and service costs also grow. The correlation of added value and costs of materials and services was -0.536, i.e., the more the added value increases, the more the cost of materials and services will be reduced, and there is an inverse relationship. A negative value of -0.187 was found for the correlation of sales revenue and value-added.

The more the income from sales increases, the more the added value will decrease; again, the inverse ratio applies here. Sales revenue and economic results show a correlation coefficient of 0.992, which means that the more sales revenue increases, the more economic results will increase, and it is a close relationship. The result of the correlation coefficient of 0.877 came out when calculating the values of the costs of materials and services and the economic result. Again, it is very close to the value of +1, so direct proportionality applies, and the dependence of the values is right here. A correlation coefficient of -0.065 resulted in added value with the economic result. We can also interpret the result so that there is almost no statistically linear dependence

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between the selected values , and an indirect relationship applies here. The results of the correlations at Faurecia Automotive Czech Republic s. r. o. came out as follows.

In the case of correlated values from added value and economic result, the correlation coefficient was 0.741. The more the added value grows, the more the economic result will increase, and the result is closely dependent. 0.141 is the result of correlating the costs of materials and services with the economic result, from which it follows that there is no proven dependence. The correlation coefficient of 0.996 is based on sales revenue and costs of materials and services. It is very close to the value of +1, so we can say that the more the sales revenue increases, the more the cost of materials and services will also increase, and this is a tight relationship. The value added correlated with sales revenue was 0.654, meaning there is a loose dependence here. 0.205 is the resulting correlation coefficient for sales revenue and economic result; there is an unproven dependence, and 0.592 is obtained after the correlation of the costs of materials and services with added value, which indicates a free dependence. Results of calculated correlations at Aisin Europe Manufacturing Czech s. r. o. they came out like this. The added value with the economic result shows a result of 0.566, i.e., free dependence. The costs of materials and services, which were correlated with the economic result, took on values of 0.87 and are approaching the value of +1, so once again, there is a direct relationship and a tight dependence. The correlation coefficient charged negative values of -0.499 after entering the income values from sales and economic results; here, it is an indirect ratio. The correlation coefficient calculated from sales revenue and costs of materials and services, which was 0.973, was closest to +1 for this company, and the dependence is right here. -0.197 is the result for sales revenue and value-added data; again, an inverse relationship applies here. The coefficient closest to -1, i.e., the indirect ratio, is -0.715. The result is for material and service costs and added value.

The more the costs of materials and services rise, the more the added value will fall. Results of calculated correlations at MOTOR JIKOV Strojírenská a. s. are as follows. The added value correlated with the economic result is -0.778, closest to -1. In this case, it is true that the more the added value increases, the more the economic result will decrease, i.e., an inverse relationship. The costs of materials and services and the economic result show a correlation coefficient of 0.898, which is a direct correlation and close dependence. Sales revenue and economic results have a coefficient of 0.766, and the correlations from the values of sales revenue and costs of materials and services are closest to +1. The dependence is also tight in this case. If sales revenue increases, the cost of materials and services will also increase. The negative value of -0.326 represents the correlation coefficient of sales revenue and value-added. -0.592 is the result of the cost of materials and value-added services. Again, indirect proportionality applies here in both cases. The last values are the results of calculated correlations at SINOP CB a. s.

All their correlation coefficients come out positive. Added value with the economic result has a coefficient correlation value of 0.626; it is a free dependence, and the cost of material, and the economic result is 0.306; there is also a case of free dependence. Revenue from sales and economic results after correlation have a value of 0.650, that is, free dependence, and revenue from sales and costs of materials and services have a correlation coefficient of 0.622, i.e., free dependence of these values. The +1 coefficient of sales revenue and added value comes closest because it comes out to be 0.865, and the dependence of these values is tight. Again, direct proportionality applies here, that the more the income from sales grows, the more the added value will increase. The lowest result was achieved by the correlation coefficient for the costs of materials and services with an added value of 0.145. It comes closest to 0, which means that statistical linear dependence is not proven for these values.

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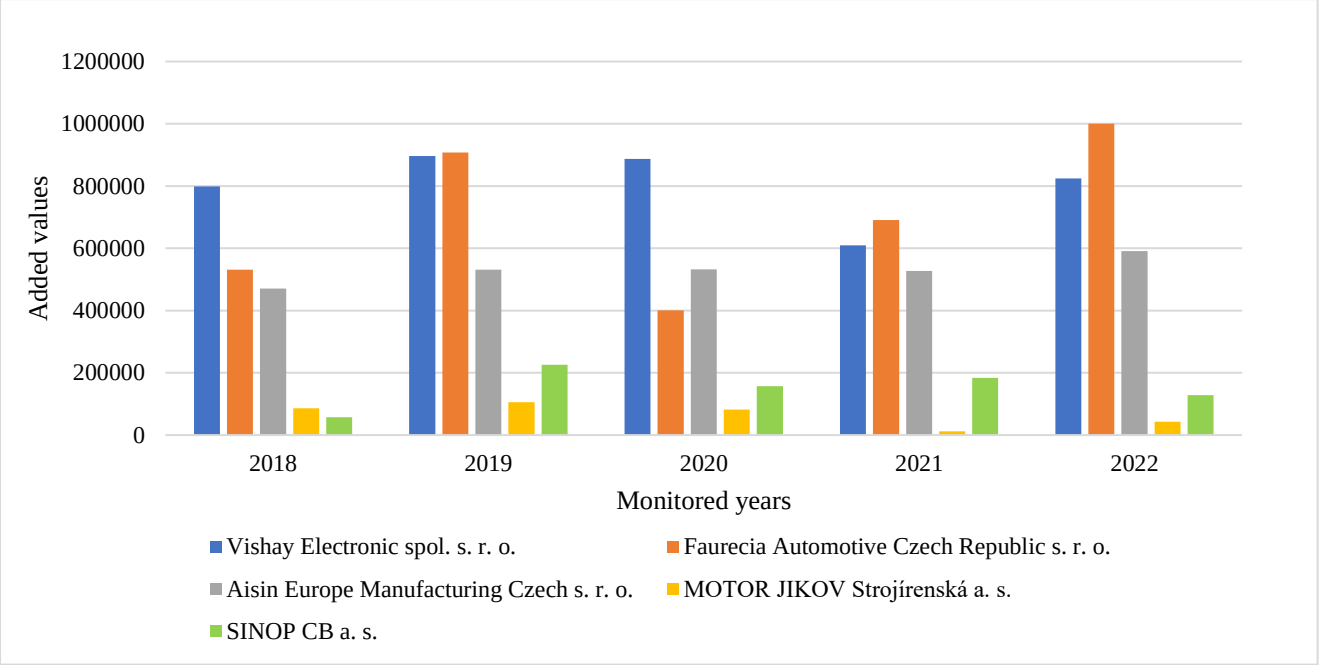


Figure 1. Comparison of added value at selected companies
Source: Custom processing, 2023

Figure 1 shows a graph in which the added value of selected companies is compared in thousands. CZK applies elements from Industry 4.0 in its corporate environment. Vishay Electronic spol. s. r. o. (First Company) and Faurecia Automotive Czech Republic s. r. o. (Second Company) Aisin Europe Manufacturing Czech s. r. o. (Third Company), SINOP CB a. s. (Fourth Company) and MOTOR JIKOV Strojírenská a. s. (Fifth Company) are comparable in terms of size. In 2018, Vishay Electronic spol. ranked first according to the added value results. s. r. o. with a result of 798,766, then Faurecia Automotive Czech Republic, s. r. o. with a result of 531,215, Aisin Europe Manufacturing Czech s. r. o. with a result of 471,064, then MOTOR JIKOV Strojírenská a. s. with a result of 85,595, and SINOP CB a. s. with 57,201. In the following year, 2019, the added value of the First Company increased to 896,852, the Second Company to 907,729, the Third Company to 531,523, the Fourth Company to 105,637, and the Fifth Company to 225,784.

Compared to the previous year, all companies increased their added value. In 2022, the first company saw a drop in value added to 886,866, the Second Company saw a noticeable drop to 400,683, the Third Company remained at very similar values of 531,866, the Fourth Company saw a drop to 82,219, and the Fifth Company also dropped to 156,577. In 2021, there is a decrease in value added for the First Company to 609,717, compared to the Second Company, which increased it to 691,048. The Third Company's values slightly decreased to 527,059, the fourth company had a significant decrease in added value to 12,448, and the fifth company saw an increase to 184,137. In the monitored year 2022, the First Company increased its added value to 824,718, the Second Company also rapidly increased to 1,000,399, the Third Company increased to 591,296, the Fourth Company also increased its added value to 43,352, and the Fifth Company saw a decrease in its added value to 128,467.

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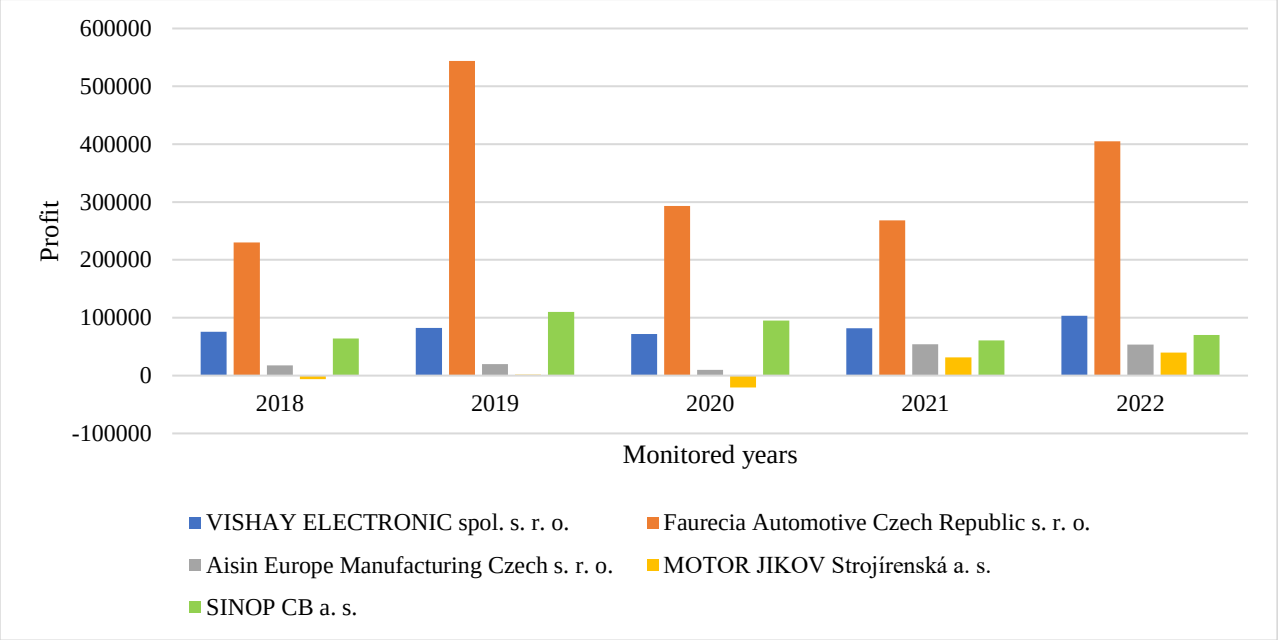


Figure 2. Comparison of profit at selected companies
Source: Custom processing, 2023

Figure 2 shows a graph in which the economic results after taxation of selected companies are compared. CZK applies elements from Industry 4.0 in its corporate environment. Vishay Electronic spol. are comparable in size. s. r. o. (First Company) and Faurecia Automotive Czech Republic s. r. o. (Second Company). Furthermore, Aisin Europe Manufacturing Czech s. r. o. (Third Company), SINOP CB a. s. are comparable in terms of size. (Fourth Company) and MOTOR JIKOV Strojírenská a. s. (Fifth Company). In 2018, the First Company reported a profit after tax of 75,814, the Second Company of 230,169, the Third Company of 17,550, the Fourth Company -5,962, and the Fifth Company 64,063. In the following year, 2019, all companies increased their economic results.

The First Company had a result of 82,183, the Second Company saw a rapid increase to 544,014, the Third Company increased its results to 20,026, the Fourth Company also increased its results to 1,543, and the Fifth Company increased to 110,022. The following year, 2020, was, on the other hand, when the economic results of all monitored companies decreased. For the First Company, it was 71,619; for the Second Company, it dropped rapidly to 293,460; for the Third Company, it was 9,846; the Fourth Company showed negative values and a rapid decrease to -20,637 and the result of the Fifth Company was 95,162. In 2021, the First Company had 82,068, a slight increase; the Second Company saw a decrease to 268,218; the Third Company had an increase to 54,252; the Fourth Company reported 31,685, a noticeable increase; and the Fifth Company saw a decline to 60,775. In the last monitored year, 2022, the First Company's profit after tax increased to 103,588, the Second Company rapidly increased to 404,762, in the case of the Third Company, there was a slight decrease to 53,383, the Fourth Company had an increase to 39,983, and the last Fifth Company saw an increase in the economic result to 70 263. All numerical values are given in thousands of Czech crowns.

5. Discussion

For the research in the article, two research questions were set, which deal with the influence of Industry 4.0 on the selected enterprises and their added value and economic result. The research questions are as follows: What is the tendency of the added value of the investigated companies after the application of Industry 4.0? Is there a proven correlation between the added value of the selected companies and their economic result after the application of Industry 4.0? Synthesis, deduction, and induction are also used to answer questions.

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Research question 1: What is the tendency of the added value of the investigated companies after the application of Industry 4.0?

To answer this question, a table was prepared, from which a graph was subsequently created, in which the comparison of individual companies in the monitored years 2018–2022 is presented. At Vishay Electronic spol. s. r. o., the added value for 2018 and 2019 had an increasing tendency. However, it decreased in the following years, 2020 and 2021, and the increase did not follow until 2022. The next monitored company was Faurecia Automotive Czech Republic s. r. o., whose added value trend was increasing in 2018 and 2019. In 2020, it recorded a decrease, i.e., the tendency was downward, but in the following years, 2021 and 2022, the added value increased again. The trend of added value at Aisin Europe Manufacturing Czech s. r. o. was increasing from 2018 to 2019.

The following years, 2020 and 2021, were balanced with 2019, so it was a constant trend. In 2022, this value was increasing. Another monitored company was MOTOR JIKOV Strojírenská a. s., whose added value increased in 2018 and 2019 and decreased in 2020 and 2021. In the last year, 2022, the added value grew again. The last monitored sample was the company SINOP CB a. s. It recorded an increase in added value in 2018 and 2019, but in 2020, it decreased slightly again. Until the following year, 2021, the value-added had an increasing tendency, and in the last year, 2022, it decreased again. From these results, it can be concluded that all the selected companies recorded an increase in added value in 2018 and 2019, but in the following years, their results differed. The company Aisin Europe Manufacturing Czechs. r. o. had the most constant added value, and Faurecia Automotive Czech Republic s. r. o. recorded the biggest jumps in added value values. According to the author Tsyba (2023), it is necessary first to develop steps that outline enterprises' innovative development and decision-making capabilities to analyse needs, define strategic goals, plan resources, and focus on financing and researching new technologies they want and can implement.

Research question 2: Is there a proven correlation between the added value of the selected companies and their economic result after the application of Industry 4.0?

To answer this question, correlations between the added value and the economic result of the monitored companies were calculated for ø consecutive years, 2018-2022. The following results emerged from these calculations: At Vishay Electronic spol. s. r. o. the result of this correlation was 0.065, and we can also interpret the result in such a way that there is almost no statistically linear dependence between the selected values because the result approaches 0. An indirect ratio applies here. For Faurecia Automotive Czech Republic s. r. o., the correlation coefficient between these values was 0.741. The more the added value increases, the more the economic result increases as the value approaches +1, and the dependence is right here. The correlation coefficient between the added value and the economic result at Aisin Europe Manufacturing Czechs. r. o. was 0.566, which means free dependence, and a direct correlation applies here. MOTOR JIKOV Strojírenská a. s. showed a result after correlation - 0.778, which means an indirect correlation. The last monitored company was SINOP CB a. s., whose correlation coefficient was 0.626, whose dependence is considered free, and a direct ratio applies here.

The correlation between the added value and the economic result was proven for the companies Faurecia Automotive Czech Republic s. r. o., Aisin Europe Manufacturing Czech s. r. o. and SINOP CB a. s. In this case, the authors agree with Issa (2023), who states that it is necessary that when implementing Industry 4.0, they understand and thus secure the driving engine and use their potential effectively. The authors also agree with the views of Labaran & Masood (2023), who state in their publication that the application of Industry 4.0 is related to Green Supply Chain Management (GSCM), which has an impact on the sustainability of the supply chain, business investments, relations between companies, transport, and logistics. In this case, all these items impact the economic result and added value.

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6. Conclusions

The article aims to evaluate the impact of Industry 4.0 on selected manufacturing companies that operate in the Czech Republic, apply it, and state whether its effect on the company's added value and the economic result is proven. Based on the content analysis, a correlation and comparison of the obtained data was carried out, based on which it was found that, based on the application of Industry 4.0 in companies, the tendency of added value is not only increasing in the monitored periods, but in some cases also decreasing and constant, but it is essential on the size of the business in which this era of industry is applied. The correlation between the added value and the economic result of the selected companies was proven only for three selected companies, in which the rule that they were large companies was not confirmed, and even the smallest selected companies had positive correlation values. The interrelation between added value and economic results is proven.

Based on these findings, the goal of the work was achieved. The limits of this research are found in the absence of the author in the field on which the study was focused and in the limited access to company materials.

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ENHANCING INCLUSIVE TOURISM: MAPPING ACCESSIBILITY AND RECOMMENDING STRATEGIES FOR THE LIBEREC REGION*

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Abstract. The article aims to map the Liberec region from the perspective of visitors with special needs and provide recommendations for the future development of accessible tourism in the region. The article explores the requirements of individuals with medical disabilities, as well as other groups such as mothers with strollers, pregnant women, the elderly, and people with dietary restrictions. This approach offers a comprehensive solution to a gap in academic literature, which often concentrates solely on individuals with disabilities. The study examines the relationship between age and disabilities of respondents, their participation in travel, and the difficulties encountered when choosing destinations in the region. To analyze correlations and frequencies related to age, disabilities, and travel participation, the study formulated three research questions and corresponding hypotheses and employed statistical tests. Descriptive statistics, chi-square tests, and frequency tables were used to analyze the data. Data collection involved primary and secondary sources, including professional literature, tourism reports, and specialized portals. Primary data was gathered through a questionnaire survey and semi-structured interviews. The survey targeted diverse groups with specific needs, focusing on the region's accessibility for barrier-free tourism. The study's comprehensive scope and unique regional focus provide valuable insights into enhancing accessible tourism in the Liberec region. The study highlights the cultural and natural attractions of the region. It suggests improving accessibility-related aspects such as accommodations, gastronomy facilities, transport, and information centres. Tailoring services, increasing destination awareness, improving infrastructure, and promoting inclusivity are recommended. The aim is for the Liberec region to become an inclusive tourist destination, achieved through physical improvements and promoting societal changes that embrace diversity and accessibility.

Keywords: accessibility; accessible tourism; inclusion; quantitative survey; Liberec region; semi-structured interviews; tourists with special needs

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1. Introduction

Tourism has traditionally focused on those who participate rather than those excluded (Smith, 1987). Marginalized groups are typically those who are 'othered,' overlooked, or ostracized based on their low socioeconomic status, ethnicity, indigeneity, age, gender, sexuality, ability, or the intersectionality of these aspects of identity. It is important to note that accessibility issues in tourism for people with specific requirements are gaining prominence.

In the 21st century, society has increasingly focused on inclusion and equal opportunities for all. It is becoming more urgent to make tourism accessible to people with specific needs, including providing accommodation services, transportation, and activities that can be enjoyed during their visit. Targeting this group of visitors can bring economic benefits to the destination due to their loyalty and frequent travel with an escort. A more targeted focus on this group could help reduce seasonal fluctuations and preserve jobs even during the off-season (Kuzmenko et al., 2023). Understanding the specific needs of these tourism participants can also provide a competitive advantage for tourism service providers in the post-COVID period and terms of the company's demographic development. Therefore, it is essential to make cultural and historical monuments, natural sites, and tourism facilities accessible. The accessibility of a destination is determined by its least accessible infrastructure and superstructure (Skare et al., 2023).

It is essential to consider each individual's diverse abilities and physical or mental states, as everyone goes through unique stages in life and has specific needs. Health conditions and the environment can influence an individual's needs. It is estimated that up to 70% of health limitations are not visible, leading to the misconception that individuals without visual disabilities do not have specific needs.

Inclusion and accessibility are crucial tourism aspects that impact visitors and residents. It is essential to acknowledge that this issue has a regional impact, especially in the context of the role of regions in national competitiveness. Investing in an accessible environment for all residents, including the Liberec region, enhances its appeal and its services.

The consideration of accessibility is critical due to the social challenges that humanity is facing. Specifically, 16% of the world's population lives with some form of disability (World Health Organization, 2023). With the population ageing and the prevalence of chronic diseases increasing, this number is expected to rise in the coming years (Ferri Sanz et al., 2019). In the EU, persons with disabilities comprise 27% of the population (European Council, 2022). Approximately 13% of the population in the Czech Republic has a disability (Czech Statistical Office, 2018). It is noteworthy that the United Nations General Assembly only established a Convention on the Rights of Persons with Disabilities in 2001. The UNCRPD was officially adopted by the EU in 2008.

The article aims to map the Liberec region from the perspective of visitors with special needs and provide recommendations for the future development of accessible tourism in the region. Our article contributes to the tourism industry by examining the needs of people with medical disabilities, as well as targeting other groups such as mothers with strollers, pregnant women, the elderly, and people with dietary restrictions etc. This comprehensive approach fills a gap in academic works, which often only focus on disabled individuals. Our work aims to broaden perspectives and reflect the diverse needs of travellers, which has the potential to strengthen inclusivity in tourism and contribute to a better understanding of the specific needs of different groups of people when travelling.

The article is structured into the following sections. The first section provides an introduction to research problems. The second section is a literature review focusing on people with specific needs and related terms. The third section covers the methodology, research implementation process, and a brief description of the research sample. The fourth section presents the results and discussion of the paper, where the hypotheses are statistically verified to formulate conclusions. This section also includes the characteristics of the Liberec region

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and recommendations for the future development of accessible tourism in the area. In the final chapter, we presented the limitations of our research, outlined the direction for future research, and provided answers to our research questions.

2. Theoretical background

When considering the participation of individuals with specific needs in tourism, it is essential to reflect on the concepts of 'accessibility' and 'inclusion,' which encompass aspects of accessible and inclusive tourism. The term accessibility can be used in many different ways. Accessibility is often associated with a sole target group, specifically individuals with disabilities. Approximately 16 % of the worldwide population experiences some form of disability, a statistic that continues to increase, mainly due to the ageing demographics of the world (World Health Organization, 2023). When it comes to the tourism industry, individuals with disabilities often encounter disregard and alienation, affecting not only them but also their extended social network, including relatives, companions, and caretakers. This issue is not limited to only people with disabilities but also affects those with specific needs in the tourism industry. The increasing visibility of the issue of accessibility in tourism for individuals with specific needs is a positive development (UNWTO, 1999; UN Convention, 2001; European Commission, 2023; Liberecký kraj, 2023c). This suggests that accessibility challenges are encountered by nearly a third of the world's population (United Nations, 2021). From a business perspective, the absence of one potential visitor may imply the loss of several.

Accessibility can be understood as barrier-free access to accommodation and gastronomy facilities, tourist attractions, etc. According to international regulations, such as the United Nations Convention on the Rights of Persons with Disabilities (UN Convention, 2001), the Global Code of Ethics for Tourism (UNWTO, 1999), European Convention on Human Rights (European Court of Human Rights, 1950), and national legislation in European countries, the right to tourism belongs to everyone, regardless of nationality, gender, age, or religion. The Global Code of Ethics for Tourism (UNWTO, 1999) says that tourism activities should respect the equality of men and women; they should promote human rights and, more particularly, the individual rights of the most vulnerable groups, notably children, older people, the handicapped, ethnic minorities and indigenous peoples. Family, youth, student and senior tourism and tourism for people with disabilities should be encouraged and facilitated.

Accessibility, including barrier-free access, must be considered comprehensively throughout a destination's entire tourism service chain - not only in tourism. The accessibility of the offering has various components (Kazuist, ENAT, NRZP, Trianon, 2010; Milfait, 2020; European Commission, 2023). Physical accessibility refers to buildings, environments, transportation, and infrastructure. Information accessibility is concerned with the reliability of information and the provision of accessible communication channels alongside standards for assessing accessibility. Communication accessibility ensures that staff can communicate effectively with customers. Economic accessibility regards the different price levels, giving people the freedom to choose. ENAT (European Network for Accessible Tourism) is working to improve accessibility in the tourism sector by consolidating existing knowledge in the universal design of environments, products and services and giving all actors the opportunity to put this knowledge to use through collaboration (ENAT, 2023).

Accessibility is not only about people with disabilities (as will be shown further on) but also about the elderly (seniors), families with young children, people with short-term or chronic illnesses, pregnant women, people with dietary restrictions, and people with communication disabilities. In Europe alone, this represents an estimated 130 million customers for the tourism industry. In contrast to the significant number of tourists demanding accessible tourism facilities, only 1.5% of restaurants and catering facilities, 6.5% of accommodation facilities, and 11.3% of tourist attractions are reported by Member States as accessible - at least for wheelchair users. According to the UN, an estimated 650 million people in the world live with disabilities. Together with their families, this means that approximately 2 billion people – a third of the global population – are directly affected by disability (European Commission, 2023).

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When discussing accessibility and people with special needs, it is also necessary to define and explain the concept of inclusion. While accessibility is generally the key term in our article, inclusive approaches and attitudes have been identified as key to providing accessibility (Darcy & Pegg, 2011; Zallio & Clarkson, 2021). An emphasis on inclusivity facilitates analytical connections between the declared ambitions of global policymaking and various grassroots initiatives. These initiatives comprise diverse stakeholders seeking to broaden the demographic of those producing, consuming, and benefiting from tourism. Often, such initiatives involve subverting existing tourism geographies. Inclusive tourism development strives to broaden access to consumption, production, and benefit-sharing at current tourism sites while redesigning the tourism landscape to create new areas of experience and interaction (Saura, Palacios-Marques & Ribeiro-Soriano, 2023). The full inclusion of people with special needs means increasing their activity in public spaces, including improving accessibility of various leisure activities (Gavurova et al., 2021; Załuska, Kwiatkowska-Ciotucha & Grześkowiak, 2022; Androniceanu, Georgescu, & Mirică (Dumitrescu), 2022).

Inclusion is a core principle of the United Nations' Sustainable Development Goals (SDGs), ratified in September 2015 worldwide. As noted by the United Nations Development Programme (UNDP), exclusion from development is faced by many individuals based on their gender, ethnicity, age, sexual orientation, disability, or poverty. Only when all groups of people contribute to creating opportunities, share development benefits, and participate in decision-making can development become inclusive, thereby reducing poverty (UNDP, 2016). Viewed in this context, an emphasis on inclusive tourism development would involve prioritizing the participation of previously marginalized voices in decisions concerning tourism and ensuring a wider distribution of the advantages of tourism.

Inclusive tourism provides individuals with special needs access to all elements of tourism, irrespective of their limitations (Slocum (Ed.), 2023). More recently, there has been a broader adoption of the term "inclusive tourism," as defined by Biddulph and Scheyvens (2018) as *"tourism that is transformative, involving marginalized groups in ethical tourism production or consumption and sharing its benefits".* While there are advantages to defining marginalization as inclusive of all forms of marginality and intersectionality, such as gender, sexuality, and indigeneity, we contend that the conceptualization of marginalization and accessibility are not convergent but divergent, hence the necessity to concentrate exclusively on accessible tourism for those with specific accessibility requirements that are not shared with other marginalized identities.

Since 2011, the Czech Republic has consistently addressed tourism for individuals with particular requirements. Noteworthy authors include Navrátilová (2011), Hamarneh (2020), Linderová (2012), Šedivá Neckářová (2016). In the realm of tourism, there is current discussion surrounding a comprehensive and inclusive framework encompassing accessible tourism, sustainable tourism, and social tourism, featuring social responsibility (Crîşmariu, 2017; Hamarneh, 2020; United Nations, 2020). This holistic approach to travel strives for universality, considers social elements, and seeks to safeguard the environment.

Because of the tourism industry's fragile structure to crises, disasters and crises (Lincényi& Bulanda, 2023; Beha, 2023), the developments in sustainable tourism have been very crucial policies that policymakers have prioritized (Vasanicova et al. 2021; Streimikiene, 2023). Sustainable tourism strategies have emphasized the importance of the tourism industry on national economies (Navickas et al., 2022). Sustainable tourism is also closely linked with society and the environment (Vavrova, 2022). This is because sustainable tourism enables the reduce regional disparities that improve the life quality of citizens and economic growth (Matijová et al., 2023), thus, it provides socioeconomic development for territories (Shpak et al., 2023; Devkota et al., 2023) and might be an engine of economic growth for different regions of a country (Vašaničová et al., 2023). The tourism industry's sustainability is also related to the innovative posture of individuals and firms' executives (Khalifa et al., 2023). Sustainability of a territory also increases the competitiveness of enterprises (Folgado-Fernandez et al., 2023). This is because firms implementing sustainability practices can provide more quality services (Cheng et al., 2022).

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By being major drivers of the global economy (Agboola et al., 2023), labour creation (Ključnikov et al., 2022; Civelek et al., 2023), economic development of sectors (Rozsa et al., 2022) and nations (Ključnikov et al., 2022; Saleh & Manjunath, 2023), SMEs also play crucial roles in the sustainability practices (Tapang & Enongone, 2023) including technological innovations (Muthee & Maina, 2023; Civelek et al., 2023). Innovative attitudes of SMEs also increase their development and ability to export (Kliuchnikava, 2022), which puts them under the spotlight. Innovative behaviour also increases competitiveness (Ključnikov et al., 2021; Civelek et al., 2021; Dušek & Sagapova, 2022).

Accessible tourism allows individuals worldwide to participate in and enjoy tourism experiences (Gillovic & McIntosh, 2020; Devile & Kastenholz, 2018). As defined by the World Health Organization, accessible tourism is an umbrella term encompassing physical impairments, activity restrictions, and participation limitations. While some disabilities are apparent, many are not, resulting from long-term physical, mental, intellectual, or sensory impairments. The UN World Tourism Organization (UNWTO, 2013) has created a guidebook for tour operators and recreational industries. Quality assurance ISO certification (ISO, 2021) is also accessible. UNWTO (2023) has provided insights into applying ISO 21902 to tourism growth.

Several sources agree that incorporating accessibility is beneficial for everyone. In this context, we are referring to 'tourism for all'. Tourism for all aims to provide travel services, attractions, and environments suitable for a wide range of individuals, regardless of their age, health, or abilities (Hamarneh, 2020; Bizzarri, 2021). Tourism for all promotes inclusive tourism activities and services that involve all individuals, including guests and residents, in the same activities while fostering dialogue, peace, and human development (Gavurova et al. 2022, 2023).

The traditional model of a tourist destination is characterized by tourist attractions and associated infrastructure, often excluding the local community. Resorts and villages were conceived to entertain tourists, but they needed to engage the local population adequately. Nowadays, tourism and resorts are evolving, and many destinations are embracing a new concept of tourism that empowers the local community. This approach enables locals to support individuals with special needs, allowing them to travel independently while feeling like residents of the area (Zhang et al., 2021).

Facilitating the movement of tourists with varying accessibility needs is crucial to developing effective tourism policies (Loi & Kong, 2015; Cassia et al., 2020; ENAT, 2023). This involves not only providing accessible infrastructure, which is fundamental to tourism participation, but also overcoming any information barriers that individuals with disabilities may encounter. For these individuals, it is essential to provide information on the current accessibility characteristics of a destination (Eichhorn et al., 2008; Gillovic & McIntosh, 2020; Kolodziejczak, 2019). Their information needs typically include clear information on accessible tourism facilities, availability of support services for people with disabilities in various destinations, and training of tourism employees on their special needs (Loi & Kong, 2015; Fryer, 2020; ENAT, 2023).

There is a growing societal emphasis on inclusivity and equal opportunities for all in the present era (Biddulph & Scheyvens, 2018; ENAT, 2023; Slocum (Ed.), 2023). It is increasingly apparent that accessibility in tourism for individuals with specific needs is urgent. This includes not only offering accommodation services and transportation but also engaging activities catering to their requirements during their visits. Focusing on this segment has immense potential for economic advantages for destinations due to their loyalty and tendency to travel frequently with companions. By prioritizing this segment, destinations can mitigate seasonal fluctuations, safeguard jobs (especially during off-peak seasons), and establish a more stable tourism economy (United Nations, 2020; UNWTO, 2023). Understanding the unique needs of these participants in tourism can confer a competitive edge to service providers, especially in the post-COVID era as the industry adapts to changing demographics. Ensuring accessibility to cultural and historical landmarks, natural sites, and tourism facilities is a moral imperative and a strategic necessity for sustainable tourism development (Bizzarri, 2021; UNWTO, 2023).

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3. Research objective and methodology

The article aims to map the Liberec region from the perspective of visitors with special needs and provide recommendations for the future development of accessible tourism in the region. To achieve the objective of the paper, the following research questions were formulated:
Q1: What is the correlation between the age of the respondents and the type of disadvantage/disability?
Q2: What is the relationship between respondents' disadvantage and their participation in travel?
Q3: What are the priorities for selecting a destination, and what travel obstacles do individuals with specific needs face in the Liberec region?

The research questions were formulated to address essential aspects related to accessibility and inclusivity in tourism. In the current context, where tourism plays a vital role in economic growth, adopting sustainable and inclusive tourism practices is essential. By incorporating accessibility and universal design principles from the outset, the initial investment costs can be reduced. Incorporating a commitment to equality promotes sustainability in tourism businesses and increases their appeal, attracting new visitors. Additionally, by including functional diversity within the workforce, businesses can create new opportunities and differentiate their products. Ensuring accessibility for all tourism facilities, products, and services should be a fundamental aspect of responsible and sustainable tourism policies at both national and regional levels.

The research questions align with the following considerations. Firstly, it is essential to understand the correlation between respondents' age and their specific disadvantages or disabilities to recognize age-related patterns in disability types. Secondly, examining how these disadvantages or disabilities influence individuals' travel participation helps determine the impact of such factors on tourism engagement. Finally, examining the priorities in selecting a destination and the challenges faced by individuals with specific needs in the Liberec region reveals important factors influencing their travel decisions and experiences.

For the first research question, Q1, Hypothesis H1 posits that there is a relationship between the age of the respondents and the type of disadvantage/disability. The chi-square test will be employed to test this hypothesis. For the second research question, Q2, Hypothesis H2 posits that there is a correlation between respondents' disadvantage and their willingness and ability to travel. A frequency table will be employed to test this hypothesis.

Descriptive statistics, including the arithmetic mean (M), sample coefficient of variation (CV), and sample skewness (S), will be used to answer the third research question, Q3. These tools are parametric. The responses regarding non-barriers/barriers aspects were rated on a five-point Likert scale (1 being least important and five being most important). Qualitative data was collected through semi-structured interviews and authors' observations. Interpretative phenomenological analysis (IPA) was used to gain insight into the lived experiences of the interviewers. A word cloud was created for visual display.

The paper utilized both primary and secondary data sources. The latter consisted mainly of professional books, journal literature, publications, and reports from tourism organizations that address travel for individuals with specific needs. Additionally, recommendations from UNWTO, international documents on accessible tourism, and relevant legislative regulations of the Czech Republic were consulted. The study utilized information from various sources, including tourist information centres, web portals of tourism facilities, destination management organizations in the Liberec region, and specialized portals for disabled individuals such as vozejkmap and jedemetaky.cz, helpnet.cz, deaftravel.guide, and haptické.mapy.cz.

The quantitative methodology involved a questionnaire survey. The questionnaire was developed based on a literature review and preliminary discussions with in-field experts and participants in the Visegrad Fund project. The questionnaire included various questions, such as Likert scale, single or multi-choice, and open-ended questions. Between April and November 2023, 140 questionnaires were completed in the field, and 440 forms

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were submitted electronically. The questionnaire aimed to characterize a specific group of tourism participants regarding their travel requirements and gather their opinions on the accessibility of the Liberec region for barrier-free tourism. The survey helped identify suitable candidates for semi-structured interviews using qualitative methods. Respondents were selected based on their experience with travel barriers specific to their needs and familiarity with the Liberec region. It is important to note that the representation of age and gender was not evenly distributed. The contact took place in person at various locations, including Liberec, Harrachov, Jablonec nad Nisou, Turnov, and Česká Lípa, as well as electronically. The questionnaire survey is representative because of its unique approach in the Czech Republic. It focuses on a wide range of groups of individuals with specific needs, not just on persons with physical disabilities. The selection of respondents is random to reach a diverse range of respondents, not just those with a disadvantage. As existing surveys often cover the entire Czech Republic, our survey focuses on the regional level, a specific characteristic. This approach allows for a more detailed analysis of the region-specific factors. The recommended sample size for qualitative research varies among authors, ranging from 5 to 25 (Creswell, 1998) to an undefined number based on the research purpose (Patton, 1990). We conducted 25 semi-structured interviews.
We used a mixed research approach with primary data sources to achieve the stated goal and answer the research questions. This study employs qualitative and quantitative research methods to better understand the issue under investigation. The research methods are triangulated to ensure validity.

4. Results and discussion

4.1 The Liberec region and its characteristics

The Liberec region is located in the north of the Czech Republic. Among its neighbours are the Ústí nad Labem Region, the Central Bohemian Region, the Hradec Králové Region, the German federal state of Saxony and the Polish Lower Silesian Voivodeship. It is the second smallest territorial region of the Czech Republic, occupying an area of 3 163 km^2. According to CSO data, 450 000 inhabitants lived here in mid-2023. It is among regions with a higher proportion of children and a lower proportion of older people.

The Liberec region administratively consists of the districts of Liberec, Česká Lípa, Jablonec nad Nisou and Semily. The seat of the region is the city of Liberec. The district has a predominantly industrial nature. The glass and jewellery industry, the production and processing of plastics, engineering and processing industries are primarily developed with close ties to the production of cars. The traditional textile industry has lost its dominant position due to the slowdown in recent years. The Liberec region has much to offer in the field of study. The presence of universities in the Liberec region must thus be mentioned. The Technical University in Liberec has a Faculty of Engineering, Textiles, Economics, Pedagogy, Architecture, Mechatronics, and Interdisciplinary Engineering Studies. Furthermore, the youth have the opportunity to study at many secondary schools.

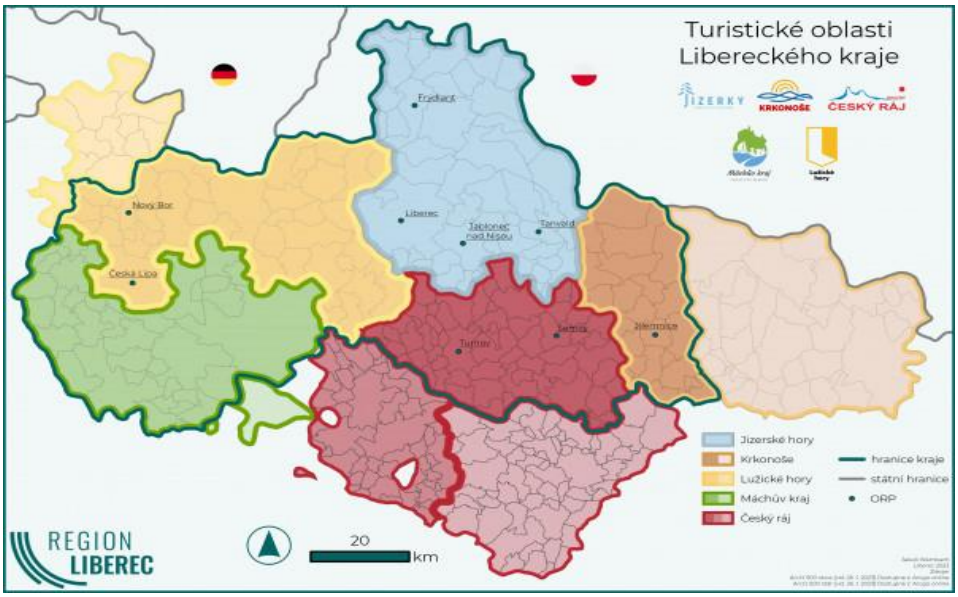
The Liberec region offers outstanding natural and cultural conditions for tourism, both in the winter (alpine as well as cross-country skiing – Krkonoše, Jizera Mountains, Ještěd ridge, but also the Luž mountains) and in the summer. Practically any activity is available for summer tourists – walking and cycling (in both the mountains as well as low-lying areas – e.g. the former military training area of Ralsko), mountain climbing (rock-ribbed cities in the Bohemian Paradise), bathing (Mácha Lake, water flows), urban tourism (Liberec, Turnov, Frýdlant in Bohemia, Jilemnice, etc.), and heritage sight-seeing (fortresses, castles, urban conservation areas, rural heritage reservations and zones). The most popular fortresses and castles are Bezděz, Zákupy, Lemberk, Frýdlant, Sychrov, Hrubý Rohozec, and Valdštejn. Spas also play an important role and are often sought by foreign visitors. Its rich cultural and historical tradition is reflected in its large number of historic buildings, monuments and cultural facilities, and it lures hundreds of thousands of visitors to the region annually. The unique structure of the Ještěd hotel has become a symbol for the region at large, which received a Perret's prize.

ZOO Liberec and iQLandia Science Center are the most visited attractions in the Liberec region. Among the TOP 3 categories of visited destinations in the Liberec Region were the categories castles and chateaux (23.15%), science and technology (21.14%), and ZOO/gardens and aquariums (17.93%) (Tourdata, 2023).

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Good transport links with Prague and the border location of the Liberec Region make the Liberec Region an interesting destination for both domestic visitors and foreign participants in the tourism industry. Based on data from the Czech Statistical Office on the capacity of collective accommodation facilities in 2022, the Liberec Region occupied a solid position compared to other regions of the Czech Republic, with 992 mass accommodation facilities and 47 155 beds. Compared to the other areas, this was an above-average position. Only three regions – South Bohemian region, Hradec Králové region, and South Moravian region – had a higher number of collective accommodation facilities (Czech Statistical Office, 2023).

In 2022, 1 113 981 guests visited the Liberec Region, of which 159 749 were foreign. Czech visitors thus made up 85. 7% of all guests. From the point of view of collective accommodation facilities monitoring, 2022 was the most successful year in the last ten years. The source countries from which foreign participants in the tourism industry traditionally include Germany, Poland, Slovakia, the Netherlands and Austria (Tourdata, 2018-2019). From the point of view of tourism management in the Liberec region, the Department of Tourism, culture, and Sports of the Municipality of Liberec and the Department of Culture, Monument Preservation and Tourism of the Regional Office of the Liberec Region play a key role. The Liberec region has five marketing tourist areas (See Picture 1). From the point of view of destination management certification, five regional destination management organizations operate in the Liberec region (CzechTourism, 2023). Nine local action groups in the Liberec region developed the region based on the European Union's LEADER initiative principles (Liberecký kraj, 2023b).



Picture 1. Tourist areas in the territory of the Liberec region
Source: Liberecký kraj, 2023a

The Neisse - Nisa - Nysa Euroregion was created in the area of the Three Borders, i.e., in the border area between the Czech Republic, Poland, and Germany, extending into the territory of the Liberec Region. One of the critical development goals is the creation of a Joint, Integrated Holiday and Tourism Region (TRN) and a "Joint Planning Area ERN" (EUROREGION neisse-nisa-nysa, 2023). Within cross-border projects from 2014 to 2020, the topic of disability appears.

Regarding disability, the Regional Office of the Liberec Region has developed a Regional Plan for Equalizing Opportunities for Persons with Disabilities 2021–2024. Although this document is primarily aimed at residents of the region, some principles in the area of making buildings, transport, and information accessible in the vicinity of culture, leisure activities, employment, and educational activities could also be applied in the development of tourism in that destination (Liberecký kraj, 2023c). However, certified destination management

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organizations, except one, do not reflect the topic of accessibility in their strategic documents. The Liberec region offers other specific activities to support accessible and inclusive tourism. As outlined in the Liberec Region 2021–2027 Development Strategy, the region aims to be an attractive destination for visitors by providing barrier-free accessibility, including awareness of tourist destinations and services.

The article's authors found that the Liberec region has significant tourist potential and a diverse range of attractions that are easily accessible, even for people with specific needs. The study shows that the region has sufficient barrier-free cultural facilities, monuments, and tourist routes for people with mobility restrictions. Public transport systems, particularly those in larger cities, are well-equipped with low-floor vehicles that cater to the needs of people with reduced mobility. Internet portals, such as www.ceskyrajbezbarier.cz and bedekr.liberecky-kraj.cz, www.kudyznudy.cz/kampane/bezbarier/bezbarierove-zazitky?region=liberecky-kraj provide information about individual objects and support the development of barrier-free tourism in the region. However, giving barrier-free services in the catering and accommodation sectors must be improved. Many dining establishments do not provide wheelchair access, and accommodations often offer only a limited number of wheelchair-accessible rooms. Information centres need more information and promotion in the field of barrier-free tourism. Although some information centres have barrier-free access, staff often provide information only verbally because they lack the necessary printed materials.

Based on the research between the years 2013 and 2016 it can be stated that Ústí nad Labem Region, Liberec Region, Carlsbad Region and Prague are the regions with the highest share of barrier-free accommodation facilities (Linderová & Janeček, 2017) in the Czech Republic. The Liberec region offers a wide range of accommodation and catering facilities with barrier-free features. These include barrier-free access to hotels, boarding houses, and restaurants, reserved parking, barrier-free social facilities, and specially equipped rooms for wheelchair users that meet all technical requirements (Syrovátková, 2011).

4.2 Research results

It is essential to recognize that each group of people with specific requirements has special needs and requires an individualized approach and consideration from tourism service providers. This section describes the results gathered from the research.

140 respondents were approached through a personal questionnaire, while 440 respondents participated in an online questionnaire survey. The following data is compiled from 140 questionnaires collected from the field. The online questionnaire survey yielded similar results. The research was conducted in the Liberec region from April to November, 2023.

Profile of respondents:
Of the total number of respondents (140), 61% are women. The structure of respondents by age is shown in Table 1.

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Table 1. Age of respondents

Age	Absolute frequency	Relative frequency
up to 20 years	4	2.9%
21–30 years	31	22.1%
31–40 years	40	28.6%
41–50 years	20	14.3%
51–60 years	14	10.0%
61–70 years	17	12.1%
71 years and over	14	10.0%
Total	140	100.0%

Source: own elaboration by the authors

The majority of respondents do not report any limitations. However, over 25% of respondents were parents with a child in a stroller. The second largest group of individuals with specific needs were people with a dietary restriction (food intolerance or allergy), as presented in Table 2.

Table 2. People with special needs

Person with special needs	Absolute frequency	Relative frequency
Person with a mobility disability	26	18.6%
Person with a visual disability	5	3.6%
Person with a hearing disability	3	2.1%
Person with a dietary restriction (food intolerance or allergy)	32	22.9%
Person with a dietary restriction (alternative way of eating)	5	3.6%
Person with a mental disability	3	2.1%
Parents travelling with a child in a stroller	36	25.7%
Pregnant women	7	5.0%
Person does not belong to any of the listed groups	51	36.4%

Source: own elaboration by the authors

When evaluating the dependence between the age of the respondents and the type of disadvantage, the statistical null hypothesis H_0 = There is no statistically significant dependence between age and type of disadvantage, and the alternative hypothesis H_1 = There is a statistically significant dependence between age and type of disadvantage.

Of the 140 respondents we observed, 26 identified as having a mobility disability. Due to the expected frequencies not meeting the requirements of the chi-square test (expected frequency less than 2), the youngest age groups (up to 20, 21-30 years) were merged into the age category 'up to 30 years'. At a significance level of 5%, we cannot confirm the null hypothesis that the age distribution of the selected group of respondents with mobility disabilities matches the age distribution of all respondents. The test criterion is 21.9 (see Table 3), which falls outside the acceptable range at five degrees of freedom $\langle 0;11.07\rangle$. Therefore, we reject the hypothesis of good agreement with the predicted distribution, as the incidence of physical disability is age-dependent.

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Table 3. Respondents with a mobility disability

Age	Observed categories	Expected categories	Test criterion
up to 30 years	3	6.5	1.9
31–40 years	2	7.4	4.0
41–50 years	3	3.7	0.1
51–60 years	3	2.6	0.1
61–70 years	8	2.6	11.2
71 years and over	7	3.2	4.7
Total	26	26.0	**21.9**

Source: own elaboration by the authors

Of the 140 respondents, 32 reported some food allergy or intolerance. To ensure a more accurate analysis, the two youngest age groups were merged into one interval for those younger than 30 years, similar to the approach taken for respondents with mobility disability.

Using a 5% significance level, the null hypothesis that the age distribution of the selected group of respondents with food allergy or intolerance matches the age distribution of all respondents was confirmed. The test criterion is 6.6 (see Table 4), which falls within the five-degree-of-freedom acceptance range ⟨0;11.07⟩ at the 5% significance level. The hypothesis of good agreement with the predicted distribution is not rejected, indicating that the incidence of food allergy/intolerance is not dependent on age.

Table 4. Respondents with a dietary restriction (food intolerance or allergy)

Age	Observed categories	Expected categories	Test criterion
up to 30 years	10	8.0	0.5
31–40 years	4	9.1	2.9
41–50 years	8	4.6	2.6
51–60 years	2	3.2	0.5
61–70 years	4	3.2	0.2
71 years and over	4	3.9	0.0
Total	32	32.0	**6.6**

Source: own elaboration by the authors

Consumer behaviour of respondents:

Most of the respondents travel occasionally. If they do not travel, the main reason is a lack of finances, not a physical or psychological disadvantage. The primary motive for travelling is to explore new places, and the most frequently visited attractions include bodies of water, nature parks and gardens, and cultural and historical sites. Respondents showed little interest in visiting places associated with active sports. According to the survey, respondents under 50 are most likely to seek travel inspiration from social networks, while those aged 50 over- rely on print and television. Travel websites are a source of inspiration for all age groups.

When evaluating the relationship between disability and respondents' willingness to travel, we tested the statistical null hypothesis H_0: Disability does not affect respondents' participation in travel against the alternative

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hypothesis H_1: There is an effect of disability on respondents' participation in travel. Based on the data presented in Table 5, which is a frequency table, it can be concluded that disability does not affect participation in travel.

Table 5. The relationship to travel

Person with special needs	Travelling is my hobby (I like to travel often)	I travel occasionally	I do not travel
Person with a mobility disability	4	21	1
Person with a visual disability	2	3	0
Person with a hearing disability	0	3	0
Person with a dietary restriction (food intolerance or allergy)	18	14	0
Person with a dietary restriction (alternative way of eating)	2	3	0
Person with a mental disability	1	2	0
Parents travelling with a child in a stroller	18	18	0
Pregnant women	2	5	0
Person does not belong to any of the listed groups	33	17	1

Source: own elaboration by the authors

Priorities for destination selection and travel barriers:
The mean score for the appeal of the specific destination category is slightly above average at 3.64. However, the accessibility scores, which reflect respondents' perceptions of the destination's suitability for their specific needs, averaged 2.58, indicating a lower overall rating.

The 'specific destination' category exhibited a relatively lower coefficient of variation at 33.96% when considering the variability in ratings. The data suggests respondents had a more consistent perception of the feature mentioned. However, the coefficient of variation for 'accessibility of the destination' was notably higher at 63.95%, indicating a wider range of opinions among respondents. This suggests a greater divergence in perceptions of accessibility based on individual needs.

Additionally, the skewness values provide insights into the distribution of ratings. The category 'specific destination' exhibits a skewness of 0.0051, indicating a nearly symmetrical data distribution around the mean. In contrast, the skewness for 'accessibility of the destination' is 0.236, suggesting a slight skew towards higher ratings. This may indicate a tendency for respondents to rate accessibility relatively higher than other categories.

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Table 6. Important aspects to consider when choosing a destination

Category	M	CV	S
Specific destination, regardless of how well it meets the respondent's needs	3.64	33. 96%	0.0051
Accessibility of the destination from the perspective of the respondent's specific needs	2.58	63.95%	0.236

Source: own elaboration by the authors

When planning their trips, respondents consider the credibility of information published on the Internet the most important factor. Additionally, they place high importance on information regarding the prices of accommodation services and transportation options at their destination.

The CV values range from 39.35% to 50.38%, indicating a medium to high variability in the perceived importance of different types of travel information. There is a diversity of opinion regarding the relevance of this information to the specific needs of travellers.
The S data suggest that certain types of travel information may be perceived as more important than others. A negative skewness value for some categories indicates that the ratings are more dispersed towards lower importance. In contrast, for other categories, a skewness value near zero indicates a higher symmetry in the perception of the importance of the information.

Table 7. Importance of travel information for specific needs

Category	M	CV	S
Accommodation options that meet specific needs in the destination	3.36	47.47%	-0.3754
Up-to-date information on accommodation options in the destination meeting specific needs	3.22	49.41%	-0.2289
Information on the prices of accommodation services meeting specific needs in the destination	3.50	41.76%	-0.52578
Information on transport options that meet the needs to the destination	3.44	44.65%	-0.49941
Information about parking options at the destination	3.16	50.38%	-0.26252
Information on catering options in the destination meeting specific needs	2.91	49.84%	0.092139
Information on the prices of meals that meet specific needs at the destination	3.24	44.06%	-0.28711
Information on the possibilities of using attractions in the destination that meet specific needs	3.58	39.53%	-0.6108
Credibility of information published on the Internet	3.61	39.35%	-0.66114

Source: own elaboration by the authors.

Respondents identified a lack of information regarding accommodation, catering, sanitary facilities, and unhelpful staff as the most significant barriers to travel. In contrast, they found the absence of assistance services, inadequate toilet facilities, and psychological barriers to be the least important obstacles.

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The CV is evaluated based on the variability of its categories. Most categories have medium variability, with a CV of around 45%-55%, indicating consistent evaluations in these areas. Categories with a coefficient of variation above 55% show a more excellent dispersion of ratings, suggesting different opinions regarding these aspects. Conversely, categories with a CV below 45% have less variance in ratings, indicating a higher agreement in how the areas are perceived. The skewness value (S) provides information about the asymmetry of the data around the mean, as previously mentioned. Categories with S values close to zero indicate a symmetrical distribution of ratings around the mean, indicating less variation among rating outcomes. For instance, no information regarding transport or leisure activities results in a nearly balanced rating. Conversely, categories with S values greater than zero indicate more significant asymmetry in the data. This means that ratings are either higher or lower than the mean. For instance, the lack of information on accommodation or sanitation needs exhibits more significant asymmetry, with some ratings significantly lower while others are significantly higher than average. This analysis indicates that specific categories have less consistent ratings, while others exhibit more excellent agreement in the distribution of ratings around the mean value.

Table 8. Barriers to travel

Category	M	CV	S
Lack of information about transport options, parking	3.25	46.41%	-0.23048
Lack of information about accommodation, catering, sanitary facilities	3.54	39.10%	-0.58425
Lack of opportunities to spend free time in the destination in terms of specific needs	3.28	45.69%	-0.21624
Limited financial resources	3.14	41.03%	-0.06627
Failure to adapt the transport to specific needs	2.76	55.01%	0.194471
Failure to adapt the accommodation to specific needs	2.77	50.72%	0.210253
Not adapting the diet to the requirements	2.56	53.79%	0.456804
Not adapting the toilets to the requirements	2.24	62.57%	0.793714
Failure to adapt the bathroom to the requirements	2.39	56.87%	0.472567
Failure to adapt the options for spending free time in the destination to my requirements	3.31	44.26%	-0.32457
Unhelpful staff	3.54	40.63%	-0.54537
Untrained staff (in terms of the specific needs)	2.76	55.67%	0.271589
Own state of health	2.68	54.90%	0.283406
Absence of assistance services	1.8	68.03%	1.368265
Missing travel partner	2.74	54.33%	0.252563
Psychological barriers (fear of travel, fear of drawing too much attention, fear of traffic, etc.)	2.27	55.85%	0.718814
Difficult terrain at the destination	2.84	52.26%	0.098808
Language barriers in the destination	2.47	55.43%	0.443834

Source: own elaboration by the authors

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The responses to the open-ended question, 'What obstacles do individuals with specific needs face when travelling in the Liberec Region?' have been simplified and presented visually in Picture 2.



Picture 2. Word cloud
Source: own elaboration by the authors.

The interpretive phenomenological analysis of the interviews (twenty-two of which took place, with at least one representative from each category of people with specific needs) revealed several main points:

- Respondents emphasized the variety of their needs when travelling, including aspects such as accessibility, transport, and financial possibilities. However, many of these needs remain unaddressed, complicating their travel.
- Transport and accessibility are significant barriers for people with mobility impairments. Physical access to public transport and insufficient design of stops and platforms significantly affect their ability to move.
- Respondents also highlighted the growing financial burden of travelling for people with disabilities. Improving financial support for this group of travellers is crucial.
- Respondents expressed interest in off-season travel but noted significant barriers to access and information during this period. Problems with catering services in the off-season also affect the quality of travel.
- Additionally, proposals were made to improve public transport in the Liberec Region, including adapting stops and vehicles for people with mobility impairments. It is essential to involve volunteers from various sectors to enhance holiday stays.
- Respondents stress the significance of travel information, including competition details, recommendations from disability organizations, and colleague advice. Respondents with dietary restrictions request more information from the staff regarding catering facilities' nutritional options. The respondents consider well-informed staff essential to meet their dietary requirements. They also value precise details on a destination's suitability and physical demands and information about local restaurants and attractions. Respondents find it challenging to locate this information, and providing it on accommodation or destination websites would be highly beneficial.
- The respondents have emphasized the need for radical changes in the approach to travellers with specific needs. They suggest that society reconsider and adjust its attitude and approach to these individuals, especially in public transport, by providing accessible and pleasant environments and information. This proposal highlights the importance of including and respecting this group in everyday life, including their travel. They desire to feel fully integrated and supported in all aspects of life, including their travel experiences.

The results of the analysis could offer valuable insights for enhancing tourism services in the Liberec region to cater to the requirements of people with specific needs.

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4.3. Recommendations for future development of accessible tourism in Liberec region

Based on the information found, the following recommendations can be made for the future development of barrier-free tourism in the Liberec region.

It is essential to recognize that each group of people with specific needs has its requirements and requires an individualized approach from tourism service providers. The diversity of needs of passengers with special needs, including accessibility, transport, and financial means, should be considered.

Improving destination awareness: Special emphasis should be placed on providing information on locations suitable for off-season travel and dining and accommodation options during this period. Ensuring sufficient information for travellers with specific needs, mainly through destination websites, including information on locations, dining, and availability of city attractions and services.

Public transport and infrastructure support: Improving public transport and adapting stops and vehicles for people with mobility impairments in the Liberec region. Involving volunteers from different areas is essential to enhance the travel experience.

Expanding the range of barrier-free services: This proposal aims to increase the accessibility of catering and accommodation establishments. To achieve this, premises should be made more accessible, the number of barrier-free rooms and social facilities should be increased, and catering establishments should provide sufficient options for people with food intolerances.

Additionally, information centres should expand their range of services. Information centres play a crucial role in providing information about wheelchair-accessible attractions. These centres must be equipped and adapted to provide information to tourists with specific needs effectively.

It is recommended that regional destination management organizations consider accessibility in their strategic documents to improve destination strategies. Incorporating accessibility and barrier-free tourism could enhance services for travellers with specific needs in the Liberec region and boost visitor numbers overall.

A shift in societal attitudes is necessary, particularly in public transportation and creating a welcoming and accessible environment. To improve accessibility and services for travellers with specific needs, including this group in everyday life, and ensure their full inclusion and support in all aspects of life, including travel.

These recommendations represent the direction the Liberec region could go, strengthening its position as an attractive tourist destination.

5. Conclusion

Tourism plays a key role in economic development and brings many benefits. However, tourism must be sustainable and inclusive. Incorporating accessibility and universal design principles from the outset, investment costs can be kept to a minimum; by committing to equality, tourism businesses become more sustainable, attract new visitors, and employ people with functional people with functional diversity, creating business opportunities and more excellent product differentiation. Accessibility to tourism facilities, products, and services should be a central part of any responsible and sustainable tourism policy at the national and regional levels.

The research aimed to answer the following questions:
Q1: What is the correlation between the age of the respondents and the type of disadvantage/disability? The incidence of physical disability is age-dependent, and the incidence of food allergy/intolerance is not dependent on age.

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Q2: What is the relationship between respondents' disadvantage and their participation in travel? Disability does not affect participation in travel.
Q3: What are the priorities for selecting a destination, and what travel obstacles do individuals with specific needs face in the Liberec region?

When planning their trips, respondents consider the credibility of information published on the Internet the most important factor. Additionally, they place high importance on information regarding the prices of accommodation services and transportation options at their destination. Respondents identified a lack of information regarding accommodation, catering, sanitary facilities, and unhelpful staff as the most significant barriers to travel.

The research questions relate to three main considerations. Firstly, it is essential to understand the relationship between respondents' age and their specific disadvantages or disabilities to identify age-related trends in types of disabilities. Secondly, examining how these disadvantages or disabilities affect individuals' participation in travel helps to assess the impact of these factors on their engagement in tourism. Finally, examining the factors that influence destination selection and the challenges faced by individuals with specific needs in the Liberec region reveals crucial elements that shape their travel decisions and experiences. The identified priorities and obstacles indicate crucial areas for improvement to promote more accessible and inclusive tourism experiences.

The investigation into the accessibility of the Liberec region for tourists with specific needs has revealed a landscape rich in cultural, natural, and recreational offerings. However, it has also highlighted areas that require improvement. The region's appeal lies in its diverse attractions, ranging from historical monuments to natural wonders, providing a promising foundation for inclusive tourism. However, to create a genuinely welcoming environment for travellers with diverse needs, these assets must be complemented by enhanced accessibility measures.

The study revealed that the Liberec region offers a variety of destinations and services suitable for visitors with varying accessibility requirements. Nevertheless, gaps still need to be addressed, particularly in accommodations, gastronomy establishments, public transport, and information centres. Although some progress has been made, it is necessary to take further steps to bridge these gaps and create an environment where all travellers feel empowered to explore and engage with the region's offerings.

The recommendations presented in this study provide a blueprint for the region's advancement toward becoming an inclusive and sought-after tourist destination. To ensure a seamless and enjoyable experience for travelers with specific needs, it is essential to tailor services to meet the distinct needs of different groups, increase destination awareness through comprehensive information dissemination, and strengthen infrastructure and services.

By prioritizing accessibility in accommodations, gastronomy establishments, public transport, and information centres, the Liberec region can establish itself as a model of inclusive tourism. Implementing these recommendations enhances the region's appeal and encourages a change in societal attitudes, promoting inclusivity as a fundamental value in the tourism industry and beyond.

In summary, the journey towards making the Liberec region an accessible destination involves implementing structural changes and fostering a culture of inclusivity and support. These efforts will enable the region to welcome diverse travellers and offer enriching experiences to all who wish to explore its treasures.

One fundamental limitation of our research is the inadequate representation of age and gender groups among the respondents. This issue requires attention in future research to ensure that the age and gender structure of the respondents correspond to the demographic composition of the population in the Czech Republic. Increasing the number of respondents would be appropriate. Additionally, future research could include a group of parents with long-term sick children to expand and deepen our knowledge.

The research makes a dual contribution. Firstly, it provides academic insights and perspectives from the Liberec region, which can deepen understanding of the situation of people with specific needs in the area and is crucial for further academic research and analysis. Secondly, the research has practical implications for the Municipality of Liberec, other municipalities, and destination management organizations. This information can be used to communicate effectively with entrepreneurs and support the inclusion of people with specific needs and interests in strategic plans. By doing so, tourism and tourism activities can be better tailored to the needs of a diverse group of visitors, improving the experience and benefits for all parties involved.

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ASSESSING ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS IN EU MEMBER STATES – DECOMPOSITION ANALYSIS*

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Abstract. This paper addresses the growing global concern regarding energy consumption and its adverse environmental impacts, particularly the increase of greenhouse gas emissions linked to economic development and population growth. To comprehensively assess the environmental implications of energy consumption, a decomposition analysis employing the Index decomposition analysis (IDA) method with the logarithmic mean Divisia index (LMDI) approach was conducted, focusing on the drivers behind energy consumption and greenhouse gas emissions in the EU 27 from 1998 to 2018. This analysis discerns disparities between wealthier and less affluent countries. The findings highlight substantial reductions in greenhouse gas emissions and energy consumption within the EU, primarily attributed to the growing emphasis on reducing the emission intensity targeted by EU policies. Nonetheless, disparities persist among member states, primarily driven by economic activity levels. In relation to the unique economic structures of EU countries results however advocate for diversified approaches tailored to the unique conditions of each Member State to meet the set targets, with an emphasis on fostering collaboration, technology transfer, innovation, and renewable energy adoption to advance sustainability of the region.

Keywords: economic growth; energy consumption; CO_2 emissions; EU 27; decomposition analysis

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JEL Classifications: F63, F64, K32, O44, P28

1. Introduction

Since the dawn of civilisation, energy has been a driving force behind human progress and development, powering economic growth, transport and industry. However, the production and consumption of energy have also caused significant damage to the environment and human health in the form of climate change, air pollution and natural disasters (Chen et al., 2022; Skare et al., 2023; Androniceanu & Georgescu, 2023).

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Findings from the Intergovernmental Panel on Climate Change (IPCC) report show that human-induced global warming has already exceeded 1°C above pre-industrial levels and is projected to exceed 1.5°C between 2030 and 2045 unless strong mitigation action is taken (IPCC, 2021). The consequences of such changes pose a profound threat to both humanity and ecosystems, leading to extreme weather events, health problems, loss of biodiversity and other negative impacts.

As the issue of the negative impact of energy consumption gains widespread attention, the European Union (EU) is emerging as a proactive actor, setting ambitious targets to achieve climate neutrality within the next three decades. This commitment has increased the urgency of analysing and evaluating the driving forces behind the increase in energy consumption and greenhouse gas emissions in the EU-27.

The main objective of this paper is to conduct a comprehensive decomposition analysis to examine the factors contributing to the growth of energy consumption and greenhouse gas emissions in the European Union. A distinctive feature of this study is that it focuses on the two groups of EU countries based on their Gross Domestic Product (GDP): (1) richer countries with a GDP above the EU-27 average and (2) poorer countries with a GDP below the EU-27 average.

By disaggregating the energy consumption and greenhouse gas emissions data for each group, this study aims to reveal the differences between these so-called rich and poor countries. Such insights gained from the decomposition analysis will facilitate a deeper understanding of the underlying factors driving energy consumption and greenhouse gas emissions in each group, ultimately leading to the identification of effective mitigation strategies and policies to achieve climate neutrality within the EU.

The structure of this paper is as follows: First, we review the theoretical background and evidence from previous empirical studies. Our research methodology, decomposition analysis, and the data sources used are outlined in Section 2. Section 3 is devoted to presenting the results and an in-depth discussion. The final section summarises our findings, policy implications, and research limitations.

2. Literature review

Understanding sustainable development and its interconnectedness with the economic, social, and environmental spheres aims to maintain and stimulate financial growth while considering societal well-being alongside environmental quality (Reyers et al., 2017). Rapid economic development and population growth are closely linked to increased energy demand, which leads to increased greenhouse gas emissions (GHG). In recent decades, there has been a significant global increase in GHG emissions from anthropogenic activities such as transport, electricity generation, heating and cooling of buildings, operation of fuel-burning appliances and equipment, and industrial and manufacturing activities (Kijewska & Bluszcz, 2016; Tyagi et al., 2016; Wang & Feng, 2018).

The largest global energy consumers and GHG emitters are China, the US, India, Russia, Japan, Germany, South Korea, and Canada. The largest share of global GHG emissions is CO2, which is the main driver of climate change and a major contributor to global warming worldwide. For this reason, reducing CO2 emissions has been identified as a new global goal in research and economic development (Nejat et al., 2015; Nordhaus, 2013; Kijewska & Bluszcz, 2016; Xu et al., 2018; Istudor et al., 2021).

Developed countries in Europe and North America, which emitted large amounts of CO2 in the wake of the industrial revolution, have found several ways to reduce CO2 emissions per unit of output in recent decades, such as reducing energy consumption, using less carbon-intensive fuels, or structurally shifting production to less energy-intensive industries (Nordhaus, 2013; Skare et al. 2024).

Decomposition analysis began to be used to study energy consumption and other environmental issues during the energy crisis of the 1970s. Energy prices were skyrocketing, and the intention of many researchers was to use this analysis to find effective channels to reduce energy consumption by decoupling changes in energy consumption and energy intensity (Chontanawat et al., 2020; Ahmad et al. 2022). Decomposition analysis is

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also used nowadays to investigate the source of emissions growth and intensity change in different economic sectors of developed and developing countries, as climate change and GHG emissions growth are currently a major global concern (Xu & Ang, 2013; Ang, 2015; Simionescu et al. 2021). The results of previous studies using decomposition analysis have shown that CO2 changes in the industrial sector are generally driven by the expansion of manufacturing and a country's industrial development policies. Reducing energy intensity is an important factor in reducing industrial emissions (Chontanawat et al., 2020; Simionescu et al. 2022). (Jeong & Kim, 2013) decomposed greenhouse gas emissions into five different effects, namely activity effect, structural change effect, intensity change effect, fuel mix effect and emission factor effect. Their main finding was that both structural change and intensity change were critical to reducing GHG emissions, but structural change played a larger role than intensity change.

Researching and understanding the relationship between emissions, energy consumption, and economic growth is essential for effectively controlling and reducing emissions to ensure the sustainability of economic development. These key indicators indicate whether policies can be designed and implemented to improve energy efficiency. In designing and implementing these policies, it is also useful to have reliable information on the main drivers of emissions change. This clearly includes indicators such as population growth and gross domestic product (Román et al., 2018; Wang et al., 2014; Mohmmed et al., 2019). Most research has been conducted in developed countries, and previous studies have shown that economic activity and population growth are the main drivers of emissions change (Bhattacharyya & Matsumura, 2010; Cansino et al., 2016; Drastichová, 2017; Kisielewicz et al., 2019). Within developing countries, studies have shown that economic activity and structural change are the main drivers of economy-wide emissions changes (Xu et al., 2014; Qi et al., 2016; Chong et al., 2019). An overview of the studies conducted in the study area, primarily using the IDA with the LMDI methodology, along with their objectives and main findings, is provided in Table 1.

Table 1. Overview of previous research

Authors	Aims of the study	Methods	Findings
(Löschel et al., 2015)	- to investigate the forces driving improvements in energy intensity in the European Union between 1995 and 2009	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: energy use, GDP, energy intensity, trade openness, capital intensity, productivity, energy prices)	- The factors such as economic growth, capital intensity, and energy prices affect energy intensity.
(Achour & Belloumi, 2016)	- to analyze the Tunisian transportation sector over the period 1985–2014; - to identify the driving factors and measure their corresponding contributions in transport related energy consumption	- The Logarithmic Mean Divisia Index (LMDI) decomposition using Tunisian statistical data from an extensive time series of 30 years covering the period of 1985–2014 (factors: population, road-related energy consumption, gross domestic product, civil aviation, rail, water transport-related energy consumption)	- The overall effect of economic output, transportation intensity, population scale, transportation structure on energy consumption is positive, and the overall effect of energy intensity is negative. - Energy intensity played the dominant role in decreasing energy consumption.
(Karmellos et al., 2016)	- to investigate the driving factors of CO_2 emissions from electricity generation in the European Union countries (EU-28) during the period 2000–2012	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: level of activity, electricity intensity, electricity trade, efficiency of electricity generation and fuel mix)	- In times of economic growth, the main factor counterbalancing the activity effect was, in most countries, the decreasing electricity intensity, while the contribution of all other factors became apparent later, despite the economic crisis and in view of the Kyoto targets.
(Mousavi et al., 2017)	- to quantify driving forces of CO_2 emissions in Iran as the one of the top ten CO_2 emitting countries	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: population, affluence, energy intensity of economy, carbon intensity of energy use, fuel consumption)	- The main driver of Iran's CO_2 emissions is increased consumption. - Natural gas capacity, especially in the transport sector, helps improve the energy mix but would require more.
(Boqiang & Liu, 2017)	- to explore the influencing factors of CO2 emissions from China's heavy industry during 1996-2015	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: carbon intensity, energy efficiency, income, population,	- The labour productivity, energy intensity, and industry scale are the

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		energy structure, industry scale, energy intensity, labour productivity)	main factors affecting CO_2 emissions in heavy industry. - The improvement of labour productivity is the main cause of the increase in CO_2 emissions; a decline in energy intensity leads to CO_2 emissions reduction, and the industry scale has different effects.
(Chen et al., 2018)	- to explore the impacts of selected factors on CO_2 emissions in the OECD from 2001 to 2015; - to explore the decoupling relationships between the selected factors and CO_2 emissions	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: CO_2 emission intensity of fossil energy, energy consumption structure, energy intensity, GDP, population distribution, population size); - Tapia decoupling analysis	- Energy intensity and GDP are the main factors affecting CO_2 emissions. - The impact of population distribution on CO_2 emissions is negligible. - The influence of technical factors is greater than that of non-technical factors, and their influence directions are always opposite.
(Chen et al., 2018)	- to unveil the driving factors behind the changes in greenhouse gases emissions related to internal energy consumption and imbalance of emissions in external trade in Macao during 2000-2011	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: economic scale, industry structure, energy intensity, energy structure)	- The economic scale effect and energy structure change were identified as the main driving factors of increasing energy-related emissions, while trade structure and embodied emission intensity contributed to making Macao a net importer of embodied emissions.
(Du et al., 2018)	- to identify the drivers of energy-related CO_2 emissions change of high-energy intensive industries in China during 1986-2013	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: industrial scale, industrial structure, energy intensity, energy structure).	- The expansion of industrial scale was the leading force explaining CO_2 emissions change. - Energy intensity was the major contributor to promoting the decline in CO_2 emissions. - The effects of energy structure and industrial structure have relatively small impacts on CO_2 emissions change due to the relatively stable energy structure and industrial structure over the years.
(Mohmmed et al., 2019)	- to identify the drivers and variation of CO_2 emission in the top 10 emitting countries (China, USA, India, Russian Federation, Japan, Germany, South Korea, Iran, Canada and Saudi Arabia) from 1991-2014; - to find the causal relationship between CO_2 emissions and human development, and the impact of CO_2 emission on health life expectancy; - to forecast sector CO_2 emissions over the next 16 years	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: population, income, energy intensity, carbon intensity); - Panel Regression Model; - Autoregressive Integrated Moving Average models to forecast of the sectors´ CO_2 emissions	- The population displayed positive effects on CO_2 change in China, US, India, Korea, Canada, Iran, and Saudi Arabia. - The energy intensity had negative effects on the carbon emissions change in China. - CO_2 emissions from most sectors had a significant relationship with human development and healthy life expectancy and a highly significant relationship with economic growth. - The forecast showed that CO_2 emission would increase significantly by 2030.
(Chontanawat et al., 2020)	- to analyze the sources of changes in CO_2 emissions as well as the CO_2 emission intensity of the manufacturing sector in Thailand in 2000–2018	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: emission intensity, energy consumption, total industrial production, structural change)	- The amount of CO_2 emissions and the CO_2 emission intensity increased each year relative to the baseline. - The structural change effect reduced, but the intensity effect increased the amount of CO_2 emissions and the CO_2 emission intensity.

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			- The unfavourable CO_2 emission intensity change came from the increased energy intensity of individual industries. The increased use of coal and electricity raised the CO_2 emissions.
(Ortega-Ruiz et al., 2020)	- to analyze the evolution of the main driving forces of CO_2 emissions in India during the period 1990–2016	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: population, economic activity, economic structure, energy intensity and energy mix)	- The per capita income is the main contributor to the CO_2 emissions increase. - Energy intensity is the main contributor to the decrease in CO_2 emissions.
(Luo et al., 2021)	- to investigate the potential indicators influencing CO_2 emission in Shanghai during 1995–2017	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: motor vehicle amount, disposable personal income, urbanization rate, per motor vehicle secondary industry, per secondary industry population, per residents' income GDP support coefficient, carbon intensity)	- The motor vehicle amount, the disposable personal income, the carbon intensity, and the urbanization rate are the top four driving forces of CO_2 emission.
(Habimana Simbi et al., 2021)	- to analyze the driving forces of CO_2 emissions from economic development in selected African countries during 1984−2014	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: emission efficiency, industrial structure, economic growth, population)	- Population and economic growth were the primary driving forces of CO_2 emissions. - Industrial structure and emission efficiency effects partially offset the growth of CO_2 emissions. - The economic growth effect was an offset factor in Central African countries and Zimbabwe due to political instability and economic mismanagement.
(Dai et al., 2021)	- to decompose the national annual greenhouse gases emissions from enteric fermentation and manure management in pig farming in China from 1976 to 2016	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: technological progress, structural adjustment in the livestock sector, structural adjustment in agriculture, affluence, population growth)	- The net greenhouse gases emissions from increased carbon dioxide equivalents. - The structural adjustment in agriculture, affluence, and population growth contributed to an increase of the greenhouse gases emissions.
(Wang et al., 2022)	- to explore the changes in carbon emissions and their underlying factors in the post-COVID-19 era from a national and sectoral perspective by drawing on the experience of carbon emissions before and after the 2008 global crisis in major developing and developed countries	- The Logarithmic Mean Divisia Index (LMDI) decomposition (factors: carbon intensity, energy intensity, economic structure, economic level, population scale, carbon emission, energy consumption, gross output of industry)	- The energy intensity and economic level are major contributor and inhibitor to emission reduction. - In developed countries, energy intensity has a stronger impact on carbon emissions than economic level. - Carbon intensity had both positive and negative impact on carbon emission, and population scale drove carbon emission increase, mainly in developing countries. - Industrial carbon emissions continue to decrease in developed countries and increase in developing countries.

Source: own elaboration

Despite the increasing recognition of the European Union (EU) commitment to carbon neutrality and the implementation of various policies and measures to mitigate GHG emissions, there remains a significant research gap on the specific factors driving energy consumption and emissions differences between EU countries at different economic levels. Existing studies have often focused on overall EU trends or on analysing individual countries, but limited attention has been paid to a comprehensive comparison of energy consumed

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and emitted patterns between richer and poorer countries within the EU-27 (Soltes and Gavurova, 2015; Gavurova et al. 2021; Tkacova and Gavurova, 2023).

This research gap raises important questions about the underlying causes of the disparities in energy consumption between these two groups of countries, and whether the economic development of these countries plays a significant role in shaping their energy demand and emissions profiles. Moreover, a deeper understanding of the key drivers specific to each group could unlock untapped potential for targeted policies and mitigation strategies that better address the unique challenges and opportunities faced by richer and poorer EU Member States.

We can gain valuable insights into the complex dynamics behind energy consumption and emissions in the EU by filling this research gap and conducting a detailed decomposition analysis.

3. Research methods

Decomposition analysis allows us to monitor the driving forces that affect a particular variable. In our case, we will deal with two variables: (1) energy consumption and (2) greenhouse gas emissions. As mentioned in the previous section, the simplicity and flexibility of the IDA method allow its wider use than in the case of SDA, for the implementation of which input-output (I-O) tables are necessary. For this reason, we will use the IDA method for the purposes of our analysis.

Each decomposition analysis begins with the creation of an equation, which is used to define the relationships between the dependent variable and several factors, the so-called driving forces. In this equation, the product of all factors must be equal to the variable whose change is the subject of the analysis.

In this analysis, we observe the influence of three factors:
1) Activity effect: Depending on the industry, this component is measured in different ways. In the case of industry, this is measured as the added value or physical output of the industry.
2) Structure effect: This component represents a combination of activities within the sector and further divides the activity into subsectors.
3) Intensity effect: This component refers to the energy consumption/emission production per unit of activity.
Various decomposition methods can be used within the IDA to quantify the effects of factor changes on the aggregate. The two most used approaches include methods based on the Divisia index, including LMDI, and methods using the Laspeyres index. For both categories, decomposition analysis can be performed additively or multiplicatively. In the case of a multiplicative decomposition, the ratio change of the aggregate is decomposed, and in the case of an additive approach, the total change, or its increment (indicated by the symbol Δ in our analysis) is decomposed.

The differences lie in the ease of presentation and interpretation of the results (Ang & Zhang, 2000). LMDI I is recommended for general use and is also applied in this analysis. The advantage of this approach is, among other things, that it does not leave residues, which is a property of perfect decomposition and can work with zero values in the dataset (Ang, 2004). The logarithmic mean (L) of two positive numbers x and y is defined as:

$$L(x,y) = \frac{y-x}{\ln\frac{y}{x}}; if\ x \neq y; then\ L(x,y) = x \quad (1)$$

According to (Ang & Zhang, 2000), we can express the quantitative basis of IDA using LMDI by equations (4) - (11). The formulas for the multiplicative and additive decomposition of LMDI are expressed using equations (2) and (3):

$$E_{tot} = \frac{E_T}{E_0} = E_{x1} \times E_{x2} \times E_{x3} \ldots \times E_{xn} \quad (2)$$

$$\Delta E_{tot} = E_T - E_0 = \Delta E_{x1} + \Delta E_{x2} + \Delta E_{x3} + \cdots + \Delta E_{xn} \quad (3)$$

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Equations (2) and (3) denote that the total environmental impact (Etot) for the period 0 - T is generally decomposed into n factors, where Exn denotes the contribution of the n-th factor to the change in the total environmental effect in the period 0 - T. Etot indicates a change in a variable whose change factors are analyzed. ET is the value of the variable at time T and E0 is the value at time 0.
In a three-factor additive decomposition analysis, ΔEtot is decomposed into an activity effect (ΔEact), a structure effect (ΔEstr) and an intensity effect (ΔEint), and we express it using equation (4):

$$\Delta E_{tot} = E_T - E_0 = \Delta E_{act} + \Delta E_{str} + \Delta E_{int} \quad (4)$$

Using three-factor decomposition analysis, the above three factors are calculated as follows:

$$\Delta E_{act} = \left(\sum_{i=1}^{n} L(E_i^0 ;\ E_i^T) \times \ln\left(\frac{Y^T}{Y^0}\right)\right) \quad (5)$$

$$\Delta E_{str} = \left(\sum_{i=1}^{n} L(E_i^0 ;\ E_i^T) \times \ln\left(\frac{S_i^T}{S_i^0}\right)\right) \quad (6)$$

$$\Delta E_{int} = \left(\sum_{i=1}^{n} L(E_i^0 ;\ E_i^T) \times \ln\left(\frac{I_i^T}{I_i^0}\right)\right) \quad (7)$$

where the symbols Y, S, I denote activity (rate), structure (composition) and intensity effect.

In the case of multiplicative decomposition, we will proceed according to equation (8):

$$E_{tot} = \frac{E_T}{E_0} = E_{act} \times E_{str} \times E_{int} \quad (8)$$

In the case of multiplicative decomposition, the individual factors will be calculated using equations (9) – (11).

$$E_{act} = exp\left(\sum_{i=1}^{n} \frac{L(E_i^T, E_i^0)}{L(E^T, E^0)} \times ln\left(\frac{Y^T}{Y^0}\right)\right) \quad (9)$$

$$E_{str} = exp\left(\sum_{i=1}^{n} \frac{L(E_i^T, E_i^0)}{L(E^T, E^0)} \times ln\left(\frac{S_i^T}{S_i^0}\right)\right) \quad (10)$$

$$E_{int} = exp\left(\sum_{i=1}^{n} \frac{L(E_i^T, E_i^0)}{L(E^T, E^0)} \times ln\left(\frac{I_i^T}{I_i^0}\right)\right) \quad (11)$$

The subject of the research is the EU countries (current composition of 27 countries, without the United Kingdom) in the period 1998 - 2018. We performed the decomposition in both ways: additive and multiplicative.

Moreover, based on average GDP, we have divided EU countries into countries above GDP average (referred to as higher-income countries) and below GDP average (referred to as lower-income countries) and repeated the analysis for both groups of countries. The sources of data are the database of World Bank for GDP (in purchasing power parity in current international dollars) and Eurostat - the European Union's statistical office for greenhouse gas emissions (in thousands of tonnes) and primary energy consumption (in millions of tonnes of oil equivalent).

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4. Results of decomposition analysis

Decomposition analysis of energy use

The results of the additive decomposition analysis of energy consumption in relation to GDP show that the most significant impact on energy consumption over the whole period considered, from 1998 to 2018, was due to aggregate activity. However, it is important to note that energy intensity played a crucial role in reducing energy consumption, leading to a notable reduction of 23.43 million tonnes of oil equivalent over the whole period.

For a more comprehensive examination of trends over time, we have divided the observed period into five-year intervals. A closer look at the individual time series reveals an energy-intensive start, with energy consumption showing a notable increase of 76.19 million tonnes of oil equivalent between 1998 and 2003. During this period, the effect of aggregate activity was the main driver of the increase in energy consumption. This was followed by an improvement in the period from 2003 to 2008, when energy consumption continued to increase, but at a more modest rate of 13.53 million tonnes of oil equivalent. This progress can be attributed to the mitigating effect of energy intensity.

A notable breakthrough occurred in the years 2008 to 2013, when there was a remarkable decrease in energy consumption of 103.68 million tonnes of oil equivalent. During this period, the impact of total activity decreased compared to the previous interval, while the mitigating effect of energy intensity increased significantly. This positive trend continued in the period from 2013 to 2018, albeit in a milder form, resulting in a decrease of 9.47 million tonnes of oil equivalent.

The detailed results of the additive decomposition analysis are presented in Table 2.

Table 2. Additive decomposition - breakdown of energy consumption depending on GDP

	1998-2018	**1998-2003**	**2003-2008**	**2008-2013**	**2013-2018**
Δ Eact=	1217.2590	318.6638	432.5996	159.2453	349.7706
Δ Estr=	32.9709	6.7183	13.7678	10.0539	-2.6590
Δ Eint=	-1273.6600	-249.1920	-432.8370	-272.9790	-356.5820
Δ Etot=	-23.4300	76.1900	13.5300	-103.6800	-9.4700

Source: own calculations

Table 3 presents the results of the multiplicative decomposition of energy consumption in the EU countries, which are consistent with the results of the additive decomposition. The analysis shows an overall decrease in energy consumption of 1.7% over the whole observation period. At the beginning of the study period (1998-2003), energy consumption increased by 5.4%, which continued in the subsequent period from 2003 to 2008, but at a slower rate of 0.9%. In particular, EU countries achieved a significant reduction in energy consumption of 7% between 2008 and 2013, and this downward trend continued between 2013 and 2018, albeit at a lower rate of 0.7%.

Table 3. Multiplicative decomposition - breakdown of energy consumption by GDP

	1998-2018	**1998-2003**	**2003-2008**	**2008-2013**	**2013-2018**
Eact=	2.4048	2.4058	2.4064	2.4058	2.4061
Estr=	1.0241	0.5213	0.5616	0.4677	0.5345
Eint=	0.3993	0.8408	0.7467	0.8269	0.7723
Etot=	0.9833	1.0545	1.0092	0.9304	0.9932

Source: own calculations

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We have also divided the EU countries into two groups: 'rich' countries with a GDP above the EU average and 'poor' countries with a GDP below the EU average. The decomposition analysis for both groups revealed a remarkable disparity. Rich countries contributed significantly to the reduction in energy consumption, with a decrease of 23.55 million tonnes of oil equivalent (2.1%) over the whole study period. On the other hand, poor countries with a more energy-intensive economic structure experienced a slight increase of 0.12 Mtoe (0.04%). The detailed results of the additive and multiplicative decomposition for both rich and poor countries over the period 1998-2018 are presented in Table 4, while Figure 1 graphically illustrates the result of the additive decomposition of energy consumption for these two groups.

Table 4. Decomposition - breakdown of energy consumption by GDP for rich and poor countries (1998-2018)

	Additive decomposition		**Multiplicative decomposition**	
	Higher-income countries	**Lower-income countries**	**Higher-income countries**	**Lower-income countries**
	1998-2018		**1998-2018**	
Δ Eact=	-13.5081	344.8185	0.9875	3.0081
Δ Estr=	-295.2060	11.4158	0.7597	1.0371
Δ Eint=	285.1637	-356.1140	1.3000	0.3207
Δ Etot=	-23.5500	0.1200	0.9783	1.0004

Source: own calculations

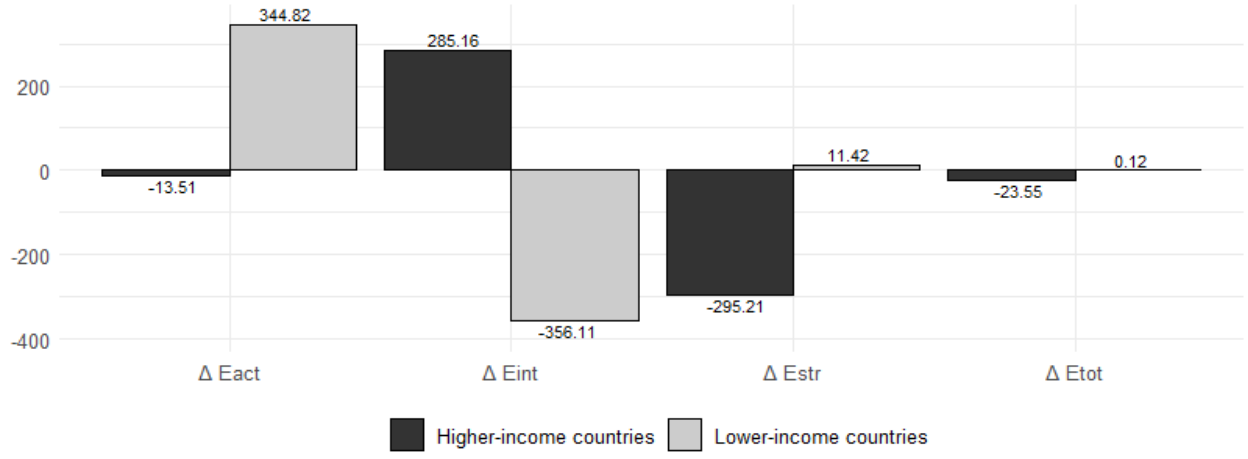


Figure 1. Comparison of higher-income and lower-income countries in terms of energy consumption (additive decomposition)
Source: own processing

In addition, Figure 2 provides an overview of the breakdown of energy consumption for each EU country over the period 1998-2018. Notable decreases in energy consumption were observed in Germany (-30.41 million toe), Italy (-11.05 million toe) and Romania (-7.19 million toe). Conversely, significant increases were recorded in Spain (+20.72 Mtoe), Poland (+9.4 Mtoe) and Austria (+4.14 Mtoe). Table 5 colour codes countries with decreasing energy consumption (green) and countries with increasing energy consumption (red) to visually distinguish the two trends.

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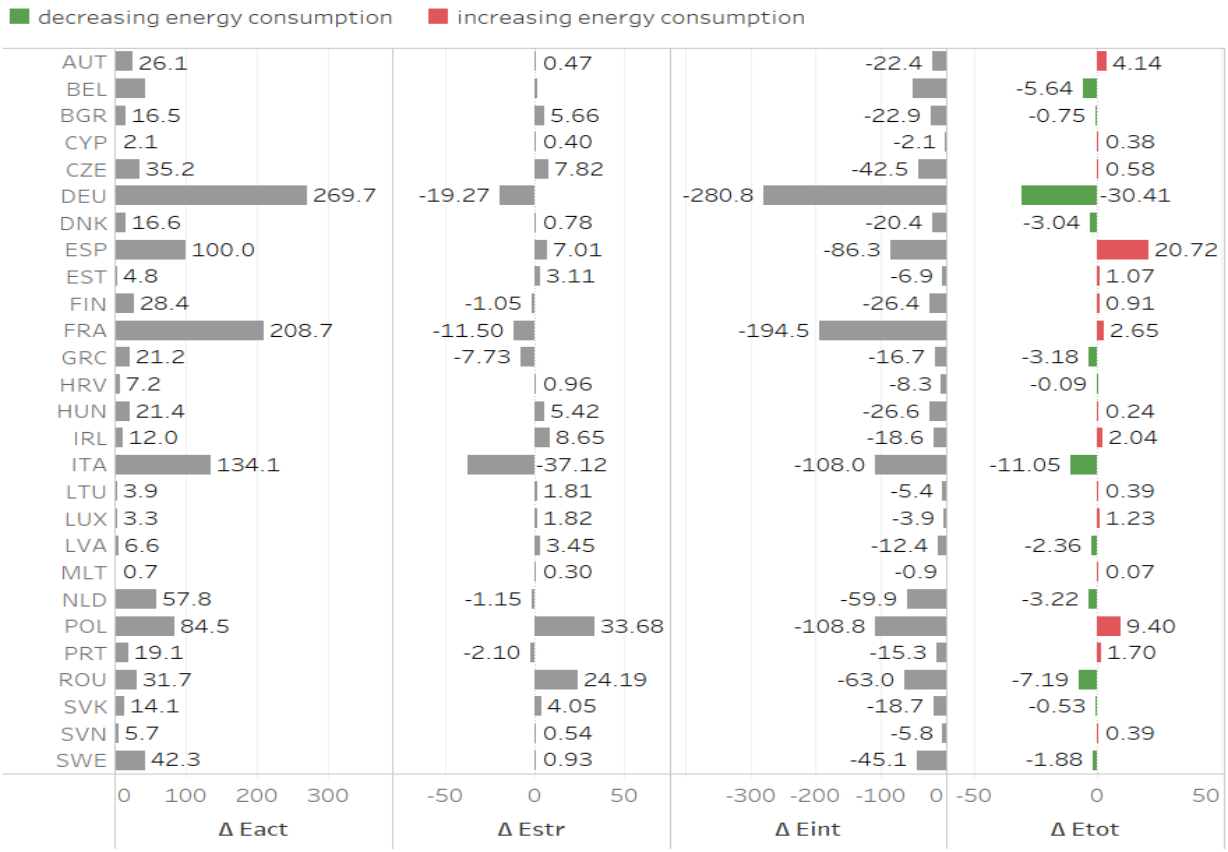


Figure 2. Additive decomposition - breakdown of energy consumption in individual EU countries (1998-2018)
Source: own calculations

Decomposition analysis of greenhouse gas emissions production

The production of greenhouse gas emissions is closely linked to energy consumption, which is mainly driven by the combustion of fossil fuels. This section of the analysis focuses on the decomposition of GHG emissions from GDP, using both additive and multiplicative decomposition methods. The analysis examines the effects of aggregate activity, sectoral structure and emission intensity.

First, the breakdown of GHG emissions within the EU over the entire observation period and in five-year periods is analysed. As shown in Table 5, the EU countries achieved an overall reduction in GHG emissions of 722.85 Mt over the reporting period. The main driving force behind this reduction was total activity, while emission intensity played a crucial role in reducing emissions. At the beginning of the observation period (1998-2003), greenhouse gas emissions increased by 60.44 million tonnes. However, in the following periods a decrease in emissions production was observed. A reduction of 201.5 million tonnes of greenhouse gas emissions was achieved between 2003 and 2008, followed by a remarkable decrease of 494.24 million tonnes between 2008 and 2013. Towards the end of the period (2013-2018), this reduction reached 87.55 million tonnes of GHG emissions. The growing emphasis on reducing the emission intensity of the EU's economic activities contributed significantly to this positive trend.

Table 5. Additive decomposition - breakdown of greenhouse gas emissions

	1998-2018	1998-2003	2003-2008	2008-2013	2013-2018
Δ Eact=	3373986.6	943312.1	1220526.0	424512.1	898030.3
Δ Estr=	137883.5	23751.7	57439.3	29840.8	20094.1
Δ Eint=	-4234723.7	-906628.0	-1479466.0	-948588.4	-1005677.0
Δ Etot=	-722853.7	60435.6	-201501.0	-494235.5	-87552.8

Source: own calculations

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The results of the multiplicative decomposition are in line with those of the additive decomposition. Over the whole observation period, emissions decreased by 17.11%. In the first phase of the review, greenhouse gas emissions increased by 1.4%. However, in subsequent years, the data show a decrease, with reductions of 4.70% from 2003 to 2008, 12.10% from 2008 to 2013 and 2.44% from 2013 to 2018. Within each monitored period, the effectiveness of the emission intensity reduction proved to be a decisive factor in the reduction of greenhouse gas emissions. The results of the multiplicative decomposition of GHG emissions in relation to GDP for the whole observation period and for individual time intervals are presented in Table 6.

Table 6. Multiplicative decomposition - breakdown of greenhouse gas emissions

	1998-2018	1998-2003	2003-2008	2008-2013	2013-2018
Eact=	2.4014	2.4052	2.4055	2.4048	2.4055
Estr=	1.0365	0.5219	0.5643	0.4682	0.5386
Eint=	0.3330	0.8081	0.7021	0.7806	0.7530
Etot=	0.8289	1.0143	0.9530	0.8790	0.9756

Source: own calculations

Similar to the analysis of energy consumption, we compared the GHG emissions situation in rich and poor countries as a function of GDP level. Both groups showed improvements, but rich countries made more significant progress, reducing GHG emissions by 622.35 million tonnes (19.88%) over the whole period. In contrast, poor countries saw their emissions fall by 100.50 million tonnes (9.19%). The detailed results of this analysis are presented in Table 7 and Figure 3.

Table 7. Decomposition - breakdown of greenhouse gas emissions by GDP for rich and poor countries (1998-2018)

	Additive decomposition		Multiplicative decomposition	
	Higher-income countries	**Lower-income countries**	**Higher-income countries**	**Lower-income countries**
	1998-2018		**1998-2018**	
Δ Eact=	-35293.4550	1143955.0000	0.9875	2.9978
Δ Estr=	-536880.3700	28435.2400	0.8260	1.0277
Δ Eint=	-50176.4160	-1272894.0000	0.9823	0.2948
Δ Etot=	-622350.2400	-100503.0000	0.8012	0.9081

Source: own calculations

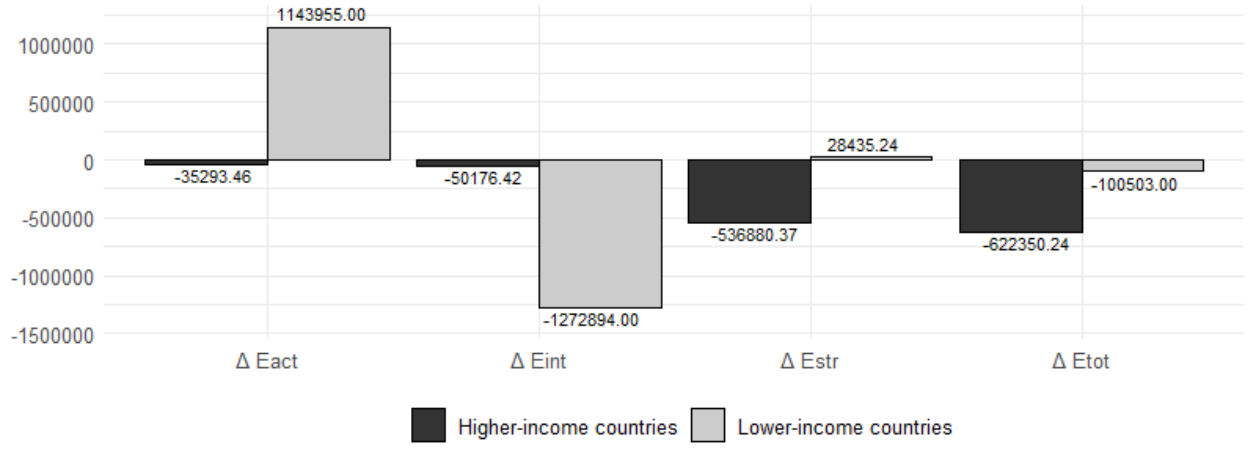
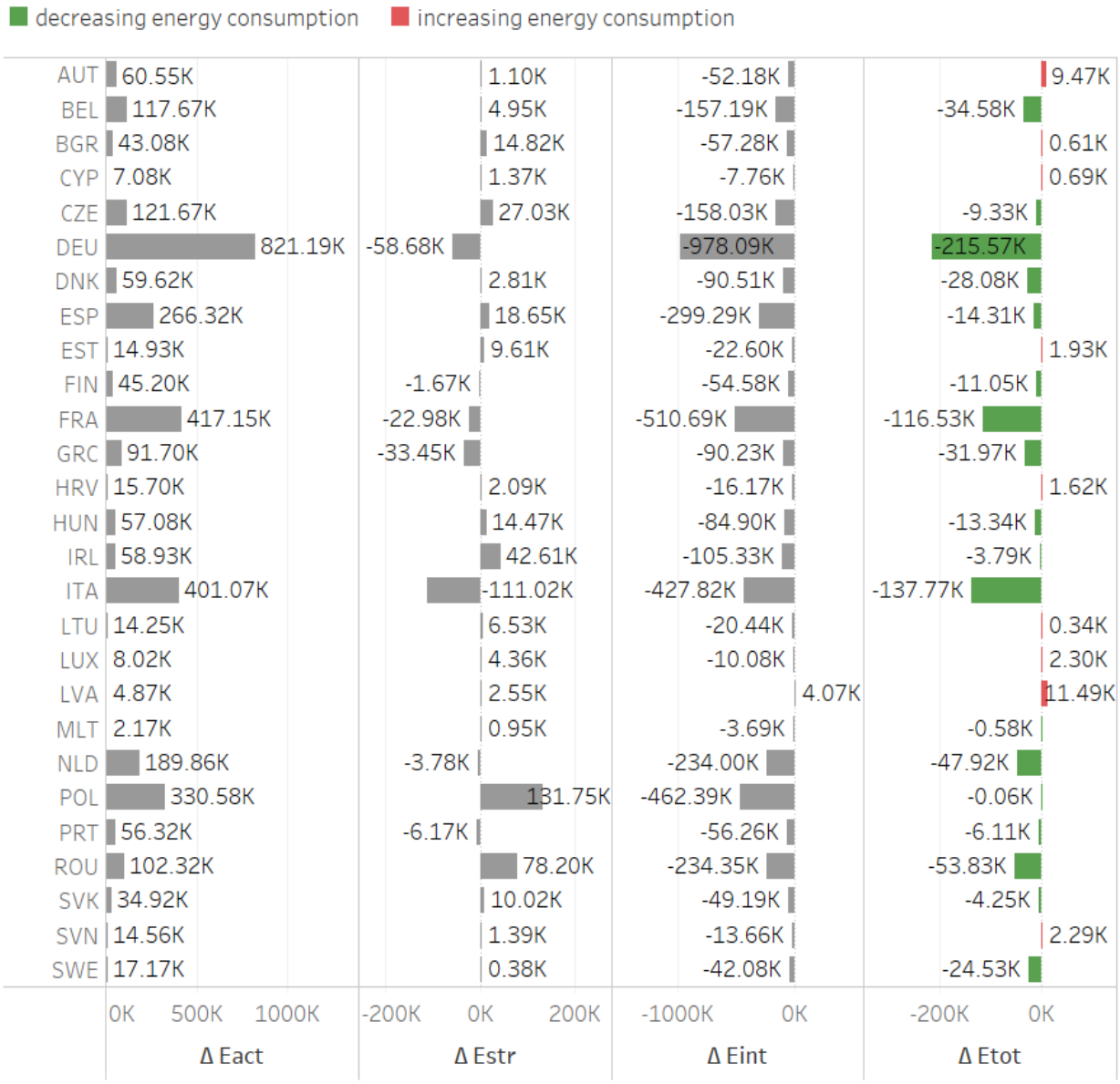


Figure 3. Comparison of higher-income and lower-income countries in terms of greenhouse gas emissions (additive decomposition)
Source: own processing

Figure 4 provides a detailed view of the GHG emissions production of individual EU countries. Throughout the reporting period, the countries with the largest reductions in greenhouse gas emissions are Germany (-215.57 Mt), Italy (-137.77 Mt) and France (-116.53 Mt). These reductions can be attributed to the composition of their

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energy mix, with Germany relying heavily on renewable energy sources and France making extensive use of low-carbon nuclear energy. On the other hand, Lithuania ranked last with an increase in emissions of 11.49 million tons, followed by Austria (increase of 9.47 million tons) and Luxembourg (2.30 million tons). The results of the additive decomposition of GHG emissions by GDP for each country are shown in Table 8, with countries showing a decrease in GHG emissions highlighted in green and countries showing an increase highlighted in red.



Note: K - Thousands

Figure 4. Additive decomposition - breakdown of greenhouse gas emissions in individual EU countries (1998-2018)
Source: own calculations

5. Discussion

Analysing energy consumption and GHG emissions in the European Union (EU) over the period considered (1998-2018) revealed remarkable trends and disparities between Member States. In particular, energy consumption showed a reduction in the period 2008-2013, with a significant decrease of 7%, followed by a more moderate decrease of 0.7% in the period 2013-2018. Wealthier countries contributed significantly to this reduction with a decrease of 2.1%. Poorer countries experienced a slight increase of 0.04%.

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These findings are consistent with various academic contributions on the factors influencing energy intensity, emitting and reducing it. The impact of economic growth, capital intensity and energy prices on energy intensity was highlighted by Löschel et al. (Löschel et al., 2015). Achour & Belloumi (2016) emphasised the key role of energy intensity in reducing energy consumption. Factors such as economic output and transport intensity have a positive impact.

On the other hand, with an impressive total reduction of 722.85 million tonnes over the entire monitoring period, greenhouse gas emissions showed an overall positive trend. The most significant reduction occurred between 2008 and 2013, when emissions fell by 494.24 million tonnes. This was followed by a further reduction of 87.55 million tonnes up to 2018. Rich countries showed a stronger improvement, achieving a 19.88% reduction in GHG emissions, while poorer countries achieved a 9.19% reduction over the study period. These results are in line with (Chen et al., 2018), who highlighted the significant influence of energy intensity and GDP on CO_2 emissions in OECD countries, highlighting the opposite directions and greater weight of technical factors. Similarly, Mohmmed et al. (2019) identified population, energy intensity and various socioeconomic factors as influences on CO_2 emissions, with a significant increase predicted by 2030. Ortega-Ruiz et al. (2020) and Wang et al. (2021) both highlighted the role of per capita income and energy intensity in CO_2 emissions, with developed countries demonstrating a stronger impact of energy intensity on emissions.

While wealthier countries may appear to perform better, it should be noted that these countries often import goods and services that are energy-intensive to produce from other countries. This effectively offshores the environmental impacts associated with their consumption. This approach can give the appearance of reduced energy consumption within their borders, while shifting the environmental burden elsewhere.

This practice, known as 'carbon leakage' or 'embodied energy consumption' (Meunier et al., 2014; Moreau & Vuille, 2018), means that while direct energy consumption within a wealthier country may appear reduced, the energy embedded in imported goods and services often contributes to the energy consumed by exporting, typically poorer, countries. As a result, the overall environmental impact isn't reduced - it's just shifted across borders.

Therefore, while richer countries may show reductions in domestic energy consumption and CO_2 emissions, this observation could be influenced by their shift towards less energy and carbon-intensive activities domestically and reliance on imports that have the energy and carbon burden of production. This phenomenon underlines the importance of a holistic approach to environmental accounting, taking into account the whole supply chain and the global impact of consumption.

In addition, further efforts should be made in the form of political and financial incentives for industry to focus on finding technologies to reduce energy intensity or to increase the use of alternative energy sources (renewables) and reduce the use of fossil fuels (Chovancová et al., 2021; Petruška et al., 2022; Stefko et al., 2021). In addition, each country should cooperate with various international organisations to achieve the global goal of reducing CO_2 emissions (Chontanawat et al., 2020). It is also necessary to see a wide range of indicators of economic growth in the context of the need for an absolute reduction in the use of sources and the elimination of emissions, which is necessary to mitigate the climate crisis and strive for sustainability. In policy and research agendas, improving resource and energy efficiency appears as a key strategy to decouple economic growth from environmental pressures and impacts (Chovancová & Tej, 2020; Chovancová & Vavrek, 2020; OECD, 2019; Parrique et al., 2019; UNEP-IRP, 2019; Vavrek & Chovancova, 2016).

To mitigate carbon leakage, the introduction of carbon taxes should be considered. Carbon taxes act as an economic instrument, putting a price on carbon emissions and creating a financial incentive for both industry and consumers to reduce their carbon footprint. By internalising the cost of carbon emissions, these taxes encourage a shift towards cleaner technologies and practices, while generating revenue that can be reinvested in sustainable initiatives and renewable energy projects.

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6. Conclusion with policy implications

The objective of this analysis was to examine the factors influencing energy consumption and greenhouse gas emissions in the European Union (EU) using the IDA and LMDI methodologies. The results show that the EU has made significant progress in reducing greenhouse gas emissions and energy consumption, thus making steady progress towards its long-term commitments to resource efficiency and climate change mitigation. However, progress has not been uniform across all EU countries, as it varies according to their unique economic structures, resource bases, and other factors that affect their ability to reduce energy consumption and emissions.

Over the period from 1998 to 2018, the reduction in EU GHG emissions was mainly driven by the significant contribution of the emission intensity reduction effect. This factor also had a positive impact on the reduction of energy consumption. However, an important driver for both variables was the level of economic activity in each country, which contributed to their increase. The role of the economic structure was found to be relatively marginal, but had a positive influence.

In addition, the analysis revealed notable differences in the approaches taken by different EU countries. In general, countries with above-average GDP have been more successful in reducing energy consumption and greenhouse gas emissions than countries with GDP below the EU average. This discrepancy can be attributed to different economic structures, with wealthier countries being more service-oriented (and less emission-intensive), while poorer countries, especially those from the former Eastern bloc, tended to be more production-oriented, resulting in higher energy and carbon intensity.

The EU has made significant progress in reducing emissions and energy consumption, reflecting its commitment to climate action and resource efficiency in line with its global commitments such as Agenda 2030 and the Paris Agreement (Vavrek & Chovancová, 2020). However, the results show uneven performance across Member States, influenced by economic structures and resource endowments. As the EU continues on its path towards climate neutrality, several policy implications emerge:

- The EU should adopt a flexible and tailored approach to address the different challenges faced by individual Member States. Recognising that the drivers of energy consumption and emissions differ from country to country, specific policies and support mechanisms should be designed to suit the unique context of each country.
- To bridge the gap between richer and poorer EU countries in reducing energy consumption and emissions, a focus on technology transfer and green innovation is essential. Promoting the uptake of sustainable technologies, renewable energy sources, and energy-efficient practices can accelerate progress in reducing emissions.
- Encouraging cooperation and knowledge sharing among EU countries can promote collective learning and best practices. Facilitating the transfer of expertise from more advanced Member States to those facing challenges can accelerate the transition to sustainable energy and lower emissions.

The decomposition analysis used in this study provides valuable insights into the drivers of energy consumption and emissions. However, the approach simplifies complex interactions and may miss certain nuances in the relationships between variables.

Future research could conduct in-depth case studies of individual EU countries to examine more comprehensively the factors influencing their energy consumption and emission reduction efforts. Similarly, sectoral analysis could be undertaken to examine the variations in energy use and emissions across different sectors.

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IMPACT OF DIGITALISATION ON COMPANIES' PERFORMANCE DURING COVID-19

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Abstract. The main objective of this paper is to investigate how different digitalisation measures have affected business performance in Czech companies during the pandemic. A questionnaire survey of Czech companies from various business sectors was used for data collection. The sample was defined randomly based on voluntary completion. For testing the hypotheses, the instruments used were one-factor ANOVA, Pearson Chi-square test. The study determines the digitalisation measures used and the change in the level of digitalisation of business processes. It provides an overview of the short-term impact of the measures on business performance. It confirmed the link between the growth in the level of digitalisation of external communication and the business sector (for industrial enterprises). Confirmed the association between the digitalisation of product offerings and service measures) and the level of digitalisation of marketing, the level of the website, the education and training of staff (measures), and the level of external communication. The association between the measures taken and the enterprise's financial situation during the pandemic was not confirmed. The results are limited to the Czech environment and the pandemic period. Due to how the sample is defined, insights regarding the wholesale and retail sectors are inconclusive. The study does not take into account long-term follow-up of changes**.**

Keywords: general management; management of non-government organisations; research methods; business processes

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1. Introduction

The COVID-19 pandemic had a significant impact on businesses around the world, causing widespread disruption and unprecedented financial losses. Major economic impacts of epidemics include supply chain disruptions, reduced consumer demand, or increased operational costs due to the need for personal protective equipment, disinfection, and other measures to ensure the safety of employees and customers (Harel, 2021). Unlike other previous epidemics, this pandemic affected all links and linkages in the supply chain, significantly disrupting the flow of the supply chain (Gunessee and Subramanian, 2020; Paul and Chowdhury, 2021). The pandemic affected supply chain activities, operations, processes, and management due to supply disruptions, demand fluctuations, and government measures to combat the crisis (Pollak et al., 2021). Factory closures, border restrictions, travel bans, port closures, and suspended shipping disrupted the supply network, leading to shortages (Magableh, 2021). Sammarco et al. (2022) have shown that adopting certain technologies during a

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disruptive event, such as the COVID-19 outbreak, can positively impact organisations' ability to be resilient. Overall, the COVID-19 outbreak had a significant impact on business performance and forced many companies to rethink their business strategies and goals (Civelek et al., 2021). According to (Igbinakhase 2021), the digitalisation of key business activities will be one of the essential aspects for enterprises to achieve competitiveness in the post-pandemic era. By adopting digital technologies, enterprises have reorganised their business processes to increase productivity, reduce costs and innovate. Digital transformation includes using the Internet as a data-driven management model in design, production, marketing, sales, and communication (Civelek et al., 2021; Zheng and Sun, 2022). Significant technological developments have brought new digital technologies and opportunities for their use (Frenzel et al., 2021; Lincenyi et al., 2023).

Hellsten and Paunu (2020) define digitalisation as the creation and implementation of changes associated with applying digital technologies in all components of human civilisation. Sandberg et al. (2020) state that digitalisation changes the firm's organisational logic and introduces new features to product platforms. The greatest impact of digitalisation on business processes has been seen in sales or online payments, which have saved countless businesses in this crisis (Civelek et al., 2021). Specifically, Clancy et al. (2022) conclude that the introduction of digitalisation in the manufacturing sector minimises waste, resulting in cost savings and increased efficiency in the production process. Thus, digitalisation plays a significant role in optimising business processes (Zotov et al., 2021). Digitalisation of business processes has a positive impact on the utilisation of the potential of the enterprise (Schaupp et al., 2017). However, it is necessary to determine which digitalisation measures contribute to increasing the performance of the enterprise and raising the level of business processes within the value chain concept.

The main objective of this paper is to find out how different digitalisation measures have affected enterprise performance during the pandemic in Czech enterprises.

To fulfil this main objective, the following research questions were set:
Research question 1: Is the change in the level of digitalisation of business process components related to the size of the enterprise and the business sector?
Research question 2: How have digitalisation measures affected the level of digitalisation of individual business process components?
Research question 3: How have digitalisation measures affected the economic efficiency of the enterprise?

2. Theoretical background

The current view of management defines each firm and its processes as being characterised by a value chain, a continuous set of core business and supporting activities. The current priorities and objectives of each specific enterprise define the division into main and supporting processes. (De Meio Reggiani et al., 2022; Linkov et al. 2020). The COVID-19 pandemic changed consumer habits and innovation processes of organisations, leading to an accelerated digital transformation of micro, small, and medium enterprises (MSMEs) and large firms (Gavrila Gavrila and De Lucas Ancillo 2022; del Olmo-García et al. 2020). The impact of the pandemic is evident for all companies, regardless of their size and market position (Guan et al., 2020; Dvorak et al., 2021; Khan et al., 2021). The impact of the pandemic on the economy has caused an economic downturn, a reduction in GDP, high inflation rates, and significantly lower government revenues (Chiaramonti and Maniatis, 2020; Nicola et al., 2020). Global trade, the health sector, unemployment, manufacturing, foreign direct investment, and tourism have also suffered (Khan et al., 2021). The crisis has had an impact on business operations and financial performance. Because of this, strategies were forced to focus on reducing costs by reducing supplies, production, and sales volume (Danielak, 2021). The decline in product demand has led to many companies experiencing a reduced cash flow due to order cancellations, interruptions in domestic or international logistics, and unfulfilled orders due to limited production capacity (Sharma et al., 2020). Limited production capacity has led companies to reduce employment or work hours. The financial crisis due to the pandemic may have caused the temporary closure of the business or suspension of current investments and R&D activities (Danielak, 2021). During a recession, the structure of demand changes, competition increases, and uncertainty arises (Kim et al., 2020). The management of a company must emphasise both core and supporting processes (Komodyova et al., 2020). Of all business processes, core processes contribute the most to performance (Gošnik and Stubelj, 2022).

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Process optimisation means improving existing company processes to enhance competitiveness (Shen and Han, 2020; Rubinsin et al., 2022).

In the current understanding, firm performance is how effectively and efficiently a firm uses its limited resources (land, labour, capital) at its disposal to create value (Aifuwa, 2020). Performance measurement can be understood as indicators that assess an organisation's effectiveness and efficiency and its ability to attract and retain customers in an increasingly competitive market (Lukáč, 2020; Kollmann and Dobrovic, 2022). Any organisation that wants to manage its operations, activities, and supply chains must start with performance measurement (Yousuf et al., 2021). Enterprise-level performance is evaluated in many different ways. The most common categories of indicators tracked to determine an organisation's performance are financial and non-financial (Tulcanaza-Prieto et al., 2020). These indicators include accounting profitability ratios, financial analysis, total factor productivity, and the Balance Score Card (BSC) method (Suryaatmadja,2020; Sharma et al., 2021; McCormack et al., 2020). Rudewicz (2021) focuses on the contradiction between optimisation and strategic stabilisation during the pandemic. In addition to the direct effect on performance change, the firm in a recession is also modelled by the relationship between opportunity recognition and performance (Conti et al., 2020). The COVID-19 pandemic has increased interest in digitising processes (Bikse et al., 2021; Sagapova and Dusek, 2021). Today, enterprise performance is related to continuous digitalisation. Digitalisation has become part of products and services and increasingly supports business processes (Truant et al., 2021). Companies interested in digitising processes during COVID-19 realised the importance of digital transformation to sustain business in times of crisis. This digital transformation includes various business processes such as sales, marketing, human resources, operations, finance, research and development, and customer support services (Antonizzi and Smuts, 2020). Today's economy is often called the "digital economy," characterised by hyperconnectivity, data sharing, and automation (Harasim and Klimontowicz, 2021). Today, business performance is related to continuous digitalisation (Sabino, 2020).

The digitalisation has become part of products and services and increasingly supports business processes. Many industrial countries have embraced automation with the advent of digitalisation, which has fundamentally changed their manufacturing and industrial processes (Leal Filho et al., 2022; Kádárová, 2022). The adoption of digital tools to support the daily operations of a company is still in its embryonic stage (Truant et al., 2021). According to (Renn et al., 2021), the dynamic development of digitalisation has both positive and negative effects. The positive impact relates to business markets and increasing consumer choice and employee freedom (Jurasek et al., 2021).

On the other hand, the development of digitalisation can uncontrollably increase employee insecurity and competition between local and global companies (Renn et al., 2021; Androniceanu and Marton, 2021). Digitalisation has distinct impacts on enterprise performance and contributes to enterprise value (Wang et al., 2022; Tsou and Chen, 2022; Deng et al., 2022). Martínez-Caro et al. (2020) have shown that the greater the extent of digitalisation in an enterprise, the higher the likelihood of being able to develop enterprise performance and thus achieve higher value.

Several studies have examined the impact of digitalisation components on firm performance. For example, Yu et al. (2021) focus on researching the nature of the relationship between enterprise digitalisation and financial performance. In a quantitative empirical survey of Chinese enterprises, it was found that there is an inverted-U-shaped relationship between enterprise digitalisation and financial performance (Yu et al., 2021). Research (Okfalisa et al., 2021) focuses on analysing the determinants of digital transformation readiness in small and medium-sized enterprises. Readiness factors (priority indicators in measuring small and medium-sized enterprises' readiness) include business activities (supply chain activities), transactions (commercial activities to transmit and treat digitised data), marketing, management, micro-environment, and macroenvironment. IT perspectives included culture, education, financial resources, and technical infrastructure. The empirical research was conducted through interviews with experts from IT and business academics (Okfalisa et al., 2021). In the Czech environment, digitalisation in business is addressed, for example, in a study by (Kwarteng et al., 2022), which examines the drivers and barriers related to the tendency of owner-managers of small and medium-sized enterprises to digitalise. The survey was conducted through a questionnaire survey with Czech small and medium-sized enterprise owners (Kwarteng et al., 2022).

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According to the nature of the research questions and the results of these studies, the current research will be conducted as a questionnaire survey, and correlation methods will be used for data processing.

3. Research objective and methodology

The research questions of the study were set as follows:
Research question 1: Is the change in the level of digitalisation of business process components related to the size of the enterprise and the business sector?
Research question 2: How have digitalisation measures affected the level of digitalisation of business process components?
Research question 3: How have digitalisation measures affected the economic efficiency of the enterprise?
To answer the research question, a questionnaire survey will be conducted in Czech enterprises from different sectors. The sample will be drawn using non-probability sampling based on voluntariness. The minimum return threshold in this research has been set at 200 enterprises. Figure 1 shows the schematic structure of the empirical research.

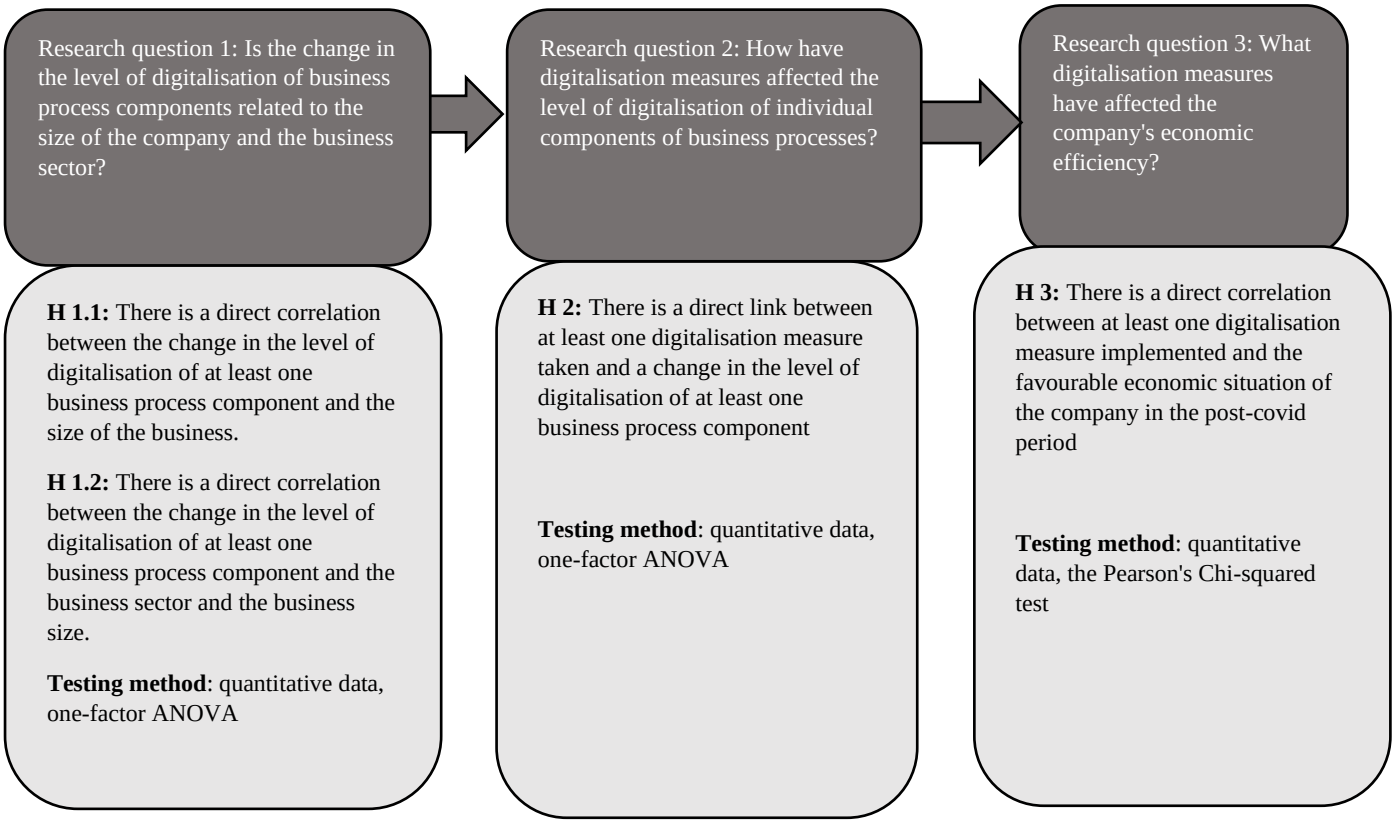


Figure 1. Brief structure of the empirical research
Source: own processing

The first research question reads: Is the change in the level of digitalisation of business process components related to the size of the company and the business sector? To answer research questions 1 and 2, hypotheses were constructed, which will be referred to as H1.1 and H1.2.

Hypothesis H1.1 is defined as: There is a direct relationship between the change in the level of digitalisation of at least one business process component and the size of the enterprise.
Hypothesis H1.2 is formulated as follows: There is a direct correlation between the change in the level of digitalisation of at least one business process component and the business sector and business size.

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To answer this and other research questions in the questionnaire, the following questions were formulated:

1) Business size (answer options: micro-businesses, small businesses, medium-sized businesses, large businesses),
2) Business sector (answer options: service sector, industry sector, wholesale and retail sector),
3) Evaluate the level of digitalisation of the enterprise before the pandemic (February 2020). Business process components:
   - Websites (e-shop, web configurators, web chat etc.),
   - Digital marketing (traffic and conversion measurement, SEO/SEM, social media, Emailing and other),
   - Measurement of processes productivity and monitoring,
   - External communication,
   - Data use and personalisation (personalisation, product offering, pricing etc).
   - The level of digitalisation can be selected by respondents according to the scale of Basic, Intermediate, Advanced, and Excellent.
4) Evaluate the company's current level of digitalisation (October 2021). Business process components: website, digital marketing, processes and productivity, external communication, data use and personalisation. The level of digitalisation has response options: Basic, Medium, Advanced, and Excellent.
5) Have you taken any digitalisation measures that have helped you? If yes, in which area?
   - I have not taken any measures in the area of digitalisation,
   - Communication with customers,
   - Team communication (internal management processes and communication),
   - Communication between organisational units within the company,
   - Data and document sharing, use of internal data,
   - Production (new machines and technologies),
   - Product/service offering (creation of an online shop – introduction of online sales of education and training),
   - Other .....
6) How do you assess the company's situation at the moment (as of October 2021)?
   - We are considering closing the business,
   - We are trying to recover, but the situation is still uncertain; we have several problems,
   - We have almost recovered, and we are continuing the business,
   - We are fully recovered and continue as before the pandemic,
   - We are fully recovered and doing better than before the pandemic,
   - The pandemic has not hurt the business.

To test hypothesis H1.1, the answers to questionnaire tasks 1, 3, and 4 will be analysed. The change in the level of digitalisation of business process components will be defined as the difference in answers between questions 4 (during the pandemic) and 3 (before the pandemic). For the testing of hypothesis H1.2, the analysis of the answers to questions 2,3, and 4 will be carried out.

The second research question is formulated as follows: Which digitalisation measures have influenced the level of digitalisation? To answer the second research question, hypothesis H2 was formulated: There is a direct link between at least one digitalisation measure taken and the change in the level of digitalisation of at least one business process component. In this case, the answers to tasks 3,4,5 in the questionnaire will be analysed. The change in the level of digitalisation of business process components will be the same as in the case of testing hypothesis H1.1 and hypothesis H1.2.

The third research question was defined as: What digitalisation measures have affected the economic efficiency of the company? To answer research question 3, the following hypothesis H3 was set: there is a direct link between at least one digitalisation measure implemented and the favourable economic situation (based on the subjective opinion of the entrepreneur) of the company in the post-Covid period. To test hypothesis H3, the answers to questions 5 and 6 will be analysed in the questionnaire.

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Hypothesis H 1.1 and hypothesis H 1.2, which are aimed at establishing the link between the change in the level of digitalisation of business processes and the factors of size and sectoral focus, will be tested using the one-factor ANOVA in the tool Recommander (Recommander Team, 2023). The significance level will be set at 5 per cent. The one-factor ANOVA aims to demonstrate the dependence of the explained variable Y (quantitative variable) on the explanatory variables (factors) and to determine whether the differences found are statistically significant or random. The result of the analysis is the determination of the p-value. An association is not confirmed if the resulting significance value for a given group is more significant than 0.05 (p-value > 0.05), i.e. there is no significant difference. An association is considered to be established if the significance is less than or equal to 0.05 (p-value ≤ 0.05), i.e., a significant difference between the groups.

Hypothesis H2, oriented to investigate the relationship between the measures taken and the change in the level of digitalisation of business processes, will be tested using one-factor ANOVA in Recommander. The significance level will again be set at 5 per cent.

Hypothesis H3, which is aimed at proving the link between the measures taken in the digitalisation field and the company's economic situation in the post-covariance period, will be tested using Pearson's Chi-squared test in Recommander, observing the X-squared parameter. The significance level will be set at 5 per cent. Pearson's chi-squared test is a common test for determining significance that links two categorical variables. It can be used to test whether the two variables are independent or dependent (Xu et al., 2019). The result of the analysis is the determination of the p-value. A relationship between variables is considered to be established if the significance is less than or equal to 0.05 (p-value ≤ 0.05); that is, there is a significant difference between the groups.

4. Results and discussion

A total of 251 different enterprises participated in the survey. After selecting relevant respondents (leaving blank responses), 225 enterprises remained. The survey was conducted in October 2021 in Czech enterprises. The industrial sector in the sample represented 82 enterprises from the following sectors: wood processing, paper, electricity, heat, gas, water, waste, food processing, construction and crafts, textiles and clothing, footwear and leather, agriculture, livestock, forestry, fishing, and manufacturing. The services sector in the sample represented 123 enterprises in the following sectors: security services, personal protection; travel agency; transport, postal, and courier services; event and experience agencies; IT; hospitality; consultancy; intermediation; business and professional services; personal services; health; ambulance services. There were 20 enterprises in the sample that reported retail trade as their main activity. Table 1 presents the results of testing H1.1 and H1.2, using the one-factor ANOVA tool in Recommander software.

Table 1. Testing the association between the change in the level of digitalisation of business process components and the factors of enterprise size and business sector

Hypothesis H1.1	*Tested factor: Business size*				
	Df	**Sum Sq**	**Mean Sq**	**F value**	**Pr (>F)**
Web	3	0.40	0.1334	0.297	0.828
Residuals	221	99.44	0.4500		
Processes and productivity	3	1.15	0.3846	1.127	0.339
Residuals	221	75.44	0.3414		
External communication	3	3.25	1.0842	2.196	0.0895
Residuals	221	109.13	0.4938		
Digital marketing	3	0.82	0.27850	0.698	0.554
Residuals	221	87.02	0.3937		

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Hypothesis H1.1	*Tested factor: Business size*				
	Df	**Sum Sq**	**Mean Sq**	**F value**	**Pr (>F)**
Data use and personalisation	3	1.29	0.4301	1.229	0.3
Residuals	221	77.35	0.35		
Hypothesis H1.2	*Tested factor: Business sector*				
Web	2	1.93	0.9667	2.192	0.114
Residuals	222	97.91	0.4410		
Measurement of processes productivity and monitoring	2	0.60	0.3025	0.884	0.415
Residuals	222	75.99	0.3423		
External communication	2	4.26	2.131	4.375	0.0137*
Residuals	222	108.12	0.487		
Digital marketing	2	0.83	0.4139	1.056	0.35
Residuals	222	87.01	0.3919		
Data use and personalisation	2	0.46	0.2320	0.659	0.518
Residuals	222	78.18	0.3521		

Source: own processing

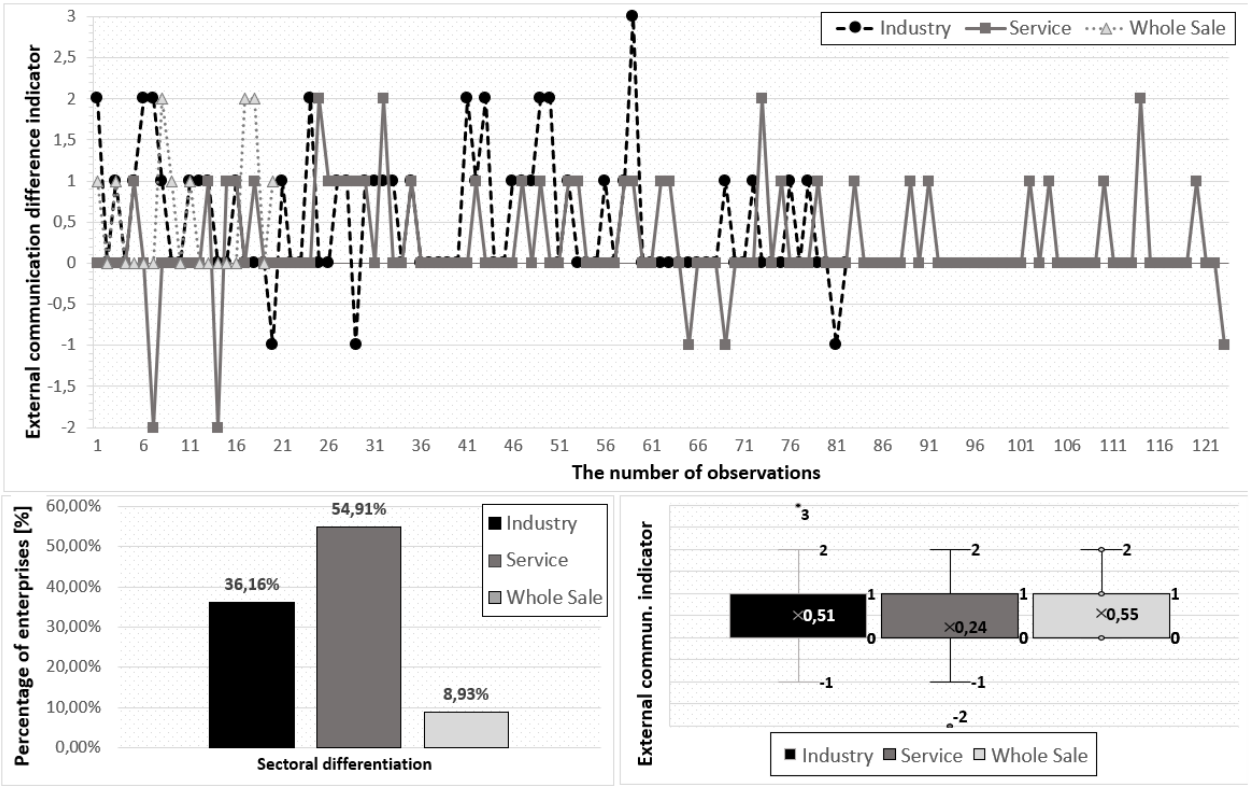


Figure 2. Data distribution in H1.2 testing
Source: own processing

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Hypothesis H1.1 testing showed a slight indication of an association only between the change in the level of digitalisation of external communication and the company's size. However, the associations still needed to be confirmed. Hypothesis H1.1 is rejected; therefore, the change in the level of digitalisation of any of the business process components was unrelated to firm size. In testing hypothesis H1.2, only the association between the sector and the increase in the level of digitalisation of external communication was confirmed (the association is more pronounced for service providers). The association with the business sector was not confirmed for the other observed components of business process digitalisation. Hypothesis 1.2 is confirmed, and the link between external communication and business size is demonstrated. Table 2 presents the selected results of testing hypothesis H2 using a one-factor ANOVA.

Table 2. Selected results of testing H2: the link between digitalisation measures taken and the change in the level of digitalisation of business process components

	Df	**Sum Sq**	**Mean Sq**	**F value**	**Pr(>F)**
Measures: digitalisation of product and service offerings					
Changing the level of digital marketing	2	1.248	0.6241	3.42	0.0355
Residuals	137	25.002	0.1825		
Measures: digitalisation of communication with customers					
Changing the level of digital marketing	2	0.04	0.02176	0.089	0.915
Residuals	137	33.56	0.24494		
Measures: digitalisation of product and service offerings					
Changing the level of the website	2	1.31	0.6549	3.597	0.03
Residuals	137	24.94	0.1820		
Measure: communication between organisational units					
Changing the level of external communication	2	0.89	0.4450	2.358	0.0984
Residuals	137	25.85	0.1887		
Measure: digitalisation of product and service offerings					
Changing the level of external communication	2	1.05	0.5250	2.854	0.061
Residuals	137	25.20	0.1839		
Measures: education and training of staff					
Changing the level of external communication	2	0.921	0.4607	3.728	0.0265
Residuals	137	16.929	0.1236		

Source: own processing

The hypothesis H2 testing confirmed the link between the digitalisation of product offerings, services (measures), and the change in the level of digital marketing. There is no direct link between the measure (communication with customers) and the change in the level of digital marketing. The measure (digitalisation of product and service offers) impacted the change in the level of the website. There was no confirmed clear, direct correlation between the measure of inter-organisational communication and the change in the level of external communication. The results of testing also indicate that there is a slight indication of a correlation between the measured digitalisation of product and service offerings and the change in the level of external communication. Also, there is a confirmed correlation between the measure of education and staff training and

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the change in the level of digitalisation of external communication. In summary, the hypothesis H2 is confirmed. The testing results indicate a correlation between the digitalisation measures taken and the change in the level of digitalisation of some components of business processes.
The results of hypothesis H3 testing are presented in Table 3 using the Pearson Chi-Square tool.

Table 3. Results of testing H3: the relationship between digitalisation measures taken and the financial situation of the company during the pandemic

Pearson's Chi-squared test results, Hypothesis H3			
Measures taken	**X-squared**	**df**	**p-value**
Communication between organisational units within the company	3.0524	4	0.5491
Communication with customers	6.7095	4	0.1521
Team communication (internal processes, management, and communication)	1.6204	4	0.8051
Offer of products and services (creation of an online shop, introduction of online sales)	3.3914	4	0.4946
Data and document sharing (use of internal data)	2.818	4	0.5887
Production (new machines and technologies)	5.46	4	0.2433
Education and training	2.0646	4	0.7239
We have not taken any action on digitalisation	17.671	4	0.001431
Relationship between the number of measures taken and the financial situation after COVID-19	*12.405*	*9*	*0.1914*

Source: own processing

Empirical data suggest that there is no clear direct correlation between the digitalisation measures taken and the financial situation of businesses during the pandemic. Hypothesis H3 is rejected; the individual measures taken did not have a direct impact on the financial situation of the enterprise during the pandemic Covid- 19.

The research questions were defined as follows:
Research question 1: Is the change in the level of digitalisation of business process components related to the size of the enterprise and the business sector?
Research question 2: How have digitalisation measures affected the level of digitalisation of business process components?
Research question 3: How have digitalisation measures affected the economic efficiency of the enterprise?

The correlation between the change in the level of digitalisation and the size of enterprises has not been demonstrated. The literature concludes that it is more difficult for small and medium-sized enterprises to achieve investments in digitising business processes (e.g., Ingaldi & Klimecka-Tatar, 2022). The benefits of digitalisation for all sizes of enterprises are evident from the results of several studies (e.g., Doyle & Cosgrove, 2019; Osmonbekov et al., 2022). Thus, it can be assumed that the change in the level of digitalisation due to COVID-19 in the short term has occurred at a similar rate for enterprises of all sizes. Further, it can be concluded that although larger enterprises are assumed to have higher investments in digitalisation, the rate of visible changes in the level of digitalisation of business processes is similar for enterprises of all sizes. Further, it can be summarised that the lack of correlation between the change in the level of digitisation and the size of the firm may be related to the different initial level of digitisation. Despite the undisputed benefits of digitisation for businesses of all sizes, the opportunities for larger firms are quite different from those for smaller companies.

The correlation between the change in the level of digitalisation of business process components and the business sector has only been partially demonstrated. According to the results, only the digitalisation of external communication was influenced by the business sector (the link is more evident for service providers than industrial enterprises). The result follows the findings of (Ingaldi & Klimecka-Tatar, 2022) regarding the benefits of digitalisation within the supply chain in the service sector. In contrast, the result only partially confirms the findings of (Abdallah et al., 2022) on the increase in the level of digitalisation in industrial firms due to COVID-19. Thus, it can be concluded that although there has been an increase in the use of digital technologies in both these sectors, the service sector shows a stronger trend. This finding is logical because external communication is vital for implementing its processes for service providers, especially during service restrictions.

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The correlation between the digitalisation measures and the change in the level of digitalisation of individual components of business processes was partially demonstrated. The confirmed links include:

- the digitalisation of product and service offerings (measures) and the level of digitalisation of marketing,
- the digitalisation of product and service offerings (measures) and the level of websites,
- staff education and training (measures) and the level of external communication.

These results are indirectly related to the findings of (Okfalisa et al., 2021). (Okfalisa et al., 2021) cite staff education in different areas of business operations, level of business processes, and level of external communication as critical determinants of readiness.
The research findings also build on an article (Wilkinson et al., 2021) on the impact of digitalisation on HR management development.

The results are also in line with the findings of (Franco et al., 2021), which state that customer relations and the behaviour of co-workers are crucial in the digitalisation and management of small and medium-sized enterprises. Thus, the measures (digitalisation of product and service offerings, education and training of staff) directly impact the development of the components of business processes (marketing, web development, and external communication). Thus, developing a knowledge base of employees is an effective tool in implementing the elements of digitalisation and, consequently, a tool for achieving flexibility in times of crisis.

Conversely, interesting unconfirmed relationships include:

- communication with customers (measures) and the level of digitalisation of marketing,
- communication between organisational units (measures) and the level of external communication,
- the digitalisation of product and service offerings (measures) and the level of external communication.

Integrated marketing communication in the context of digital marketing and its impact on buyers' purchase decisions is the result of research (Bormane, 2019). Although the digitalisation of customer support may not primarily affect the growth of digital marketing, their common goal is being met. The linking of internal and external communication is the object of research (Rauwers et al., 2016). It cannot be ruled out that these variables will be interrelated in the long run. According to the current state of scientific knowledge, the digitisation of external communication leads to a change in the digitisation of internal documentation to unify the qualitative requirements for information flows. The digitalisation of product offerings and services is logically linked to the level of external communication. An unconfirmed relationship may imply an uncontrollable diversity of IT tools within the external communication partners.

The research results build on the findings of (Papagiannidis et al., 2023) regarding the change in consumer behaviour during a pandemic and the subsequent adoption of digitalisation tools to achieve competitiveness.

The link between the measures taken and the company's financial situation during the pandemic was not confirmed. The authors consider this conclusion one of the most important in their research. The conclusion needs to be consistent with several studies. For example, (Yu et al., 2021) confirm the impact of digitalisation on firm economic performance, and (Etienne Fabian et al., 2023) find a potential positive impact of small and medium-sized enterprises' digitalisation on performance improvement according to small and medium-sized enterprises' characteristics. The difference, in conclusion, may be due to the different time perspective of the observation. Another reason is the comparison of the impact of digitalisation implementation as a whole without breaking down the individual measures within the implementation of digitalisation. Thus, what needs to be demonstrated at a sub-level may be shown at a higher level. Small and medium-sized enterprises that focus on radical change and are more rigid are disadvantaged and achieve lower returns from digitalisation and implementing elements. It can be assumed that the crisis period distorts the real effectiveness of implementing

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digitalisation elements. On the other hand, digitisation has helped the flexibility of the business in times of crisis, and without the implementation, more companies would have considered ending their business.

Conclusions

The main objective of this paper was to find out how digitalisation measures affected business performance during the pandemic of Covid- 19 in companies in the Czech Republic. The novelty of the findings lies primarily in the complexity of the view of the impact of the pandemic on business behaviour from the perspective of digitalisation. The study determines the digitalisation measures used and the change in the level of digitalisation of business processes. It provides an overview of the short-term impact of the measures on business performance.

In the context of the study's results, some practice recommendations, i.e. the target segment, can be made.

The introduction of digitalisation into business processes must be accompanied by measuring individual effects and evaluating benefits. Measuring the effectiveness of introducing digitisation tools may reflect, among other things, the business sector, so measuring the performance of the implementation of digitisation elements cannot be approached as a universal value. In the service sector, it is recommended that the digitalisation of in-house processes be focused on as a recognised tool for achieving competitiveness. It is essential to view the digitalisation of internal processes as a complex process that has a cumulative effect on business performance. It is crucial to monitor the impact of the digitalisation of individual components over a long time horizon. The results of the study show that measures that can bring an immediate effect in the short term include digitalisation of product and service offerings (to achieve a higher level of digitalisation of marketing and to improve the website), last but not least, staff training (to increase the level of digitalisation of external communication). It can also be recommended in relation to measuring the effectiveness of staff training to focus on "output indicators" in the short-term and long-term.

The research results have some limitations. Due to the geographical distribution of respondents, the conclusions are valid only in the Czech environment. Further research may show that such findings could apply to the conditions of the Visegrad Group countries or economies similar to the Czech Republic. Based on the available data, it is not possible to generalise the conclusions for wholesale and retail due to insufficient sample size. The study does not consider the impact of long-term changes on the object of research. The findings are tied to specific periods before and during the pandemic and thus may not be valid for other periods. The performance measurement for this study is relatively narrow and does not consider the monitoring of dynamic indicators. The results can also be distorted by the subjectivity of the respondents' perception of some values in the questionnaire.

Future work in the field should focus primarily on examining the differences in the level of digitalisation over the long term across sectors and across firms of different sizes and lines of business. Furthermore, research can focus on monitoring the impact of the digitalisation of business process components on the quality of value chain functioning at the enterprise and inter-enterprise levels. Another interesting question for future research is whether adequate methods can be provided for evaluating the effectiveness of introducing digitalisation elements tailored to the actual conditions of a particular company. Concerning HR management, we can also note the current research direction on the effectiveness of staff training in the dimension of explicit and implicit knowledge in single-sector industries.

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FROM INTERACTION TO INTEGRATION: LEVERAGING AI IN ENHANCING TEAM COMMUNICATION AND TASK EFFICIENCY

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Abstract. At a time when digital transformation is reshaping work processes and how companies approach and perform tasks, artificial intelligence (AI) is emerging as a vital element of this evolution. AI-powered tools are changing how companies interact with customers and fundamentally impacting internal processes and how they assign tasks to teams. This trend raises questions about the efficiency with which humans and AI perform assigned tasks and the potential implications for future workplace dynamics. The main objective of this study is to provide a deeper understanding of the differences in task performance efficiency between humans and AI and to identify optimal ways in which these two resources can be used together to maximize their potential in the modern workspace. Through a comprehensive methodology and range of research methods, the paper offers both theoretical and practical benefits for academics, management practitioners and AI developers. Through this approach, the article expands the academic discourse on task performance effectiveness in the AI era. It provides strategic insights for organizations seeking to effectively leverage AI alongside human resources.

Keywords: Artificial Intelligence (AI); task efficiency; human - AI collaboration; digital transformation; teamwork and productivity; ai in workplace; task assignment strategies; management; communication; content

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1. Introduction

Today's economy is undergoing dynamic development, with industry digitalisation being one of the most significant trends. This shift requires businesses and organisations to adopt new technologies and develop strategies for effective interaction between workers and digital tools. Artificial Intelligence (AI) plays a crucial role in this transformation as it becomes the centre of new methods of management, communication, and decision-making (Angelova, Stoyanova and Stoyanov, 2023). The integration of AI into everyday work processes not only changes the configuration of social and economic relations but also opens new opportunities for increased efficiency and innovation in all sectors (Palos-Sánchez et al., 2022; Tugui et al., 2022; Giraud et al., 2023; Androniceanu, 2023).

The arrival of artificial intelligence (AI) has revolutionized many industries, and the field of human resource management is no exception. Artificial intelligence is changing how businesses, companies and organizations conduct HR activities and develop their work teams. AI is now a common part of an individual's daily life and work environment (Kim, Jang and Kim, 2022). One of the primary roles of artificial intelligence, which also hides its colossal potential, is the collection and analysis of data. Nowadays, this is mainly used in marketing to

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collect and interpret customer preferences and data or analyze resumes in recruitment (Angelova Stoyanova and Stoyanov, 2023).

Empirical studies show that integrating AI into business processes positively impacts business performance, increases levels of creativity, and contributes to a more efficient and inclusive workforce (Su, Togay and Côté 2021; Burnett and Lisk, 2019). However, at the same time, there are concerns about data privacy and AI's potential replacement of human labour (White and Lidskog, 2022). These challenges highlight the need for a balanced approach to AI implementation that considers its potential and its use's ethical aspects.

In the context of these changes and challenges, this paper focuses on analysing the effectiveness of human task performance compared to artificial intelligence. This paper brings new perspectives on the possibilities of collaboration between humans and AI in work processes. Through this approach, we aim to enrich the academic discourse on the use of AI, to provide managers and executives with practical guidelines for improving work efficiency, and to contribute to the ethical and sustainable development of technology in business. The study relies on a comparative analysis of the performance of "HOW" type tasks between human teams and AI systems, emphasizing qualitative assessment of their performance, adaptability, and innovation potential. Through this paper, we offer a new perspective on the future direction of the use of AI in the world of work and the place that humans will occupy in it.

2. Task assignment

Task assignment is a sub-element of management. The literature agrees that the essential criteria that should be clearly defined when assigning a task include the desired outcome, time horizon, responsibility for performance, available resources, and specification of what is considered successful completion of the task (Pechová, Volfová and Jírová, 2023). According to Plamínek (2009), expressing support and creating space for questions and discussion is also an important point, as understanding the assigned task is considered the basis for future success and acceptance. In some ways, a well-managed process of defining the work task and the associated responsibilities can optimize the worker's approach to the assigned work from the beginning (Kriek, 2019).

Without setting a goal, the task could not exist. The question remains, however, to what extent it is also necessary to determine how it is to be achieved. In this case, the preferences of each taskmaster/leader/manager are radically different (and usually closely related to the management style chosen), as are the preferences of each executor/subordinate/employee (Kamei and Markussen, 2022). Some need rigid structures and roles to achieve results, the presence of which reduces uncertainty, ambiguity, and misunderstanding. On the other hand, others may be demotivated by such an approach (Delfgaauw, Dur and Souverijn, 2020).

The "HOW" or process type of assignment mainly specifies how the performer's work will be done. It includes an enumeration or direct description of working methods. Yet, it is burdened with frequent control and consultation, as a result of which the assignor can manage only a small number of performers, and his work becomes less effective (Plamínek, 2009; Parkes, 2016).

In "WHAT" type assignments, we encounter a more autonomous approach; only the outcome to be achieved and the evaluation criteria are specified.

The paper's current title focuses on the "HOW" type of task assignment performed by members of the working team from Škoda Auto Vysoká škola o.p.s. and Škoda Auto a.s. and AI systems such as Chat GDP, Copilot Edge, Midjourney nao Bing AI or Alphabets Bard. The "WHAT" type of task assignment, associated with autonomous access and creativity, would not yet be handled correctly by AI systems. AI systems still need and will likely need specific types of information to process the task (Galanos, 2019). This paper compares the results of the implemented task to those acceptable to humans and AI systems.

This paper also works with data from a survey conducted by the authors in 2023 with 388 respondents and draws on the following data:

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In the 2023 survey, when given a "WHAT" type task, 20.6% of respondents felt they had enough information to complete the task. 79.4% of respondents, on the other hand, lacked additional information in the task assignment. The following types of information were the most frequently identified by respondents (in order of response frequency):

- Information on the exact date, agenda, focus and objective,
- specific location of the venue,
- what is the deadline for completing the task,
- the priority of the task,
- the reason or purpose for performing the task,
- information on whether the task is confidential or public
- and a thank you or appreciation of the task.

58.8% of the respondents would find a specific procedure guide easier to complete the task, 41.2% did not require a guide to complete the task. At the same time, 58.8% of the respondents perceived the task as creative and 23.7% of the respondents ranked the task type as medium level of creativity. The remaining respondents rated the task as routine. 69.3% of the respondents believed they had all the skills and abilities to complete the task, 30.9% had only some skills, and 5.2% believed they did not have the skills and abilities to complete the task. Respondents felt that the following skills (in order of frequency) were necessary for completing the task:

- Good interpretation of information,
- good knowledge of grammar and stylistics,
- graphic skills,
- the art of motivation in written text
- and imagination (Pechová, Volfová, Jírová, 2023).

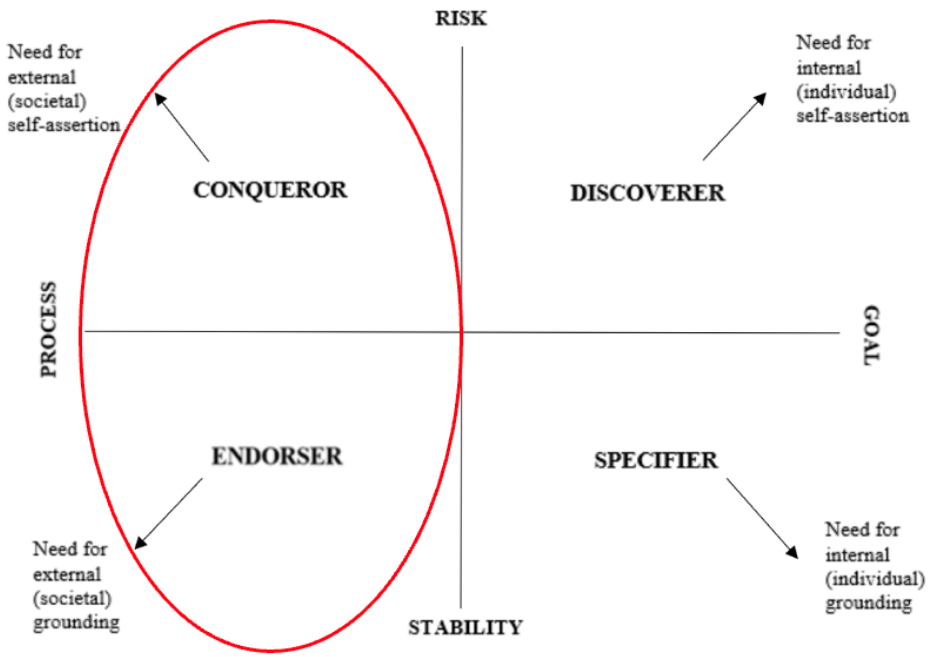


Figure 1. People preferring task type "HOW"
Source: the authors

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3. The importance of AI

The way AI is perceived is closely related to whether the author considers it an existential threat to workers or even human existence or whether it is seen as a tool that can help people improve our society and living conditions (Galanos, 2019; Schwesig et al., 2023). There are beliefs that AI will evolve in ways that are harmful to jobs and society as a whole (White and Lidskog, 2021). On the contrary, analysts who see AI as a useful but not at the same time omnipotent technology stress that it will remain a tool that requires human intervention to be truly useful (Griva et al., 2023).

There are several perspectives on AI and the resulting definitions, e.g., machine-oriented view or human-oriented view, etc.; for this paper, the general perspective is drawn, i.e., that AI is the ability of artificial machines to emulate and simulate human methods for deductive and inductive knowledge acquisition and application and inference (Griva et al., 2023).

Chapter 3.1 characterizes selected AI systems, and Chapter 5. 2 presents the results and evaluation of the "HOW" task performed by AI systems.

3. 1 AI Systems

A key element of all AI systems introduced subsequently is natural language processing (NLP), which deals with the interaction between computers and human language. In practice, this means the ability to understand input queries, commands or context and respond with appropriate answers (Vithayathil and Nauroth, 2023). To achieve this goal, techniques and algorithms are used to analyse and understand text, recognise patterns and generate responses. These techniques include machine learning, deep learning, statistical methods and others.

Artificial intelligence based on NLP, be it chatbots, automatic translators, speech recognition software or sentiment analysis, is trained on datasets and huge amounts of textual data from various sources, be it books, newspapers, internet articles or even discussion forums and more. Thus, different language patterns and structures are learned. This training also occurs during the actual use of the application, which therefore adapts to the changing needs and trends in language and communication (Vithayathil and Nauroth, 2023; Vrontis et al, 2022).

ChatGPT

ChatGPT is a language model that is capable of generating text, answering questions, and leading controversies based on input data. ChatGPT uses deep neural networks to process natural language and was trained with reinforcement learning using human feedback (Farazouli et al., 2023).

Luke et al. (2024) report that in its first five days of existence, ChatGPT surpassed the one million registered users mark, making it the fastest-growing service on the Internet. Costa-Dookhan et al. (2024) state that NLP is one of the most important AI technologies, as most of the data we have around us is in the form of text. NLP is also widely used today to automate communication with customers using dialogue boxes on websites - the so-called chatbot. Landim et al. (2022) state that these virtual employees can recognize what the customer is asking, advise or suggest solutions to the problem 24 hours a day, and once programmed, the company does not have to incur any additional costs.

ChatGPT can write essays in hundreds of languages, compose celebrity-style speeches, summarize documents, write code, learn from previous exchanges, answer entertainment questions, or pass legal and medical exams (Kikalishvili, 2023).

However, the most significant threats associated with using this tool include the inability to identify real and reliable sources, errors in basic facts and reasoning, or the generation of misinformation. At the same time, it is also still possible to bypass ethical measures and guidelines when working with ChatGPT (Adeshola and Adepoju, 2023).

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Bing AI

Bing AI is also known as Bing Chat or Copilot Edge. Bing Chat is a possible revolutionary tool that answers some of the problems of its biggest competitor, which is ChatGPT. The most significant difference is that the Bing chatbot has access to the Internet, so it can answer questions about current events. It also provides footnoted links to sources and can even format them as academic citations when asked (Bhardwaz and Kumar, 2023).

The Bing chatbot was originally in a limited pre-testing mode while Microsoft tested it with the public, and there was a waiting list that those interested in early access could join. Today, it is freely available and integrated into the Microsoft Edge web browser as part of the Bing search engine.

Alphabet's Bard

In the case of Alphabet, a chatbot called Bard is a search engine companion that uses Google's extensive LaMDA language model, making it similar to ChatGPT. Alphabet describes Bardo as an 'experiment' and although it threatens to fall behind Microsoft in the race for chatbots, Alphabet claims it is implementing Bardo in a 'responsible' way. The Barda question entry window even warns users that it is an experiment and may provide inaccurate or offensive answers (Waisberg et al., 2024).

Bard is not yet massively promoted. It has a separate website, and under each of its replies, there is a button that allows the user to leave the chatbot and use the Google search engine (Waisberg et al., 2024).

MidJourney

Midjourney is an independent research lab that explores new media of thought and expands the imaginative capacities of the human species (MidJourney, MidJourney, undated). Midjourney, like DALL-E or Stable Diffusion, generates images based on natural language descriptions, called "prompts," in English (Bhardwaz and Kumar, 2023).

The images generated at Midjourney are now of such high quality that they have raised controversy and questions about both the future of art and fairness. For example, one user entered and won an art competition with a generated image, which sparked substantial controversy. There are also comics based on images generated from Midjourney, which have raised copyright discussions. Again, therefore, ethical issues arise (Aiumtrakul, 2023)

DALL-E

DALL-E and DALL-E 2 are machine learning models developed by OpenAI to generate digital images based on descriptions. DALL-E consists of two neural networks; one is GPT, and the other is VQ-GAN. DALL-E 2 uses another development of OpenAI - CLIP - Contrastive Language-Image Pre-training artificial vision system (Comparative Text-Graphic Training). The system learns from hundreds of millions of images and their descriptions, learning to distinguish "how much" of text fragment X correlates with image X. That is, instead of predicting which image this description is more appropriate for, the artificial vision model studies exactly how this text and this image are related. Comparison instead of prediction allows CLIP to make connections between textual and visual representations of the same meaning. CLIP defines and creates semantic links between text and images (Aiumtrakul et al., 2023).

Due to ethical and security concerns, DALL-E access was restricted to pre-selected users for research insight. As of 2022, DALL-E 2 is available to anyone and the waiting list requirement has been removed; users can generate a certain number of images for free and can purchase more.

4. Methodology of research surveys

This paper focuses on investigating the effectiveness of task assignment and performance in work teams, with a particular emphasis on comparisons between humans and artificial intelligence systems. We build on previous research examining task assignments' impact on teamwork effectiveness and extend this theory by adding a new dimension - AI integration. The earlier paper, IMPACT OF TASK ASSIGNMENT ON EFFECTIVENESS IN

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WORK TEAMS, develops a theory of task assignment of the "HOW" type, evaluates its effectiveness in work teams, and compares it with the effectiveness of tasks performed by AI. According to Svozilova (2016), a task is part of a complex activity; we can specify a desired outcome for it, and it has a relatively short duration. A manager can choose from two options when assigning tasks and assigning them to specific performers (Pechová, Volfová, and Jírová, 2023).

The main goal of our study is to compare the efficiency of "HOW" tasks, which are characterized by their specific instructions and procedures, between human teams and AI. To this end, we set two sub-objectives: first, to identify the key factors that influence the efficiency of task performance by human teams, and second, to assess how AI systems perform these tasks compared to humans.

A combination of quantitative and qualitative methods was used to answer these questions. First, a focus group survey was conducted in January 2024, involving students of ŠKODA AUTO University o.p.s. and employees of ŠKODA AUTO a.s., preferring the "HOW" method of assigning the task. At the same time, identical tasks were given to AI systems, including ChatGPT, Copilot Edge, Midjourney and Bing AI, to compare their effectiveness with human teams.

In the final stage, task performance was evaluated using the criteria of effective work performance. This evaluation was carried out with a target group of Škoda Auto a.s. managers who provided an assessment of task performance by both human teams and AI systems. The results of this evaluation and the facilitated workshop discussions with the executives offer deeper insights into the dynamics of task performance in the modern work environment and open further discussion on the role of AI in task assignment and performance.

This approach allowed us to comprehensively explore how task performance differs between human and AI teams and identify the factors that influence these differences. The methods and techniques used, including focus groups and executive evaluation, provided us with a robust dataset from which we could thoroughly analyse and interpret the differences in effectiveness we found.

The study's methodology was designed to ensure the validity of the findings. The selection of participants for the focus group was made based on their experience and preferences in the assignment of "HOW" type tasks, ensuring the data's relevance and representativeness. At the same time, the set of AI systems that were tested was carefully selected to reflect the wide range of tools available and their ability to perform the specific tasks assigned.

The analysis of focus group data and the evaluation by managers was conducted using both qualitative and quantitative analytical methods. This combination allowed us to quantify differences in effectiveness and explore in more depth the motivations, practices, and challenges that participants experienced during task completion. This methodology provides a comprehensive framework for exploring and understanding the dynamics of task performance effectiveness in an environment where the boundaries between human and artificial intelligence are blurring.

4. 1 Target group

The target group for the focus group was carefully selected to reflect the wide range of positions and specialisations within the organisation of ŠKODA AUTO a.s. and ŠKODA AUTO University o.p.s., allowing for a comprehensive view of the interaction between humans and AI in task performance. The focus group consisted of both Škoda Auto College students and Škoda Auto employees. This group was further differentiated by gender, age and field of study or work specialisation to ensure that the results were representative of a wide range of work styles and preferences, all according to the results of previous research (Pechová, Volfová and Jírová, 2023). Respondents were divided into two main age categories: 22-25 years and 36-39 years, which allows us to compare attitudes and approaches to AI between the younger generation, who enter the labour market with up-to-date knowledge of digital technologies, and the middle generation, who have extensive work experience. In terms of study and work specializations, respondents were represented in three main areas: HR (Human Resources Management), SM (Sales Management) and LQ (Logistics and Quality Management), as

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these are the specializations and work focuses that prefer to handle "How to" type tasks. This selection reflects the diversity of job roles and tasks within the organization. It allows us to understand better how different types of tasks and job requirements affect the effectiveness and adoption of AI. The target group can be seen in Fig. 2.

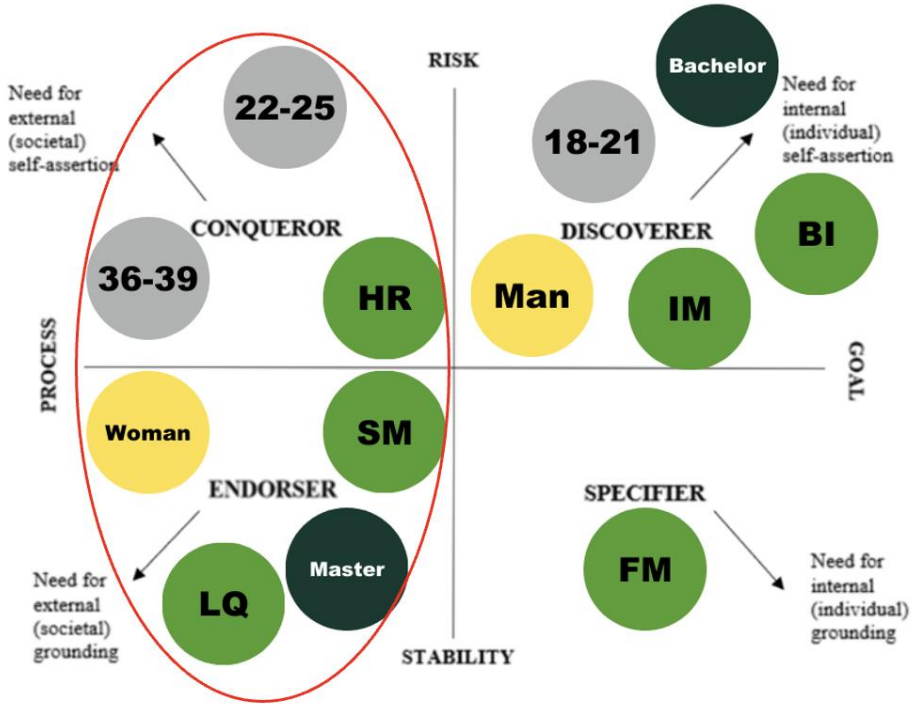


Figure 2. People preferring task type "HOW" by various criteria
Source: the authors

4. 2 Evaluation process

The managers of Škoda Auto a.s. and Škoda Auto University o.p.s. subsequently evaluated the completed tasks. Facilitated discussion brings many benefits for academic research and practical applications, mainly due to its ability to generate more profound understanding and consensus among stakeholders. It allows participants to share their experiences, perspectives, and suggestions in a structured but open dialogue, leading to the discovery of new perspectives and solutions. In the context of our research, facilitated discussions with senior leaders enabled the identification of practical barriers and opportunities for more effective use of AI in work teams through an interactive process highlighting the importance of collaboration and shared understanding. This approach encourages innovation and adaptation to change, strengthens organisational culture, and increases employee engagement in decision-making and implementation of new technologies.

4. 3 The experiment

Finally, based on the findings from the comparison of human work and AI-generated outputs, an experiment was conducted to explore the synergy between human creativity and the analytical capabilities of the AI system; after a detailed analysis of the results from the previous phases, the most successful focus group participant was selected and tasked to use the AI system that was deemed most effective based on prior evaluations - namely ChatGPT - to complete the same task. This approach aimed to combine unique human skills with AI's computational efficiency and objectivity to achieve the optimal solution to the task.

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4. 4 Characteristics of the task

Building on the findings from the previous research investigation (Pechová, Volfová, Jírová, 2024), a process-based task was designed, the structure and parameters of which were carefully designed to reflect all the key aspects identified in the study. The task was formulated with an emphasis on explicit definition and the provision of complete and specific information to enable its precise and efficient execution. The task specification included the creation of an invitation to a three-day team meeting to be held at the Clarion Hotel Špindlerův Mlýn on 23-25 March 2024. The brief emphasised that the task was highly prioritised and not considered confidential. The main objective of the assignment was to ensure that all employees were informed in a timely and adequate way about the planned meeting, the attendance of which was defined as mandatory for all team members.

"Dear "completed name of respondent", please create an invitation to a three-day team meeting of the working team in the first half of 2024. The team meeting will be held at the Clarion Hotel Spindleruv Mlyn. The date is 23-25 March 2024. The task is not confidential and has urgent priority. The purpose of your assignment is to inform your colleagues in time about the planned meeting, which is mandatory for all employees. Thank you for your handling, and I am counting on you. Jana

In addition to a detailed description of the task, a task guide was also provided, containing instructions and recommendations on how to complete the task effectively. This guide was developed to facilitate completing the task while supporting the participants' development and application of key skills. Within this guidance, mechanisms were also put in place to provide support to participants who requested it, ensuring that the approach was flexible and adaptable to the individual needs and preferences of participants.

5. Results of research investigations

5. 1 Evaluating human tasks

The "winning" invitation was selected using multi-criteria decision-making and pairwise comparisons at a WS with managers of Škoda Auto College Inc. and Škoda Auto Inc. on 23 February 2024. The managers identified in chap. 4, were shown all fifty completed tasks and a decision was made on the task that scored best according to the defined criteria. If there was a score match, the pairwise comparison method was chosen to make the final decision.

Suppose multiple evaluation criteria and problem-solving options are specified, and the weights of each criterion can be determined according to their importance. In that case, the multi-criteria decision-making method can be used to decide. The multi-criteria decision-making method allows the options to be ranked from best to worst in order of preference. It must be taken into account that there is rarely one solution option that is the most advantageous according to all the chosen criteria and that the criteria may be contradictory. This method is suitable for decision-making situations arising under conditions of risk and uncertainty and for decision-making situations that are exclusively rational. Decision matrices and decision trees are also suitable for rational decision situations determined by risk or uncertainty. A decision matrix is essentially a table where the different options for solving a situation form its rows, and the chosen criteria for evaluating the options form its columns. The aim is to determine the most favourable decision option by calculating the criteria and their importance determined through weights. Although the use of decision matrices is based on rational reasoning, the determination of variants and weights can only be subjective, and this then applies to the nature of the optimal variant (Štrach et al., 2023).

Fig. 3 shows the completed winning task of the "HOW" type, which was implemented by the people in the focus group. It was then compared with other tasks performed by AI systems presented in Sect. 4.2.

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Figure 3. Task carried out by people within the focus group
Source: the authors

The quality of the information was at the same level in the evaluated tasks. Given the information processing guidelines developed and the respondents' responsibilities, there were almost no differences between the evaluated outputs.

The speed of the completed task ranged from 12-36 minutes. Figure 3 presents the task completed the fastest; however, it should be taken into account that the focus group participants worked in conditions that eliminated communication noise, e.g. physical noise, psychological noise, etc.

Within the criterion of comprehensiveness of information, the highest differences in the scores of individual tasks were recorded. The top positions were occupied by the realized tasks, where email links were automatically inserted in the invitation to confirm participation, the exact address of the venue or even information processed with a QR code. At the same time, the evaluators preferred the processed tasks in the Czech language. They justified their decision because the development event will be held in Czech, so there is no need for English or any other language on the invitation.

The graphical form of the task emerged as the criterion with the lowest weight of importance. Although there were high score differences in this criterion, and indeed, some invitations had very creative and pleasing graphic design, this was the least important to the evaluators. For example, the winning invitation did not meet this criterion at all.

In the last criterion above, managers were reluctant to provide additional support to accomplish the task. They assume that if the task is given as a "HOW" type, there is a guide for completing it, and the task is relatively routine; no additional support is needed. The invitation visualized above was created without any extra support from the assignor.

5. 2 Evaluating tasks processed by AI

Section 5.2 presents the results of another qualitative investigation. AI systems such as Chat GPT, Bing AI, Alphabet¨s Bard (now Gemini), Midjourney or DALL-E were given an identical task to those in the focus group. The exact wording of the task is given in chap. 4.4. The task was given in Czech. At the same time, the task was

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again selected as the winning task by the managers at the WS on 23.2.2024, according to the criteria listed below. Fig. 4 shows the completed winning task of type "HOW", which was implemented by the GPT system.

Dear colleagues,
I would like to invite you all to our upcoming three-day team meeting scheduled for March 23-25, 2024.This meeting will be held in the beautiful surroundings of the Clarion Hotel Špindlerův Mlýn, which will provide us with an ideal environment for our joint work, teambuilding, and relaxation.

Meeting agenda: over the course of three days, we will focus on several key topics and projects that are essential to our society. We will discuss achievements, set new goals, and look for the best ways to face the challenges ahead of us together. We will also have workshops, team building activities and plenty of opportunities for informal networking.

Attendance: I sincerely urge you all to book this date in your calendars as attendance at this meeting is mandatory for all employees. Your attendance and active participation are crucial to the success of our meeting.

Logistics: all necessary information regarding accommodation, agenda and transport will be provided to you in advance of the meeting. For any questions or specific requirements, please do not hesitate to contact the organizing team.

Registration: please confirm your attendance by 15 February 2024 via email to [organizing team email]. This will allow us to better plan and arrange everything necessary for a comfortable meeting.

I look forward to meeting you all in person and spending productive time together in the beautiful surroundings of Špindlerův Mlýn. Thank you for your cooperation and commitment to the success of our team.

Sincerely,
[Your name and position]

Figure 4. Task implemented by the GPT system (translated)
Source: the authors

The task implemented by the GPT system was best evaluated within these defined criteria:

- Quality of information (e.g. accuracy)
- Speed of task completion
- Comprehensiveness of information
- Graphic design
- Level of support from the contracting authority

The quality of the information varied at different levels in the individual systems, and the least successful were the DALL-E and Midjourney systems, which did not understand the task given in Czech. Bing AI inaccurately stated the location of the development action. The highest scoring was Chat GPT, which accurately stated the date and location of the development action. However, none of the outputs examined were rated with the maximum number of points.

The speed of the completed task ranged between 15 and 40 seconds, and there were almost no differences between the outputs.

Within the criterion of comprehensiveness of information, the highest differences in the scores of individual tasks were recorded. According to the evaluators, Chat GPT structured the information best, formulated it in a motivating way and was even the only system examined that required confirmation of participation by a specific date. It also listed several particular activities that could be implemented during the team meeting and highly praised the environment in which the event would occur. The Bing AI system was rated the lowest in relation to the defined criterion.

None of the above-mentioned AI systems met the criterion of graphical form of outputs. The Anaphabet Bart system stated that it cannot create images. Chat GPT graphically produced fascinating thematic images, but the information embedded in them regarding the date and location of the development event needed to be more meaningful. Bing AI, DALL-E and Midjourney submitted images the evaluators felt were inappropriate for a teambuilding event. Figure 5 presents the output of the completed tasks using the Bing AI system.

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Figure 5. Completed task using Bing AI
Source: the authors

In the last criterion mentioned above, the evaluators' reluctance to specify the task further and better was evident, and none of the examined outputs met the defined criterion. Each of the systems mentioned above needs additional AI user competencies and has its specifics for task assignment.

5. 3 Comparison of results

To synthesize the findings, a comparison was made between tasks processed by human participants and AI systems such as ChatGPT, Bing AI, Alphabet's Bard (now Gemini), Midjourney and DALL-E, to evaluate their performance according to the following criteria: quality of information, speed of task completion, comprehensiveness of information, graphical form and level of support from the tasker. This structured analysis offers more profound insight into the capabilities and limitations of both human labour and AI technologies in processing and completing specific tasks.

Information quality (especially accuracy): both human teams and AI systems, especially ChatGPT, have achieved high levels of information quality and accuracy. However, the human teams tended to add more contextual knowledge and nuance to the tasks, reflecting a deeper understanding of the topic. Conversely, ChatGPT and other AI systems excelled in quickly processing and providing accurate information, but sometimes without deeper contextual understanding.

Speed of task completion: In this category, AI systems significantly outperformed human teams, completing tasks in seconds because of their ability to process information instantaneously. Human teams took longer to complete the same task, reflecting the time required for analysis, creative processing, and quality control.

The comprehensiveness of information: human teams typically provided more complete and detailed information that reflected a comprehensive understanding of the task and its objectives. While AI, particularly ChatGPT, could provide extensive information, it sometimes lacked depth and alignment with the specific needs of the task. Human teams were also more responsive to the need for adaptation and providing complex answers.

Graphic design: in the area of graphic presentation, people's work was considered to be of higher quality because it could better reflect specific design and aesthetic requirements. AI systems, such as DALL-E and Midjourney, had limitations in producing graphically appealing outputs that also met the assignment's specific requirements.

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Level of Assignor Support: Human teams require and value feedback and support from the assignment assignor, allowing for iterative refinement of outcomes. AI systems are limited to the instructions given and thus can only easily adapt their outputs based on additional feedback if it is directly coded into their program.

This comparison shows that while AI systems can offer significant advantages in speed and efficiency for certain types of tasks, human teams still prevail in areas requiring deep understanding, creative processing, and aesthetic evaluation. Human interaction with the task also brings value in the form of adaptability and flexibility in response to unexpected demands or the need for change, something AI currently cannot fully emulate. Additionally, when dealing with complex tasks that require a multi-disciplinary approach and deeper contextual understanding, human teams can better integrate different information sources and perspectives, creating richer and more customized solutions. While AI can provide powerful support for data processing and automation of repetitive tasks, human skills of critical thinking, empathy, and creativity are key to solving more complex and less structured problems.

It is also important to emphasise in the context of assignor support that the success of any assignment depends not only on the performer's skills but also on the quality of communication and clarity of the assignment. While AI can work effectively with well-defined instructions, human teams can better navigate situations where the assignment is ambiguous or requires additional clarification.

Thus, the comparison suggests that the most effective approach to task performance in the modern work environment will likely lie in the synergy between human and AI capabilities. Integrating AI can maximise efficiency and accuracy while the human element remains essential for tasks requiring deeper understanding and creative processing, making achieving higher productivity and higher quality outputs possible.

Following identifying key insights into the synergy between human capabilities and the potential of AI, we proceeded to an experiment to practically test this synergy in action. The experiment consisted of assigning a task initially designed for focus group participants whose outcome was evaluated as the most successful but with the additional requirement of using artificial intelligence, specifically the ChatGPT system, to implement it. This approach aimed to combine the deep understanding and creative approach of humans with AI's computational efficiency and speed. As part of the experiment, the participant was provided with the top-rated AI system, ChatGPT, with instructions on using this tool to maximise the task brief, including generating the relevant image. Armed with a deep understanding of the task and the specific needs of the project, the participant was encouraged to provide the AI system with the most accurate and detailed instructions to ensure that the resulting work met all criteria.

5. 4 Task assignment process in human-AI collaboration

Communication between the human participant and ChatGPT 4.0 was an interactive dialogue, where the participant provided specific instructions and feedback on iteratively generated suggestions from ChatGPT. This process involved several steps, from initial input to final edits, leading to the creation of an optimal invitation.

Step 1: Task definition

Participant: "I need to create an invitation for a three-day team meeting to be held on 23-25 March 2024 at the Clarion Hotel in Spindleruv Mlyn. The invitation should be brief, informative and visually appealing. It should include the date of the meeting, the location, the main programme points and a contact to confirm attendance.

The brief is as follows:

Dear "completed name of respondent", please create an invitation to a three-day team meeting of the working team in the first half of 2024. The team meeting will be held at the Clarion Hotel Spindleruv Mlyn. The date is 23-25 March 2024. The task is not confidential and has urgent priority. The purpose of your assignment is to inform your colleagues about the planned meeting, which is mandatory for all employees, on time. Thank you for your handling, and I am counting on you. Jana

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Step 2: First proposal from ChatGPT 4.0

ChatGPT: "I created a draft invitation. It contains all the required information and is accompanied by a basic graphic design. I would like to get your comments on the content and design."

Step 3: Feedback and adjustments

Participant: "The content looks good, but could you add more details about the meeting agenda and especially select the most important information so that even a less attentive reader can pick up the key information? Also, highlight the contact section to confirm attendance. I would also like the graphic design to correspond more with the theme of teamwork. Also, don't include any text in the visual; this will be added afterwards."

Step 4: Further suggestions and adjustments

ChatGPT: "Based on your feedback, I have modified the content and design of the invitation. I have added a more detailed program description and improved the graphic design. How do you like the new design?"

The human participant and the AI interacted with the content through further modifications, where minor modifications were always specified, especially according to the knowledge specified in the event program. Significant interaction was also noted in the creation of the visuals, where ten different versions were generated before the visual was appropriate to the task, e.g. in the form of a prompt: I need the mountains, teamwork and joy to be accentuated. The overall communication is less relevant to this article than the introduction of the process.

Step 5: Final approval

Participant: 'The new design looks good already! The program is clearly described, and the graphic design fits our theme. This invitation now meets all our requirements."

The result of this experiment was exciting. Using instructions from a person who had already completed the task, ChatGPT could efficiently process the information and generate text that matched the required criteria and create a visually appealing visual to complement the task. The limitations of creating graphics with ChatGPT are well known, so an approach based on generating a visual of the event was chosen, with essential information added after the fact. The human participant provided context and direction to the AI system, while the AI brought speed, accuracy, and content generation capability, which together resulted in a solution that maximally met the requirements. This output demonstrates how human guidance of AI - by providing clear, structured, and context-rich instructions - can significantly enhance the quality and relevance of AI-generated outputs. Human-AI collaboration can enrich work processes and outputs, opening new possibilities for future applications of AI in practice. The experiment thus provides valuable insights for further research in this area and offers a new perspective on optimizing work processes using AI technologies.

Output generated in collaboration between a human worker and AI

Fig. 6 shows output generated in collaboration between a human worker and AI. This situation clearly shows that the key to the successful integration of AI into work processes is not only the technological development of the AI systems themselves but also the ability of people to interact with and manage these systems effectively. The symbiosis of human creativity, intuition, and adaptability, along with AI's speed, accuracy, and data capacity, is a powerful combination that can bring new levels of efficiency and innovation in many areas.

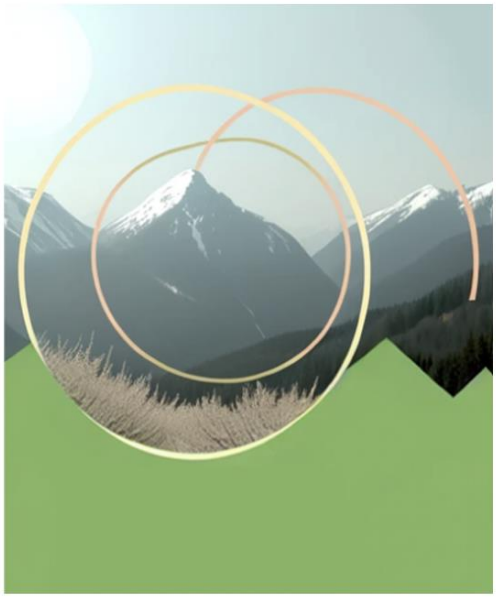
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Invitation to the team meeting

Dear colleagues,

It is my pleasure to invite you to an important team meeting, which will take place in the beautiful surroundings of the Giant Mountains. This meeting is a key milestone for our team and represents an ideal opportunity to strengthen our collaboration.

Meeting Details:



- **Date:** 23-25 March 2024
- **Place:** Hotel Clarion, Spindleruv Mlyn
- **Participation:** mandatory for all team members

Program

- Day One: Opening with a welcome speech by our CEO, followed by workshops on innovation and strategy.
- Day 2: Team-building activities in nature and evening discussion circles around the fireplace.
- Day 3: Presentation of team projects, evaluation of the meeting and planning of next steps.

Important information: please confirm your participation by 15 February 2024 by replying to this email: [email of the organiser]. In case of questions or specific requirements, please do not hesitate to contact the organizing team.

Detailed information regarding accommodation and transport will be sent to registered participants.

We look forward to spending productive and memorable times together that will not only strengthen our team spirit, but also find new ways to face challenges and achieve our goals.

We look forward to your participation and contribution to the success of our meeting.

Sincerely,

[Surname]
[Position]

Figure 6. Output generated in collaboration between a human worker and AI
Source: the authors

This approach also highlights the importance of developing digital skills and understanding AI among the workforce, which are key competencies for the 21st-century workforce.

Conclusions

This paper investigates the effectiveness of task performance between humans and AI systems, focusing on "HOW" tasks. Through a comprehensive research investigation, we examined how human teams and AI systems cope with the challenges of performing specifically defined tasks and what factors contribute to their effectiveness.

The main objective of our study was to compare the effectiveness of "HOW" tasks between human teams and AI, with sub-objectives aimed at identifying key factors influencing this effectiveness. The results of our investigation clearly show that AI systems, especially ChatGPT 4.0, can outperform human teams in certain aspects, such as speed and accuracy of information. However, when it comes to depth of understanding, creativity, and adaptability, human teams still hold their position firmly as an indispensable element of an effective work process. The sub-objectives of this study have been successfully met through a comprehensive analysis and comparison of the performance of human teams and artificial intelligence systems in performing "HOW" tasks. The first sub-objective was to identify the key factors influencing human teams' task

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performance effectiveness. Using qualitative and quantitative research methods, we discovered and documented how the scope of the task, clarity of instructions, and the ability of teams to adapt to changing demands affect task performance. The second sub-objective was to assess how AI systems perform on tasks compared to humans, which we did by comparatively analyzing the performance of the two groups based on predetermined criteria. The results showed specific strengths and limitations of AI in the context of task performance, particularly in processing speed, information accuracy and content consistency, but also highlighted the need for human intervention for creative solutions and contextual adaptability. Thus, this study provides valuable insights into the synergy between human capabilities and AI, suggesting the optimal use of their combination to enhance the efficiency of work processes.

One of the key findings of our study is that synergy between human capabilities and AI can lead to optimized efficiency and quality of task performance. An experiment in which a human participant used an AI system to accomplish a task demonstrates the potential of this synergistic collaboration. With the combination of human understanding, creativity, and intuitive guidance from the AI system, a solution exceeded expectations in all evaluated criteria.

This paper thus makes an essential contribution to understanding the dynamics of task efficiency in the AI era. It confirms that while AI systems are a powerful tool for streamlining and automating processes, the human element remains essential to ensure outputs' depth, quality, and adaptability. For organisations, the integration of AI should be done with a view to its complementary role to human capabilities to create a working environment where the potential of both is maximised.

Our findings thus open the way for further research and discussion on combining human skills and AI to achieve the highest possible efficiency and innovation in different areas of working life. They also highlight the importance of developing digital literacy and AI skills amongst the workforce to enable them to interact effectively with these systems and maximise their potential.

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INNOVATION PERFORMANCE OF V4 COUNTRIES*

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Abstract. This study delves into the innovation performance of the Visegrad Four (V4) countries, aiming to uncover the pivotal role that research development and innovation play in regional development and the broader economic landscape. Focusing on properly structured research and development policies, financial support mechanisms, and collaborative efforts, we investigate the prerequisites for fostering innovative activities within these nations. Innovation performance is a critical factor that allows organisations and economies to adapt to rapid changes and an ever-evolving environment, stimulating growth, competitiveness, and long-term sustainability. The goal of the article was to evaluate the innovation performance of the V4 countries. Utilising the TOPSIS method, we analyse 7 key input-output indicators to rank the V4 countries in terms of their innovation performance for 2022, identifying them as moderate innovators relative to the EU-27 average. Our findings reveal that among the V4, the Czech Republic leads in innovation performance, followed by Slovakia, Poland, and Hungary, respectively. The analysis underscores the importance of innovation as a critical factor for adaptation to rapid changes, fostering growth, competitiveness, and sustainability. This research contributes to understanding how innovation performance can improve economic prosperity in the V4 countries and inform policy direction towards enhancing innovation ecosystems.

Keywords: innovation performance; research and development (R&D); competitiveness; V4 Countries; TOPSIS method

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JEL Classifications: O11, O31, O38

1. Introduction

In the contemporary economic landscape, innovation, science, research, and development (R&D) stand as critical pillars of progress and prosperity. These elements drive the advancement and competitiveness of various sectors and underpin nations' economic growth (Dušek & Sagapova, 2022; Androniceanu, Georgescu & Sabie, 2022). However, the current conditions lead firms to collaborate for innovation activities rather than taking individualistic initiatives (Rigelsky et al., 2022). For this reason, policymakers, including the European Union, direct businesses to make joint investments in innovation activities. Alliances between enterprises also make them apply more R&D activities, improving innovation capabilities (Ključnikov et al., 2022a) that provide financial sustainability. Since many issues exist in the economic growth and deterioration of resources, the sustainability concept needs to be considered by everyone worldwide (Folgado-Fernández et al., 2023), including firms from different industries (Cheng et al., 2022). European Commission also implements new

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strategies to stimulate firms in various industries to adopt a digital transformation process that increases and sustainable development of businesses (Streimikiene, 2023).

Moreover, this digitalisation process increases technological productivity (Lincényi & Bulanda, 2023) and the competitiveness of enterprises (Krajčík et al., 2023). Through the lens of innovation and technological evolution, industries are born and transformed; productivity is enhanced. For instance, firms, especially in the manufacturing industry, indicate more technological developments and emphasise innovation and R&D activities (Civelek & Krajčík, 2022). Therefore, both economic and social development are accelerated. In this context, the innovative performance of a country is intricately linked not only to the capabilities of its firms but also to the broader national system, encompassing a network of public and private institutions. This study, therefore, seeks to illuminate the significance and topicality of innovation in shaping regional development and the economic performance of the national economy. Specifically, we focus on the Visegrad Four (V4) countries to evaluate their innovation performance within a comparative framework. Recognising the essential role that properly structured R&D policies, financial support mechanisms, and collaborative efforts play in fostering innovation, this article delves into the dynamics of innovation within the V4. By exploring these aspects, we aim to contribute to the broader understanding of how innovation is a lever for economic prosperity and sustainability. As such, our analysis seeks not only to assess the current state of innovation performance in these countries but also to offer insights that may guide policy direction and support mechanisms to enhance their innovation ecosystems.

2. Theoretical background

The relationship between research, development, and innovation is highly complex. It's essential to recognise that innovations cannot arise without adequate research and development (Wach & Daszkiewicz, 2023). Innovations are interpreted as a process in which organisations do something new, introduce novel procedures, create new goods or services (Khalifa et al., 2023), or establish new ways of internal organisational relationships. Hanáčková et al. (2019) further clarify that innovation should not be confused with the concept of change, as change is typical for most organisations; innovations pertain to creating and implementing new processes, products, services, and delivery methods. Typically, innovations improve outputs, efficiency, effectiveness, or the quality of goods, services, and processes (Espino-Rodríguez et al., 2022). Innovation involves qualitative and sustainable change. Therefore, the following criteria can also apply to identifying innovations: novelty or creativity, efficiency - focus on results, the significance of the problem being addressed, and applicability (Staroňová et al., 2012).

Effective economic and social development (predicated on innovation) is an indispensable condition for mitigating disparities between impoverished and affluent regions (Ključnikov et al., 2022b). Development that is fundamentally anchored in research, development, and innovations plays a pivotal role in regional development and in enhancing the performance of national economies. This becomes increasingly vital in escalating global competition, heightened population mobility, swift technological advancements, and the emergence of spatial disparities and imbalances. Moreover, it is essential for the strategic distribution of companies, which in turn augments local employment opportunities. Giguère (2007) argues that the ever-widening regional disparities are the result of the fact that investments are directed mainly to large agglomerations with developed infrastructure and a skilled workforce, while other regions are still lagging behind. The ability to produce innovations and new economic activities is essential for developing local economies and, thus, improving the living standards of the local population. Strong knowledge and technologically advanced regions can benefit from better opportunities for networking and relations with foreign 'partners so that they have a leading position within the country.

On the contrary, in less developed regions and peripheral areas, the low ability to produce new ideas and inappropriately directed policies can be reflected in the widening knowledge and technological gap between regions (Maguire et al., 2011). The introduction and dissemination of innovations are important for overall increases in private sector investments, improving the flow of information, focusing on content and methods of research as well as relationships with investors or developers, and promoting cohesion and trust (Clark, Huxley,

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Mountford, 2010; Maturkanič et al., 2022; Lacko et al., 2023; Mishchuk et al., 2023; Zhang et al., 2023). Innovations typically emerge in environments with a sufficient foundation of human and physical capital. The effect of such innovations is the creation of a dynamic economy, which, in turn, attracts additional human resources and capital (Oliinyk et al., 2021; Floriš et al., 2022; Masárová & Ivanová, 2023;). Therefore, according to the theory of endogenous growth, innovations and human capital tend to be located in relatively the same geographical areas. The endogenous growth model fully incorporates the view of innovations as the result of planned efforts and sheds new light on innovations' contribution towards understanding dynamic growth (Crescenzi & Rodríguez-Pose, 2011; Tadevosyan, 2023). The action dynamics is present in innovation (Kondrla et al., 2023). Cheah (2016) also emphasises the importance of quantifying the economic consequences of innovations, asserting that with substantial investments in research and development intended to bring changes in both the private and public sectors, it is essential for policymakers to be able to implement logical tools and procedures when estimating economic impacts.

The interaction between R&D actors and the knowledge economy, foundational for innovations, is represented by the triple helix model that connects the academic, public, and private sectors. The private nonprofit sector complements the trio of innovation actors in R&D. Key players in the development of R&D primarily include enterprises (Zsigmond & Mura, 2023), or the business sector. Businesses are pivotal in creating and implementing innovations. Innovation activities, research, development, knowledge transfer, and the knowledge economy in the context of digitalisation are significant prerequisites for survival and enhancing the competitiveness of companies in a fierce market environment (Androniceanu, 2023). In the EU countries, tools are established to motivate the private sector to conduct research activities within their business operations. Companies are encouraged to invest a larger volume of their resources in R&D and create jobs for scientific workers. Leading countries in the EU in terms of financing R&D in the business sector include Sweden, Austria, France, and Germany. In principle, there is a different approach to implementing innovative procedures in the private and public sectors (Jans et al., 2015), with the process in the public sector perceived as less dynamic (Christensen et al., 2016; Androniceanu et al., 2023). The loss of dynamics in the public sector is mainly caused by regulations connected with a need for efficient, effective and economical/cost-effective usage of public funds and public sources in general (Kučera & Nemec, 2022). This situation may be because incentives leading to innovation in the public sector are more the result of political and legislative efforts than market forces. Moreover, their implementation is often accompanied by a lack of financial and human resources (Rusaw, 2007). Cifranič and Valach (2017) suggest that employers and education providers should step into one another's world to understand each other's situation better. It is therefore evident that to overcome these fundamental differences, it is necessary that the companies, as representatives of the business sector, cooperate closely with universities and vice versa. Universities should seek to establish cooperation with companies in the common sector as much as possible.

A country's economic productivity level is influenced by a set of institutions, policies, internal and external factors (Sun et al., 2023). States are intermediaries that influence how firms can be competitive. Because it is increasingly difficult for firms to compete based on price factors (factors of production), they must strive to produce with a high share of knowledge. Knowledge, especially in terms of innovation, is vital to maintaining a productive economy and enables companies from developed countries to face competition from developing economies to succeed in globalised markets (Cooke, Boekholt & Tödtling, 2000). SMEs possess the capability to introduce and implement innovations. Present economic growth theories emphasise the innovative capacities of these enterprises.

In comparison to larger corporations, SMEs operate more efficiently and enhance the competitiveness of regions and countries. A prevalent trend within the SME sector is innovative entrepreneurship. This form of entrepreneurship responds to current market challenges characterised by intense competitive pressure, prompting businesses to explore new products and service innovations. These innovations are designed to meet the unmet needs of market participants and differentiate the company's activities from those of other entities. Innovative entrepreneurship derives its strength from innovations that can provide a competitive edge. The genesis of these innovations lies in knowledge (Mura et al., 2021).

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Haneda and Ito (2014) find that internationally engaged firms use more innovation inputs and generate more innovation outputs, and firms with R&D establishments abroad show the best innovation performance.

Innovations represent a competitive advantage for organisations, pushing competitors to move forward, whether in the development of new products or in improving the quality of services provided. Stern and Jaberg (2010) argue that more competitive advantages generally can be achieved with innovations than with old products/services/processes. All innovations carry certain risks. Innovations are a critical survival factor for small and medium-sized enterprises, but they are strongly motivated primarily by the possibility of profit (Warentin, 2002; Tvaronaviciene & Burinskas, 2021; Odei, 2023). However, in the economy of innovation, there is a broad understanding that the innovation process involves significant risks and, therefore, requires organisations to tolerate both risk-taking and failure. The ability of managers and senior employees dealing with risk to implement appropriate combinations of risk management strategies is the driving force behind innovation. Innovators who fail to innovate successfully could learn from the strategies used by successful innovators to manage risk and emulate them, moving away from merely imitating what works elsewhere. Data Envelopment Analysis - DEA and its efficiency models (e.g., Slack Based Model - SBM, Charnes, Cooper and Rhodes Model – CCR) are great tools to manage the risk of investment inputs in a wide range of economic areas (Kučera et al., 2023). The dissemination of innovations is essential for improving the quality and efficiency of the products, services, and processes provided (Torugsa & Arundel, 2017).

The main result of the literature review on the measurement of innovativeness in countries and regions emphasises the complexity and multidimensionality of assessing innovation. It underscores the diversity of approaches and methodologies used to gauge innovativeness across different levels. Gössling and Rutten (2007) found that wealth, cultural diversity, talent, and population density positively influence a region's innovativeness, although the correlation between GDP and innovation was unexpectedly negative. Carrincazeaux and Gaschet (2015) explored the diversity of regional innovation systems in Europe, finding a high level of variability in regional configurations and emphasising the importance of national institutional settings in shaping regional innovation outcomes. Roszko-Wójtowicz and Białek (2019) proposed a methodology for measuring innovativeness growth over time, stressing the need for dynamic assessments to capture changes in innovation performance among EU member states.

There are a number of methods and indicators that are used to measure the innovation performance of countries and regions. One of the most frequently used methods is the Innovation Index, which combines various indicators and measures the ability of countries or regions to innovate. This index may include factors such as research and development spending, number of patents, level of education and support for innovation in the business environment. Other possible methods include the Innovation Performance Index, the Global Innovation Index or methods based on specific indicators, such as the number of patents, shares of R&D expenditure in GDP, share of innovative firms, etc. (Majerová, 2015).

The European Commission regularly evaluates the innovation activity of individual global economies through the global innovation index, which assesses the overall innovation performance of the monitored global economies and compares it with the EU. The European Innovation Scoreboard 2023, published by the European Commission, shows that innovation performance continues to improve across the EU. It increased the most in Cyprus, Estonia, Greece, Italy and Lithuania. Convergence continues within the EU, with poorer performers growing faster than higher performers, narrowing the innovation gap between them. The European Innovation Scoreboard 2023 is based on 32 indicators grouped into 12 dimensions: human resources, attractive research systems, fixed investments in research and development, finance and support, innovation-friendly environment, intellectual assets, use of information technology, impact on employment and trade and more. Based on the number of points, EU countries are divided into four performance groups: innovation leaders (their innovation performance is above the EU average), strong innovators (their innovation performance is below the leaders but above the EU average), moderate innovators (their innovation performance is below the EU average) and emerging innovators (their innovation performance is below the EU average, but the growth rate in terms of innovation is above the EU average) (European Commission, 2023).

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A notable research gap exists in the detailed analysis of barriers to innovation within the V4 countries, particularly in terms of regulatory challenges and the effectiveness of technology transfer. Addressing these gaps is essential for developing effective strategies that overcome innovation obstacles and enhance regional economic competitiveness.

3. Research objective and methodology

The content of this scientific publication relates to the effects of innovations in selected V4 countries. The first objective of the article is to explore the relationships between expenditures on research, development, and innovation on the one hand and various types of innovative activity and market expansion on the other. We also examined the extent of the impact of public financial support on the level of innovativeness.

The data used to prepare this study were obtained from a survey on the innovation activities of the V4 countries. The data result from processing information over the years 2014 to 2022. We focused on the level of innovation activities, considering innovation as the introduction of new products/product innovation, the introduction of new methods of production/process innovation, implementation of a new organisation of the company/organisational innovation, and the implementation of new or significantly improved designs or sales methods/marketing innovation. Technological and non-technological innovation aims to improve the use of the company's knowledge in research and development, increase the quality of goods and services or the efficiency of work processes, increase the attractiveness of goods and services, or facilitate the possibility of entering new markets. Enterprises with innovation activity have had any form of innovative activity, i.e., introduced or implemented new products or processes or had ongoing or discontinued innovative activities.

We used the TOPSIS method to compare various parameters. This mathematical method is used to select the best option from a set of alternatives. TOPSIS compares each alternative in terms of its distance from the ideal solution and from the worst possible solution. The goal is to identify the option that is closest to the ideal and farthest from the negative extreme. This method is often used in decision-making processes (Odu, 2019, Wang et al., 2019).

The TOPSIS method can be described by the following steps (Triantaphyllou, 2000, Ardielli, 2019):

- Creating the criteria matrix $Y=(y_{ij})$ based on input data

$$Y=\begin{pmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{pmatrix}$$

- Creating the normalised matrix $R=(r_{ij})$ in the given form

$$r_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{m} y_{ij}^2}}; i = 1, 2, \dots, m;\ j = 1, 2, \dots, n.$$

- Creating the weighted normalised matrix $Z=(z_{ij})$

$$z_{ij} = w_j r_{ij};\ \ i = 1, 2, \dots, m;\ j = 1, 2, \dots, n.$$

- Determining solutions in the given form

$$h_j = \max_i z_{ij}\,; j = 1, 2, \dots, n$$
$$d_j = \min_i z_{ij}\,; j = 1, 2, \dots, n$$

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- Calculating the distance between each alternative

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (z_{ij} - h_j)^2}; \; i = 1, 2, \dots, m$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (z_{ij} - d_j)^2}; \; i = 1, 2, \dots, m$$

- Calculating the relative distance indicator for each alternative in this form

$$c_i = \frac{d_i^-}{d_i^+ + d_i^-}; \; i = 1, 2, \dots, m.$$

To determine the ranking of countries in terms of innovation level, indicators were selected and divided into two groups: input and output (Table 1).

Table 1. Selected input-output indicators

	Code	Indicator	Description
Input indicators	K1	Government expenditure in R&D to the business enterprise sector	Including government expenditures in the innovation index allows monitoring and evaluating the level of government engagement in supporting innovative activity and tracking developments in this direction over time. This provides a comprehensive view of a country's innovation environment and enables comparison with other countries and regions
	K2	Government expenditure in R&D to the government sector	This indicator can be useful in assessing the government's commitment to supporting scientific research and technological development.
	K3	Number of employees in corporate, private R&D	The indicator of the number of people employed in research and development in the private sector is an important prerequisite for staffing research and development.
	K4	Number of all R&D employees across all sectors	This indicator measures the number of R&D employees in the governmental, private, higher educational and non-profit sectors.
Output indicators	K5	Manufacturing Value Added (MVA) per capita	This indicator measures the manufacturing sector's contribution to economic production per capita and is important for assessing a country's economic performance in terms of innovative technologies.
	K6	Eco-Innovation	This indicator deals with innovations leading to improved resource utilisation, reduction of greenhouse gas emissions, protection of natural resources and ecosystems, and the support of renewable energy sources.
	K7	Product innovators (SMEs)	Small and medium enterprises focusing on product innovations usually invest in research and development and collaborate with external partners such as universities, research institutes, or other businesses to access new technologies and know-how. These companies can be key players in stimulating growth and innovation within the economy and can significantly impact job creation and economic development.

Source: own processing

4. Results and discussion

One of the fundamental indicators for assessing a country's research and development level is the ratio of gross domestic expenditures on research and development to the GDP of the respective country (GERD). The

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development of gross domestic expenditures on research and development activities as a percentage of GDP for selected V4 countries is shown in Figure 1.

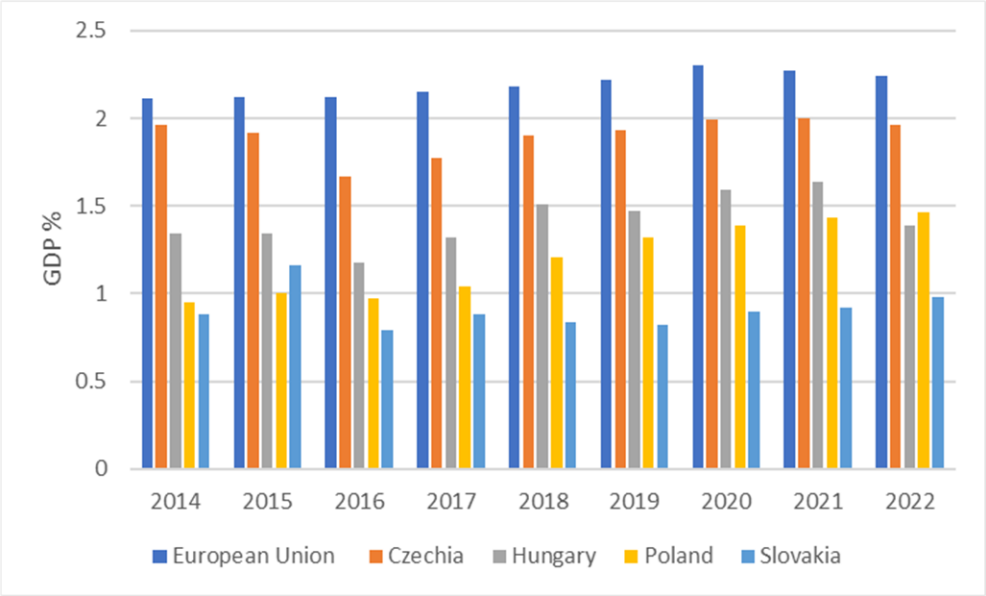


Figure 1. Development of the GERD to GDP ratio in % in the V4 countries in the years 2014-2022

Source: own processing

The value of the observed indicator in all four analysed countries has long been below the average of the European Union, which was at the level of 2.04 % of GDP in 2015 and at the level of 2.24 % of GDP in 2022. Basic descriptive statistics for the observed indicator over a period of 14 years across all four compared countries are presented in Table 2.

Table 2. Descriptive Statistics for the GERD Ratio

	CZ	HU	PL	SK
Min	1.67	1.18	0.95	0.79
Max	2.00	1.64	1.46	1.16
Average	1.90	1.42	1.20	0.91
Median	1.93	1.39	1.21	0.88
Standard deviation	0.11	0.15	0.21	0.11

Source: own processing

Based on these statistical indicators, we constructed a BoxPLot for the proportion of GERD. The value of the indicator expressing the share of gross domestic expenditures on research and development as a percentage of GDP has changed. All countries showed a lower value in that indicator than the EU average. The Czech Republic showed the highest share of spending on research and development from GDP, followed by Hungary, Poland and Slovakia (Fig. 2).

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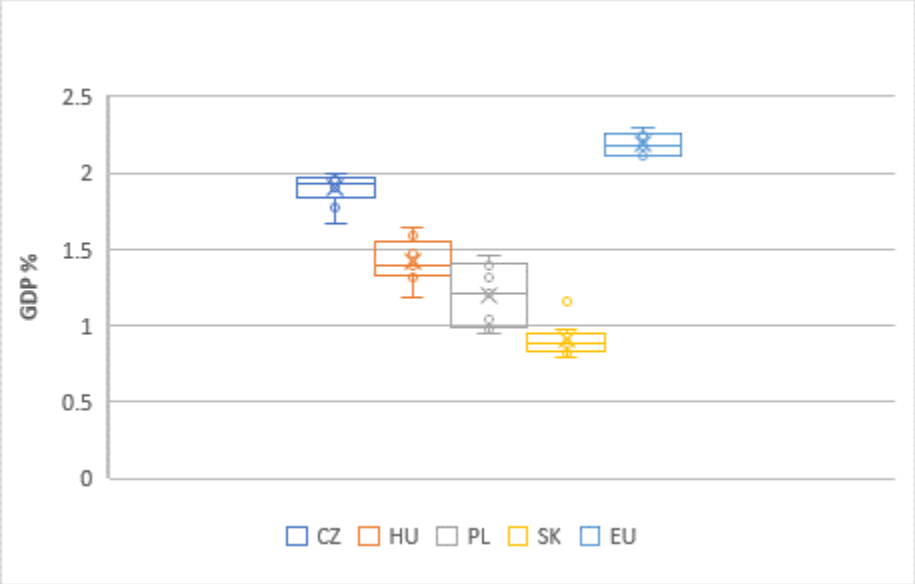


Figure 2. BoxPlot for the proportion of GERD

Source: own processing

At the beginning of the observed period, Hungary spent almost twice as much financial resources as Slovakia. Their volume, as in the other two V4 countries, gradually increased over the years to almost 1.5 billion € in 2015 and 2.3 billion € in 2022. In Poland, the volume of expenditures increased over the observed years from 3.8 billion € to 9.5 billion € (Fig. 3).

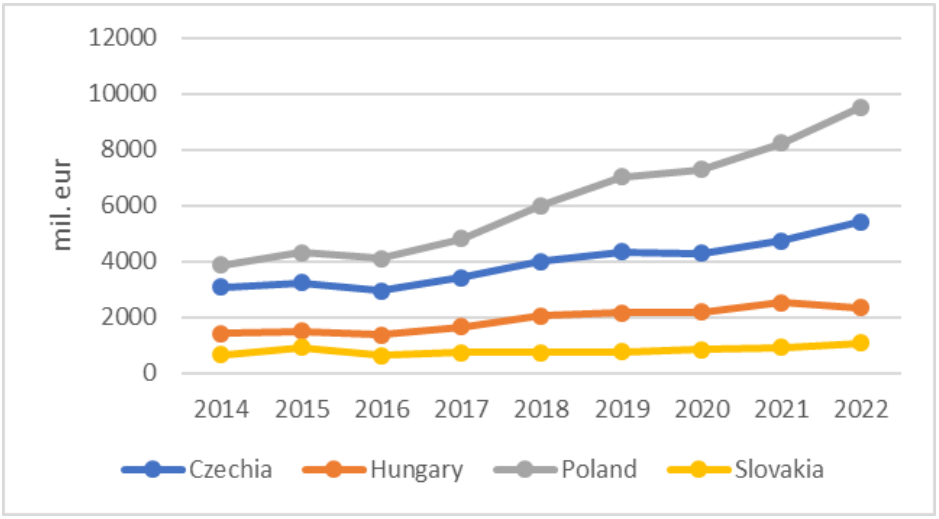


Figure 3. Development of GERD in million € in V4 countries in 2014-2022

Source: own processing

In our opinion, the indicator expressing the size of expenditures on research and development activities per capita has a greater explanatory value. The arrangement of the four countries analysed and compared is slightly different if we compare them using the total volume of expenditures. Expenditures per capita in Slovakia and Poland developed roughly equally for many years. Changes have occurred only in recent years. In Slovakia, they increased from 123.6 € in 2014 to 197.8 € in 2022, in Poland from 101.6 € to 253.3 € per capita. As for the European Union, the observed value was 561.2 € in 2014 and reached 793.3 € in 2022 (Fig. 4).

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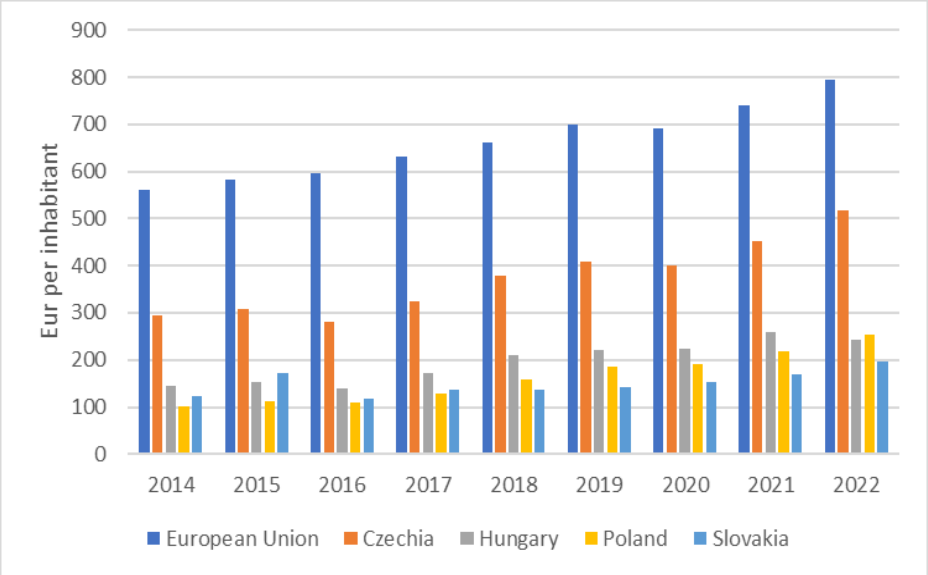


Figure 4. The volume of research and development expenditures per capita in € in the V4 countries in the years 2014-2022

Source: own processing

The structure of research and development expenditures can also be analysed from a different perspective, such as in terms of the activities on which these expenditures are spent. The European Commission, in monitoring expenditures on research and development activities, distinguishes the following categories:

- Expenditures related to the acquisition of machinery, equipment, and software (1)
- Expenditures on acquiring external knowledge (2)
- Expenditures on other innovation activities, such as training and marketing (3)
- Expenditures on external research and development (4)
- Expenditures on internal research and development (5)

Based on the analysis of indices and parameters that influence a country's performance, we established parameters for comparing performance in the given area of the V4 countries. The research methods' chapter describes the individual parameters and reasons for their selection. In this part of the contribution, we analyse innovation activities in the V4 countries according to 7 criteria, with the reference period being 2014 and 2022. We normalised the data to be on the same scale. In this way, we compiled a criterion matrix for the individual years we wanted to compare (Tables 3, 4).

Table 3. Criteria matrix 2014

	K1	K2	K3	K4	K5	K6	K7
CZ	2910944.4	343789.9	1243013741.0	4152964692.3	25495430.5	8576.6	6162.3
HU	1044467.6	38544.7	491819329.0	1393454241.0	7128366.0	2771.0	4225.0
PL	3240309.6	36011.9	17079209.3	309548836.0	14944409.6	4641.7	3708.8
SK	60850.0	856607.6	1387793459.6	10890842624.6	6156849.7	2157.6	2916.0
Total	**7256571.7**	**1274954.1**	**3139705738.9**	**16746810393.9**	**53725055.8**	**18146.9**	**17012.1**

Source: own processing

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Table 4. Criteria matrix 2022

	K1	K2	K3	K4	K5	K6	K7
CZ	12140827.3	754874.3	2566678773.8	7417446725.2	25441936.0	12316.6	18577.7
HU	2855522.0	82766.7	1453134400.0	3929785344.0	8702500.0	6585.3	4733.4
PL	39509169.6	34052.4	85205822.5	544932998.4	12531600.0	8913.2	1840.4
SK	378282.8	33972.4	13400701730.0	38062293139.4	6848689.0	4538.7	1892.3
Total	**54883801.8**	**905665.8**	**17505720726.2**	**49954458207.0**	**53524725.0**	**32353.8**	**27043.8**

Source: own processing

Upon obtaining the necessary input data, the initial phase involved assigning significance to the specified criteria through weighting. To achieve the highest level of objectivity in our evaluation, we adopted two distinct methodologies to distribute weights across the criteria. In the first method, we applied an equal-weight approach. This uniform distribution ensures that no single criterion disproportionately influences the overall evaluation. Conversely, Method II, known as the entropy method, calculates weights based on the variability within the input data, as detailed in Table 5. This method leverages the inherent information provided by the data to assign weights, ensuring that criteria with greater variability have a correspondingly higher impact on the evaluation. Both methods, the equal weights and the entropy method, are rigorously dependent on the characteristics and quality of the input data, underscoring the critical role that precise and accurate data plays in our analytical process.

Table 5. Criteria weights

Criteria **Weights**	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**
Method I in 2014 and 2022	0.1428	0.1428	0.1428	0.1428	0.1428	0.1428	0.1428
Method II in 2014	0.1401	0.1379	0.1393	0.1398	0.1468	0.1472	0.1486
Method II in 2022	0.1378	0.1389	0.1373	0.1393	0.1503	0.1512	0.1453

Source: own processing

After assigning weights to the individual criteria, we used two methods to rank the alternatives. The first method used for evaluating the countries was the TOPSIS method with equal value of assigned weights, as shown in Table 6. Equal weights can reflect the principle of fairness and equality among different criteria.

Table 6. TOPSIS method 2014

	di+	**di-**	**ci**
CZ	0.062	1.213	0.951
HU	1.052	0.175	0.142
PL	0.658	0.572	0.465
SK	1.208	0.158	0.116

Source: own processing

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We carried out the same process with the analysis of data from the relevant area measured in 2022. The relevant results are presented in Table 7.

Table 7. TOPSIS method 2022

	di+	di-	ci
CZ	0.113	0.165	0.594
HU	0.188	0.054	0.224
PL	0.208	0.113	0.351
SK	0.180	0.159	0.469

Source: own processing

Within the TOPSIS method, a relative closeness indicator c_i is used to evaluate alternatives based on the distance of each alternative from the baseline variant. This indicator is calculated based on the distance of each alternative from the ideal and undesirable solutions in the given multicriteria decision-making problem. The ranking of the individual examined countries varied from 2014 to 2022 due to the different political and economic directions of the examined countries.

Using entropy, we wanted to verify the results we achieved. TOPSIS using entropy can provide a more objective assignment of weights to criteria based on data distribution. It can be used to consider different data distributions and reflect their relative importance in evaluating alternatives. When evaluating data with entropy, we present the relevant Z matrix. This matrix contains the weighted values of each alternative with respect to the individual criteria. (Table 8, 9).

Table 8. Matrix Z 2014

	K1	K2	K3	K4	K5	K6	K7
CZ	0.088755	0.076997	0.07235	0.063909	0.092427	1731.942	0.083888
HU	0.053165	0.047508	0.024226	0.085876	0.058139	1003.23	0.07453
PL	0.093642	0.103289	0.023416	0.06937	0.010834	472.8449	0.067846
SK	0.012832	0.013306	0.114205	0.057292	0.097662	2804.69	0.070018

Source: own processing

Table 9. Matrix Z 2022

	K1	K2	K3	K4	K5	K6	K7
CZ	0.064799	0.049565397	0.12534	0.054328	0.057544	0.058253	0.080281
HU	0.031426	0.037823391	0.041503	0.07621	0.043298	0.042401	0.074654
PL	0.116894	0.123519702	0.026621	0.076813	0.010484	0.015789	0.070339
SK	0.011438	0.012330361	0.02659	0.068871	0.131485	0.131959	0.064337

Source: own processing

In summary, in Table 10, the resulting values of the relative closeness indicator in the reference years 2014 and 2022 are displayed to compare the development or changes over time. These values provide an overview of performance, trends, or change in the evaluation of the given indicators between these two years. Analysing

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these values makes it possible to identify whether the condition or situation in the given period has improved, worsened, or remained stable.

Table 10. TOPSIS method

	Method I 2014	Rank	Method I 2022	Rank	Method II 2014	Rank	Method II 2022	Rank
TOPSIS	c_i		c_i		c_i		c_i	
CZ	0.951	1	0.594	1	0.999	1	0.532	1
HU	0.142	3	0.224	4	0.539	2	0.257	4
PL	0.465	2	0.351	3	0.221	4	0.443	3
SK	0.116	4	0.469	2	0.354	3	0.536	2

Source: own processing

Based on the obtained results, we determined the final ranking of the countries in terms of innovations and chosen criteria using both methods, TOPSIS with equal weights and entropy. For a better presentation of the summary results, we present them in Figure 5.

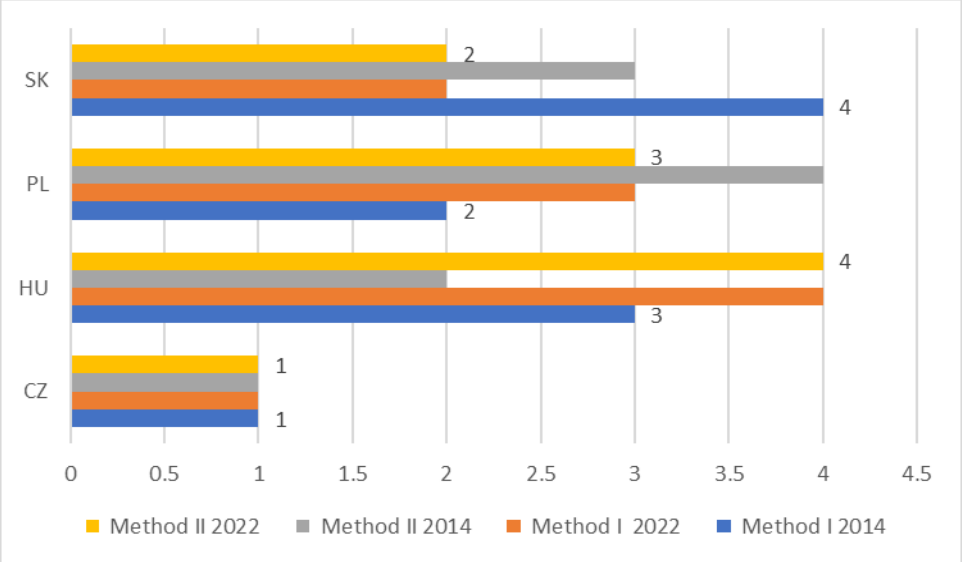


Figure 5. Average rank of the countries

Source: own processing

An interesting finding is that the Czech Republic emerged as a leader within the V4, as evidenced by the results from 2014, but a significant shift occurred in the ranking of Slovakia. This was likely influenced by the sixth criterion, which deals with eco-innovations that lead to the improvement of resource utilisation, reduction of greenhouse gas emissions, protection of natural resources and ecosystems, as well as the support of renewable energy sources, where Slovakia becomes a leader within the V4. All the countries of the Visegrad Group are classified among moderate innovators, with their innovation index values being below the EU-27 average. The Czech Republic is best positioned among all the Visegrad Group countries. Hungary is at the opposite end of this spectrum with the lowest innovation performance based on our reasoned parameters.

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Based on our results and other indicators freely available in EU statistics, we can make the following statements about individual countries:

Slovakia ranks among moderate innovators. During the observed period, Slovakia's performance was up to 32 % lower than the EU-27 average. Slovakia's performance improved significantly until 2013, but there was a decline from 2013 to 2018. Within Slovakia's innovation system, relatively strong areas were identified in categories such as impact on employment, impact on sales, and human resources. On the contrary, relative weaknesses were shown in categories like innovators, intellectual assets, and attractive research systems. Currently, Slovakia is still considered a moderate innovator. Slovakia still has a lower level of innovation performance than other European Union countries. However, Slovakia is improving its innovation potential and strengthening its innovation system through various initiatives and policies. These initiatives include various financial incentives, grant programs, support for research and development in the public and private sectors, and support for startups and emerging companies.

The Czech Republic also belongs to moderate innovators. The Czech Republic's performance was 14 % lower than the EU-27 average during the reported period. In the case of the Czech Republic, annual performance changed relatively moderately. Over time, performance decreased by 4 % compared to the EU performance. During this time, the Czech Republic is trying to strengthen its innovation infrastructure, such as technology parks, innovation centres, and incubation programs, providing space and support for innovative companies. Among the V4 countries, the Czech Republic is the most actively involved in various international programs, such as Horizon 2020, which provides access to financing and the opportunity to collaborate on research projects and better innovation performance.

Poland is among the moderate innovators. During the reported period, Poland's performance was 47 % lower than that of EU-27 countries. The relatively strong sides of Poland's innovation system are identified in these categories: impact on employment, corporate investments, and an environment favourable for innovations. Relative deficiencies were found in categories: innovators and connections to the academic ground. In recent years, Poland has been increasing investments in research and development. According to Eurostat data, in 2020, Poland's total research and development expenditures amounted to approximately 1.17 % of its Gross Domestic Product. Patent activity is an indicator of innovation. In recent years, Poland has seen an increase in the number of patent applications filed at national and international levels, reflecting the country's growing innovation efforts. Poland has a rapidly developing startup ecosystem, with a multitude of startups emerging in various sectors including technology, biotechnology, fintech, and e-commerce.

Hungary is also a moderate innovator. During the reported period, Hungary's performance was 32 % lower than the EU-27 countries. In the case of Hungary, there was a decline in performance until 2014, after which there was an increase in performance from 2014 to 2017. The relatively strong sides of Hungary's innovation system are identified in these categories: impact on employment, sales impact, and an environment favourable for innovations. Hungary is increasing its investments in research and development. According to Eurostat data, in recent years, Hungary's total research and development expenditures as a percentage of GDP have been approximately 1.4 % to 1.5 %, reflecting the country's commitment to supporting innovation.

The European Innovation Scoreboard 2023, published by the European Commission, declares that Denmark is the new top innovator with the best performance in the EU, having overtaken Sweden as the leader after several years. Other innovation leaders are Sweden, Finland, the Netherlands and Belgium. Austria, Germany, Luxembourg, Ireland, Cyprus and France are strong innovators, performing above the EU average. Estonia, Slovenia, Czech Republic, Italy, Spain, Malta, Portugal, Lithuania, Greece and Hungary are moderate innovators. Croatia, Slovakia, Poland, Latvia, Bulgaria and Romania are new innovators (European Commission, 2023).

In discussing our findings on the innovation performance and strategies of the V4 countries, it's crucial to consider the broader academic context, which sheds light on the multifaceted nature of innovation dynamics within these nations.

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Pavlík et al. (2022) identify potential areas for the V4 to enhance their position within the European innovation ecosystem. They emphasise the need for improvements in specific European Innovation Scoreboard indicators, suggesting that targeted efforts could significantly bolster the V4's innovation capabilities and standings. This perspective aligns with our observations of the varying performance levels and the identified areas for improvement across the V4 countries.

Similarly, Pařízková and Šipikal (2009) delve into the evaluation of innovation support through the creation of regional innovation strategies in these countries. By comparing their approaches to both theoretical backgrounds and each other, they provide a nuanced understanding of how each country's unique strategy and implementation impact its innovation outcomes. This comparative analysis complements our findings by highlighting the importance of tailored, region-specific innovation policies and strategies.

Spišáková (2011) specifically highlights the Czech Republic's classification as a "moderate innovator," noting its position as the closest to the European average among the V4. This variability underscores the potential for leveraging unique national strengths. Our analysis concurs with this view, pointing to the Czech Republic's relatively stronger innovation performance and the potential for other V4 countries to identify and leverage their unique strengths.

Kowalska et al. (2018) highlight the direct correlation between R&D expenditure and innovation performance, alongside the significance of broader economic metrics like GDP and foreign trade in understanding the innovation landscape. These perspectives support our findings on the crucial role of investment in R&D and the broader economic context in driving innovation.

Together, these scholarly works provide a comprehensive backdrop to our analysis, underlining the importance of a holistic approach to enhancing innovation performance in the V4 countries. By considering both the specific areas for improvement identified in our study and the insights offered by these researchers, policymakers and stakeholders can better navigate the challenges and opportunities in fostering innovation within the V4 context.

Conclusions

This study has rigorously examined the innovation performance of the Visegrad Four (V4) countries, underscoring the pivotal role of innovation in driving economic development and competitiveness on the global stage. Our findings categorically position the Czech Republic as the most innovative among the V4, attributed to its substantial investment in research and development (R&D) relative to GDP and a robust industrial sector that actively supports innovation initiatives. This places the Czech Republic at the forefront of innovation performance within the V4 across the years 2014 and 2022, aligning with the European Commission's classification of moderate innovators. The remaining V4 countries—Slovakia, Poland, and Hungary—also qualify as moderate innovators. However, the innovation landscape has seen shifts over the years. Notably, Slovakia's emphasis on eco-innovations has elevated its ranking, showcasing the impact of strategic focus areas on overall innovation performance.

Our analysis reveals several barriers to innovation across the V4, including limited financial resources for innovative activities, particularly in the private sector, high innovation costs, and challenges in securing state or grant funding. Additionally, the lack of collaboration partners and qualified personnel for innovation implementation emerged as significant obstacles, especially for small and medium-sized enterprises (SMEs).
To surmount these challenges and enhance innovation performance, the study recommends enhanced financial and policy support for R&D and innovation activities, particularly targeting SMEs; strategic focus on sectors with high innovation potential, such as eco-innovations, to leverage unique strengths and opportunities within each country; facilitation of collaboration between academia, industry, and government to foster a vibrant innovation ecosystem that supports knowledge transfer and commercialisation of research.

Conclusion, while the V4 countries demonstrate a commendable commitment to fostering innovation, there is a need for targeted strategies to overcome existing barriers and fully leverage their innovation potential.

The study's novelty lies in its comprehensive application of the TOPSIS method to assess the innovation performance of the V4 countries, providing insights into regional development and economic competitiveness. However, it has limitations, including its reliance on potentially outdated data and a focus on macro-level indicators that may overlook detailed micro-level dynamics in innovation. These constraints suggest areas for further research. Strengthening the innovation ecosystem through comprehensive support mechanisms and fostering collaboration can significantly enhance their economic development and competitiveness on the international stage.

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ENTREPRENEURIAL, LEGAL AND LOGISTICS ASPECTS OF GAS IN NIGERIA

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Abstract. The current situation in global gas trade indicates a redistribution of suppliers and consumers - solvent markets are opening that diversify gas purchases (mainly the European Union), and sellers are appearing who are more active in expressing themselves and have significant gas reserves. Moreover, pipeline gas and LNG flows are redistributed. In this context, special attention should be paid to Nigeria, which has both the opportunity and the desire to become one of the major players in the global gas market. This article aims to analyze the current situation in the Nigerian gas market and consider the probable development of events in Nigeria's gas production and transportation industry. The methods employed in the study include statistical analysis and descriptive approach. Our findings indicate that the modern economic and political context opens up broad prospects for Nigeria in pipeline gas logistics and LNG projects. This development of events could be favourable for all interested parties - buyers will receive the necessary volumes of gas, and Nigeria will be able to make a profit, reduce unemployment and develop its country's economy. Against this background, the paper evaluated the evolution of gas development and utilization in Nigeria with respect to the Nigerian Gas Master plan and the gas development and utilization measures. The authors, therefore, concluded that the proper exploitation and exploration of gas, barring any other odds, could be the game changer of the Nigerian economy.

Keywords: natural gas; hydrocarbon; global market; industry; logistics

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JEL Classifications: L32, L53, L95

Additional disciplines: law, logistics

1. Introduction

Nigeria has abundant natural resources and is blessed with a large hydrocarbon resource endowment, both in absolute terms and relative to other petroleum-producing countries (Plan, 2004). The oil and gas sector is the backbone and mainstay of Nigeria's economy. Value of energy goods exported from Nigeria has a sharp increase tendency (see Figure 1).

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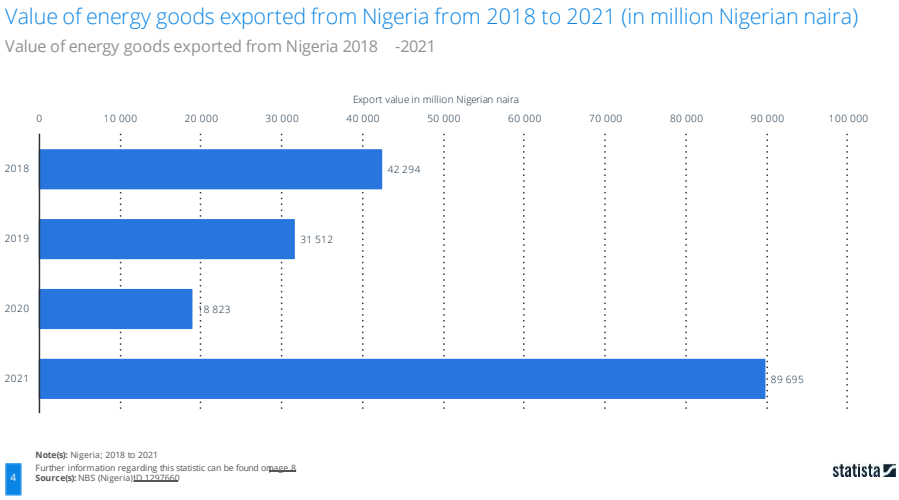


Figure 1. Value of energy goods exported from Nigeria during 2018-2021

Source: NBS (Nigeria), (March 1, 2022). Value of energy goods exported from Nigeria from 2018 to 2021 (in million Nigerian naira), provided by Statista

Natural gas is a "cleaner energy" than crude oil in the energy sector and regime. It has attracted more investors than petroleum, mineral ores, and other valuable extractive products, especially in developing nations like Nigeria.

Nigeria has a vast gas reserve. This resource is of growing benefit as gas has become, and continues to be, the fuel of choice in developed and developing countries (World Bank, 2004). Natural gas reserves in Africa totaled over 620 trillion cubic feet in 2021. Nigeria housed the largest reserves in the continent, around 200 trillion cubic feet – equivalent to roughly three percent of the proved global natural gas reserves (Galal, 2024).

Nigeria is among major gas exporting countries (see Figure 2).

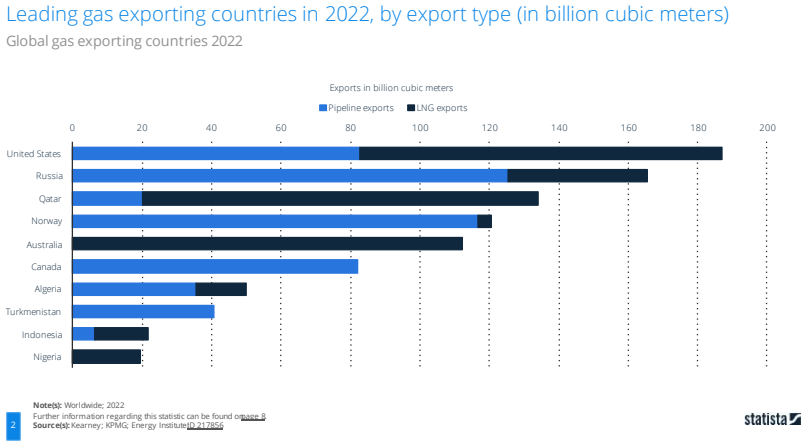


Figure 2. Leading gas exporting countries
Source: Energy institute, provided by Statista

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Natural gas exported from Nigeria grows (see Figure 3)

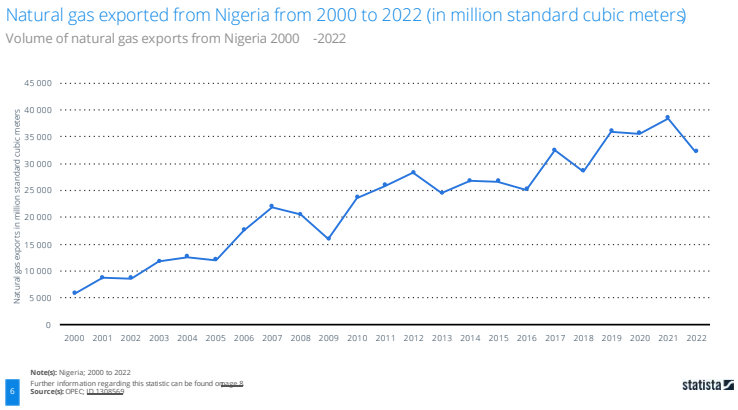


Figure 3. Natural gas export from Nigeria
Source: OPEC, provided by Statista

However, due to flaring during crude oil exploration, Nigeria loses most of its gas. Today, the government pays great attention to the development of exploration, production and marketing of natural gas. To achieve this goal, it is necessary to create adequate infrastructure and improve natural resource management in Nigeria. There are initiatives to increase transparency in the extractive industries, including, for example, a national resource management strategy, a clear legal framework and competent institutions to ensure maximum benefit to its citizens, transparency and accountability, private sector investment to diversify the economy, improved accounting systems to reduce the number of thefts to reduce emissions from gas combustion. The Nigerian gas sector has many players involved in exploration and production, including international and local companies.

2. Theoretical background

Many scientific articles are devoted to Nigeria's gas sector problem. Current trends in the aggravation of energy issues in the global economy have led to increased struggle between countries, including on energy exchange markets (Zhu et al., 2021; Amuda at al., 2023; Androniceanu et al., 2023).

Nigeria, possessing enormous energy potential, including gas generation potential (Akintola et al., 2021), today continues to be a leader in the West African region and lays claim to leadership within the entire continent. The Nigerian foreign policy strategy aims to expand international trade relations, including in the energy sector. The leading role is economic diplomacy, the policy aimed at attracting external assistance and foreign investment. This approach gives Nigeria a more optimistic view of possible economic growth (Galadima et al., 2022).

The problem of gas flaring in Nigeria has remained relevant for many decades. About 40 years ago, a new economic development strategy was adopted; the program aimed to extract oil, ore, and coal and sell these raw materials on the world market. Further, the government carried out several necessary economic measures, which resulted in the state's share in the assets of foreign companies expanding. But even in the 20s of the 21st century, alternatives to gas flaring are being discussed in Nigeria Elehinafe et al., 2022) and the Economic Impact of Gas Flaring in Nigeria (Okoro et al., 2021) is emphasized.

For example, the issue of producing electricity from gas (Ihejirika et al., 2022) is being discussed, a technical and economic analysis is being carried out (Adewuyi et al., 2023), Project Life Cycle Costing is calculated (Oruwari & Ogbuike, 2023). However, the complexity of the problem is that it is necessary to create conditions for freedom of international economic activity on the territory of the country with the state's regulatory role. In the context of the globalization of world energy, the impact of gas legislation on the local economy (Adegun et al., 2022) can be pretty significant.

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The role of Nigeria's international trade in the global economy is small due to low levels of exports and imports compared to other developed market economies in the world. The legal and contractual terms of transactions with international gas production companies are the basis for expanding the volume of attracted foreign investment and improving the organizational forms of the oil business in the state. Over the past few years, oil and gas production in Nigeria has been hampered by militant attacks on infrastructure. The growth in exploration and production volumes on the Nigerian shelf was mainly due to the government's efforts to develop the hydrocarbon component of the country's economy. The domestic market expansion is also hampered by the need for more infrastructure, unresolved security problems, and transportation problems (Osuagwu et al., 2021).

It should be noted that in a global context, the topic of natural gas is often associated with an environmental issue. The most significant negative impact on the environment occurs within the territories of gas and oil fields, as well as in nearby populated areas and along trunk pipelines. Vegetation, soil, and microrelief are directly affected.

Oil and gas production leads to changes in deep-lying horizons of the geological environment, which can lead to irreversible deformations of the earth's surface and, in some cases, can contribute to earthquakes (Zhang et al., 2024). Pipeline transport can be considered an environmentally friendly mode of transport of hydrocarbons only if strict environmental discipline is observed in the design, construction and operation of gas pipelines. The operation of compressor stations (Luo et al., 2024) has a technogenic impact on the environment. The negative effects of air pollutants are due to their toxic and irritant properties (Nsaif et al., 2024), since natural gas from specific fields may contain very poisonous substances.

The large-scale construction of trunk pipelines has a negative impact on the state of wildlife. Drilling and other gas extraction activities can lead to soil degradation, compaction and loss of vegetation. Environmental problems can also arise during the production of liquefied natural gas, transportation, and regasification (Jung, 2024; Yang et al., 2024). Dredging and erosion can have a negative impact on the habitats of aquatic organisms. Direct impacts may include physical destruction of habitats, and indirect impacts may occur through changes in water quality. Wastes commonly generated at LNG facilities (Yu et al., 2024) include packaging waste, used oils, hydraulic fluids, used batteries, and chemical containers. The main sources of noise at LNG facilities are pumps, compressors, generators and engines, compressor discharge and suction lines, recirculation system piping, air drying units, heaters, gas coolers in gas liquefaction plants, evaporators, unloading and unloading of tankers and gas carriers.

Finally, the third area of scientific research activity was the problem of corruption in the gas sector. The need to intensify the processes of Nigeria's integration into the world economic system (including attracting foreign direct investment) is associated with an attempt to ensure the acceleration of the country's economic growth.

Of course, government effectiveness (Adabor, 2023) and institutional quality (Akbar et al., 2022) are of great importance here. To enhance the Nigerian gas industry's attractiveness to regional and global investors, Nigeria has expanded its existing incentives for private investors. This is indirectly related to “Mobilising Rents” (Irarrázaval, 2022), but in Nigeria, the level of such investment is still not high enough. Researchers often note that economic success in such situations requires an intensified fight against corruption (Krivins et al., 2023) and a reduction in crime (Remeikiene et al., 2022). It has been established that when making strategic investment decisions (Karim et al., 2020), investors also take into account the socio-cultural (Kipane et al., 2023; Tsheola et al., 2023; Ntshangase et al., 2023) aspect.

Among the laws aimed at improving the conditions for attracting investment in the gas sector of the Nigerian economy, it is necessary to highlight those related to structural adjustment and liberalization reform to ensure greater openness and support (Mahmood et al., 2021) in the privatization process. Today, many enterprises in the country are state-owned, but a privatization program is being actively implemented here, which causes corruption risks (Gani, 2021). Thus, critical changes in the regulatory environment for foreign direct investment in Nigeria relate to foreign ownership of businesses, issues of expropriation and compensation, dispute resolution, transparency (Vasić et al., 2023) and protection of property rights. Nigeria has joined international

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institutions that regulate economic cooperation with foreign investors, so it is impossible to ignore the ethical component.

3. Research methodology

The research methods are statistical analysis, analysis of regulatory legal acts, Qualitative Document Analysis (QDA) and content analysis. These research methods make it possible to ensure systematic and reliable recording of some aspects of the content of documents and qualitatively process the data obtained. This allows us to establish the characteristics of documentary sources and the features of the entire process: social orientations and attitudes of Nigeria as a gas producer, values and norms replicated in documents. Non-quantitative content analysis records the presence of a text content element - an indicator corresponding to the content category. This approach allows us to identify types of qualitative content models - regardless of the frequency of occurrence of each type. This approach made it possible to implement the content of the analyzed document into a social context and to comprehend it as a manifestation of social life. Before examining the established data, categories of analysis were determined - fundamental concepts and semantic units - available in the text and corresponding to those definitions and their empirical indicators recorded in the research program.

4. Research data

The first part of the research base consists of information related to Gas Utilization and Concomitant Options in Nigeria. Nigerian domestic and regional demand from the greater West Africa region may push annual gas production in Nigeria beyond the 10 BSCF/D mark by 2020. The global population is expected to rise to nearly 10 billion by 2050, spurring global energy demand to almost 60% higher than today by 2060 (Plan, 2004).

Gas utilization in Nigeria, as earlier discussed, has been through a chequered history as phased below (Table 1):

Table 1. Characteristics of historical periods of development of the gas sector in Nigeria

Phase	Historical period	Characteristic
Phase 1	Pre-1999, The Demand Constraint Era	• Era marked by intense flaring • Fiscal incentives to stimulate demand • Focus on exports (LNG) as a most promising source of demand, hence the birth of an export-oriented gas sector • Proliferation of fiscal incentives and absence of a legal framework to regulate the sub-sector
Phase 2	Between 1999 and 2005, that is, the Nigerian Liquefied Natural Gas Era	• Kick-off and subsequent growth of LNG • Beginning of steady decline in flares • Initiation of new export projects – Gas to Liquid, etc. • Commencement of fiscal and legal regime consolidation to incentivize and regulate operations in the sub-sector.
Phase 3	2005: The Demand Boom/Supply Constraint Er	• Sudden boom in demand from both domestic and export sectors • Sudden shift from demand to supply constraint • Birth of the Gas Master Plan initiative • The Gas Master-Plan initiative was born in response to the sudden boom in gas demand in Nigeria.

Source: authors created based on research data (NTUFAM, 2013).

The second part of the research base consists of information related to the typical Gas Utilization Projects. Available and commercially priced gas can initiate a real expansion in many domestic and export-based projects - excluding Pipelines (Plan (2004). These options will include a cross-section of facilities that can support that growth over a long period once the more extensive and strategic options have been implemented (World Bank, 2004). Options relevant to Nigeria include (see Table 2):

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Table 2. Characteristics of historical periods of development of the gas sector in Nigeria

Priority 1	Priority 2	Priority 3
• Power Generation • Gas to Liquids (GTL) manufacture	• LPG processing • Cement manufacture • Steel (DRI) manufacture • Fertilizer (Ammonia/Urea)	• Further Liquefied Natural Gas (LNG) • Methanol • Aluminium smelting

Source: authors created based on research data (NTUFAM, 2013).

There was a concentration of market power in a few dominant joint ventures (JVs), and these core IOC operators typically focused their gas activities on the export of LNG rather than on the domestic market (NTUFAM, 2013). Pressure to reduce flaring, desire for economic growth and general enhancement of populace quality of life, and desire for industrial development are the principal drivers for developing natural gas (Ojijiagwo, 2017). The development of the Nigerian LNG project was pivotal to increased gas utilization in Nigeria and to create a position in the international market.

Concerning the domestic market, the NNPC, through its subsidiary, Nigerian Gas Company (NGC), supplies gas for power generation, either as a source of fuel or as feedstock (Ojide et al. 2012) to cement and fertilizer plants, glass, food and beverages, manufacturing industries and so on. More local industries are now aware of the advantages and benefits of using gas; hence, the demand for gas is increasing. The Nigerian gas market is a profit-oriented market awaiting potential investors.

For the international market, NNPC and its Joint Venture partners are currently embarking on several gas utilization projects (Export- Oriented Gas Projects), which include the following: 1) Escravos Gas Project, 2) OSO NGL Project, 3) LNG Projects, 4) Ekpe Gas Compression Projects, 5) OSO 2Y2 Project, 6) Belema Gas Injection Project, 7) Odigbo Node Gas Project, 8) Odidi AGG Project, 9) Cawthorne Channel Gas Injection Project, 10) The West African Gas Pipeline Project.

The third data group summarizes the following themes: Economic/Fiscal Incentives Associated with the Nigerian Oil and Gas Industry; Midstream and Downstream (M&D) Gas Operations; Administration of Midstream and Downstream Gas Operations; and Domestic Response to Demand Growth.

The Petroleum Industry Act (PIA, 2021) establishes 7 new gas operations licensees. The Nigerian Gas Company a subsidiary of the Nigerian National Petroleum Company, engages in the transmission, distribution and marketing of natural gas and operates most of the gas transportation network alongside other pipeline system owners granted an operator license/authorization by the Department of Petroleum Resources under the Nigerian Gas Transportation Network Code, 2020 (Opsng, 2021). The newly created midstream and downstream licensees created under the Petroleum Industry Act relating to gas are license for: 1) "Natural Gas Processing"; 2) "Bulk Gas Storage License (BGSL) - bulk storage of natural gas"; 3) "Gas Transportation Pipeline License: (GTPL) - exclusive right to own, construct, operate and maintain gas transportation pipeline"; 4) "Wholesale Gas Supply License (WGSL) - sell and deliver wholesale gas to wholesale customers and gas distributors" (5); "Retail Gas Supply"; 6) "Natural Gas Distribution"; 7) "Domestic Gas Aggregation".

The Petroleum Industry Act requires that a holder of an existing lease, license, or permit involved in midstream or downstream gas operations before the Act's effective date must apply to the Authority within 24 months of the effective date. The Authority may issue the relevant license or permit if, according to Section 125, involvement in midstream and downstream or downstream gas operations without a license or authorization commits an offence and faces a penalty of: (a) 1 year in prison or a fine imposed by regulation in the case of a license-required Activity; or (b) 6 months in prison or a fine imposed by regulation in the case of a permit-required Activity. The Act in Section 314 proposes that employees of the Department of Petroleum Resources, Petroleum Pricing and Product Regulatory Agency, the Petroleum Equalization Fund (Management Board) and Petroleum Inspectorate be transferred to their respective regulators. Section 52 of the Petroleum Industry Act creates a Midstream Gas Infrastructure Fund to 'make equity investments of Government-owned participating or shareholder interests in infrastructure related to midstream gas operations aimed at: (a) increasing the

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domestic consumption of Natural Gas in Nigeria in projects which are financed in part by private investment, and (b) encouraging private investment. The source of the Midstream Gas Infrastructure Fund shall be a 0.5% levy on the wholesale price of petroleum products sold in Nigeria and natural gas produced and sold (PIA, 2021). The objectives of the Gas Master Plan are summarized below (see Table 3).

Table 3. The Objectives of the Gas Master Plan

[1] Maximize the Multiplier Effect of Gas in the Domestic Economy	**[2] Optimize Nigeria's Share and Competitiveness in High-Value Export Markets**	**[3] Balancing the trans-generational needs-managed exploitation.**
[1.1.] Facilitate gas to power, fertilizer, etc. [1.2.] Domestic LPG [1.3.] Stimulate broad gas-based industrialization-methanol, fertilizer, etc.	[2.1.] Selective participation in high-value markets [2.2.] Strategic positioning for growth [2.3.] Assure long-term energy (gas) security for Nigeria	[3.1.] Balancing the trans-generational needs [3.2.] Managed exploitation

Source: authors created based on research data (Ubani, 2016).

It should be noted that in January 2020, the Government of Nigeria passed the Finance Bill. This act amends several tax laws and aims to improve tax participation and collection and modernize the tax system. For example, the tax on profits from oil production (which abolishes the tax exemption on dividends paid from after-tax profits) and the value-added tax were changed. In addition, this law, which is also an amendment to the 1999 Law on Production Sharing Contracts in Deep-Sea and Inland Basins, changed the royalty rates for deep-sea (water depth more than 200 meters) and inland basins. Since international oil companies primarily operate in Nigeria's deepwater fields, the law has increased the government's share of revenue generated from these fields. It will force investors to reconsider their investment plans for currently developing fields as well as new ones. There is still a pressing need to eliminate technical shortcomings and increase production, profit, and safety on construction sites while minimizing the environmental impact to make the work of relatively small enterprises more formalized by law and trustworthy.

In this part of the article, we will summarize the main events of the last three years that have occurred in the gas transport sector in Nigeria:

On June 30, 2020, the Federal Government of Nigeria announced the commencement of construction of the 614-kilometer Ayaokuta-Kaduna-Kano natural gas pipeline. The pipeline will supply gas for power generation and stimulate new industries in the cities of Kogi, Niger, Kaduna and Abuja. Construction is being carried out within the framework of the Chinese "New Silk Road" project. The pipeline will connect to the Trans-Saharan gas pipeline, which will export natural gas to Europe. Nigeria's oil reserves are expected to last for 30-40 years, and its vast gas reserves will allow it to diversify the economy.

In 2021, a plan was unveiled to transition the Nigerian economy to the widespread use of gas - Nigeria intends to radically change the situation by using its vast gas fields to become one of the leading gas-consuming countries. By 2030, Nigeria will be one of the world's largest gas consumers.

In 2023, China National Electrical Equipment Corporation commissioned the last of the four units of the Zungeru hydroelectric power station in Nigeria. The new facility, with a total capacity of 700 megawatts, will generate 2.64 terawatt-hours of electricity per year, equivalent to 10% of Nigeria's annual electricity consumption.

In October 2023, it became apparent that Nigeria and Algeria were speeding up the Trans-Saharan Gas Pipeline (TSGP) construction to export Nigerian gas to Europe. The TSGP gas pipeline project cost is estimated at $13 billion, and the gas pipeline length will be 4,128 kilometres.

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On November 21, 2023, The Nigerian gas company Riverside LNG and the German Johannes Schuetze Energy Import AG entered a deal for liquefied natural gas (LNG) supply. The first gas deliveries from Nigeria to Germany will begin in 2026. According to the agreement, Nigeria will annually supply 850 thousand tons of LNG to Germany, with a planned increase in exports to 1.2 million tons. Under the new deal, Nigeria will provide 2% of the total imports of liquefied natural gas into Germany. In turn, Germany will increase investment in renewable energy in Nigeria (Deutsche Welle, 2023).

In January 2024, it became known that the Nigerian company NIGUS International and the Chinese company Zhongmin Xinjunlong signed a $1 billion agreement involving the use of associated gas. The gas is assumed to be processed into synthetic diesel fuel and liquefied gas for domestic needs. The partnership will bring the latest technologies to commercialize flare gas and develop green energy in Nigeria.

At the same time, the Nigerian company Riverside LNG is negotiating gas supplies to South Africa, and the company is also exploring opportunities in Liberia and Cameroon. Currently, South Africa cannot receive LNG, so deliveries under the project will begin by 2027.

Thus, today, logistics transportation of Nigerian gas is planned in three main ways: 1) TSGP pipeline, 2) WAGP pipeline, and 3) liquefied natural gas (LNG). Let us briefly summarize the basic information that is available for each of these options today.

TSGP pipeline. The Trans-Saharan Gas Pipeline (TSGP) appeared in the 1970s but still needs to be implemented due to high costs and specific risks. However, on June 21, 2022, the energy ministers of Algeria, Niger and Nigeria agreed to lay the foundations for the implementation of the TSGP project and a memorandum of understanding was signed on July 28, 2022. This project benefits all interested parties - Europe will receive additional gas volumes; Algeria will increase gas supplies to Europe without significant investments in its gas production; Nigeria will gain a new market. It is planned that this gas pipeline with a capacity of 30 billion cubic meters (initially, it is intended to send 20 billion cubic meters of gas annually) could be launched in 2026. An increase in pumping from other West African countries, including Ghana, Senegal and Equatorial Guinea, is not excluded. Some Asian and Eurasian gas-exporting countries considered this idea utopian; however, in May 2023, the African Development Bank took over the financing of this project, and already in March 2024, the Algerian authorities announced the completion of more than half of the gas pipeline: 2,200 kilometres of pipes with associated infrastructure out of the planned 4,100 kilometres. It remains to lay 100 km of pipes in Nigeria, 1000 km in Niger and 700 in Algeria. In technical terms, specialists from Italy, Germany and France are actively assisting in the implementation of the project; construction is proceeding at a rapid pace, so it is possible that the first volumes of gas could flow through the pipeline in 2025 or even in December 2024.

WAGP pipeline. On September 15, 2022, Nigeria, Morocco and the Economic Community of West African States (an economic union of 15 countries) agreed to build the 5,600-kilometer West African Gas Pipeline (WAGP) along the West African coast from Nigeria to Europe. Because the TSGP Pipeline may be vulnerable, Europe is also supporting the construction of the alternative Nigeria–Morocco Gas Pipeline (WAGP). The construction of a gas pipeline from Nigeria to Morocco is planned from 2024 to 2026 - there are both technical and financial possibilities for this. The Islamic Development Bank and the OPEC Fund for International Development have already committed about $60 million to finance feasibility and engineering studies.

Liquefied natural gas (LNG) is the third working option for Nigerian gas logistics. Europe is developing LNG projects at an accelerated pace; now, the capacity for receiving LNG is already available in Europe. However, Nigeria has many strong competitors, such as the United States and Qatar, which plan to significantly increase the volume of their LNG production in 2025 and 2026—countries such as Nigeria, Angola, and Sinegal offer untapped potential in liquefied natural gas. Nigeria seeks to increase gas supplies to foreign markets, and the European Commission can certainly conclude an agreement to cooperate on fuel imports.

Thus, two new gas pipelines (TSGP and WAGP) will appear in the coming years. In the first stage, they will supply Europe with at least 50 billion cubic meters of gas and, later, 66 billion cubic meters. Gas reserves allow Nigeria to ensure the operation of both gas pipelines for 80 years. In addition, the LNG development direction

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is quite realistic. Nigeria can earn up to 800 billion euros from gas projects. (Deutsche Welle, 2022). This aligns well with Nigeria's ambition to become a top 10 global economy by 2050.

5. Results and discussion

During the study, 17 countries were considered, which for 20 years have provided the most significant volumes of natural gas on the world market (Algeria, Australia, Canada, China, Egypt, Indonesia, Iran, Malaysia, Netherlands, Nigeria, Norway, Qatar, Russia, Saudi Arabia, , United Kingdom, United States, Uzbekistan). Global gas production (unit - bcm) in 2022 was as follows: United States 1027, Russia 699, Iran 244, China 219, Canada 205, Qatar 170, Australia 162, Norway 128, Saudi Arabia 105, Algeria 102, Malaysia 76, Egypt 68, Indonesia 57; Uzbekistan 52, Nigeria 41, United Kingdom 38; Netherlands 18. It must be taken into account that global gas production (unit - bcm) in 2002 was as follows: Russia 584, United States 536, Canada 187, United Kingdom 109, Algeria 80, Netherlands 76, Indonesia 74, Iran 70, Norway 69, Uzbekistan 54, Malaysia 51, Saudi Arabia 46; Australia 35; China 33; Qatar 29; Egypt 26; Nigeria 14. We summarized the data obtained in a comparative Table 4.

Table 4. Global gas production (bcm) in 17 countries

	Gas production 2022 (bcm)	Gas production % of 17 analyzed countries	Gas production 2002 (bcm)	Gas production % of 17 analyzed countries	Increase/decrease in the analyzed group of countries, %	Volume increase/decrease from 2002 to 2022 (times)
United States	1027	30.10847	536	25.85625	4.25222	1.916045
Russia	699	20.49252	584	28.17173	-7.67921	1.196918
Iran	244	7.153327	70	3.376749	3.776578	3.485714
China	219	6.420405	33	1.591896	4.828509	6.636364
Canada	205	6.009968	187	9.020743	-3.01078	1.096257
Qatar	170	4.983876	29	1.398939	3.584937	5.862069
Australia	162	4.74934	35	1.688374	3.060966	4.628571
Norway	128	3.752565	69	3.328509	0.424056	1.855072
Saudi Arabia	105	3.078276	46	2.219006	0.85927	2.282609
Algeria	102	2.990325	80	3.859141	-0.86882	1.275
Malaysia	76	2.228086	51	2.460203	-0.23212	1.490196
Egypt	68	1.99355	26	1.254221	0.739329	2.615385
Indonesia	57	1.671064	74	3.569706	-1.89864	0.77027
Uzbekistan	52	1.52448	54	2.60492	-1.08044	0.962963
Nigeria	41	1.201994	14	0.67535	0.526644	2.928571
United Kingdom	38	1.114043	109	5.25808	-4.14404	0.348624
Netherlands	18	0.527704	76	3.666184	-3.13848	0.236842
	3411	100	2073	100		1.645441

Source: authors created based on https://yearbook.enerdata.net, 2024

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Important conclusions can be drawn by comparing these volumes with those of 20 years ago. The changes in the global natural gas market will unevenly impact individual markets across different continents. The main indicators of these differences will be delivery speed and transaction volume. In the European Union, natural gas production in the North Sea is declining, but demand remains significant. Monopolistic tendencies are gradually disappearing - growing competition will take their place. New projects (e.g. Brazil, Mexico, Iran, Angola, Egypt, Trinidad, Nigeria, Oman, Qatar) will increase supply. Increasing the number of services offered will provide more options for buyers.

During the analyzed period (from 2002 to 2022), Nigeria entered the top five countries with a multiple increase in gas production - over the years, the volume has almost tripled. However, we noted that gas supplies from Nigeria to the European Union have remained relatively high. In this regard, our analysis highlights the main problematic issues.

Nigeria has declared the 2020s a "decade of gas"; however, Nigeria has found itself unable to satisfy increased gas demand from the European continent, which is moving away from Russian gas, just as Nigerian oil production falls due to limited gas projects and export infrastructure, underinvestment and technical issues. Nigeria's LNG exports to Europe fell 22.7% in 2023, according to S&P Global Commodity Insights data, due partly to insufficient deepwater gas projects and export infrastructure (Spglobal, 2024). Nigeria is looking to fast-track the construction of a 5,600-km gas pipeline to Morocco (the 3 Bcf/d Nigeria-Morocco pipeline snaking across 13 West African countries), capable of supplying Europe, after a breakdown in diplomatic relations with Niger scuttled the Trans-Sahara pipeline to Algeria (Spglobal, 2024).

Our analysis shows that Nigeria needs to focus not on gas pipelines but on the transportation of liquefied gas. The liquefied gas transportation method dominates international trade due to the technological challenges of producing very long pipelines (especially subsea gas pipelines at great depths). In addition, in today's world, buyers no longer want to commit themselves to long-term contracts with a fixed price. Maritime trade can provide a more flexible system of agreements, including long-term and short-term contracts. Additional use of liquefied natural gas can meet global energy needs during peak demand periods. Of course, the production and liquefaction of natural gas should be based on an analysis of many factors, including natural gas reserves in the ground, which should provide contracts for at least 15-20 years. Sufficient gas volume means reserves should be approximately 30 times greater than the estimated annual mining capacity. The equipped liquefaction plant includes plants for separating natural gas from impurities, a main liquefaction plant, storage tanks for liquefied natural gas, quay and ship loading facilities for liquefied natural gas, sufficient supply of electricity and water, and proper transport logistics planning. The country's entry into the liquefied natural gas trade in practice requires installing installations and specialized terminals with tanks and docks for unloading ships and storing gas. It is also necessary to build a network of pipelines to distribute gas to end consumers.

Carriers can be either government fleets or independent ships. Still, the costs of building and maintaining such a fleet are exceptionally high due to the absolute specialization for this type of trade. The required number of ships directly depends on the distance between the importing and exporting countries. The construction of gas liquefaction plants requires significant investments; this construction must be carried out in a region with a natural harbour, flat terrain and a short distance from the gas source. However, in practice, these conditions are challenging to satisfy, significantly increasing the project's overall cost. Thus, before the importing country carries out the necessary construction of infrastructure for receiving liquefied gas, it must be justified (a significant number of consumers, the absence of more reliable alternative sources, etc.). Finally, the country's market must be willing to receive natural gas as fuel. Otherwise, the enterprise will fail, and the infrastructure costs will not be recouped. Five main factors assess the success of an LNG project: 1) gas reserves, 2) infrastructure, 3) capital, 4) cooperation between trading countries, and 5) market conditions.

The analysis of data (including Gas Utilization and Concomitant Options in Nigeria, a list of international projects, The Petroleum Industry Act, The Nigerian Gas Master Plan, etc.) indicates that the problems of corruption and environmental protection issues remain very important. The danger of corruption in the Nigerian gas industry, in our opinion, is caused by the following factors: 1) competition for access to natural resources (lack of transparency in negotiations, incomplete legislative regulation of the process, extremely high barriers

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to entry into the relevant market); 2) diversity of legal frameworks for the activities of actors in the extractive sector; 3) the international nature of the extractive sector; 4) gaps in the legislative system (Teivans-Treinovskis et al., 2022); 5) highly politicized decision-making on the development of mineral resources; 6) incorrect distribution of government functions in the industry; 7) lack of monitoring systems at the firm level; 8) opacity of beneficial ownership; 8) possible bribery for the sake of providing a more favourable tax regime (Krivins, 2018); 9) possible bribery (Krivins, 2014) in the distribution of subsidies between national firms and foreign partner companies (Krivins, 2019). These risks must be reduced by improving decision-making transparency, legal regulation, and law enforcement practice. The environmental protection problem was considered a completely independent context and an aspect interconnected with corruption.

6. Conclusions

The gas market is gradually expanding, demonstrating a tendency towards balancing. Full liberalization of national gas markets could help attract private capital, increase transactions, and develop healthy competition conditions for entrepreneurs. Technological progress and experience significantly reduce the cost of constructing plants to extract, liquefy and return liquefied natural gas to gaseous form.

The global gas trade context, which has changed markedly since 2022, opens up new prospects for Nigeria. Nigeria has significant advantages when the European Union is interested in establishing trade relations with new, stable, secure gas suppliers to the EU market.

Firstly, the volume of gas in Nigeria is very significant, and Nigeria has the opportunity to increase the volume of liquefied gas supplies to different countries worldwide. Secondly, the emergence of a new supplier will help the European Union diversify gas supplies (at the same time, due to objective reasons, the volume of supplies from Nigeria will not be huge, and Nigeria will not be able to become a monopolist in the EU market). Thirdly, the European Union has significant investment and technological and innovation capital. The excellent solvency and sustainable development of the European Union, on the one hand, and the capabilities of Nigeria, on the other hand, create a unique combination in the global gas market. In this way, both parties can mutually benefit from cooperation.

The main obstacles (which are pretty surmountable) may be: 1) the problem of corruption - the European Union, the USA and Western countries traditionally pay increased attention to fair trade agreements. The primary method for concluding such contracts is an open tender, which best corresponds to the principle of free competition between entrepreneurs; 2) special attention should be paid to environmental protection, which may become the second most significant aspect of cooperation between the European Union and Nigeria; 3) the problem of political instability, especially characteristic of the continent of Africa and Nigeria in particular; 4) problems of long distances and logistics; 5) risks of a possible global decline in gas prices due to the discovery of new fields and increased competition; the likelihood that gas buyers will eventually turn to other forms of energy that replace natural gas in efficiency.

Having compared two competing types of gas transportation in Nigeria, the authors emphasize that pipelines have advantages and disadvantages. Difficulties associated with soil deformation, terrorism, and political differences can actualize traditional methods of maritime trade, which inspires confidence in supplies. The main recommendation for Nigeria could be more active construction and use of LNG terminals.

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USE OF MOBILE TECHNOLOGIES BY BUSINESS COMPANIES IN THE CONTEXT OF DIGITALIZATION OF THE LATVIAN ECONOMY *

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Abstract. The article aims to identify the factors contributing to the development of mobile technologies among Latvian entrepreneurs. The limited spread of mobile technologies can lead to issues in Latvia's economy, like limited access to digital services and resources, a decline in competitiveness between enterprises, limitations in the case of innovation, and unavailability of economic growth. Suppose the use of mobile technologies stays limited in certain areas or between certain groups of people. In that case, it can lead to unequal conditions for information, education, work opportunities and new businesses. With mobile technologies, Latvia can achieve a digital transformation in economics, leading to an advantage in digital economics compared to other countries. With the use of analyzed data from the questionnaire that was given to Latvian entrepreneurs, as well as the analysis of literature sources, the authors emphasize the importance of informative and technological development, IT specialist qualifications and digital literacy for the development of the digital economy, as it can be seen that high digital literacy and availability of IT infrastructure can stimulate economic growth, although, the deficit of qualification can become a big obstacle. The drawn conclusions emphasize the importance of work in terms of information about the advantages of digital technologies among small and average entrepreneurs. Further research can be focused on rating the effectiveness of specific programmes about digital literacy and the availability of IT infrastructure in the context of the Latvian economy.

Keywords: factors affecting the use of mobile technologies; business companies; SMEs; entrepreneurship; digitalization; Latvia

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1. Introduction

The impact of mobile technologies on entrepreneurship cannot be overestimated. Mobile computing devices (smartphones, computers, and tablets) are essential business tools. Mobile devices are connected to the Internet through wireless networks, making them convenient. Today, a network has already been established to support processing vast amounts of information. By the end of 2021, more than 27.1 billion devices were connected to

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the Internet, more than three devices per person on the planet (Cisco, 2021). In the first quarter of 2023, mobile devices (excluding tablets) generated 58.33% of global website traffic. The market share of mobile devices and tablets in Europe in 2023 (Statcounter GlobalStats, 2024a) is 51.89% and 2.48%, respectively. In Latvia in 2023, the market share of mobile devices and tablets is 38.43% and 0.91%, respectively (Statcounter GlobalStats, 2024b).

Today, when digitalization and mobile technologies become integral to business processes, understanding the factors influencing their development is critical for enterprises to adapt to modern market requirements successfully (Berawi et al., 2020; Bernardino & Freitas Santos, 2020; Schlegel & Kraus, 2021; Androniceanu & Georgescu, 2022; Dinu et al., 2022; Musiello-Neto et al., 2022; Rua et al., 2023; Quyet, 2024). Slinger et al., 2024). What factors contribute to the use of mobile devices in entrepreneurship? How to increase the market share of mobile devices in Latvia and the intensity of their usage?

This research aims to assess the factors influencing the use of mobile devices for entrepreneurship in Latvia. Based on a survey of entrepreneurs, the study outcomes emphasize several vital factors influencing the development of the mobile economy in Latvia. These factors include the level of development and quality of IT infrastructure, availability of IT specialists, and ability of enterprises to adapt to new conditions of corporate structures, including the effects of EU sanctions. The importance of technological tools, such as identification systems and electronic digital signatures, in encouraging the use of mobile technologies is also noted. Equally important is to provide enterprise employees with financial and technical means for mobile access to the Internet.

The study also emphasizes the importance of mobile literacy of the population as consumers of mobile technologies, which indicates the need for technical and educational support in this area. It is noted that the lack of skilled labour can harm the development of mobile technology, which makes it essential to pay attention to the training of specialists in this area. Finally, the study points to a reserve of growth in the intensity of mobile technology use in the SME sector, highlighting the need to educate entrepreneurs in this sector about the link between mobile technology use and the success of their businesses.

2. Methodology

Assessing the factors affecting the use of mobile technologies in entrepreneurship in the context of economy digitalization, it is methodologically justified to consider such economic theories and approaches as innovation theory, human capital theory, economic growth theory, theory of institutional change, and theory of technological progress.

The innovation theory studies new technologies' creation, diffusion, and application. According to the innovation theory, the extent to which mobile technology offers advantages over existing alternatives is the critical factor influencing mobile technology use in entrepreneurship (Liu et al., 2022; Lesebo et al., 2023). It may include improved operational efficiency, increased accessibility to information, or new opportunities to communicate with customers (Bassano et al., 2017; Heavin & Power, 2018; Warner & Wäger, 2019; Hazzam et al., 2022). If mobile technologies are considered difficult to use or require significant effort to master, their adoption by entrepreneurs may slow. However, its adoption may increase as technology becomes simpler and more sophisticated. Such social factors as peer opinion, public opinion, and influential industry leaders can significantly impact the adoption of mobile technology in the entrepreneurial community. If influential entrepreneurs actively use mobile technology, it may encourage others to adopt it. Channels of communication and information dissemination can also influence the adoption of mobile technologies. For example, if information about the benefits and opportunities of mobile technologies is widely disseminated through professional communities, this may encourage their adoption. At the same time, the process of adopting new technologies takes time. Entrepreneurs may not be ready to move onto mobile technology immediately due to the need for training or financial investments. However, its adoption may increase as technology becomes more widely available and known. These factors may interact and may be more or less significant depending on the context and specific conditions in the entrepreneurial environment.

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The innovation adoption process model proposed by Rogers (2003) describes how new ideas, products, or practices diffuse among members of society. He identifies a few key steps in the process. The first innovation stage is characterized by a group of individuals who quickly adopt a new idea. They usually have a large number of connections and access to information. This group is followed by a large part of the population, which also adopts the new idea but slower than the previous group. The next population group adopts an innovation only after the majority have already done so, and it may take them an even longer time to adopt the innovation. The last group, which adopts the innovation with a long delay as compared to other groups, associates itself with traditional ways, and this group may be the most resistant to change. This model helps to understand how innovation diffuses in society and how to encourage this process more effectively.

Davis et al. (1989) investigated the factors influencing user acceptance of computer technology. Two theoretical models were compared: the Technology Acceptance Model (TAM) and the Theory of Reasoned Action and Decision Making (TRA). According to the Technology Acceptance Model (TAM), the main factors influencing the acceptance of computer technology include Perceived Usefulness, where users rate how useful they find the technology to their business process or tasks and Perceived Ease of Use, i.e., how easy it is for them to use the technology. The Theory of Action and Decision Making (TRA) also considers other factors, such as the user's expected behaviour (Behavioural Intention) and the user's general attitude towards using the technology (Attitude Toward Using), including their belief in its usefulness and ease of use. These factors together form a model explaining why and how users accept or reject computer technology in their entrepreneurship.

Ramaswamy and Nayak (2014) conducted a systematic review of factors influencing mobile commerce adoption among small businesses. They determined the influence of Perceived Usefulness, Perceived Ease of Use, Perceived Risks, Access to Technology, and socio-demographic factors such as age, education, and experience of using technology, as well as Social Influence.

Human capital theory focuses on the role of knowledge, skills and education in economic development, as well as adaptability to technology and its impact on the use and performance of entrepreneurial activities. In the context of entrepreneurs' use of mobile technologies, human capital theory can help assess how trained and skilled employees contribute to the successful adoption and use of new technologies.

The technological progress theory studies technological change's impact on economic growth and production structure. In assessing the use of mobile technology in entrepreneurship in Latvia, the theory of technological progress helps to understand how new technology changes business models and the competitive advantages of enterprises.

Lee and Larsen (2016), having investigated the impact of mobile technology on productivity and innovation in the workplace, determined how mobile technology affects ways of working in the office and remote workplaces, how the use of mobile devices and applications affects the productivity of workers and organizations as a whole, how mobile technology contributes to workplace innovation including improved communication, collaboration, and access to information. The article also discusses the challenges of adopting mobile technology in the workplace and potential opportunities to improve business processes and achieve competitive advantage. The authors determined that mobile technology provides flexibility and mobility, allowing workers to perform tasks from anywhere and at any time; remote working becomes more common and mobile devices play a crucial role in keeping remote workers connected to the office; mobile technology makes it easier to access work information and tools, which results in more efficient and flexible working process; mobile devices allow workers to respond quickly to requests and tasks, which can increase productivity; mobile applications provide real-time access to tools and data, which speeds up decision-making and task completion. Organizations that actively use mobile technology can benefit from increased productivity and competitiveness. Mobile technology has also improved employee communication and collaboration, which can encourage ideas and innovation. In contrast, mobile device access to information and tools allows employees to quickly and easily share ideas and find new solutions. Innovation in mobile applications and technology can lead to new ways of working and business models, contributing to the growth and development of an organization.

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Haldar et al. (2023) argue that Internet usage and technological innovation promote economic growth. Using data from 16 developing economies from 2000 to 2018, the authors investigated the impact of ICT, innovation, electricity consumption, and renewable energy generation on the economic growth of developing economies. It is established that ICT not only monotonically increases economic growth but also increases the efficiency of financial development through growth.

The economic growth theory examines the factors that contribute to long-term economic growth. Mobile technologies affect entrepreneurship in the context of their contribution to productivity, innovation, and economic competitiveness. Mobile devices are used on the Internet to expand the dissemination of knowledge, which is in line with neoclassical models of economic growth regarding sources of innovation (Kwan & Chiu, 2015). The creation and dissemination of knowledge complement each other in innovative production (Kwan & Chiu, 2015). Rehman and Nunziante (2023) stated that the digital economy positively and significantly impacts total factor productivity in European regions. Public policy should support investment in digital infrastructure and increase digital literacy in lagging regions of Europe.

Exploring the impact of the theory of institutional change on the use of mobile technology in entrepreneurship is also an essential area for research. The institutional change theory analyses institutions and rules' role in economic development. In the context of mobile technology use in entrepreneurship, it may be important to research such institutional factors as legal and regulatory frameworks, intellectual property protection, and access to finance. Brown and Magill (2019) investigated the influence of institutional and organizational factors on small businesses' adoption of digital marketing. The authors found that such institutional factors as legal regulations, cultural values, and consumer expectations have a significant impact on the decision made by small businesses to adopt digital marketing. For example, an appropriate legal and regulatory environment can encourage or inhibit digital marketing development in small businesses. It was determined that organizational characteristics such as enterprise size, access to resources, and enterprise culture significantly influence digital marketing adoption. For example, small businesses with limited resources or lacking the understanding of the value of digital marketing can face great difficulty implementing it. The authors emphasize the need for small businesses to adapt to the rapidly changing digital environment and actively learn new digital skills. They highlight the importance of creating a supportive environment that encourages learning and competence development in digital marketing. The article thus highlights the complexity of small businesses' digital marketing adoption process. It shows that the successful adoption of digital strategies requires consideration of institutional and organizational factors as well as continuous learning and adaptation.

The Internet has enabled new digital business models for selling products and/or services such as subscription, on-demand, partnerships, direct delivery, consulting, advertising, blogging, etc., as well as new venture capital opportunities in the field of Internet technology (Antonizzi & Smuts, 2020).

The continuing research on the contribution of various factors influencing the use of mobile technology in entrepreneurship in a digitized economy cannot be overestimated (Ling et al., 2024; Fadhil-Ondoy et al., 2024).

To achieve the research goal, the authors surveyed Latvian entrepreneurs in May – June 2023. A total of 252 entrepreneurs were surveyed. The survey was conducted in the primary languages of communication in the regions: Latvian and Russian. The planned sampling design is as follows: the sampling method is combined, the method is non-repeated, and the sampling method is stratified based on the main research directions. To conduct the survey, the method of interviewing was applied, as well as telephone interviews and a questionnaire available for completion on the Internet. The authors applied the following methods for data processing: frequency analysis, correlation analysis, and factor analysis.

The largest number of enterprises under survey are engaged in agriculture, accounting for 16.7%, followed by 13.1% involved in wholesale and retail trade; automotive and motorcycle repair; 8.3% in the arts, entertainment, and recreation sector; 7.1% in education; and another 7.1% in accommodation and catering services. The survey covered all types of entrepreneurial activity in Latvia.

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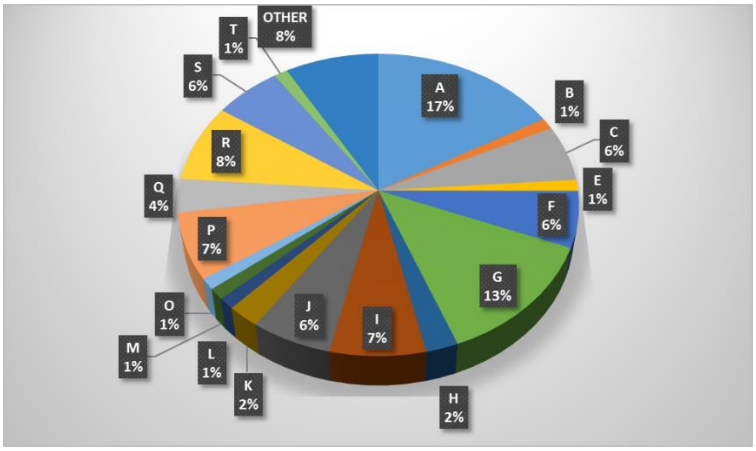


Figure 1. Types of activities of the enterprises under survey.
Source: authors' calculations based on survey data

Note: (A) Agriculture, forestry, fish industry, (B) Mining industry and quarrying, (C) Manufacturing industry, (D) Electric energy, gas industry, heat supply and air conditioning, (E) Water supply; upkeep and rehabilitation of wastewater and waste, (F) Construction, (G) Wholesaling and retailing; automobile and motorbikes repair, (H) Transport and storage, (I) Accommodation and catering services(hotels, etc.), (J) Information and communication services, (K) Finance and insurance activity, (L) Real estate, (M) Professional, scientific and technical services, (N) Administration and servicing offices, (O) Public administration and security; mandatory social insurance, (P) Education, (Q) Health and social care, (R) Arts, entertainment, and recreation, (S) Other services, (T) Household activities as employers; production of goods for own use and provision of services in individual households.

The authors found that among the enterprises under survey, 29.8% have been operating for 1-5 years, 22.6% have been operating for less than 1 year, 20.2% have been in operation for more than 20 years, 14.3% have been operating for 6 - 10 years, and 13.1% have been in business for 11 - 20 years. Among the surveyed enterprises, 54.8% have fewer than 10 employees, 26.2% have 10 – 49 employees, 9.5% have 50 - 249 employees, and 9.5% have more than 250 employees.

The median annual turnover of the enterprises under survey is 17,500 euros, and the mean annual turnover is 1,700,742 euros. In the past year, the revenue of the enterprises under the survey changed as follows: 46.4% experienced a decrease, 31% remained unchanged, and 22.6% saw an increase. The change in the profitability of the enterprises under the survey is as follows: 40.5% experienced a decrease, 36.9% remained unchanged, and 22.7% saw an increase. The change in the volume of products sold and services provided by the enterprises under the survey is as follows: 22.1% experienced a decrease, 32.1% remained unchanged, and 35.7% saw an increase. The change in the volume of exported products/services is as follows: 29.8% experienced a decrease, 45.2% remained unchanged, and 25% saw an increase. The change in market share for the enterprises under the survey is as follows: 36.9% experienced a decrease, 39.3% remained unchanged, and 23.9% saw an increase.

3. Results and discussion

91.7% of respondents use email for conducting business from mobile devices. 82.1% of entrepreneurs use the ability to purchase (order, pay, select delivery options) goods and services through mobile devices, and 84.5% have and use a mobile version of their website. Payments for bills from mobile phones are made by 86.9% of entrepreneurs. Most entrepreneurs, specifically 91.7%, use messaging groups to solve business tasks, and 86.9% use SMS marketing. Therefore, the methods described for using mobile technologies are among the most popular among entrepreneurs.

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Table1. Use of mobile technologies and devices (smartphones, tablets, etc.) in business in the context of digitization in the last few years (%).

	never	rarely	medium	often	always
Mobile access to e-mail	8.3	25	17.9	10.7	38.1
Mobile version of the website	15.5	17.9	19	19	28.6
Messenger groups for solving business tasks	8.3	26.2	19.1	20.2	26.2
SMS marketing	13.1	21.4	22.7	19	23.8
Mobile access to company resources (databases, etc.)	13.1	25	14.3	23.8	23.8
Company has developed its own mobile applications	31	22.6	16.6	17.9	11.9
Advertising targeted for use on mobile devices	23.8	19	23.8	17.9	15.5
Mobile devices for managing production processes	17.9	27.4	20.1	17.9	16.7
Payments of a company bills from a mobile phone	13.1	17.9	23.7	16.7	28.6
Equipment of a company transport system with location data transmission systems	16.7	21.4	17.8	26.2	17.9
Own mobile application	26.2	21.4	19	16.7	16.7
Augmented reality technologies	38.1	13.1	20.3	20.2	8.3
Possibility to purchase (order, pay, choose a delivery method) your products or services through mobile	17.9	14.3	25	10.7	32.1

Source: authors' calculations based on survey data

29.8% of entrepreneurs consider the availability of IT infrastructure to be a factor that strongly or very strongly influences the development of the mobile economy. 27.3% of entrepreneurs believe that the level and quality of IT infrastructure strongly or very strongly influence the use of mobile devices. It has been established that, according to entrepreneurs, the most significant impact on the development of the mobile economy in Latvia is attributed to the consequences of EU sanctions related to the military actions in Ukraine: 25% of entrepreneurs assess the impact of this factor as strong or very strong. For 23.8% of entrepreneurs, the direct military actions taking place in Ukraine have a similar level of impact. According to 26.2% of entrepreneurs, the level of digital literacy among the population has a strong or very strong influence on the development of the mobile economy in Latvia. A total of 25% of entrepreneurs believe that the ability to adapt to new conditions of corporate structures and the restructuring of business models and management paradigms for new conditions (21.4%) are strong or very strong factors in the development of the mobile economy. The quality and quantity of IT specialists also have a strong or very strong influence on the development of Latvia's mobile economy, according to 25% and 21.3% of entrepreneurs, respectively. Only 14.3% of the respondents believe that public awareness has a strong influence on the development of the mobile economy.

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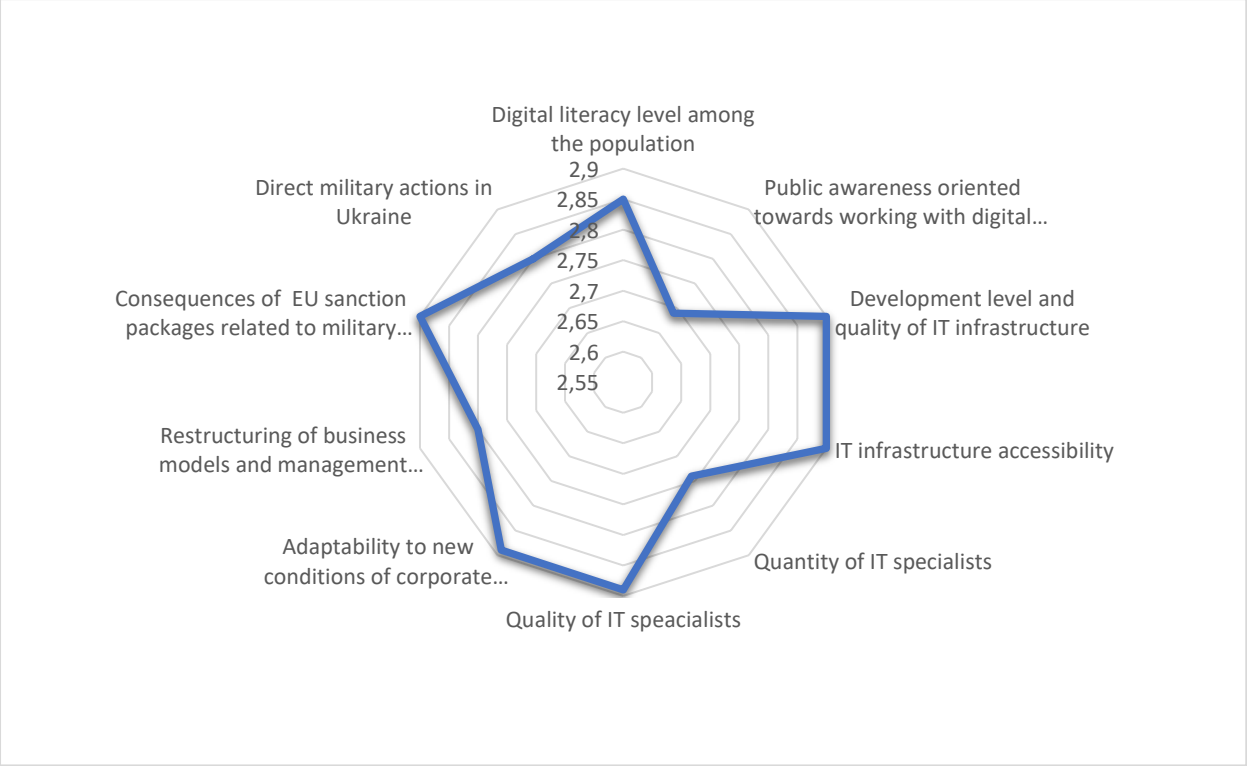


Figure 2. Types of activities of the enterprises under survey. Factors contributing to the development and use of the mobile economy in Latvia
Source: authors' calculations based on survey data

According to the averaged values of the degree of influence of factors contributing to the development of the mobile economy in Latvia, it has been established the following: the factors that have the greatest impact on the mobile economy development in Latvia are the level of development and quality of IT infrastructure, its accessibility, the quality of IT specialists, adaptability to new conditions of corporate structures, and the consequences of EU sanction packages related to military actions in Ukraine. According to entrepreneurs, factors such as public awareness oriented towards working with digital assets rather than physical ones, the quantity of IT specialists, the restructuring of business models and management paradigms for new conditions, and the direct military actions in Ukraine have a much lesser influence on the mobile economy development.

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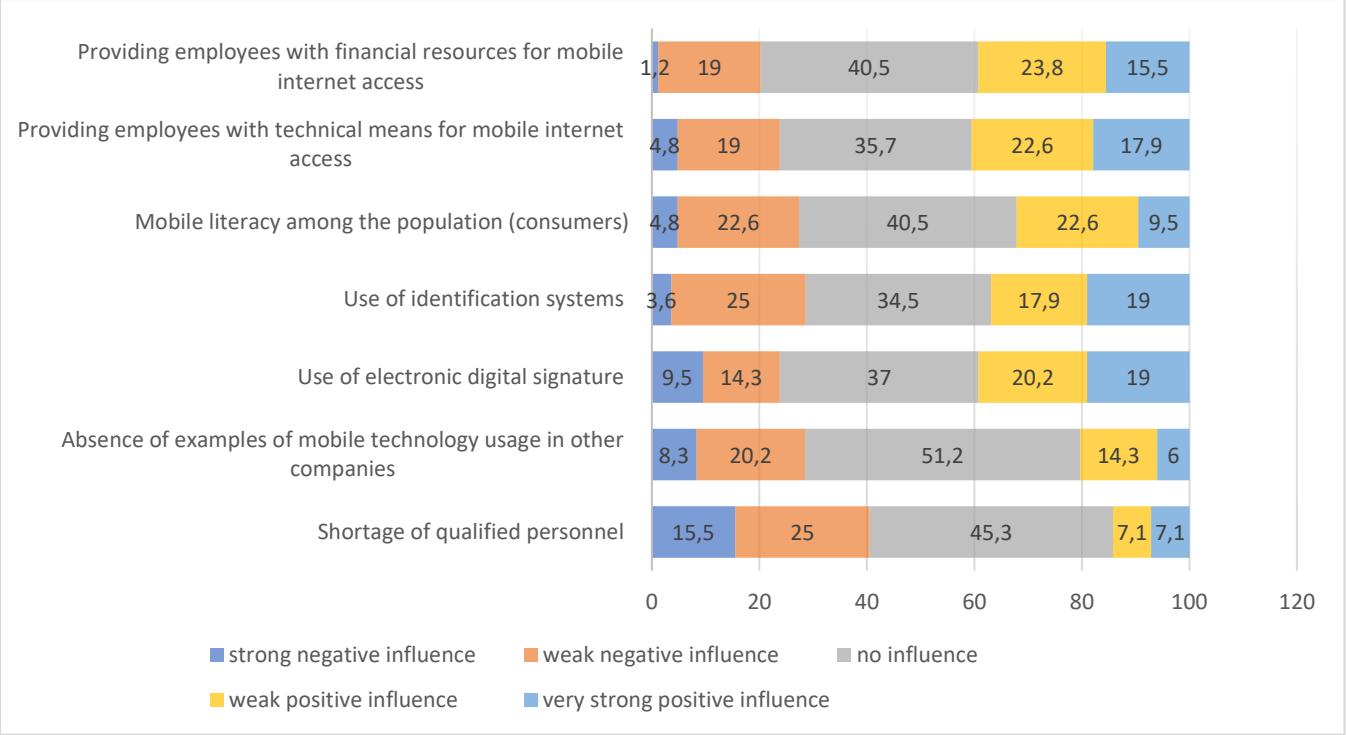


Figure 3. Factors influencing the intensity of mobile technology implementation at surveyed enterprises in the context of digitization in recent years
Source: authors' calculations based on survey data

When assessing the factors influencing the intensity of mobile technology implementation at enterprises in the context of digitization in recent years, it has been found that 19% of respondents believe that the use of identification systems and electronic digital signatures has a very strong influence on the development of mobile technologies; 17.9% consider providing employees with technical means for mobile internet access to be a significant factor; 15.5% of the respondents agree that providing employees with financial resources for mobile internet access contributes to the development of mobile technologies. Certainly, the level of mobile literacy among the population (consumers) has a certain influence according to 9.5% of respondents. However, the most significant negative impact is the shortage of qualified personnel (15.5%) (see Fig.3).

According to the survey results, it has been established that in recent years 53.2% of specialists in mobile platforms, 52.4% of top-level executives, as well as 50% of professionals with various qualifications in the business sector have started using mobile technologies and devices more frequently (see Fig.4).

The usage of mobile technologies has remained the same for 50% of remote monitoring specialists, 56.6% of mobile application developers and testers, and 57% of copywriters. This is likely because these specialists have always been using mobile technologies very intensively. At the same time, 15.8% of web designers, 12.7% of copywriters, 10.7% of accountants, and 10.8% of mobile application security specialists have reduced their usage of mobile technologies.

However, the larger the enterprise is in terms of the number of employees, the more likely it is that senior executives, professionals of various qualifications in the business sector, mid-level and lower-level managers, financial department specialists, IT specialists (all types), specifically, mobile application developers and testers, mobile platform specialists, back-office support specialists for mobile applications, and remote monitoring specialists have increased their usage of mobile technologies in recent years.

Certainly, at larger enterprises with more employees, the usage of mobile technologies tends to be higher among senior executives (Spearman coefficient 0.193, p-value=0.002), professionals of various qualifications in the business sector (Spearman coefficient 0.183, p-value=0.003), mid-level and lower-level managers (Spearman

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coefficient 0.275, p-value=0.000), financial department specialists (Spearman coefficient 0.262, p-value=0.000), IT specialists (all types) (Spearman coefficient 0.262, p-value=0.000), mobile application developers and testers (Spearman coefficient 0.216, p-value=0.001), mobile platform specialists (Spearman coefficient 0.212, p-value=0.001), back-office support specialists for mobile applications (Spearman coefficient 0.159, p-value=0.018), and remote monitoring specialists (Spearman coefficient 0.181, p-value=0.006).

The annual turnover only correlates with changes in the intensity of mobile technology usage among senior executives (Spearman coefficient 0.209, p-value=0.001), professionals of various qualifications in the business sector (Spearman coefficient 0.209, p-value=0.001), financial department specialists (Spearman coefficient 0.168, p-value=0.000), and equipment maintenance specialists (Spearman coefficient -0.143, p-value=0.028). Therefore, the number of employees is indeed a factor that promotes the usage of mobile technologies.

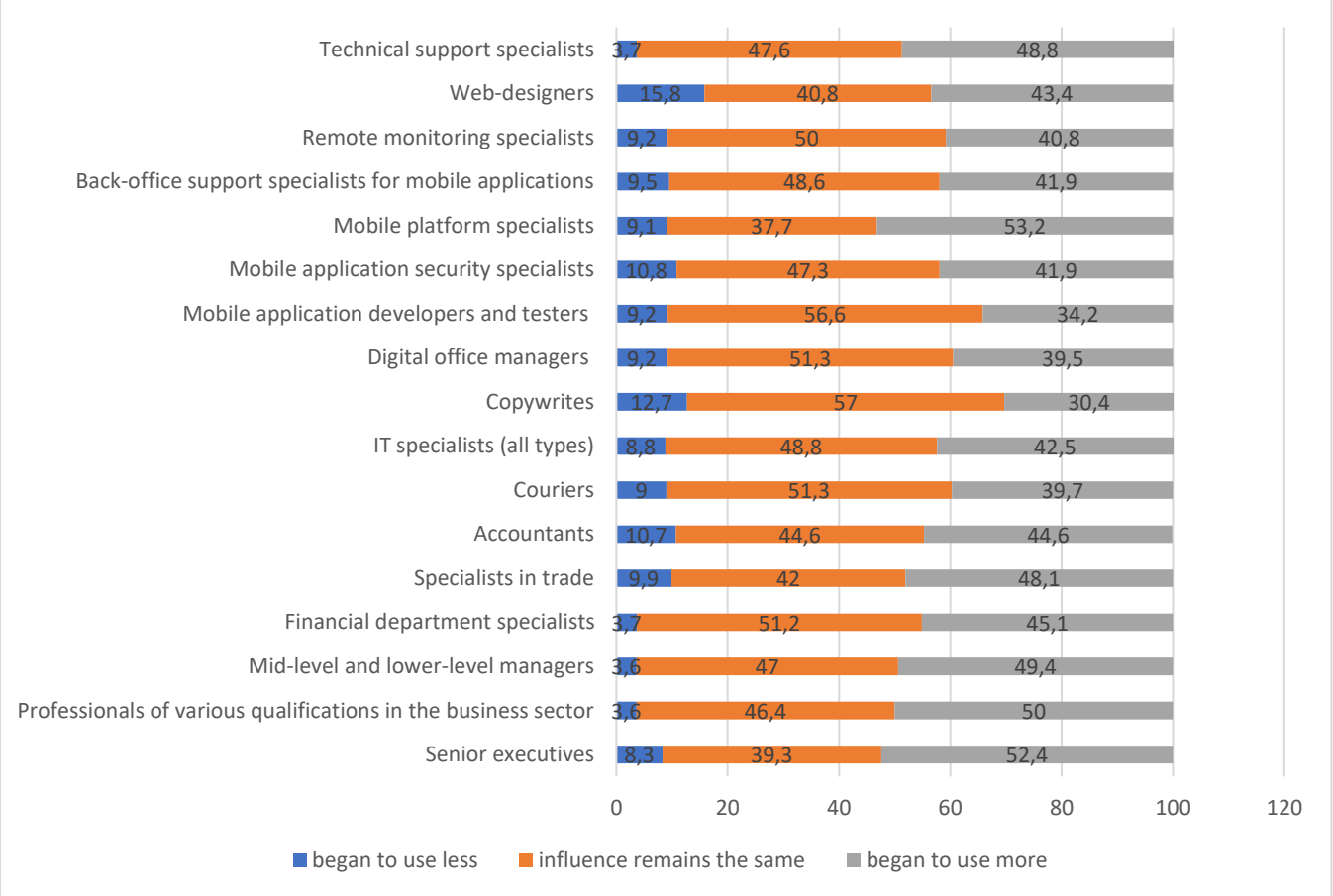


Figure 4. Has the usage of mobile technologies by employees changed in the context of digitization in recent years?
Source: authors' calculations based on survey data

The authors have also determined a positive linear relationship between the annual turnover of the enterprise and certain factors influencing the use of mobile technologies. The larger the turnover of the enterprise is, the more companies tend to experience a shortage of qualified personnel (Spearman coefficient 0.199, p-value=0.002) and the lack of examples of mobile technology usage at other companies (Spearman coefficient 0.278, p-value=0.000). The larger the annual turnover is, the more often electronic digital signatures (Spearman coefficient 0.350, p-value=0.000) and identification systems (Spearman coefficient 0.140, p-value=0.031) are used, as well as the provision of technical means for mobile internet access (Spearman coefficient 0.225, p-value=0.000) and financial resources for mobile internet access (Spearman coefficient 0.255, p-value=0.000).

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Conclusions

The level and quality of informative and technological infrastructure in Latvia are important factors that show a positive impact on the development of the digital economy, since the country attempts to develop digitalization and make acceptable conditions in the IT sector.

The availability of IT infrastructure plays a key role, especially in terms of making access to the Internet and digital services available for a wide range of citizens. Qualification of IT specialists has an important role for the development of the digital economy in Latvia, since highly qualified specialists can stimulate the growth of innovation in the IT sector. The higher use of digital technologies among the entrepreneurs in the country, especially in the age of digitalization, adds to the accessibility of digital signatures, the availability of the technologies to access the Internet for the employers and employees and the availability of financial resources for the use of mobile Internet. The flexibility of corporate structures is also an important aspect, in order to quickly develop technology and to notice the changes on the market. The consequences of the sanctions made by the EU, due to the military actions taking place in Ukraine, have a limited impact on the digital economics of the country, yet it is important to mark the possible consequences for the economic stability and investment.

The level of digital literacy among the citizens is an important aspect, especially if we analyze it in the context of development of small and average enterprises in the country, since it showcases the ability to use digital technologies efficiently in their daily and work life. Higher digital literacy can lead to development of digital services and technology, which can lead to development of the digital economy. On the other hand, the deficit of qualified specialists can become a big disadvantage in terms of bringing technology into different economic sectors. Deficit of qualified specialists can slow down the digitalization and the growth of the digital economy. The quantity of employees in the enterprise is also a factor that needs to be looked into in terms of the use of digital technologies. In small and average enterprises, where they usually lack the quantity of employees, the integration of digital technologies can happen smoother and faster, which leads to the growth and effectiveness of the enterprise. The work that can be done in between small and average enterprises about the importance and advantages of the use of digital technologies can lead to active integration of these technologies in the workspace, which can help with the development of the digital economy in Latvia.

From the findings provided, it is evident that various factors influence the development of mobile economy and the use of mobile technology in entrepreneurship in a digitized economy. In the authors' opinion, innovation theory, human capital theory and theory of institutional change best explain these findings. Innovation theory explains the process of introduction and adoption of new technologies in society and business. In the context of this case study, it explains how such factors as the quality of IT infrastructure, availability of IT professionals, and adaptability to new enterprise environments can encourage or inhibit the adoption of mobile technologies at enterprises. Human capital theory focuses on the role of education, training, and employee competencies in the development and use of technology. In this context, employee skills and mobile literacy have an impact on the effective use of mobile technology at enterprises. The theory of institutional change helps to understand how laws and other institutional factors shape the context for the use of technology in business.

Therefore, based on the aspects studied in the research, innovation theory probably has a greater influence on the use of mobile technologies in entrepreneurship under the digitization of the Latvian economy, as it takes into account the process of adopting new technologies and the factors facilitating or hindering this process. However, human capital theory and institutional change theory also play an important role as they take into account resources and context required for successful adoption and use of mobile technologies.

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IMPACT OF FOREIGN CAPITAL INFLOWS ON THE ECONOMY OF A HOST COUNTRY THROUGH LENSES OF EMPLOYMENT

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Abstract. The expansion of multinational corporations has a significant impact on such small economies as Lithuania. While structural changes in the economy indicate the shifts in the sectoral composition of employment and production, the transfer from labour-intensive to knowledge-intensive sectors substantially contributes to the economy's growth and, therefore, its economic security. The paper aims to determine the impact of the expansion of Nordic capital companies in different sectors on sectorial employment in Lithuania. The study aims to fill this gap by conducting an empirical analysis to investigate patterns and interactions between MNC expansion and employment. The research applied correlation, the Augmented Dickey–Fuller and Granger causality tests. Further, to evaluate the impact of sectorial FDI on sectorial employment, we have applied the Clark-Fisher three-sector model by classifying sectors into primary, secondary, and tertiary. A particular emphasis was placed on the need to evaluate the effect of the expansion of MNCs in different sectors from the single country on the host economy's sectorial employment. Thus, inward sectorial FDI might have a distinct impact on sectorial employment. Our findings prove that the expansion of Norwegian capital companies in the secondary sector affects employment in the secondary sector. Meanwhile, secondary sector employment affects Danish capital companies' expansion in the secondary sector. Our study integrates the Clarks-Fisher model of structural changes and internationalization theory, which extends and fills the gap in the interaction between these two theories.

Keywords: Lithuania; Nordic countries; multinational corporations (MNCs); foreign capital; FDI; sectorial employment; structural changes; Lithuania

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JEL Classifications: O1, O15, O19

1. Introduction

The movement of foreign capital has become a driving force for economic development worldwide. Previous studies focussed on the performance of FDI-related firms and the impact of foreign capital on economic growth (Morales & Moreno, 2020). Little research addresses the relationship between foreign capital companies' expansion (movement) in different economic sectors and employment. The number and size of foreign capital companies may significantly impact the employment structure. Some studies have not found a causal relationship between unemployment and FDI in certain European countries, including Lithuania. The spillover effects of FDI have traditionally been seen as a key contributor to the economic development of host countries. The impact of foreign capital on the decrease of unemployment may not always be straightforward, as evidenced by studies showing weak correlations between FDI and decreasing unemployment rates (Vasa & Angeloska,

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2020). The movement of foreign capital and expansion of MNCs abroad is often linked with job creation, which increases labour utilization by opening new businesses and sectors in the host country. MNCs impact various business areas, including structural economic changes. Studies have shown that FDI as the form of the MNC expansion can transfer workers from primary and informal sectors to more modern sectors like manufacturing and services, thereby affecting employment patterns (Habanabakize & Mncayi, 2022). China's foreign capital companies have constantly increased since the 1990s. In addition, it has been found to influence employment in the manufacturing sector, indicating the role of foreign firms in shaping employment dynamics (Karlsson et al., 2009). MNCs in sectors like mining can impact employment through factors such as capacity utilization, labour, and sectorial contributions to GDP (Gochero, 2018). Sectoral analysis MNCs in countries like China and Vietnam has shown varying impacts on different sectors, with some sectors benefiting more from foreign capital in growth and employment (Vu et al., 2008). In regions like Beijing, the coupling mechanism between the volume of foreign capital and an employment structure has been studied, revealing that expanding the number of MNCs can promote employment in certain sectors like services in the long run while showing negative spillover effects in the short term (Liu & Lee, 2020). Understanding the relationship between foreign capital and sectorial employment can provide valuable insights into the mechanisms by which global capital flows affect local economies. For example, the Organisation for Economic Cooperation and Development (OECD) and the International Monetary Fund (IMF) regularly conduct research and analysis on FDI, the labour market, international trade, and economic development issues (OECD, 2022). Both the OECD (2022) and the IMF (2020) generally acknowledge the positive contribution of foreign capital to job creation and economic growth. It is often pointed out that FDI can contribute to more active economic activity and, thus, higher employment levels. International organizations recognize that the impact of foreign capital flows on labour use can vary from region to region. Additionally, the volume of foreign capital, number, size, and age of companies matter. The concentration of MNCs in some regions can create many jobs and widen regional employment-level disparities. Furthermore, the OECD and IMF acknowledge that foreign direct investment can contribute to transferring knowledge and technology. Such relocation can increase the productivity and efficiency of the local workforce, which can affect the skills set up in the labour market. The OECD also recognizes potential challenges of expanding companies to the host country, such as the risk of redundancies due to technological developments and the importance of countering negative externalities to ensure a sustainable impact on the labour market. The OECD (2022) has often stressed the importance of flexibility in the labour market. Foreign capital companies can also contribute to increasing labour market dynamism and resilience by fostering competition and adapting to changing economic conditions. The OECD (2022) and the IMF (2020) often recommend that countries maximize the benefits of attracting labour use. This may include creating a business-friendly environment, investing in education and skills development, and ensuring inclusive growth through labour market policies. The paper aims to determine the impact of the expansion of Nordic capital companies in different sectors on sectorial employment in Lithuania. The paper briefly overviews the importance of foreign capital in the global economy. It presents the main topic of the study – the relationship between sectorial FDI and sectorial employment. The paper consists of several parts. An empirical research plan and research results follow a literature review. Finally, we will present concluding remarks and other areas of research.

2. Literature review

2.1. The impact of FDI on the structure of employment

Structural changes in employment drive economic development and growth, which conditions economic security in longer terms. These changes involve the transformative processes that occur alongside economic expansion, including shifts in the sectoral distribution of production and employment, organization of industries, income distribution, and demographic changes (Olczyk & Kordalska, 2018; Bello, 2021; Androniceanu et al., 2021). The theory of structural changes goes back to 1935–1940 when Clark and Fisher improved the Lewis model of structural changes by stating that economic progress would stimulate the expansion of the service sector. Thus, structural changes in the economy stimulate the contribution of different sectors to growth, employment, and productivity (Aggarwal, 2018). Foreign capital impacts various sectors, including the primary sector, influencing economic development and employment. Research indicates that FDI in the primary sector can lead to technological advancements, potentially causing shifts in employment due to automation and increased efficiency (Bogliaccini & Egan, 2017). Moreover, FDI in the primary sector has been found to significantly affect net emigration significantly, indicating its influence on migration patterns (Sanderson &

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Kentor, 2009). Studies focusing on specific regions, such as Ethiopia, have investigated structural changes from an employment perspective, providing insights into the speed and nature of these changes within the labour market (Martins, 2014). Structural changes in employment are dynamic and can be influenced by various factors, such as business cycles, which can either speed up or slow down structural changes depending on economic conditions (Storesletten et al., 2019). Meanwhile, the transformation in sectoral employment contributes to changes in labour productivity and convergence within economies. Furthermore, structural changes in employment have been explored in the context of formal sector growth in countries like Indonesia, where the shift from informal to formal employment has substantially impacted economic development (Naticchioni et al., 2008). In sub-Saharan African countries, studies on employment growth have underscored the importance of structural changes and demographic transitions in shaping labour market dynamics (Herrero, 2021). Additionally, research on gender employment equality in the UK has delved into the influence of individual worker characteristics and the structural changes in the industry on advancements towards employment equality (Adegboye & Ighodaro, 2021). Thus, the structural changes in employment significantly influence economic landscapes and labour market dynamics. The movement of foreign capital is understood as one of the most significant means to promote structural economic changes in developing countries since it has the impact of reducing poverty and solving the problem of resource scarcity (Hauge, 2019). Additionally, expanding many MNCs into a particular host country can bring about substantial structural changes within economies. Recent trends indicate a shift in the destination of FDI and an increased involvement of developing economies in FDI, which are key developments contributing to structural transformations. The impact of foreign capital on structural change varies depending on the region and type of economy. While the investment of MNCs has led to notable structural changes in new EU Member States, its effects have been less pronounced in Balkan countries (Estrin & Uvalic, 2014). Studies have also emphasized the role of FDI in driving agricultural economic growth and its implications for socio-economic development in emerging nations. Furthermore, the expansion of MNCs has been linked to positive outcomes in labour markets, influencing employment rates and average net wages (Perić & Stanisic, 2020). The relationship between the attracted number of large MNCs and structural changes in economies is intricate and multifaceted. Foreign capital companies can indirectly spur technological advancements, foster economic growth, and facilitate sectoral transformations (Kannen, 2020; Bergougui & Murshed, 2023). Promotion and attracting foreign capital companies are often associated with enhancements in infrastructure, institutional reforms, and energy consumption, all of which contribute to structural changes within economies (Zeng et al., 2020; Tsheola et al., 2023; Yalçınkaya, 2024). Structural economic changes mean transforming from labour-intensive to knowledge-intensive sectors, encouraging economic growth (Thirión, 2020). Even many foreign small and medium-sized enterprises (SMEs) might result in structural changes in the economy by assisting host countries in receiving investments for expanding market opportunities, increasing tax revenue flows, accumulating capital, and creating new jobs. It is emphasized that the expansion of foreign capital companies, especially MNCs, influences structural changes in the economy by developing production capacity through creating greater competition for domestic companies, innovations, knowledge and technology transfer, even moving the labour force to the greater productivity sectors (Emako et al., 2022). In such circumstances, MNCs can encourage labour re-allocation within business sectors. Thus, it might be noted (Elekes et al., 2019) that increasing the number of foreign SMEs and MNCs capital companies promotes more intensive competition and forcing domestic companies to innovate, can have an indirect effect on the host economy and structural changes in it, since, depending on the stage of economic development, countries attract foreign capital companies to the different economic sectors. Thus, the scope of analysis on the influence of the expansion of MNCs in different sectors on economic growth has been constantly increasing. A study by Tanaka (2017) investigates the impact of the expansion of foreign capital companies on temporary workers in Japan. It finds that initiating foreign capital among Japanese manufacturers increased the share of temporary workers in total wages and employment. This suggests that many MNCs can have implications for the composition of the workforce in terms of temporary and permanent employment. The expansion of MNCs in the host countries impacts the prices of final goods and investments (Ni et al., 2022). A country's labour force is a significant factor in determining higher foreign capital flows. Thus, the importance of education in the context of investment attraction becomes evident. According to Shahbaz et al. (2021), an educated and highly qualified labour force increases the country’s investment attractiveness towards foreign investors due to the opportunities to find employees with the necessary qualifications, ensuring higher work productivity and efficiency. For example, a high unemployment rate and a low average wage can be among the factors that attract investment, as investors associate it with an abundance of potential workers and lower operating costs,

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respectively (Anderson et al. 2019). It was observed that there is an inverse relationship between the unemployment rate and foreign direct investment, which is based on the idea that a decrease in the unemployment rate is associated with higher wages; therefore, due to the improvement of labour market conditions, more jobs are created for skilled labour, and these factors, from the point of view of the authors of the article, attract a greater number of foreign capital companies (Gawrysiak et al., 2019). Given that foreign investment in different sectors results in the redistribution of medium- and low-skilled labour to more productive sectors, the expansion of foreign capital companies in employment may differ in individual economic sectors (Mühlen & Escobar, 2020). The entry of foreign companies into the market can affect union membership, bargaining power, and employment patterns. An increasing number of attracted MNCs or foreign capital medium-size companies typically contributes to urbanization and attracts mobile workers to urban areas where the industry is booming (Li et al., 2020). This phenomenon changes the demographic structure of urban centres and affects residential and commercial purposes (Hudala et al., 2020). Large MNCs affect different sectors of the economy because the structure of employment varies from sector to sector. For example, a study in the Czech Republic highlighted the effects of territorially concentrated foreign capital companies on local labour market outcomes (Dinga & Münich, 2010). Similarly, research in Italy has demonstrated that FDI is linked to accelerated local employment growth compared to the national industry average (Federico & Minerva, 2007). Moreover, investigations in Serbia have sought to estimate the influence of foreign capital inflows on average wage and employment, emphasizing the connection between FDI and labour market dynamics (Perić, 2019; Perić & Filipovic, 2021; Perovic et al., 2021). The relationship between FDI and employment structure is intricate and can vary based on factors like industry composition and regional characteristics. While some studies suggest that attracting foreign capital companies, especially MNCs, might lead to increased employment rates, others have found that FDI may decrease median weekly wages (Kim, 2020). Additionally, the impact of attracting large MNCs on employment growth can be influenced by factors such as labour market regulations and the skill intensity of sectors (Bellak & Leibrecht, 2009). Meanwhile, the inward flow of FDI may play a pivotal role in the emergence and advancement of high-tech industries, leading to technological improvements (Czaller & Lőcsei, 2018). This demonstrates how foreign capital companies can drive changes in sectoral employment by fostering the growth of specific industries through investments in technology and innovation. Moreover, the sectoral analysis of FDI by the source country can provide valuable insights into the diverse effects of FDI on different sectors of the economy. Research focusing on the divestment of Spanish FDI in Morocco underscored the importance of examining FDI impacts at a sectoral level to understand the varied consequences across industries better (Soussane et al., 2022). By delving into sector-specific implications, policymakers and stakeholders can better understand how many foreign capital companies influence employment dynamics within different sectors.

2.2. Collaboration between Nordic Countries and Lithuania

The Nordic countries have historically maintained economic ties with the Baltic Sea region. This relationship has led to Nordic investments being significant in the inward Western flow of FDI into the former Soviet area of the Baltic Sea. Moreover, Nordic companies rapidly expanded into the Baltic States and the St Petersburg area of Russia (Johansen et al., 2000). The interest in the interlinkages between attracted foreign capital and the economic growth of the Baltic States has been growing since the collapse of the Soviet Union. FDI analysis has led to the conclusion that cumulative inflows of FDI had a positive and significant effect on the economic growth in the Baltic States (Tvaronavičienė & Grybaitė, 2007).

The tendencies of expansion of Nordic companies in Lithuania, Latvia, and Estonia, as well as outward FDI from the three Baltic States, reveal similarities and differences between these neighbouring countries. Various factors, including the economic ties with the Nordic nations, influence the patterns of FDI in the Baltic States. The impact of inward Nordic FDI on the structural changes in the Lithuanian economy has been a recent subject of interest (Tvaronavičienė et al., 2023). The Baltic States, including Lithuania, have attracted large amounts of Nordic FDI, and some studies have been carried out to acknowledge the implications of this investment on the economies of these countries (Hlaváček & Bal-Domańska, 2016). The other recent study based on primary data proved that attracted Nordic capital companies have less impact on innovations in the secondary sector in Lithuania. However, it has an extremely high impact on employment in the financial industry. Swedish capital companies made the most significant impact on the financial sector.

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Meanwhile, Estonia primarily benefited from the Finnish capital. However, it was found that in Estonia, Nordic capital companies do not significantly impact wages. Nevertheless, the inward FDI had a substantial impact on the productivity of firms (Šimelytė & Tvaronavičienė, 2022). Furthermore, another study based on firm-level data proved that Nordic SMEs and MNCs positively increase productivity due to knowledge spillover. Hence, The vulnerability of the Baltics when dealing with the Nordics, particularly Sweden, during the 2008/9 crisis has also been highlighted (Hilmarsson, 2021). Classical foreign capital models suggest that foreign capital flows from more affluent to poorer countries, and only poorer countries may benefit. Thus, it is unsurprising that the Baltic States attract more FDI from a more prosperous region, such as the Nordic countries, although the countries of both areas are defined as high-income countries. Burinskas et al. (2021) found that Nordic capital companies treat the Baltic States similarly. In conclusion, Nordic companies have had a notable effect on the economies of the Baltic countries, including Lithuania. The positive impact of FDI on economic growth and productivity spillover has been observed, and the historical and economic ties between the Nordic and Baltic countries have further strengthened the relationship, extending to such areas as defence cooperation.

3. Methodology

The fact that foreign capital is considered one of the drivers for economic structural changes might impact the relocation of labour from low-tech to high-tech, from manufacturing to service sectors. FDI has been chosen as a variable defining foreign capital. Thus, FDI leads to structural changes in the economy by raising new capital, creating jobs, increasing tax revenue flows, generating greater GDP and promoting exports in different sectors (Tvaronavičienė et al., 2023). We have chosen to analyze how inward Nordic FDI in various economic sectors influences employment in Lithuania. The Nordic countries cover the areas of Iceland, Denmark, Finland, Sweden, and Norway. We used sectorial data from 1999 to 2022 from the State Data Agency of Lithuania. Our research is based on the Clark-Fisher three-sector model. The sectoral data have been classified into the primary, secondary, and tertiary sectors. The primary sector involves business activities in the earliest stages of the production cycle, such as agriculture, forestry, fisheries, mining, and quarrying.

The secondary sector refers to the companies that produce goods from natural resources, and the tertiary sector includes various services and trade. Data collection and classification are based on the NACE standards. The research has been performed in three stages. First, an analysis of the performance of the Nordic companies has been conducted. We have then estimated the correlation between inward Nordic FDI and Lithuanian employment. For the detailed analysis, we have estimated the correlation between inward Nordic FDI in the secondary sector and Lithuanian employment in the secondary sector. The interlinkages between inward Nordic FDI in the tertiary sector and Lithuanian employment in the tertiary sector were also evaluated. We further performed the ADF test and the Granger causality test.

The Granger causality test is commonly applied to find the direction of causality between different economic variables (Chowdhury & Mavrotas, 2006). For instance, in the context of FDI, these tests have been employed to investigate the causal links between FDI and various economic factors such as inflation, government spending, unemployment, trade openness, economic growth, tourism, renewable energy investment, sustainability, etc. The results of these tests have revealed diverse causal relationships. Some studies have found unidirectional causality, such as from trade openness to FDI, while others have reported bidirectional causality, for example, between economic growth and FDI. Additionally, there are inconclusive findings where the causality between FDI and economic growth was not firmly established.

The Granger causality tests have been applied in various geographical contexts, including China, Central Europe, Turkey, North Africa, Canada, etc., indicating the widespread use of these tests in examining the FDI relationships across different regions. The application of the Granger causality tests has also extended to investigating the nexus between FDI and other variables, such as circular economy, pollution and waste management, and other sustainability issues. It is essential to point out that the choice of statistical techniques, such as the multivariate regression method and the Toda-Yamamoto causality test, has been crucial in these studies to identify associations and causal links between FDI and other economic indicators. Using panel data and vector error correction models has also allowed for a comprehensive analysis of the interlinkages between FDI and other financial variables in different countries and regions. Applying the Granger causality tests in the

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context of FDI has provided valuable insights into the causal relationships between FDI and various economic factors, contributing to a better understanding of the dynamics of FDI and its impact on economic variables in different settings. The Granger test (1969) shows whether the independent variable X causes dependent Y by testing how much the current dependent variable Y can be predicted by using the value of past dependent variable Y and the lagged values of independent variable X. Thus, the Granger causality between Y and X exists if past values of X allow to estimate current Y or if the coefficient of the lagged values of X is statistically significant. The causality might be in any direction or even both. According to the Granger test, two conditions should be fulfilled. First of all, X should make a statistically significant contribution to the prognosis of Y, and the second Y should not make a statistically significant contribution to the prediction of X.

The Granger test discloses a causal link between the allocation of FDI from Nordic countries across economic sectors and employment, considering the stationary nature of the time series of variables. To estimate Granger's causal link, we first examined whether the variables satisfy the assumption of stationarity. These tests are based on the belief that when the process is integrated, it has at least one unit root of the characteristic polynomial. The stationary test is carried out using a single root ADF test to ensure that the mean, variance, and covariance of the variables' time series remain constant. There are three variations of ADF.
With no constant and no trend:

$$\Delta Y_t = \gamma_1 Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \mu_i \quad (1)$$

With constant and no trend:

$$\Delta Y_t = \gamma_0 + \gamma_1 Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \mu_i \quad (2)$$

With constant and trend:

$$\Delta Y_t = \gamma_0 + \gamma_1 Y_{t-1} + \gamma_2 t + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \mu_i \quad (3)$$

Where μ_i is a pure noise error, $\Delta Y_t$is the first difference of the dependent variable, ΔY_{t-i} is the lagged difference form of the dependent variable. Additionally, it has been included in the equation as an explanatory variable for checking the autocorrelation. The ADF can be used when the errors are autocorrelated and homoscedastic.

After estimating the parameters of the equation, the null hypothesis is tested. The significance of the parameter is tested using the t-statistic, but in the case of a correct null hypothesis, the distribution of this statistic is not Student's, but the asymmetric Dickey-Fuller distribution.

The Granger theorem states causality exists if variables cointegrate with the error correction. To determine the direction of causality between sectorial FDI and sectorial employment, we have created the following equations:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \cdots + \alpha_p Y_{t-p} + \beta_1 X_{t-1} + \cdots + \beta_p X_{t-p} + \vartheta_{1,t} \quad (4)$$

$$X_t = a_o + a_1 X_{t-1} + \cdots + a_p X_{t-p} + B_1 Y_{t-1} + \cdots + B_p Y_{y-p} + v_{2,t} \quad (5)$$

Where $\alpha_1$to α_p and $a_1$to a_p are coefficients of the lagged dependent variable, and $\beta_1$to β_p and $B_1$to B_p are coefficients of the independent lagged variables.

The results of the Granger causal test are estimated in line with the Fischer criterion. If p value exceeds 0.05, the null hypothesis will be rejected, and the alternative hypothesis will be accepted. Meanwhile, if the p values of the F statistics are more significant than 0.05, the null hypothesis is rejected, meaning that one variable causes the other.

4. Research and results

Lithuania's average labour force between 1999 and 2023 comprised 1.533 million people. Out of this number, 26% were employed in the secondary sector, 8% in the primary sector and the rest in the tertiary sector, which made up 73%. Over this period, 2.6% of all companies operating in Lithuania were controlled by foreign capital. Moreover, 11.9% of all companies operating in the primary sector were controlled by foreign capital. Meanwhile, this number was more significant in the secondary and tertiary sectors, accounting for 13% and

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22.94%, respectively. Hence, 15% of all employees in Lithuania have worked in foreign capital companies, of whom 47.9% were in the IT sector and 26.8% in manufacturing. In contrast, a similar percentage (25%) have worked in mining and quarrying. In general, the amount of foreign-controlled capital has constantly increased since the collapse of the Soviet Union and the opening of the market. At the end of 2021, more than 6,200 foreign-controlled enterprises have been operating in Lithuania. Fifty-two per cent of all foreign-controlled companies were from the European Union, including some Nordic countries. The most significant number of foreign capital enterprises were from Belarus (577), Germany (526), Russia (506), Latvia (492), Ukraine (420), Estonia (350), Sweden (288), the United Kingdom (286), Denmark (275), Norway (251). Unfortunately, the data about the number of foreign capital companies provided by the State Data Agency of Lithuania ends in 2021. Thus, the structure of the top 10 investing countries might be different due to the Russia–Ukraine war. The number of Belarusian capital companies has increased since the fraudulent elections in Belarus in 2020. The turnover of foreign-controlled companies is presented below in Fig. 1.

However, 951 Nordic capital-controlled enterprises were operating in Lithuania, which makes 15.3% of all foreign capital enterprises. Swedish capital companies made the highest turnover (1,781,097,294 thousand euros) from 2005 to 2021; Finland took second place with an average turnover of 1,509,985,059 thousand euros. The lowest turnover was from Icelandic capital companies, as it is the lowest number of companies controlled by Iceland's capital (see Fig. 2).

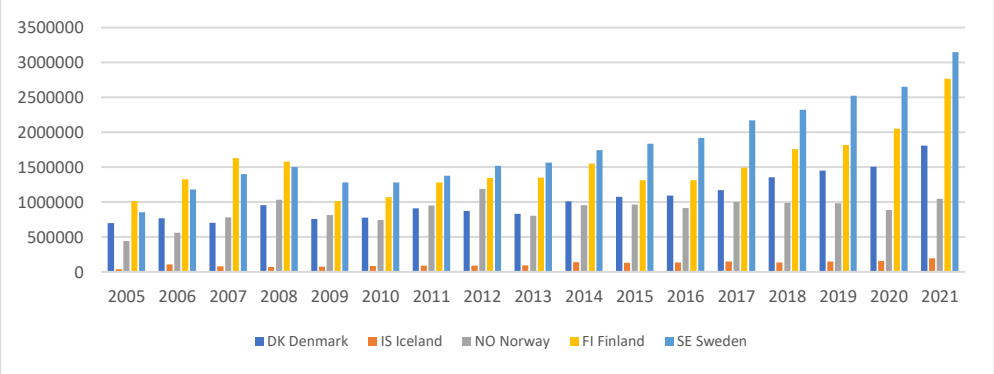


Fig. 1. The turnover of foreign-controlled companies in thousands of euros.

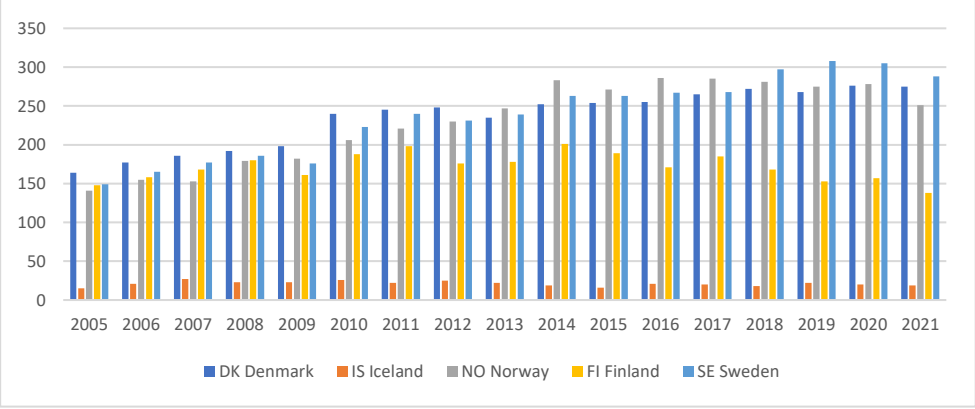


Fig. 2. The number of Nordic capital-controlled companies

From 2005 to 2022, the calculated average of annual inward FDI showed that Lithuania received the greatest FDI flows from Sweden (57%), followed by Denmark (18%), Finland (13%), and Norway (12%). FDI from Iceland accounted for just 1%. In Lithuania, Sweden invested the most in the tertiary sector, i.e. service and knowledge-intensive business sector, which accounted for an average of 93%. Swedish companies mainly invest in the finance (54%) and IT (24%) sectors. Finland (67%), Denmark (73%) and Norway (75%) targeted the tertiary sector less during the considered period. Moreover, 29% of Danish, 71% of Icelandic, and 34% of

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Norwegian FDI have been attracted to manufacturing sectors. Meanwhile, less than half of inward Finnish FDI (41%) targeted wholesale and retail trade (WIPO, 2023). Iceland invested only 54% in the tertiary sector in Lithuania. Yet, the total flow of inward Nordic FDI during 2005–2022 accounted for 31.26% of all investments. The flows of inward Nordic FDI fluctuated over the whole period. The presented data show that Lithuania attracted the least amount of FDI from Iceland compared to other Nordic countries. Meanwhile, during the global crisis, Lithuania suffered a loss of FDI from the Nordic countries. For example, compared to 2007, Denmark's FDI declined by 61%, Finland's – 2%, and Iceland's – 48% in 2008. Since 2005, Denmark's FDI in Lithuania has grown by 78%, Finland's – 65%, Sweden's and Norway's – 87%, and Iceland's – 80%. Further, the study evaluates the relationship between FDI from each Nordic country and employment in Lithuania. The correlation is statistically significant in all cases, as it is below p=0.05. However, the strongest relationship exists between employment in Lithuania and Finnish FDI (r=0.643), although Finland's inward FDI makes up 13% of all FDI flows in Lithuania, less than Swedish and Danish FDI. The second most robust relationship between Lithuanian employment and FDI from Sweden has been estimated (r=0.438). The weakest relationship exists between employment in Lithuania and Norway's inward FDI (r=0.208). This result is unexpected, as Norway takes 10th place among foreign investors in terms of the number of companies established in Lithuania. Thus, it might be concluded that Norwegian companies are not significant. Furthermore, the relationship between inward FDI from each Nordic FDI in the secondary sector and employment in the secondary sector was estimated (Table 1). The results prove that inward Nordic FDI and employment in the secondary sector have a statistically significant relationship (p<0.05). In particular, the correlation between Nordic FDI and Lithuania's secondary-sector employment was assessed (Table 2).

Table 3. Relationship between Nordic foreign capital in the secondary sector and Lithuanian employment in the secondary sector

		Lithuanian employment in the secondary sector
Denmark's foreign capital, the Lithuanian secondary sector	Correlation coefficient	0.403
	p-value	<0.001
Iceland's foreign capital in Lithuania's secondary sector	Correlation coefficient	0.310
	p-value	0.007
Finland's foreign capital in Lithuania's secondary sector	Correlation coefficient	0.684
	p-value	<0.001
Norway's foreign capital in the Lithuanian secondary sector	Correlation coefficient	0.862
	p-value	<0.001
Sweden's foreign capital in Lithuania's secondary sector	Correlation coefficient	0.421
	p-value	<0.001

Source: authors

The results show a moderate positive correlation between Danish (r=0.403), Finnish (r=0.684), Swedish (0.421) and Icelandic (0.310) FDI in the secondary sector and secondary-sector employment. The strongest relationship between employment in the secondary sector and inward FDI has been found in the case of Norway (r=0.842). Thus, the strongest interlinkages are determined in the case of Norway, Finland, and Sweden. Further, the research estimates the relationship between FDI from each Nordic country in the tertiary sector and employment in the tertiary sector in Lithuania (Table 4).

Table 4. Correlation between Nordic foreign capital in the tertiary sector and Lithuanian employment in the tertiary sector

		Employment in the tertiary sector
Denmark's foreign capital in the Lithuanian tertiary sector	Correlation coefficient	-0.391
	p-value	<0.001
Finland's foreign capital in Lithuania's tertiary sector	Correlation coefficient	0.491
	p-value	<0.001
Iceland's foreign capital in Lithuania's secondary sector	Correlation coefficient	0.034
	p-value	0.769
Norway's foreign capital in Lithuania's secondary sector	Correlation coefficient	0.258
	p-value	0.025
Sweden's foreign capital in Lithuania's tertiary sector	Correlation coefficient	0.699
	p-value	<0.001

Source: authors

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The results reveal that only in the case of Iceland, the correlation between Iceland's inward FDI in the tertiary sector and Lithuanian employment in this sector is statistically insignificant (p=0.769). A low Iceland FDI flow in the tertiary sector might explain this. The strongest relationship has been observed in the case of Sweden (r=0.699, p<0.001), followed by Finland (r=0.491, <0.001) and Denmark (r=-0.391, p<0.001). Hence, the correlation between Nordic FDI in the tertiary sector and employment in the tertiary sector in Lithuania is statistically significant for Denmark, Finland, Sweden, and Norway. Nevertheless, Norway's FDI in the tertiary sector and Lithuanian employment in the tertiary sector have the weakest correlation (r=0.258). Before carrying out the Granger causality analysis, the stationarity of the time series of the selected variables – Danish, Finnish, Swedish, Icelandic, Norwegian FDI and Lithuanian employment – has been evaluated by employing the ADF test (Table 5).

Table 5. Results of the ADF test

Indicator	Sector	Constant		1st level differentiation (constant)	
		ADF t-statistics	p-value	ADF t-statistics	p-value
Denmark's foreign capital	Secondary	-1.0381	0.7357	-9.3026	0.0000
	Tertiary	-2.2047	0.2064	-5.4954	0.0000
Finland's foreign capital	Secondary	-2.3090	0.1719	-10.2489	0.0001
	Tertiary	-2.9619	0.0432	-	-
Iceland's foreign capital	Secondary	-1.3847	0.5854	-14.9506	0.0001
	Tertiary	-1.9408	0.3122	-8.8428	0.0000
Norway's foreign capital	Secondary	-1.2969	0.6272	-9.6579	0.0000
	Tertiary	-1.6161	0.4694	-8.5146	0.0000
Sweden's foreign capital	Secondary	-1.4847	0.5359	0.5359	0.0001
	Tertiary	-1.5181	0.5191	0.5191	0.0000
Lithuanian employment	Secondary	-1.6634	0.4455	-5.4163	0.0000
	Tertiary	-0.4187	0.8998	-7.8459	0.0000

Source: authors

If the p-values of the transformed variables are below the significance level (p<0.05), the data satisfy the stationarity condition. Since the stationarity of the data has been evaluated, the VAR models are constructed to estimate the number of lags to be used in the Granger causality test. In the first step, the Granger causality test has been applied to assess causal links between the distribution of Nordic FDI in the secondary sector and employment in the same industry (Table 6). We further employ the Granger causality test to determine causal links between Nordic FDI in the tertiary sector and jobs in the tertiary sector.

Table 6. Results of the Granger causality test

Sector	Null hypothesis	Observations	F statistics	P value	The null hypothesis is accepted or rejected
Denmark					
Secondary	Denmark's foreign capital _2sec ⇏ Lithuanian Employment_2sec	73	0.26281	0.7697	Accepted
	Lithuanian Employment_2sec ⇏ Denmark's foreign capital _2sec		4.13582	0.0202	Rejected
Tertiary	Denmark's foreign capital _3sec ⇏ Lithuanian Employment_3sec	65	1.79701	0.0895	Accepted
	Lithuanian Employment_3sec ⇏ Denmark's foreign capital _3sec		1.01901	0.4434	Accepted
Finland					
Secondary	Finland's foreign capital _2sec ⇏ Lithuanian Employment_2sec	74	1.70324	0.1961	Accepted
	Lithuanian Employment_2sec ⇏ Finland's foreign capital _2sec		0.00156	0.9686	Accepted
Tertiary	Finland's foreign capital _3sec ⇏ Lithuanian Employment_3sec	74	0.00012	0.9914	Accepted

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	Lithuanian Employment_3sec ⇏ Finland's foreign capital _3sec		0.00954	0.9225	Accepted
Iceland					
Secondary	Iceland's foreign capital _2sec ⇏ Lithuanian Employment_2sec	74	0.00285	0.9576	Accepted
	Lithuanian Employment_2sec ⇏ Iceland's foreign capital _2sec		0.00987	0.9211	Accepted
Tertiary	Iceland's foreign capital _3sec ⇏ Lithuanian Employment_3sec	67	0.39933	0.9157	Accepted
	Lithuanian Employment_3sec ⇏ Iceland's foreign capital _3sec		0.79510	0.6095	Accepted
Norway					
Secondary	Norway's foreign capital _2sec ⇏ Lithuanian Employment_2sec	66	2.42358	0.0237	Rejected
	Lithuanian Employment_2sec ⇏ Norway's foreign capital _2sec		1.19525	0.3204	Accepted
Tertiary	Norway's foreign capital _3sec ⇏ Lithuanian Employment_3sec	67	0.76056	0.6385	Accepted
	Lithuanian Employment_3sec ⇏ Norway's foreign capital _3sec		0.62915	0.7494	Accepted
Sweden					
Secondary	Sweden's foreign capital _2sec ⇏ Lithuanian Employment_2sec	74	0.10619	0.7455	Accepted
	Lithuanian Employment_2sec ⇏ Sweden's foreign capital _2sec		0.32163	0.5724	Accepted
Tertiary	Sweden's foreign capital _3sec ⇏ Lithuanian Employment_3sec	69	1.73682	0.1294	Accepted
	Lithuanian Employment_3sec ⇏ Sweden's foreign capital _3sec		0.58973	0.7371	Accepted

Source: authors

The results of the Granger causality test revealed that Lithuanian employment in the secondary sector impacts Denmark's foreign capital inflows to the secondary sector. Meanwhile, Norwegian foreign capital inflows into the secondary sector are also estimated to affect Lithuanian employment in the secondary sector.

Discussion

Over the years, Nordic FDI has contributed positively to the Lithuanian economy. This has been proven in previous studies. The research aimed to disclose the relationship between sectorial FDI from Nordic countries and sectorial employment in Lithuania. In this study, the sectors have been divided according to the Clark-Fisher three-sector model. Two (Denmark and Norway) of the five Nordic countries are among those that opened most of the companies in Lithuania, although the leading country in the flows of FDI is Sweden. However, the strongest correlation between employment in Lithuania and inward FDI from each Nordic country has been estimated in the case of Finland.

Meanwhile, the strongest relationship between employment in the secondary sector has been observed in the case of Norway ($r=0.862$, $p<0.001$) and Finland ($r=0.684$, $p<0.001$). Hence, only inward Norwegian FDI in the secondary sector impacts employment in the secondary sector in Lithuania. In the meantime, the FDI from other Nordic countries has no effect on employment in the secondary sector. Nevertheless, employment in the secondary sector impacts the FDI inflows from Denmark. Causal links do not exist between Nordic FDI and employment in the tertiary sector. Thus, it might be concluded that Nordic countries do not tend to invest in the tertiary sector compared to other countries. Yet, Swedish FDI has been mainly attracted to the financial sector. However, in general, it does not have an impact on employment in the tertiary sector. Thus, Norwegian FDI flows to the secondary sector are appropriate for predicting Lithuanian employment in the secondary sector. It is also confirmed that changes in Danish FDI in the secondary sector can be used to predict Lithuania's employment, which is in line with the results of Inekwe (2013). The study found a positive long-term relationship between the manufacturing sector's FDI and Lithuania's employment rate. However, FDI in the service sector was found to have a negative association with the employment rate (Inekwe, 2013).

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The results are partially different, as Inekwe (2013) analyzed Nigeria as a developing country. Hence, the study of Tvaronavičienė & Grybaitė (2007) suggests that FDI has significantly driven economic growth and employment in Lithuania. However, this paper has not focused on a specific FDI donor country and jobs in a particular sector. Overall, the literature suggests that FDI has positively impacted employment in Lithuania. FDI in the manufacturing sector has been found to improve the employment rate, while FDI in certain economic activities has been shown to drive economic growth. However, the impact of FDI on employment may vary depending on the sector and the specific characteristics of the economy. For instance, FDI was found to have a positive but modest impact on manufacturing employment in Mexico (Waldkirch et al., 2009), which is partially in line with the results of our study since the secondary sector mainly covers manufacturing and construction. In contrast, the impact of FDI on employment in developing countries can be more significant, with capital or technology-intensive FDI potentially leading to job losses, especially in developing nations (Sinha et al., 2022). Meanwhile, a moderate to weak relationship exists between inward FDI from the Nordic countries to the tertiary sector and employment in the tertiary sector.

Conclusions

The study has proven that attracting Norwegian FDI into the secondary sector, such as manufacturing or construction, would positively impact employment. Hence, increasing employment in the secondary sector would look promising for Danish investors in this sector. Thus, the Lithuanian government should fund and promote studies related to manufacturing sectors or the most required professions to promote the manufacturing sector. It is essential for policymakers to understand the factors that attract FDI and to create an environment that encourages investment and job creation. In addition, stimulating the manufacturing sector and tightening relationships with the Nordic countries may promote the development of innovation or attract more FDI into these sectors from the Nordic countries. Meanwhile, there is a weak link between technology and knowledge transfer (Šimelytė & Tvaronavičienė, 2023).

Theoretical and practical implications. Finally, this study complements the existing literature by examining interlinkages between sectorial FDI and employment. Thus, the study extends the internalization theory by integrating the Clarks-Fisher model of structural changes, expanding and filling the gap in the interaction of these two theories and summarizing the main findings. According to the Clarks- Fisher development theory, the emergence of the service sector would stimulate economic growth, and most of the labour force would be distributed in the service sector. Studies find (Tvaronavičienė et al., 2023; Burinskas et al., 2021) that Finnish, Swedish, and Norwegian FDI positively impact Lithuania's GDP. These results align with the previous study by Hlavacek and Bal-Domanska (2016), which found that inward Nordic FDI positively impacts the Lithuanian economy. Meanwhile, 73% of the labour force in Lithuania is concentrated in the service sector. Hence, less than half of employees working in a foreign capital company are employed in the tertiary sector. Thus, the study fills the gap in the interaction between internationalization and structural changes theory, as empirical results confirm the existence of the relationship between FDI as a form of internationalization and the structure of employment. It confirms the relationship between foreign direct investment and the importance of labour force distribution across different sectors. The study uses a rigorous empirical analysis to explore the nuances of these relationships. It provides valuable insights to policymakers, investors, companies, and researchers interested in the intersection of foreign investment and work dynamics. The article stresses the need for a differentiated approach to optimizing the functioning of the labour market and considering the positive aspects of foreign direct investment. The policy towards FDI attraction might have had an impact on the relationship between sectoral FDI and sectorial employment. Thus, governments and policymakers can use the study results to formulate strategies to attract foreign direct investment while ensuring economic growth and promoting jobs in the most promising or promotional sectors. The study examines how governments can use foreign direct investment to maximize job creation, develop skills, and encourage inclusive labour market growth. This study contributes to the academic debate on the impact of foreign direct investment on the economy. It provides valuable insights into how foreign direct investment shapes the labour market and generally affects employment patterns.

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*Future research and limitations***.** The study has some limitations. First of all, the research has focused only on inward Nordic FDI. Thus, the impact of FDI from other countries has been eliminated. The results focus on the impact of Nordic FDI on employment.

FDI from a particular country may significantly impact other economic factors such as sectorial value-added, GDP, international trade, or even migration. Meanwhile, the study covers the data until 2021 and does not evaluate the impact of the Ukraine–Russia war, which started in 2022. Historical data show that Belarus and Russia are in the top three regarding the number of companies opened in Lithuania. However, after the fraudulent presidential election in 2020, some Belarusian companies transferred their business to Lithuania. Meanwhile, Russian capital companies were closed after February 24, 2022. Thus, a recent geopolitical event has changed the distribution of foreign capital companies. Hence, further research should focus on the sectorial inward FDI from other countries. In addition, the study should be replicated within five years to estimate the impact of geopolitical events.

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AN ACTOR-NETWORK THEORY CONCEPTUALIZATION FOR SMART SPECIALIZATION STRATEGIES (S3): CREATIVE BROKERAGE TOWARDS SUSTAINABILITY TRANSITION

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Abstract. Smart Specialisation Strategies, their planning and implementation are becoming more important in Europe's transition but also bring up several challenges, especially when it comes to complex innovation processes and requirements arising from the call for sustainable development on several levels. Even though the concept of Smart Specialisation has been elaborated on in a lot of research, the literature still lacks sufficient theoretical justification for the policy concept, resulting in a gap between theory and practice in terms of Smart Specialisation Strategy design and implementation. In this context, this paper provides cross-linkages to evidentially drivers of sustainability transition such as social innovation, cross-border cooperation, Entrepreneurial Discovery Processes and creative innovation. The exploration of synergies towards these concepts under S3 is still scant. The conducted research is based on an extensive literature review and uses a comparative analysis of Smart Specialisation and Actor-Network Theory. By applying Actor-Network Theory within Smart Specialisation Strategy research discourse, known problems of the concept might be overcome, Entrepreneurial Discovery Processes can be improved, and critical concepts for sustainability transition can be well incorporated into S3 understanding. In this, conducted research is also breaking new ground in theoretical conceptualization by providing the analysis and crosslinks of Actor-Network Theory with Smart Specialisation Strategies. Moreover, the integration of essential aspects towards sustainability transition under S3 can be enabled through the Actor-Network Theory application as it opens further research streams to be integrated into Smart Specialisation, such as social innovation and creative industries.

Keywords: Economic Theory; Regional Innovation; Research and Innovation Strategies; Entrepreneurial Discovery Process; Creative Brokerage; Cultural and Creative Industries; Cross-Border Cooperation; Social Innovation; Quadruple-Helix

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JEL Classifications: O3, O43, P25

1. Introduction

Smart Specialisation Strategies (S3) are important regional innovation and development policies for European regions in the upcoming years, planted in the context of the current transition from the lasting funding period of the European Union 2014 – 2020 (n+3 rule) towards its implementation in the current period as of 2021 – 2027. Here, European regions also aim to comply with the ambitious targets the European Green Deal set to accelerate Europe's transition to become a more sustainable society. Hence, contributions to the global UN Sustainable Development Goals (SDG) can also be identified. Initially, the S3 concept was implemented by the European Commission as an innovation governance concept on a regional level to support economic development and exploit growth potentials alongside the Europe 2020 Strategy (European Commission, 2010abc). The roots of the concepts can even be traced back as an answer to the increasing economic gap between Europe and other macro-regions in the 1990s (Foray et al., 2009). Considering that Europe is still

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facing a productivity gap between its own countries (Borovic and Radicic, 2023), the origins of Smart Specialisation still exist, pinpointing the importance and relevance of this innovation policy.

One of the main objectives of S3 concept is to increase the efficiency and targeted distribution of European funds (Forey, 2014; Prause, 2014) through individual identification of specific S3 priority areas in the strategy documents of each European region (McCann and Ortega-Argiles, 2015). As of now, the S3 implementation between 2014 and 2020 is still under evaluation by responsible regional S3 institutions and boards to update their strategies according to the experiences made so far (Boschma, 2015) but also to set a roadmap to accelerate the region's sustainable transition and increase economic competitiveness (Gianelle et al., 2020, Meyer, 2021).

At the beginning of the first S3 implementation period, 2014 - 2020, researchers have criticized the poor design of regional strategies (Morgan, 2015). However, a gap between theory and practice (Komninos et al., 2021), lack of comprehensive micro and macro-level frameworks for S3 implementation (Andersons and Bushati, 2019) as well as missing scientific theoretical conceptualization (Boschma, 2014; Fellhofer, 2017; Gerlitz et al., 2020) is still valid and calls for such new research approaches for strategy design (Tödtling et al., 2021). Even more, the selection of S3 priority areas as the main part of strategy design remains poor regarding regional strength and capabilities (Meyer, 2021), confirmed empirically in recent research (Marrocu et al., 2022).

On top of that, S3 design and implementation as a European approach also lacks sufficient cross-border cooperation concepts on policy and entrepreneurial levels among regions (Tiits et al., 2015), even though the EU mindset facilitates cooperation, and, from a theoretical perspective, cross-border cooperation is well known as a success factor for regional competitiveness and innovation (Lorenz and Oleaga, 2020). The reason might be low understanding, interest, and policy capacity for potential cross-border initiatives alongside S3 (Radosevic and Stancova, 2018). Furthermore, absent willingness for political commitment and an existing obstacle to developing common policy tools hamper approaches to overcome this lack (Uyarra et al., 2018), resulting in a still-existing research problem on how to utilize, incorporate and implement cross-border cooperation in the development and design of future S3 towards the period as of 2021-2027 (Masana, 2022). Policy learning mechanisms are key pillars of S3-driven governance (Gianelle et al., 2019), described as the political capabilities to transform theoretical concepts into sufficient innovation policies and implement policy changes to foster regional (innovative and sustainable) development. Hence, efficient innovation policy governance is also bound to path dependency paradigms. Consequently, networking, (policy) learning, open innovation and knowledge drive are key enhancers and social aspects for smart development (Dagiliene et al., 2019) and critical pillars of S3 design and implementation.

The conducted research is stepping into such new research approaches by offering a theoretical conceptualization to include four aspects into the S3 discourse on sustainability transition: Entrepreneurial Discovery Processes, Social Innovation, Cross-Border Cooperation and Cultural & Creative Industries. All four aspects have been put into discussion on S3 improvements individually as well as effects for sustainability already in previous studies of the researcher (Meyer, 2022; Meyer et al., 2021, 2022; Grigariene and Jureniene, 2023). Consequently, this research is building up on that and steps into the theoretical justification and framework exploitation to incorporate all four aspects into S3 design towards sustainability transition.

However, concepts and theories of Smart Specialisation as a regional innovation policy have been analyzed and exploited in several existing research items (Hassink and Gong, 2019; Landabaso, 2014; Lopes et al., 2021), including different literature reviews (Fellnhofer, 2017; Janik et al., 2020; Komninos et al., 2014; Lopes et al., 2019; Meyer, 2022). In this, place-based approaches have been mainly utilized regarding S3 design, implementation, and monitoring. Thus, place-based approaches have been identified as one of the main theoretical concepts when it comes to S3 elaboration in literature in general, but also specifically towards sustainable development (Meyer, 2022) and especially when it comes to the involvement of regional actors in Entrepreneurial Discovery Processes (EDPs) (Aranguren et al., 2019). However, the Smart Specialisation and EDP concept is originally based on a quadruple-helix actor approach in its nature as it enables a large variety of innovations (Nordberg, 2017) and is an enabler for sustainability transition (Roman et al., 2020; Veldhuizen, 2020). While most research approaches consider the triple-helix approach only, quadruple-helix (and other higher-order helix models) need to be better elaborated in the context of S3 and EDPs on the micro-level when

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it comes to aspects such as actor relationships, synergies, cooperation, and value creation (Cunningham et al., 2018; Höglund and Linton, 2018). Moreover, S3 must adopt outward-looking concepts in its understanding and design (Giustolisi et al., 2023). Since the regional institutionalization setup strongly determines the EDP's potential (Papamichail et al., 2022), design and monitoring concepts of European regions with a focus on their theoretical justification are required. Existing place-based theories do not explain and justify S3 design and implementation towards more sustainable perspectives and quadruple-helix applications. In this nexus, this paper argues to initiate a research discussion on applying the Actor-Network Theory (ANT) for S3 to exploit its potential. Consequently, the conceptual paper deploys the following research questions:
How can the actor-network theory be applied in S3 design and implementation? How does an actors-network theory application in S3 enable sustainability transition through Entrepreneurial Discovery Processes, Social Innovation, Cross-Border Cooperation, and Cultural & Creative Industries?

By answering these questions, the conceptual paper in hands does not only elaborate and utilizes ANT but also contributes to the elaboration of potential insights and add-values for S3 implementation, of benefits for new understanding of S3 design, of approaches to enable more efficient stakeholder involvement and interaction as well as of theoretical contribution to the on-going scientific discourse in the particular research field.

The paper is structured as follows: after this section, main literature findings within the research scope compiles the theoretical background and the implemented research methodology provides an overview of the research path, followed by the conceptual interlinkage between S3 and ANT. Afterwards, the results of ANT application in S3 to answer the research questions are presented. The paper concludes with a discussion of the results of the overall research discourse and concluding remarks summarising the paper, providing limitations and an outlook for future research.

2. Theoretical Background

One of the core elements of S3 implementation is the Entrepreneurial Discovery Processes concept, which aims to optimize the usage of limited resources and innovation exploration on the entrepreneurial level (micro-level) for certain domains of specialization (S3 priority areas of the regions) (Mieszkowski and Kardas, 2015). EDPs are groups of processes and activities implemented by involved stakeholders in an ecosystem, including formal and informal bodies and networks (Foray, 2014; Asheim, 2019). Hence, an EDP strongly relies on regionally involved actors in innovation processes and tries to establish multilevel combinations of stakeholders to transform the innovation strategy into reality (Grillitsch, 2016). In other words, the EDP is the operational instrument on a micro-level designed by the strategic approach of Smart Specialisation on the macro-level. The development and implementation of such EDPs are creating highly individual challenges on regional and local levels (Deegan et al., 2021). However, S3 promotes the bottom-up approach and is at the heart of EDPs. As noted by literature (McAdam et al., 2018; Gianelle et al., 2019), S3 policy design and implementation have yet to include the exploration of potential and effects on the micro-level (actors, partnerships, firm-based). Here, the literature also calls for more research on the impact and potentials of quadruple-helix (business, academic, policy and social capital) approaches on this micro-level (Hasche et al., 2020). In addition, the selected S3 priority areas shall support the application of EDPs in a particular region. At the same time, vice-versa, EDPs have the potential to identify utterly new specialization domains being turned into priority areas for S3 in the future (Deegan et al., 2021).

Social capital is strongly linked to social innovation in terms of S3 and regional development (Estensoro and Larrea, 2016). Moreover, social capital is also connected to social engagement (Secundo et al., 2017). Thus, it is a key success factor in ensuring the application of the quadruple-helix approach in policy-making towards S3, which includes ongoing knowledge competence exchange among the actors (Trillo, 2016). Thus far, social innovators and actors tend to be incorporated into such processes as outsiders or external experts rather than as direct actors for sustainable development, e.g., universities as knowledge drivers for society and policy learning (Secundo et al., 2017). Here, innovation policies such as S3 need to pay more attention to social and environmental challenges towards sustainability. Hence, explicit social needs and their contribution to sustainability transition should be at the centre of policymaking (Hassink and Gong, 2019). To achieve this commitment on the policy level, it is necessary to encourage social contribution in innovation processes,

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utilizing public and regional resources towards sustainable development in S3 (Panagiotopoulou et al., 2019; Regueiro-Picallo et al., 2020).

To contribute to those policy issues, this paper introduces the actor-network theory into the discourse of S3 and sustainability transition. Originally, the actor-network theory was born in social sciences to analyze how growth and knowledge creation can be explained through interactions of actors and networks (Muniesa, 2015), which, in turn, corresponds with the aim of innovation policies such as S3 to create informal networks, support knowledge exchange and cooperation among actors (Szakálné et al., 2022). Nevertheless, besides social sciences, the theory also receives growing attention in other research areas as an analytical tool, such as social innovation (Degelsegger and Kesselring, 2012), politics (Alcadipani and Hassard, 2010), sustainability (Irish and Romkey, 2021), urban studies (Farias and Bender, 2010), making it worth to examine the potential theoretical implications born from the theory for S3. Moreover, actor-network theory is seen as a potential performativity research steam on politics to close the gap between theory and practice (Passoth and Rowland, 2010), which is, as aforementioned, one of the existing research problems in S3 design and implementation.

Against this background, creativity can be an approach to overcome this "hesitation" for transformative changes in policymaking (Schot and Steinmueller, 2018; Prause, 2021). The paper also aims to integrate Cultural and Creative Industries (CCIs) into policy design and theory development. It is well known that CCIs play an essential role in urban economies (Mazilu et al., 2020), regional or local development (Lazzaretti et al., 2017) as well as facilitation of economies at all scales (Boix Domenech et al., 2021; Hassink and Yang, 2021). Moreover, CCI intervention is associated with positive effects on innovation through networks of relationships and alliances (Santoro et al., 2021), promoting its integration into new S3 concepts. However, exploration and integration of CCIs into the S3 context stay scant on theoretical and practical levels, e.g., only 10 per cent of the 243 S3 strategies considered culture as part of CCI as a priority area (Stanojev and Gustafsson, 2021).

Previous explanations showcase the complexity of S3 conceptualization and design. This is even accelerated as different research streams exploited spillovers to other areas. Therefore, the theoretical justification or application of economic theories must be revised and newly discussed. This paper promotes the actor-network theory as a concept that better explains S3 and its potential for a sustainability transition. This theory allows us to understand involved actor interactions better and enables cross-linkage to other concepts as introduced: creativity for innovation, social capital, EDPs and cross-border cooperation. All these concepts have an evidentially supportive impact on sustainability transition as well.

In general, Smart Specialisation Strategy concepts and approaches are often still seen as technology innovation policy in regional planning in literature and practical implementation. In contrast, new research trends shift to the quadruple-helix approach covering regional social capital towards sustainable development (Benner, 2020). Consequently, social entrepreneurship and social innovation are becoming more important in the S3 discourse as well, as they allow the discovery of new combinations of products, services, organizations, or processes (Defourney and Nyssens, 2010), which is at the core of an EDP and can also result into local innovation approaches (Noruzi et al., 2010). EDP's success and application strongly rely on the regional innovation capabilities of the involved actors.

However, the knowledge, technology and innovation capabilities of a region are key factors in pushing sustainable development (Ferreira and Seixas, 2019), which, as studies have exploited, calls for the active involvement of all innovation actors in the region: social innovators, academics, entrepreneurs and politicians as their interplay is a driver for knowledge creation, learning facilitation and spillover identification. In this, institutional perspectives are crucial (Tiits et al., 2015) as established regional (research) institutions are the main actors to support precisely this - learning, knowledge creation and spillovers – but also the specialization process itself, which again draws back to the application of the quadruple-helix approach. More precisely, regional stakeholders and institutions on vertical and horizontal network perspectives must be involved in S3 design and implementation (Grillitsch, 2016; Mishchuk et al., 2023).

Even though institutional perceptions are important in S3 discourses (Benner, 2022), only a few research items are based on institutional theories (Lehmann et al., 2022). This is partly because of complexities and difficulties

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in defining institutions and policy recommendations on a regional level (Grillitsch, 2016) since the abstract thinking in institutional theory results in problems in measuring institutional bodies, their proximity, and dynamics on a regional level (Rodríguez-Pose, 2013). In addition, regarding EDPs as a crucial concept for S3, (innovative) entrepreneurs as individuals exploring and creating knowledge are either not incorporated at all or seen as outsiders in the theoretical framework (Suddaby, 2010). This fact clearly makes institutional theories inapplicable towards S3 design and innovation governance.

Considering the call for increasing cross-border cooperation, new and unknown challenges may arise when targeting cooperation of the multilevel networks in different regions as it is still lacking theories, knowledge, and sufficient application for S3 (Korhonen et al., 2021; Tiits et al., 2015). Such challenges increase from the institutional perspective since smooth S3 implementation relies on intra-institutional coordination and cooperation at regional, national, supra-, and sub-national levels (Gianelle et al., 2016). Here, recent research has put CCIs into the context of actor mediation (Meyer et al. 2022). CCIs are crucial intermediaries, enablers, and development drivers (D'Orville, 2019). As sustainability transition demands efficient and cross-sectoral partnerships and collaboration among multilevel actors (Köhler et al., 2019), this is the logical link to CCIs' role in such settings since they endorse activities being linked to social and cultural development (Purg et al., 2009) in this context. Though CCI intervention in sustainable development is evident (Rayman-Bacchus and Radavoi, 2020; Wiktor-Mach, 2020), also increasing the level of resilience and socioecological system not only on the organizational level (Dentoni et al., 2021) fostering the quadruple-helix perspective (Dubina et al., 2012). Thus, integrating CCIs into S3 design can be a promising approach to improving the innovation capacity of a particular policy in general.

Within innovation policy governances covering multilevel actors, policy learning mechanisms are key pillars of S3-driven governance (Aranguren et al., 2019; Gianelle et al., 2019), described as the political capabilities to transform theoretical concepts into sufficient innovation policies and implement policy changes to foster regional (innovative and sustainable) development. Hence, efficient innovation policy governance is also bound to path dependency paradigms. Consequently, networking, (policy) learning, co-creation, open innovation, and knowledge drive are well-known concepts in CCIs, key enhancers for sustainability transition (Dagiliene et al., 2019; Huttunen, 2022; Van Mierlo and Beers, 2020) and in such, should be critical pillars of S3 design and implementation.

Taking up open innovation from a regional perspective, S3 strongly favours this concept (Oliviera et al., 2021; Surya et al., 2021). In this context, Open Innovation addresses the entrepreneurial level (Lopes et al., 2021) and, thus, it is connected to the concept of EDP as well by highlighting different aspects that might turn the EDP into a more sustainable one, with economic, environmental, social and institutional contributions made. This highlights the importance of EDPs, which stand as a key S3 enabler and constitute a central piece within the S3 policy puzzle (Laranja, 2021; Müür, 2022). However, EDPs find themselves caught in a dilemma. On the one hand, they enable discovery, e.g. through learning, open innovation and co-creation processes, and thus appear to be very promising S3 accelerators. On the other hand, by implying huge potential for co-creation and change, they remain under the radar among policy-makers, who, due to prevailing traditional thinking and planning of regional policies, remain somewhat reluctant in EDPs' deployment (Capello and Kroll, 2016). This is also exaggerated by the bottom-up/top-down discourses (Valdmaa et al., 2020).

In this background, various theories have been applied in research to explain, describe and elaborate S3. An extensive overview has been, for example, subsumed for S3 monitoring (Gerlitz et al., 2020). Theoretical conceptualization was linked to the affected actors being analyzed in the respective research items. Synthesizing given information, research items already covering triple-helix actors (Academics, Policy makers and Businesses) are already driven by the application of network theories (Kleibrink et al., 2016; Magro et al., 2014; McCann and Ortega-Argilés, 2016). This clearly indicates the shift from place-based towards network approaches within higher helix approaches in S3. However, the actor-network theory has not yet been a theoretical foundation in S3 literature. As the actor-network theory is an approach to critically reflect on past development while at the same time retrieving knowledge and insights towards future development (Durepos and Millis, 2012) and enabling the exploration of dynamic and socially constructed phenomena and their

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interactions (Burga and Rezania, 2017), the theory can also be utilized on to explain S3 processes and regional innovation ecosystems.

3. Materials and Methods

The conducted research places itself in the context of interdisciplinary research, aiming for transdisciplinary solutions and new paths by linking different concepts in a sustainability context. Moreover, applying actor-network theory within the S3 research and sustainability transition nexus offers a novelty in its conceptualization. As the actor-network theory provides a framework allowing the researcher to explore dynamic and socially constructed phenomena and their interactions (Er et al., 2013), it can serve as theoretical justification to elaborate regional innovation ecosystems and networks as covered in S3 research. Though, due to the complexity and intertwining of different constructs - such as multilevel actors, EDPs, and thematic priority areas – the actor-network theory seems to be a feasible and sufficient research framework as it covers not only organizational level but also humans (actors), objects and processes at all levels (Sage et al., 2011; Floricel et al., 2014).

The paper aims to contribute to future-oriented problem-solving and exploration. Research should be based on interdisciplinary approaches (Grimshaw& Miozzo, 2021; Taebi et al., 2014), collecting different insights and new findings from various research fields to elaborate on a specific topic holistically. This can even be traced back to Schumpeter's idea of creative destruction towards innovation exploration (Schumpeter, 1942; Simmie, 2014). Consequently, different aspects of the S3 discourse are taken for the conducted research and put into a new context with other concepts and ideas to explore new ways of thinking and understanding, produce knowledge, and set a path for future research. The research that was conducted claims to be highly exploratory.

Picking this up, S3-related research requires the utilisation of qualitative studies from different innovation contexts to set those new paths (Trippl et al., 2020). Consequently, the research is capitalizing on an exploratory qualitative approach (Silverman, 2020; Shields & Rangarajan, 2013). Considering the introduced research problems and gaps, a conceptualization must be explored and comprehended. Only a little research in this field has been conducted, making a qualitative approach feasible for research methodology (Creswell, 2014). Moreover, qualitative approaches shall be preferred when the researcher still needs to know which variable should be examined (Creswell, 2014). Following this argumentation, the exploratory qualitative approach is emphasized as the methodological approach of this paper.

Furthermore, the implemented research approach is hybrid (Fereday & Muir-Cochrane, 2006), combining inductive and deductive perspectives. Deductive streams are exploited by applying the actor-network theory in a new scenario as of S3 design and implementation, including elaborating whether the theory can be sufficiently used towards identified research problems and gaps. Inductive perspectives result from observations and knowledge gathered from literature and research being examined and put together in a new context to develop general statements and recommendations. Consequently, hybrid research is based on the researcher's constructivist and interpretivist assumptions (Creswell, 2013; Mertens, 2010). Constructivism is postulating theoretical constructions' utilization and practical function (Crotty, 1998), and multiple realities are being investigated.

In contrast, the researcher is integrated into the objects of interest (Lincoln et al., 2011). As the interactions and relations of involved interdisciplinary actors and stakeholders are key to explaining S3 paradigms, interpretivism allows the researcher to give specific meaning and foundation to actions, relations, and processes (King & Horrocks, 2011). However, as the philosophical research discourse is scaling off from the boundaries of strict philosophical categories, the paper can also be placed in the emerging categories, namely interactive approaches (Svensson et al., 2008). Nevertheless, it should be mentioned that actor-network theory itself is categorized as a constructivist approach (Muniesa, 2015), pinpointing its sufficiency as the theoretical background of the paper as well.

In sum, the paper is based on a conceptual research approach using an extensive literature review in a particular field to examine relevant academic literature and premises for conceptualization development. Hence, it is also

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secondary research based on previous observations and research done by the researcher and identified literature. Consequently, desk-based research has been performed to gather the most relevant research items on S3 in the sustainability nexus and actor-network theory setup. In this, the paper followed a comprehensive research journey to address the introduced research questions and set up a conceptualization to develop contributing answers to them and set the path for future research in the field.

4. Results

4.1 Linking up actor-network theory and S3 aspects

Whereas other network theories focus on the relations and boundaries of covered entities and place-based approaches examine the locally or regionally available assets, actor-network theory expands the understanding of involved actors, who can only be described as the network, which is vice-versa not non-existent without its actors (Wihlborg, 2018). The actor-network theory also disrupts the conceptual boundaries of place-based approaches, opening new thinking and new concepts being applied for S3, such as cross-border cooperation in its design.

In theory, actors can be human or non-human entities, or in other words, any entity going into some network relation (Latour, 1996; Whittle & Spicer, 2008). However, the theory calls for one crucial and binding assumption of so-called symmetry, which declares all involved actors – human and/or non-human – in the network are equally powered (Whittle & Spicer, 2008; Jackson, 2015). Though it is a bounding assumption, it can solve two issues in the context of S3 implementation. First, the idea of S3 is a practice-oriented forward-up approach, primarily through EDPs, but it is often implemented as a top-down concept set by regional politicians (Foray, 2016; Valdmaa et al., 2020). This paradox can be erased in the analyses by considering the mentioned assumption of equality between all involved actors. Second, S3 design and implementation calls for interdisciplinary cooperation according to the quadruple-helix view (Carayannis & Rakhmatullin, 2014; Fellnhofer, 2017). The theoretical assumption supports these concepts by allocating the same power to all involved actors.

In addition, according to the theory, all actors are historically driven (Durepos & Mills, 2012), and the concept of path dependency is equivalent to S3 and regional policy-making (Bellini et al., 2020).

The relations and interactions between actors are grounded in the so-called translations, which set up the actual network (Miettinen, 1999; Durepos & Mills, 2012). In addition, translations describe how involved actors create effects through negotiation or affect other actors' interests towards their own to mobilize support (Jackson, 2015). However, translations are generally aligned to four main steps in the actor-network theory: problematization, interessement, enrolment and mobilization (Callon, 1984). Putting these four stages of the theory into the policy innovation context, the actor-network theory is creating an innovation ecosystem through the establishment of a problem, development of possible solutions, iteration of potential solutions, as well as institutionalising and refining preferred solutions, which is, in fact, a key advantage compared to other theories in policy innovation discourse (Young et al., 2010).

As translations between actors can be very heterogeneous, uncertain, and ambiguous between the actors, the theory introduced so-called translation zones. Such zones subsume all actors' translations towards a common aim or field of interest (Barry, 2013) through knowledge exchange and innovation application (Rantisi and Leslie, 2015). This, in turn, is connected to the EDPs as a core concept of S3 implementation (Dubois et al., 2017), understanding translation zones as entrepreneurial discovery spaces (Morgan, 2016) to support multi-actor and cross-sectoral exchanges (Asheim et al., 2011). In addition, the translation zones can also be interpreted as priority areas fixed in the regional S3, allowing the existence of different translation zones with different actors involved for a region under S3 design and implementation.

Lastly, regarding sustainable innovation enhancement, the actor-network theory calls for translators who actively define and establish the relations between actors towards sustainable development (Aka, 2019). This position could efficiently be covered by innovators from CCIs, as they can support entrepreneurship and open

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innovation among quadruple-helix actors, being a critical capability for sustainable environmental, economic, social, and institutional thinking and acting (Gerlitz, 2017; d'Orville, 2019; Meyer et al., 2022).

However, the interrelations of S3 and actor-network theory have yet to be elaborated in scientific discourses; this paper has exposed clear linkages which can be supplemented by further discussion on key concepts of the theory and their meaning in S3 as Table 1 illustrates.

Table 1. Further key actor-network theory aspects and their implication for S3 application

Further Key Concepts in Actor-Network Theory (Jackson, 2015, p.30)	**Implications for S3**
Inscription – Embodied translations into a medium or material	Translations, as the aim of early actor mobilization, lead to a specific development aim through EDPs, innovation applications, Key Enabling Technologies, etc., with a focus on the entrepreneurial level.
Enrolment – Mobilise support by creating a body of allies through translation	The joint aim of actors in EDPs is to consortia and network creation for a specific thematic innovation application and sustainable transition.
Black box and punctualisation – A temporary simplification in a network that acts as a single unit so that the network effaces into one actor.	S3 rationale is sufficient to allocate funds through different territorial programmes. In this, building up consortia of different actors from different regions alongside a common thematic goal is a usual and successful procedure to acquire these funds.
Quasi-object – A nonhuman that is necessary for the collective to exist; an object that passes through a social group andand forms relations between members.	The thematic priority is bringing affected actors together, including potential sub-categories and objectives.
Hybridity – The idea that neither a human nor nonhuman is pure, that is, human or nonhuman in an absolute sense, but rather entities produced in associations between the former and the latter. Thus, humans are considered quasi-subjects and nonhuman quasi-objects.	Boundaries of human and non-human actors are vanishing, and social innovators and creative brokers are co-creating innovation and sustainable transformation with academic, policy, business and social nonhuman entities.

Source: Compiled by author.

In this, the actor-network theory has more potential to increase the understanding of European regions in S3 and their sustainability transformation. However, this is the first attempt to apply actor-network theory in the context of S3 to rethink a sufficient future-oriented constitution, understanding, and mindset for S3 design and implementation.

4.2 S3 Designing Framework for European Regions

Using the actor-network theory in the discourse of S3 implicitly determines how this innovation policy is ebbed in European regions. Hence, the theory also shapes the understanding and mindset towards placing relevant actors within a certain framework / European region. Here, applying actor-network theory for regions in the S3 discourse as a new approach also bears the potential to enable new or different understandings and mindsets for regional design, including multilevel actor positioning.

After introducing and applying actor-network theory and referring to the quadruple-helix approach, a framework for designing European regions under S3 planning and implementation can be derived. As such, essential parts and relations (translations) between relevant actors are showcased in Figure 1 below. This illustrated framework is based on the core concepts of actor-network theory, which, as aforementioned, offers several overlaps in S3 understanding and expands the research discourse in S3, which is theoretically justified only through place-based and network theories. However, selecting sufficient priority towards EDPs' development and implementation is crucial for the illustrated framework. However, within the chosen priorities, illustrated as translation zones in theory, are the key enablers for EDPs and quadruple-helix actors' involvement. As mentioned, the theory assumes the same power to each actor, human or non-human, facilitating interdisciplinary discovery and innovation application.

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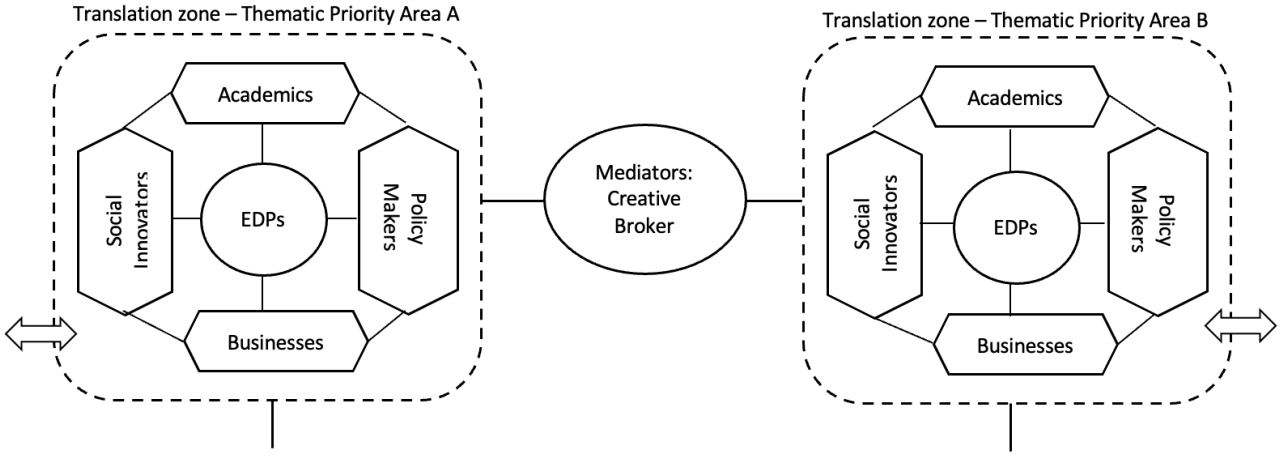


Figure 1. S3 Design Framework for Thematic Priority Areas.
Source: Compiled by author

One key aspect of sufficient actor-network theory application is the so-called mediators (Latour 2007). These actors connect other actors alongside translation measurements, whereas inputs can't predict their outputs. This is the role of CCIs and Creative Broker, notifying the unknown innovation output from creative method application (Klein and Spychalska-Wojtkiewicz, 2020). Especially when it comes to cross-border cooperation approaches in S3, the literature highlights the still-existing challenge of identifying and integrating cross-border agents (Mikko et al., 2021), which can be overcome with a Creative Broker approach.

Within the translation zones, the quadruple-helix actors are illustrated for the selected thematic priority area. In this, the EDPs are incorporated in the framework placed in a quadruple-helix perspective to contribute to the sustainability transition of the whole region.

However, this is the first attempt ever applying actor-network theory in explaining a sufficient future-oriented constitution of a European region in a particular field. Thus, this paper contributes theoretically to the research discourse and minimizes the gap in the theoretical justification for this innovation policy. Nevertheless, S3 has no one-size-fits-all solution (Ortega-Argiles, 2022). Thus, it is necessary to further investigate this framework's interpretation and explain its meaning and context.

4.3 What's in there for the S3 sustainability transition nexus?

Successful S3 implementation strongly relies on its planning and setup. As aforementioned, the current strategies are set for the full funding period as of 2021 – 2027, focusing on planning and supporting EDPs alongside the chosen priority areas. The problems between this theoretical planning and practical implementation, especially for EDPs, have been mentioned already. Due to the implemented research and actor-network theory framework, S3 developers need to change their mindset from Planning towards Designing EDPs in a region. Whereas planning pre-determines the setup and aspired outcomes, designing processes include iteration measurements, open innovation actions, and creative mindsets. Therefore, integrating CCIs as innovation brokers is important in the framework, supported by the actor-network theory.

Moreover, Designing S3 needs to shift to a more thematic priority area orientation rather than focusing on the region, which is illustrated through the translation zones being the core of interaction within the actor-network theory. The poor priority area selection in European regions is evident. It must be overcome, as the thematic priority areas are enablers for quadruple-helix application and sufficient actor identification for EDPs and S3 implementation. Furthermore, shifting to a more thematic focus also enables sufficient and comprehensive S3 monitoring across regions, which is still an evident problem on the European level (Meyer, 2020).

In addition, as a result of the conducted research, this paper calls for renouncing place-based and institutional theories as the backbone for S3 research. Even though both concepts can theoretically contribute to innovation

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research, they need more crucial approaches to explain actor involvement, open innovation, and cross-border EDPs. Cross-border cooperation as a concept for innovation development and sustainability transition under S3 design is still an underexamined field of research. Only a few attempts were made to include it in the S3 discourse, even though cross-border cooperation is an innovation driver on the entrepreneurial level and a facilitator of sustainability transition (Trippl, 2010; Meyer et al., 2021).

Linking S3 design and thematic priority areas or translation zones requires mediators according to the actor-network theory framework, calling for the integration of CCIs. One core strength of CCIs is their ability to broker and share knowledge, craft innovative policies, and mobilize EDPs. In addition, CCIs are contributing to co-designing and co-creating S3 quadruple-helix networks and partnerships in diverse collaboration models towards governance to shape innovation processes and successful EDPs. CCIs should play a crucial role in regional policy settings. Moreover, CCIs bear innovation potential and are vital actors in terms of sustainability transition in general (Gerlitz and Prause 2021). The present research calls to benefit CCIs' potential going beyond brokerage and actor incorporation. Moreover, aspects such as policy learning, social innovation, thematic priority area spillovers, and experimentation are important approaches to consider when it comes to S3 design and implementation.

5. Discussion and concluding remarks

Smart Specialisation Strategies is one of the main innovation policies on a regional level and remains in an essential position in scientific discourses. In this, synergies, spillovers and correlations to other future-driven initiatives are apparent. Hence, the research on Smart Specialisation is manyfold. Nevertheless, even at the end of the first implementation period, 2014 – 2020 and towards the design of upcoming strategies, the research emphasizes several existing problems in S3 application from theoretical, scientific, and practical perspectives (Masana 2022).

However, as the research has emphasized, research discourse partly lacks on re-shaping S3 understanding towards future-driven needs – sustainability transition. Only a few research articles can be put in this specific research area, though they are elaborate S3 and European Green Deal implications (Larosse et al., 2020), the new idea of Smart Specialisation 2.0 (Kakderi 2020; Panori et al. 2021; Masana 2022) but also introducing a Sustainable Smart Specialisation Strategy (S4) discourse, which is currently only based on improvements in EDP application (Laranja, 2021; Kangas and Ryynänen, 2022). In this, the paper in hands can be supplemented to the research discourse of EDPs as well but goes beyond the sole elaboration and improvement of EDPs by introducing the actor-network theory as a novelty and theoretical contribution to S3 discourse, placing the EDP in quadruple-helix approaches to enable further aspects for S3 design. Moreover, it supports the current research perspective on the S3 concept to adopt external or outward-looking aspects into regional strategies (Giustolisi et al., 2023), preferably through cross-border cooperation.

From a theoretical perspective, this paper has pinpointed that common theories applied in S3 are insufficient to comply with the increasing complexity and requirements of regional innovation governance and its design towards sustainability transition, nor can they include significant trends and aspects from recent literature. This, in turn, also applies to one of the main concepts in S3 implementation and innovation development – the EDP. By introducing the actor-network theory into the S3 discourse in this paper, EDPs as key concept for S3 innovation application have been elaborated and enriched in their design and application through new perspectives and approaches by linking quadruple-helix approach, CCIs brokerage and sustainability transition. As this paper's theory application and proposed framework clearly show, CCI brokerage is a crucial aspect for innovation development under S3. On the one hand, CCI brokerage is demanded from the theoretical perspective of the actor-network theory, which calls for mediators between actors and translation zones. The potential and competencies of CCIs for this role are evident (Jones et al., 2015; Virani et al., 2016). On the other hand, CCIs are the linking aspect of the developed framework and sustainability transition (Gerlitz and Prause, 2021; Meyer et al., 2022) as they can enable and facilitate different processes which are directly linked to sustainability transition, such as policy learning (van Mierlo and Beers, 2020), social innovation (Sauermann et al., 2020) or synergies between systems (Markard et al., 2011). On top of that, policy experimentation is becoming more critical in S3 literature as part of policy transfer and policy frameworks (Veldhuizen and

Coenen, 2022), which, again, is already covered by CCIs being innovators through methods such as co-creation, design thinking and open innovation.

Regarding the proposed research questions, integrating CCIs into S3 design is the second part of the research questions proposed in this paper. However, conceptual research initially developed a framework for applying the actor-network theory in S3. Conceptual linkages between the theory and the idea of S3 have been clearly shown in the literature review and put together to develop a design framework based on actor-network theory. In this discussion, S3 is still seen as a place-based concept (Kristensen and Pugh, 2022; Santos et al., 2022), but this paper clearly claims that usually applied theories such as place-based approaches need to be overcome in S3 research as they are either limited in their explanations or not applicable for S3 design in a sustainability transition matter, e.g. the mismatch of place-based approach and cross-border cooperation in EDPs.

As mentioned, integrating CCIs into S3 design is crucial to link the quadruple-helix approach as an actor involvement concept towards sustainability transition supported by the mediator position underlined by actor-network theory. Even though, CCI potential for innovation design and processes on different levels (Gerlitz and Prause, 2021), only few research items have so far elaborated CCIs in S3 design context (Cooke and De Propris, 2011; Meyer et al., 2022), mainly considering cultural heritage of CCIs as one of the thematic priority areas (Farinós, 2021; Gustafsson and Lazzaro, 2021). As illustrated in Figure 1, the actor-network theory framework showcases this positioning of CCIs as mediators within a S3 region and among the quadruple actor helices.

This conceptual paper contributes to the ongoing research discourse on the theoretical justification for S3 design and implementation. Here, introducing the actor-network theory as the backbone of S3 design is a novelty and theoretical contribution to existing literature. The overlaps of the theory and S3 concepts have been identified and exposed in the second chapter, leading to the finding that actor-network theory is a valid theoretical backbone for S3 analysis and future design. However, the discussion is initiated from the results and insights gained from the articles, which are the basis of this thesis. Hence, it is necessary to elaborate further on the theory and its applicability for S3.

Due to its conceptual nature, the research needs to be revised. The developed conclusions and framework need empirical evidence as they are only driven by an extensive literature review and synthesis of existing knowledge towards new insights. However, the research papers' objective is not to fully explain the status quo but to enable new thinking and changing mindsets to explain and understand innovation policy and governance approaches under S3. This paper is a starting point for more conceptual and philosophical research and ideas on potential theory applications and enhancements to minimize the still-existing gap between theory and practice regarding S3 design and implementation on all affected levels.

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START-UP ECOSYSTEMS: THE EXPERIENCE OF LATVIA, LITHUANIA, ESTONIA*

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Abstract. The present article aims to empirically confirm the role of start-up ecosystems in shaping and increasing the role of entrepreneurial activity in the socio-economic development of the Baltic countries (Latvia, Lithuania, Estonia). The following tasks were addressed sequentially: determining the relevance of the topic of start-up ecosystems, reflecting the given multifaceted phenomenon in the socio-economic works by contemporary authors, and examining the experience of teams of international research projects focused on start-up ecosystems. Subsequently, the role of start-up ecosystems in the Baltic countries was assessed from a comparative standpoint. The paramount factors that serve as significant positive conditions for their impact on start-up ecosystems and the factors that hinder their positive dynamics were identified. The empirical basis for the research was international research projects: Global Start-up Ecosystem Report, data science competition platform Kaggle, Global Entrepreneurship Monitor (GEM), Global Talent Competitiveness Index (GTGI)), Global Competitiveness Report by World Economic Forum, as well as the authors' own research studies on entrepreneurial activity and entrepreneurial universities. Causal and comparative analyses were used as the main research methods. During the research work, the terminology used was clarified so that it matched the main subject of the study – start-up ecosystems as the most important factor in the development of the innovative economy of countries and regions. A ranking of the factors that most positively influence the effectiveness of start-up ecosystems, especially from the perspective of their financing opportunities, were carried out. The study results showed the importance of start-up ecosystems among other drivers of the country's socio-economic growth. The role of higher education, state and municipal support in expanding the practice of start-up ecosystems was also shown. In this aspect, it is extremely important to expand the practice of entrepreneurial education for students of all specialities, gradually transforming educational and research higher schools into entrepreneurial universities.

Keywords: start-up ecosystems; innovative economy; crowdfunding; entrepreneurial universities; Latvia; Lithuania; Estonia

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1. Introduction

The term "start-up" is usually used to describe young companies that seek both rapid growth (Blank & Dorf, 2012) and scaling of their business. These companies often operate in innovative fields and strive to create new products or services that have potential to change the market. In the late 1990s and early 2000s, start-up activity and culture became widespread due to the development of the Internet and the technology boom. Many successful companies such as Google and Amazon were founded during that time. Since then, start-ups have become more popular in various countries and types of economic activity; they continue developing and attracting the attention of entrepreneurs from all over the world. In recent years, start-up ecosystems as a collection of several digital platforms with different products and services in online/offline modes as part of an integrated process have developed in many regions and cities around the world, and states have begun to actively support their development through financing programmes and business incubators (Androniceanu & Georgescu, 2022; Sharma & Goyal, 2024)

The start-up ecosystem plays an important role in attracting and retaining talent, stimulating economic growth, and fostering innovative solutions (Bikse et al., 2020; Macalik, 2021; Becker & Endenich, 2023).

It describes a set of factors, conditions and resources that contribute to the development and support of start-ups in a certain location or region (Kirsanov et al., 2023). The ecosystem creates a favourable environment for the creation, growth and success of start-ups, providing access to financing, expertise, infrastructure, network connections, and other resources that entrepreneurs may need (Ratanova & Voročuka, 2019; Popovici et al., 2021; Belitski & Büyükbalci, 2021; Montero & Parga, 2023).

According to the *Start-up Genome* report (Global Start-up Ecosystem Report), the most developed start-up ecosystems are in the following countries: the USA, the UK, Canada, Israel, and Germany. These countries stand out for their innovative approaches, availability of investment and favourable environments for the development of start-ups. The *Start-up Genome* report highlights the top 10 most successful start-ups, which include companies such as Stripe, SpaceX, Instacart, DoorDash, Robinhood, Canva, Brex, Ginkgo Bioworks, Samsara, and Flexport (Start-up Genome, 2023).

The main interconnected components of the start-up ecosystem include:

- Financing, i.e., the involvement of investors, venture funds, banks and government programmes that are ready to invest in start-ups during the early stages of their development and subsequent growth. Incubators and accelerators, which include organizations that provide space, resources, and expertise for start-ups, help them in both development and scaling (Prabhakar et al., 2023);
- Technology parks and infrastructure, i.e., all the clusters, regions or zones where high-tech enterprises, universities and scientific research centres are concentrated, providing access to technical resources and innovative expertise (Condom-Vilà, 2020; Banal-Estañol et al., 2023);
- Education and research institutions, including universities, colleges and research institutes that provide educational programmes and research activities, which create an innovative and entrepreneurial culture (Dedusenko & Elina, 2022; Voronov et al., 2023);
- A network and community of entrepreneurs, investors, mentors and experts who share knowledge, experience and support each other. Ideally, government support facilitated by a government programme, that encourages the creation and development of start-ups, tax incentives, regulatory frameworks and policies that promote innovation and entrepreneurship (Font-Cot et al., 2023).

Participants in the "start-up ecosystem" market and successful companies launching start-ups are fraught with many problems, and any mistake can harm or destroy the company. However, a large number of start-ups are

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being involed in ecosystems to provide the company with a competitive advantage to succeed in uncertain times through the following factors: tax benefits and financial incentives; shared workspace to reduce costs; access to qualified employees and clients; availability of resources; collaboration and exchange of ideas; education and training; legal and regulatory assistance; balance between open innovation and intellectual property protection. Such ecosystems can enable start-up success, potentially reducing current failure rates by approximately 90%.

2. Literature review

Let's analyse the reflection of the concerns on issues regarding the "start-up ecosystem" in the authoritative Scopus database. The number of publications reflecting this issue in scientific editions indexed in the Scopus scientometric database amounted to 995 articles. According to the Scopus database, researchers from the USA (175 publications), India (98) and Brazil (74) were the most active ones in their consideration of the issues that are of our interest (Figure 1).

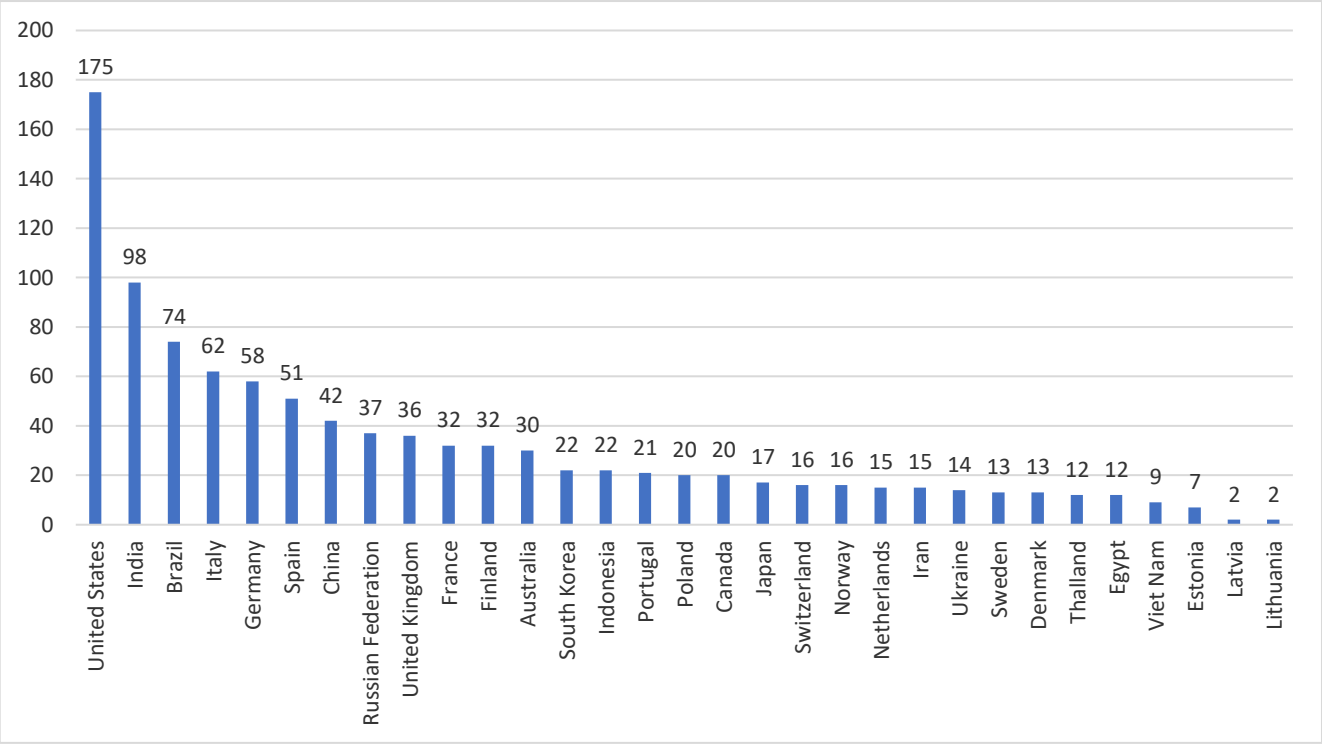


Figure 1. Number of publications in different countries, which contain the words "start-up ecosystems" in the title, abstract or keywords within the Scopus database from 2019 to 2023.
Source: elaborated by the authors based on SCOPUS database

In this distribution of scientific activity on the current research topic of "ecosystems" and "start-ups", Estonia leads among the Baltic countries with 7 publications, while Latvia and Lithuania have 2 publications each. The results displayed in Figure 2 confirm the high interest of scientists from various fields of science in this particular topic.

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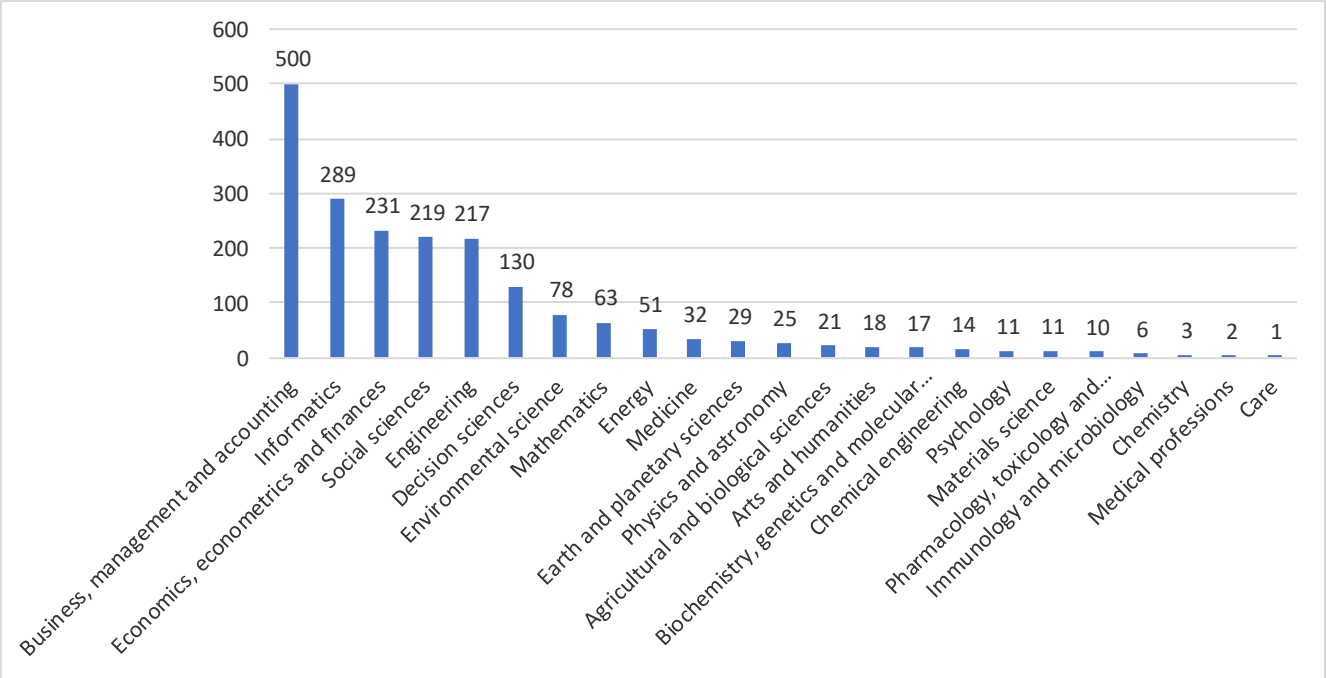


Figure 2. Subject areas reflecting ecosystem issues and start-ups in scientific publications indexed in the Scopus scientometric database in the period from 2019 to 2023.

Source: elaborated by the authors based on SCOPUS database

The majority of publications relate to business, management and accounting (25%), followed by computer science (15%). At the same time, 23% of the total number of publications are represented by economics and other social sciences.

The analysis of publications on the topic of *ecosystems* and *start-ups* showed that most often researchers of this topic cite the 2017 work by a group of authors that analyses the development of financial technology ecosystem using the example of a youth microcredit start-up in China (Leong Carmen et al., 2017). This study examines the development of a financial technology company in China that offers micro-loans to college students. The results show how digital technologies 1) provide a company with a strategic opportunity to fill a market niche in the financial sector, 2) enable the generation of alternative credit ratings based on non-traditional data, and 3) improve the financial inclusion of previously excluded market segments.

Researchers of the given issue also often cite the work published in 2017 by a group of scientists, which examines connections within the start-up ecosystem using the example of St. Louis in the USA (Motoyama & Knowlton, 2017). The researchers critically considered the way the entrepreneurial ecosystem is structured. Previous research in this area had discussed the presence of elements in the system or described the ecosystem as holistically as possible, extending to the social, cultural and institutional dimensions. However, it was found that such aggregate conceptualizations provided a limited understanding of how different elements are connected and constitute the system. In the 2017 study, the authors applied a social network approach to analyse ecosystem connections at multiple levels: (1) among entrepreneurs, (2) among support organizations, and (3) among entrepreneurs and key support organizations. Through a series of interviews with entrepreneurs and support organizations in St. Louis, the authors found out the following: the ways in which the support organizations in the

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region interacted with each other and with the entrepreneurs, including explicit interorganizational collaboration and the strategic structuring of resources, significantly influenced the way the entrepreneurs interacted with each other, and with the organizations, thereby deepening the understanding of the connections and identifying intermediate points within the ecosystem.

Start-up ecosystems have a positive impact on the creation of new businesses and the entire economy and, accordingly, attract the attention of both scientists and policymakers. However, although entrepreneurial ecosystems reflect high levels of entrepreneurial activity, they vary significantly in the proportion of female founders, which means that some ecosystems are not realizing their true potential (Berger & Kuckertz, 2016). This study uses qualitative comparative analysis to examine the combinations of ecosystem characteristics that explain the high proportion of female founders in the 20 most successful start-up ecosystems around the world. The results suggest two different configurations that explain the high proportion of female founders and indicate which issues require attention at the metropolitan level and which may require the involvement of national policymakers. These results contribute to the ecosystem literature and relate to the flow of women's entrepreneurship.

Among the authors from the Baltic region, the most frequently cited article is the one by Nolte (2019) on the connection between software developers in a certain IT field and start-up founders attracted by a special format of competition between beginners and experienced professionals. Time-limited events such as hackathons (forums for developers, during which specialists from different areas of software development such as programmers, designers, managers work together to solve a problem), code festivals, and other relatively short-term events for the exchange of experience have become a global phenomenon. Entrepreneurial hackathons, in particular, have gained widespread popularity because of their potential to become the birthplace of the next potentially billion-dollar venture. However, there is limited understanding of whether and how hackathon participants and start-up founders are related beyond studies of individual events focusing on hackathons as an entry point for start-ups. To fill this gap, a study was conducted on a dataset covering 44 hackathons over three years and 489 start-ups in the north eastern European country - Estonia. The results show that hackathons are not always the start of entrepreneurial activity, but can still be useful in the later stages as a means to develop future products, find future employees, etc. The results presented in this article are based on the initial analysis of this large data set and thus represent the starting point of a larger study of the relationship between hackathons and start-up communities, which was still in the planning stages at the time of publication of the article.

3. Theoretical basis and methodology of the research

The study used general and special methods: historical – to study the degree of knowledge of the problem; analytical-synthetic, comparative – to identify trends in the field of start-up ecosystems based on the collected empirical material; inductive – for generalization, systematization of the conclusions. To differentiate the number of international studies, the typological analysis method was used, and the content analysis method was used to study documents. Particular attention is paid to the study of ecosystem factors that influence the success of start-ups. Knowing these factors helps one understand the context, in which start-ups develop and determine the aspects of the ecosystem that need to be improved. Ecosystem benchmarking allows one to compare start-up ecosystems in different countries or regions. Studying differences in connections, structure, and dynamics between ecosystems helps identify the strong and weak points of each ecosystem (Zaidi et al., 2023), learn from best practices (Audretsch et al., 2018), and facilitate the sharing of best practices (Lee & Shin, 2017).

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4. Start-up ecosystems of the Baltic countries in the mirror of international research

A start-up is a company or project created by an entrepreneur to find, develop and test a scalable business model. While entrepreneurship refers to all new businesses, including self-employment and businesses that never intend to incorporate, start-ups refer to new businesses that intend to grow beyond the individual founder. Start-ups initially face high uncertainty and high failure rates, with only a few achieving success and impact (Gundolf, 2017).

The Kaggle dataset provides information on countries and cities with the best start-up ecosystem in 2021. Kaggle is a data science competition platform and online community for data scientists and machine learning scientists, operated by Google LLC. Kaggle gives users the ability to discover and publish datasets, explore and build models in a web-based data science environment, cooperate with other data scientists and machine learning engineers, and participate in competitions to solve data science problems.

In total, 100 countries and 983 cities are represented in the Kaggle ranking. Ranking metrics used: the overall score is equal to the sum of the quantity, quality and business score indicators. Quantity assessment: metrics related to quantity (e.g., number of start-ups, number of coworking spaces, etc.). Quality score: metrics related to quality. Business assessment: a combination of business and economic indicators (see Table 1 and Figure 3).

Table 1. Kaggle ranking of cities

Position	City	Country	Overall score	Number of points	Quality score	Business score indicator
1	San Francisco	USA	328.966	29.14	296.02	3.8
2	New York	USA	110.777	11.43	95.55	3.8
3	Beijing	China	66.049	5.01	58.61	2.43
4	Los Angeles (area)	USA	58.441	11.23	43.41	3.8
5	London	UK	56.913	15.77	37.44	3.7
6	Boston area	USA	49.835	5.5	40.53	3.8
7	Shanghai	China	42.162	3.57	36.17	2.43
8	Tel Aviv (district)	Israel	27.084	4.04	19.92	3.13
9	Moscow	Russia	25.401	7.37	15.64	2.39
10	Bangalore	India	25.367	5.04	17.95	2.38
155	Riga	Latvia	3.685	0.59	0.3	2.79
84	Vilnius	Lithuania	6.037	1.37	1.42	3.25
135	Kaunas	Lithuania	4.302	0.73	0.32	3.25
797	Klaipeda	Lithuania	0.176	0.02	0.02	0.14
66	Tallinn	Estonia	6.888	1.14	2.44	3.31
275	Tartu	Estonia	1.139	0.14	0.11	0.88

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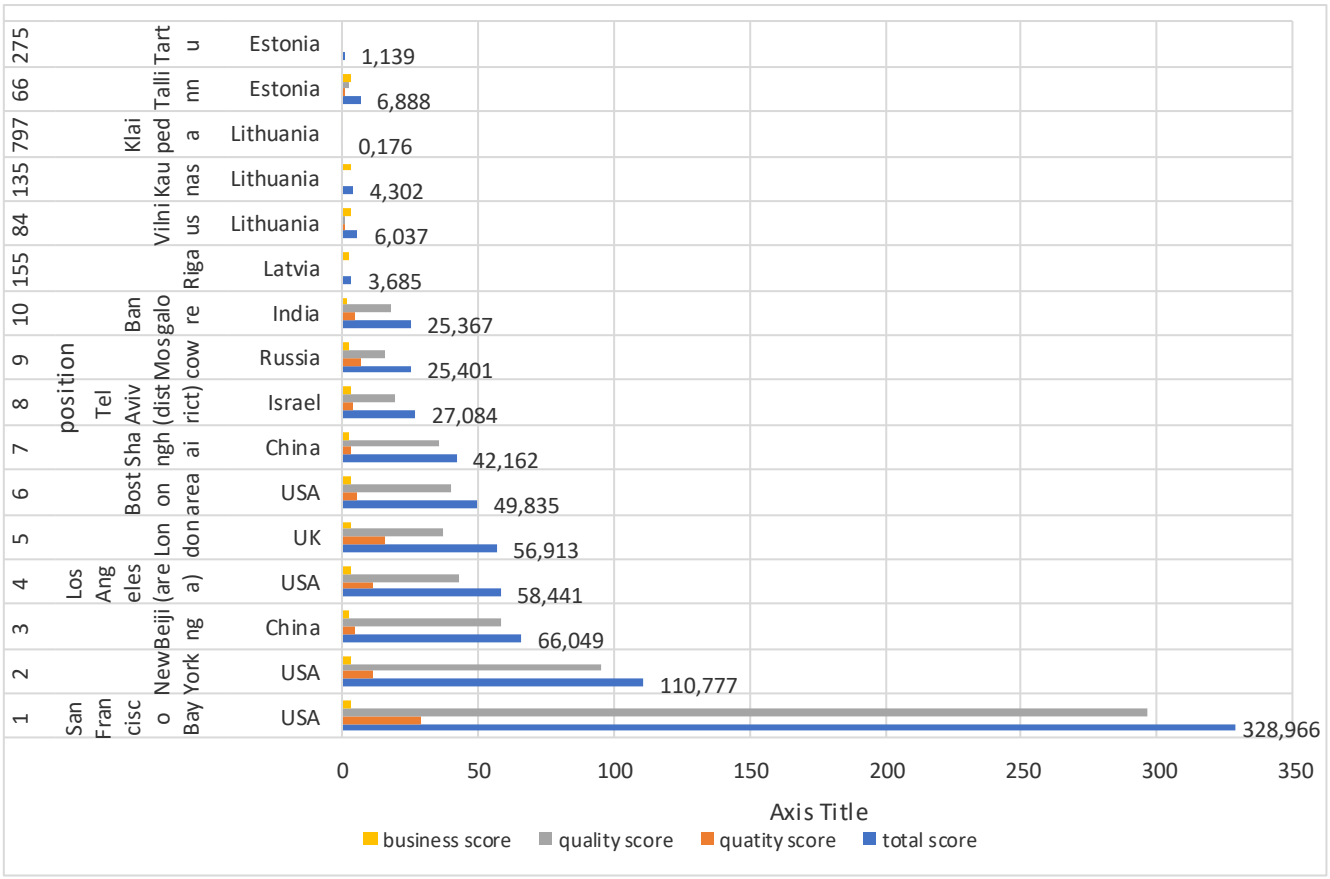


Figure 3. The best cities and countries for start-ups, including Latvia, Lithuania, and Estonia.

Source: elaborated by the authors based on Kaggle

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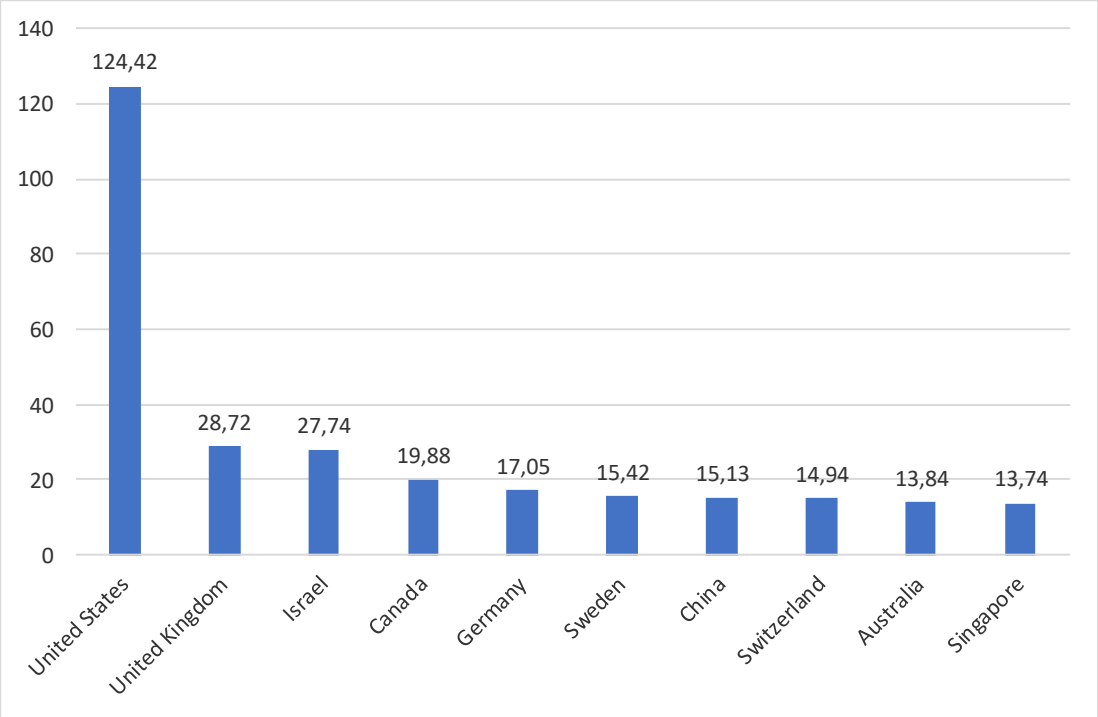


Figure 4. Top 10 countries for start-ups (3 indicators)

Source: elaborated by the authors based on Kaggle

Figure 4 shows that the USA dominates the rankings with an exceptionally high overall score of up to 124,42. The average overall score of all the countries (except the USA) is only 4,878. (Kaggle)

The overall score is calculated as the sum of three different indicators (quantity, quality and business), as each of these three indicators is taken into account when calculating the overall score. The bigger part of the overall score is due to the high-quality score. Quality Score and Overall Score have a bidirectional cause-and-effect relationship.

Overall score	1.000	0.959	0.988	0.481
Number of points	0.959	1.000	0.914	0.577
Quality score	0.988	0.914	1.000	0.351
Business score	0.481	0.577	0.351	1.000
	Overall score	Number of points	Quality score	Business score

Figure 5. Correlation matrix for a country dataset).

Source: elaborated by the authors based on Kaggle

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The correlation graph provided above (Figure 5) confirms our assumptions that Overall Score and Quality Score have an extremely high level of correlation (0.988), while Business Score has the lowest level of correlation (0.481).

There are international studies of start-up ecosystems that examine and compare the ecosystems of different countries. Some of the most significant research studies are listed below.

Global Start-up Ecosystem Report: an annual study conducted by Start-up Genome that analyses and compares start-up ecosystems around the world. It evaluates various factors, including availability of funding, quality of resources, business culture and other indicators.

Global Entrepreneurship Monitor (GEM): the largest international study of entrepreneurship, including data on start-up ecosystems in different countries. It studies the factors influencing entrepreneurial activity such as potential opportunities, perception of opportunities, financing and others.

European Start-up Monitor (ESM): ESM focuses on research into start-up ecosystems in Europe. It provides information on start-ups, investments, incubators, accelerators and other factors influencing the start-up environment in the region.

Digital start-up ecosystems in the MENA region: this study conducted by the Organization for Economic Co-operation and Development (OECD) examines the Middle East and North Africa (MENA) start-up ecosystems. It analyses investments, legal frameworks, quality of education and other factors.

There is no central registry of start-ups in Europe, and national registries typically do not consider the degree of innovation, growth goals or sources of funding when starting a business. This makes it difficult to find data on these specific types of businesses. In fact, all start-ups are small and medium-sized enterprises (SMEs) (Adams et al., 2016) (Bereczki, 2019).

European Start-up Monitor (ESM): ESM focuses on research into start-up ecosystems in Europe. It provides information on start-ups, investments, incubators, accelerators and other factors influencing the start-up environment in the region. The EU Recommendations (2003/361) define Small Medium Enterprises (SMEs) by the number of employees, as well as by turnover or balance sheet amount. In the case of start-ups, this is difficult to measure because a start-up may have a large number of employees, and simultaneously it may have a not significant turnover of the employees (19.8%). In addition, the initial capital for business development is usually much higher (sometimes millions) for a start-up than for an SMEs. Sources of funding are also often very different (see Figure 6). Support from business-angels (29.0%), venture capital (26.3%) or crowd investors (18.1%) is more common among start-ups rather than SMEs, which often rely only on traditional bank loans or founders' savings.

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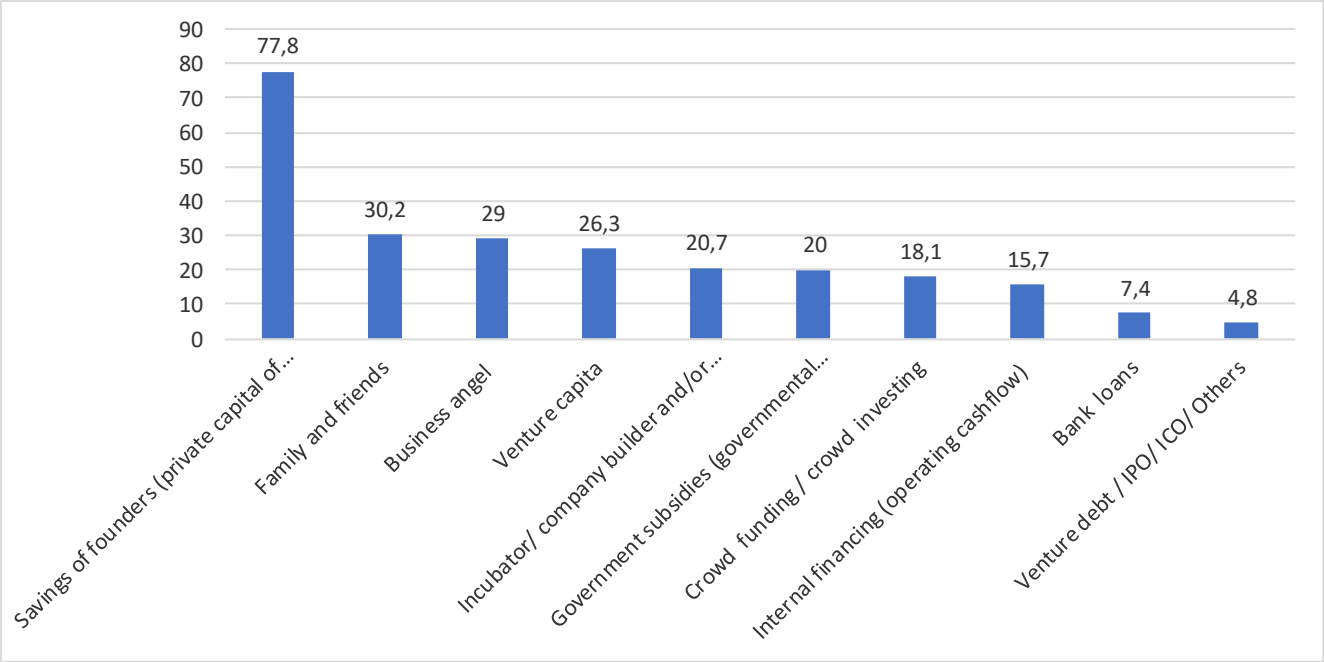


Fig. 6. Start-up funding sources

Source: elaborated by the authors based on EU-Start-up-Monitor-2018

The sectors in which start-ups are active can be described as very diverse. Most companies provide a product or service online. While sectors such as IT/software development (19.1%) or "Software as a Service" (18.5%) are still well represented, new companies have also been created in trending sectors such as "Green technology" (4.0%) and in the financial sector (5.1%). Geographically, the largest European start-up centres have been established in London, Berlin, Paris, Copenhagen and Lisbon. Typically, start-ups develop in five stages: the early stage, the start-up stage, the growth stage, the later stage and the sustainable stage. The majority of start-ups operate in business-to-business (B2B) markets (82.1%) and generate their revenue entirely (46.5%) or primarily (25.3%) through interactions with other companies. The main places where revenue is generated are mainly in continental Europe (84.2%), with a strong emphasis on the start-up's country of origin (62.4%), followed by other European Union countries that are part of the euro area (17.7 %), USA (8.9%), which, among others, is the most popular international market (Gundolf et al., 2017).

This annual study conducted by Start-up Genome analyses and compares start-up ecosystems around the world. It evaluates various factors, including availability of funding, quality of resources, business culture and other indicators.

5. Research results and discussion

In the Baltic countries, the leadership in the development of start-up ecosystems belongs to Estonia, which, in 2023, occupied the 14th position in the world, overtaking Finland. Estonia continues to lead the Baltic countries with an overall score 23.8% higher than the one of Lithuania. Estonia tops the rankings compared to other countries with a population of less than 2 million people, and is significantly ahead of, for example, Latvia and Cyprus. Estonia now has 3 start-up ecosystems out of the top 1000; in 2022, it had only 2.

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One of the most important milestones in the history of the Estonian start-up ecosystem was the success of Skype, an application developed mainly in Estonia. Skype's founders used this windfall to support new successful Estonian start-ups such as Skycam, Teleport and SpaceApe, to name a few. The "Skype Mafia," as they are called, shows that one single launching can seriously influence the culture of an entire start-up ecosystem. The Estonian public sector has also undertaken effective and aggressive marketing efforts, the likes of which we have not seen anywhere else in the world. Examples of this include several innovative projects that started in Estonia and are now being copied by dozens of governments around the world: Estonian e-Residency, visas for start-ups and digital nomads, and digital branding of companies. These efforts are resulting in increased country awareness and branding among digital nomads and small business owners in many developing countries, an impressive achievement for a country with a population of less than 2 million. The small population also means that start-ups in Estonia face strong competition for talent, and the public sector faces a difficult task in supplying the booming start-up scene with a constant flow of foreign workers. According to Statistics Estonia, every 56th person of Estonia's working population was involved in start-ups, and the top 20 start-ups created 59% of jobs in the sector in 2022, proving the country's need to attract talent from abroad. Work in Estonia programme, launched by the Estonian government, aims to attract new IT professionals, as well as talent in the field of natural and exact sciences. So far, the country seems attractive to foreigners and has managed to double its international talent pool over the past 5 years.

The country has successfully established itself as a leader in information technology, cybersecurity and public administration. Estonia positions itself as a start-up-oriented economy. However, Estonia still faces some challenges on its path to economic growth. First, initiatives such as e-residency and the digital nomad visa may attract lifestyle-oriented businesses to Estonia rather than start-ups that might be expanding globally or seeking access to capital and potential customers. Secondly, the country should also carefully move from being a development hub, where companies from richer countries can come to develop start-ups (e.g. Skype, Playtech), to creating its start-ups at the local level, especially taking into account that the cost of living in Estonia is rising in accordance with the economic success of the country. In addition, the country has proven that it can create global success stories such as Wise, Bolt and Pipedrive. According to Whitepaper of Start-up Estonia 2021-2027, the country continues to support its growing start-up ecosystem, has set several goals aimed at increasing the share of the Estonian start-up and technology sector to 15% of the national GDP by 2025, and is also actively promoting holistic start-up thinking. As the main government initiative for the Estonian ecosystem, Start-up Estonia is involved in policy development and promoting and strengthening the ecosystem. Additionally, through events such as Latitude59, the country continues to attract international attention and investment every year.

According to Start-up Estonia and Statistics Estonia, in the first half of 2023, the average gross salary of employees who worked at least one day in start-up companies reached 3,243 euros, which is almost double the average salary in Estonia. Compared to the same period last year, start-up employee salaries increased by 14 per cent. (Global Start-up Ecosystem Report, 2023).

Eve Peeterson, Start-up Estonia – CEO, said that competition for highly qualified labour in the Estonian technology sector is still high. "At the same time, it is clear that start-ups are looking for ways to save money and optimize costs, and, unfortunately, this has also led to layoffs. However, the number of employees in the start-up sector as a whole has not decreased, i.e., laid-off start-up employees usually quickly find jobs at other start-up companies. The role of foreign talent in the technology sector also remains important, as they fill positions that the local labour market cannot fill.

According to the Tax and Customs Board, the growth in the number of employees in Estonian start-ups has slowed down but has not gone into decline. At the end of the first half of 2023, the Estonian start-up sector employed 9,927 people, which is one per cent more than in the same period a year earlier. The average salary of Estonian employees in local start-ups was 3,163 euros, while the average salary of employees from abroad

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reached 3,288 euros. Start-up employees aged 41-50 receive the highest average monthly gross salary, with an average salary of €3,921 per month in the first half of this year. They are followed by workers aged 31-40 with a monthly salary of 3,614 euros. The highest salaries are found in start-ups working in the cyber technology sector, where the average salary reaches 4,230 euros. This is followed by the communications services sector, where workers earn an average of 3,967 euros per month. The top three also included transport and logistics start-ups with an average monthly salary of 3,742 euros. 61% of employees of Estonian start-ups are men, 39% are women. The employees of Estonian start-ups are also relatively young: 44% of employees are aged 31-40 and another 41% are aged 21-30. (The average.., 2023).

As of the first half of 2023, the largest employer in the Estonian start-up sector was Wise with 1,899 employees. The company increased the number of employees by 114 people compared to the end of last year. The second largest employer in the Estonian start-up sector is Bolt, the start-up employs 1,290 people, which is 20 people more than at the end of 2022. The top three largest employers also include Swappie with 409 employees. The number of start-up employees decreased by 78 people compared to the end of last year. According to the Tax and Customs Board, in the first half of 2023, Estonian start-ups paid a total of 108 million euros in labour taxes to the state. This is a third more than a year ago. The largest payers of labour taxes were Bolt (17.5 million euros), Wise (17 million euros), Veriff (4.9 million euros), Monese (2.8 million euros), Glia (2.4 million euros).

Over the past few years, Estonia has emerged as a European leader in school education, which provides good preconditions for improving the quality of higher education and the development of start-ups. Estonian students are recognized as the best in Europe according to the PISA (Program for International Student Assessment) ranking, an international study that evaluates the quality of education of 15-year-olds in different countries every three years. Students are tested in three categories: reading, math and science. This time, 81 countries took part in the study. Asian countries traditionally rank high in the rankings, and this year, in addition to Singapore, the Chinese enclave of Macau, Taiwan, Japan and South Korea showed strong results. All of these states ranked among the top ten in the world in each of the three categories. This study has been conducted by the Organization for Economic Co-operation and Development (OECD) since 2000 (BBC NEWS.2023).

According to the Global Start-up Ecosystem Report, Lithuania consistently ranks 17th in the world. Lithuania remains close to the top ten in Europe (11th place) and ranks 9th in the EU. In the Baltics, Lithuania (2nd place) is closing the gap with Estonia (1st place), showing a score difference of 23.8% in 2023 compared to 28.5% in 2022. Lithuania has 3 cities in the world's top 1000, one city in the top 100 and one city in the top 200. This makes Lithuania the only country in the Baltics with two cities in the top 200. There are two cities in the country that enter the top 200. Well-known start-ups and champions of the Lithuanian ecosystem, already in the early 2020s attracted attention in the start-up world with several interesting developments and initiatives: *TransferGo*, a company created in Lithuania, became one of the successful start-ups in the field of finance and financial technology. The company provides international money transfer services. *Vinted* is a Lithuanian start-up created for clothing exchange and sale. In 2021, Vinted attracted significant investment, highlighting investor interest in technology companies in Lithuania. The *Qoorio* platform, also based in Lithuania, provides the opportunity to connect with experts in various fields and share knowledge. It is also actively attracting attention. The national agency *Start-up Lithuania* actively supports and develops the start-up ecosystem in the country by providing resources and programs for start-ups. Another interesting Lithuanian start-up is *Vlipsy*, a platform for searching and sharing GIF images that can be integrated into various instant messengers and social networks. *Nord Security* operates as an online privacy and security provider for individuals and businesses. *Eneba.com* – digital games store. *Eneba* is quickly becoming a popular place to find the best gaming deals. Through friendly business regulation, government funding support and an open data policy, Lithuania's public sector has created an environment conducive to the development of start-ups. Start-up Lithuania, a one-stop shop for start-ups in the country, promotes a start-up visa for foreign entrepreneurs and allows you to obtain a temporary residence permit for up to a year. In addition, Lithuania boasts a start-up worker visa, an initiative aimed at attracting highly skilled

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workers. Other important players in the start-up ecosystem are Go Vilnius, an organization that attracts innovation to its ecosystem, and Kaunas University of Technology, which nurtures and trains talent. According to the Global Start-up Ecosystem Report, in terms of business assessment, Latvia ranks 11th in the EU and 24th in the world, which indicates a business environment favourable to start-ups. The country lags behind its Baltic rivals, with a score difference of more than 3 times that of Estonia and 2.5 times that of Lithuania. Riga, the only Latvian ecosystem included in the top 1000, was ranked 173rd in the world and ranked 13th in Eastern Europe.

Despite the slow pace, Latvia is starting to benefit from several public sector initiatives that make it an attractive destination, such as innovation vouchers and a start-up-friendly regulatory system. Latvia has also launched a Start-up Visa programme aimed at attracting foreign entrepreneurs. The key public sector organization supporting the ecosystem, Magnetic Latvia, operates under the Investment and Development Agency of Latvia (IDAL) and provides comprehensive services for foreign founders wishing to start a business in Latvia.

The Riga start-up ecosystem also boasts several private sector organizations that contribute to the development of the ecosystem, such as BuildIt Latvia, an accelerator that helps hardware start-ups and IoT start-ups. The programme started in Estonia but is ongoing in Latvia, demonstrating the promising potential of the ecosystem. Venture capital investment is essential to creating scalable start-ups. One of the organizations pursuing this goal is the Latvian Private Equite and Venture Capital Association (LVCA). The mission of the organization is to promote the development of the venture capital industry in Latvia and the Baltic region. A critical issue for Latvia is brain drain as skilled workers emigrate to other EU countries; the public sector should do more to demonstrate the benefits of staying in Latvia. Outstanding start-ups and champions of the ecosystem Mintos is an investment platform for the financial services sector. 4finance is Europe's largest online and mobile consumer finance group, providing convenient and responsible access to credit in 16 countries. Sonarworks is an innovative start-up in the field of audio technology. Several business support programmes are implemented in Latvia. The most popular support programmes mentioned by students in our sociological survey were those of the Latvian Investment and Development Agency (LIDA), primarily business incubators and investment incentive programmes, as well as assistance programmes for start-up entrepreneurs implemented by the financial institution Altum. Some students also mentioned local (municipal) support programmes.

Among the types of support that can be received within the framework of the programmes, the students noted the following: assistance in starting a business (both material and intangible), possible financing – partially or fully, risk assessment and management, office or production premises and equipment necessary for business, meetings with existing experienced entrepreneurs – assistance in exporting competitive products or services, preparation of necessary documents, filling out declarations and assistance from an accountant. At the same time, we need a state programme for at least a pilot project to create two or three entrepreneurial universities so far, which will allow us to have our own experience in removing economic, social and cultural barriers to the modernization of our higher education, and the emergence of our strong business leaders here (Menshikov et al., 2021).

Five leading organizations representing the Latvian financial technology sector have sent a joint letter to the Ministry of Finance and the Bank of Latvia calling for specific amendments to regulations to adapt the best practices of the fintech market from neighbouring countries to Latvia and thereby increase the attractiveness of Latvia for new entrants to the country and innovative enterprises, said Mārtiņš Puķe, board member of the Latvian Blockchain Development Association (Mixnews.lv, 2023). Representatives of the organizations Latvian Blockchain Development Association, Fintech Latvia Association, Latvian Start-up Association, Latvian Association of Payment and Electronic Money Institutions, as well as the Latvian Crowdfunding Service Providers Association call on decision makers to provide fintech service providers with the opportunity to access the international SEPA settlement system directly through the Bank of Latvia. It is also necessary to ensure the possibility of opening payment accounts at the Bank of Latvia for financial technology service providers.

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Accessing the SEPA system directly through the Bank of Latvia would provide several benefits that would make Latvia an attractive choice for financial technology companies. A similar step was taken by the Central Bank of Lithuania, which, by developing the CENTROlink system, helped Lithuania rise to the status of a financial technology power. The Lithuanian fintech sector has shown remarkable development over the past decade, growing almost fivefold in seven years, from 55 fintech companies in 2014 to more than 260 companies in 2021, and creating more than 6,000 well-paying jobs. Latvia also has the opportunity to act to become more attractive to companies operating in the financial sector, including innovative start-ups, without investing huge amounts of money in creating infrastructure, by introducing modern regulation that is suitable for the modern business environment.

In recent years, the start-up ecosystem in the Baltic countries has shown some growth and attracted the attention of investors. However, as with any developing ecosystem, certain problems and challenges may arise. The following selection comprises emerging start-ups within start-up ecosystems, with a focus on those situated within the Baltic countries:
1. Many start-ups have difficulty raising enough funding to scale their businesses. This may be due to an insufficient number of investors or difficulties in the process of attracting investment.
2. Lack of experienced investors who can provide not only financial support but also valuable advice and connections.
3. Finding highly qualified specialists.
4. Legal and regulatory complexities can also create barriers to start-up development.

Many start-ups need a variety of funding sources to reduce risk and ensure sustainable growth.
The ChatGPT chatbot and similar platforms can play an important role in the start-up funding sector in the Baltics by providing support and information in various aspects. A chatbot can:
1. provide information about available grants, investment opportunities, competitions and support programmes for start-ups in the region.
2. give advice and consultation on financial strategies, business plans, and raising investments, which will help entrepreneurs effectively manage the finances of their start-ups.
3. provide educational content on financial literacy that will help entrepreneurs better understand and effectively manage their finances.
4. help entrepreneurs prepare the information necessary to attract investment and provide recommendations for creating attractive investment proposals.
5. ensure interaction between entrepreneurs and financial institutions, simplifying the process of obtaining financial support and assisting in establishing contacts with potential investors.

Overall, the chatbot can be a valuable tool for improving entrepreneurs' access to information and resources in the field of financing, which in turn contributes to the development of the start-up ecosystem in the Baltic countries.
Unfortunately, crowdfunding is little used outside the United States – a method of financing projects, enterprises or ideas in which funds are raised from a large number of people, usually via the Internet. Instead of depending on traditional sources of funding such as banks, investors or government agencies, projects or entrepreneurs can reach out to the general public and ask them for small monetary contributions. The idea behind crowdfunding is that many people, called "crowdfunders" or "backers," can contribute small amounts of money to a project or venture that interests them. These small contributions can add up quickly and provide the funding you need. Crowdfunding can be used to support a variety of ideas and projects, including the creation of new products, films, music albums, books, research studies, charity events and much more.

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There are several main crowdfunding models, including:
1. The most common type of crowdfunding, where projects are posted on specialized online platforms, such as Kickstarter, Indiegogo, and attract funding from those interested.
2. Share-Swap Crowdfunding: in this model, investors contribute funds in exchange for a share in future profits or shares of the company.
3. Crowdfunding is about loans, not investments or donations.

Crowdfunding allows developers and entrepreneurs to raise funds and gauge interest in their ideas before the production or implementation of a project begins, and it has gained popularity due to its ability to attract support from a wide audience. The USA, China and the UK are traditionally large markets for crowdfunding. Among the crowdfunding platforms that help budding entrepreneurs is Kickstarter. Kickstarter can help: *To host projects*: people who need funds to implement their ideas can create a project on Kickstarter. This project can be related to art, design, technology, film, music, gaming and many other fields. *To publish information*: the creators of the project describe their idea, fundraising goals, deadlines and rewards for sponsors. This allows potential donors to understand where they are spending their money. *To fundraise*: people from all over the world can become sponsors of the project by contributing money to the fundraiser. Kickstarter operates on an all-or-nothing basis, meaning that a project should meet or exceed its financial goal to receive funding. If the goal is not achieved, the money is returned to the sponsors. *To receive awards*: As gratitude for the support, the creators of the project offer awards to sponsors. Rewards can range from commendations and beta versions of the product to exclusive offers or even your own copies of the work. *To promote help*: Kickstarter also provides some tools and resources to help creators promote and promote their projects. This may include marketing tips, community support, and more.

Kickstarter helps people overcome financial barriers and turn their ideas into reality. It also allows donors to support projects and ideas they love and gain access to unique products and experiences. Of course, young people, including students, can also participate in obtaining funding on platforms similar to Kickstarter to finance their projects, ideas or research. However, there are some obstacles and restrictions that may arise if the platform refuses to cooperate:
1. Age restrictions: some Kickstarter platforms may require users to be a certain age (such as 18 years old) to create projects and raise funds.
2. Geographic restrictions: some platforms restrict access to their services to residents of certain countries or regions. This may create a barrier for students from some locations.
3. Legal and regulatory restrictions: some platforms may have restrictions on project types or fundraising due to legislation or platform policies. For example, some projects may involve illegal activities or copyright infringement.
4. Lack of project support: the platform may refuse cooperation if the project does not meet their criteria or does not provide sufficient information about the goals, budget and execution plan.
5. Insufficient funding: if a project does not attract enough funding from potential funders or does not reach its stated goal, the platform may close it or refuse to allocate funds.
6. Violating platform rules: if aspiring entrepreneurs or their projects violate platform rules and policies, they may be rejected or removed.
It is important to get acquainted with the rules and requirements of the specific platform on which the project proponents intend to raise funds and ensure compliance with them to increase the chances of a successful collaboration.

In our opinion, issues of financing and quality of education in schools, colleges and universities can also be considered key for the further development of start-up ecosystems in the Baltic countries. Among our most important arguments for this conclusion are the following:

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1. Education serves as the basis for training the personnel needed for the start-up sector. Highly qualified and technically trained specialists can become engines of innovation and the successful development of start-ups.
2. Entrepreneurship-focused education can help students develop key skills such as creativity, mobility, leadership, analytical thinking and problem-solving - all qualities that are important for entrepreneurs and start-up workers.
3. Higher education also provides students with access to research and innovation opportunities, which can contribute to the emergence of new ideas and technological solutions.
4. Quality educational institutions actively collaborate with the business community, giving students the chance to participate in real projects and gain experience working in start-ups.
5. Adequate funding for educational programs is important to ensure high-quality teaching and support innovative research. Investments in education can help create an enabling environment for start-ups to thrive.

Thus, a balanced focus on the quality of education and the provision of financial resources in this area is an important element of a successful start-up ecosystem in any country, including the Baltic countries.

Conclusions

Summarizing the results of using start-up ecosystems in the Baltic countries, we note their identified strengths and weaknesses, differentiated by country. The strengths are as follows. Estonia is a leader in the field of e-government, which promotes the development of start-ups in the fields of cybersecurity and electronic services. In all three Baltic countries, there are technology parks, incubators and accelerators that provide support and resources for the development of start-ups. Programmes such as the Estonian Start-up Entrepreneur Visa help attract talented entrepreneurs and professionals from around the world. Low tax rates, relatively low living costs and government support create a favourable business environment. There is investor interest in start-ups in the region, especially in the fintech and e-commerce sectors.

Weaknesses of start-up ecosystems in the Baltic countries. Small national markets can create limited opportunities for start-ups to scale, forcing many companies to seek international expansion. A favourable business environment and attractive conditions for start-ups can lead to competition for talented personnel. In some industries, such as biotechnology or raw materials, expertise and resources are quite limited. Some countries may be heavily reliant on certain sectors, such as IT technology, which can make ecosystems vulnerable to changes in those industries. In some cases, certain industries may be underinvested, making it difficult for start-ups to develop in those areas.

Our analysis shows that over the past few years, the Baltic countries (Estonia, Latvia, Lithuania) have seen significant growth in start-up ecosystems. Here are some key features and trends: Estonia has become a leader in the field of e-government, which has contributed to the development of start-ups in the areas of electronic identification, cybersecurity, and e-government technologies. Estonia provides special visas for start-up entrepreneurs, which has become a magnet for talented people from all over the world.

Lithuania provides favourable conditions for entrepreneurship, including low taxes and relatively low living costs. Vilnius has become a popular place for investment in technology start-ups, and the city actively supports the development of innovative companies. Riga provides technology parks and incubators to support start-ups, such as TechHub Riga and the Latvian Start-up Association. Latvia is actively developing the financial technology sector, with many start-ups working in the field of digital payments, blockchain technologies, and other financial innovations.There are various initiatives in the region aimed at supporting start-ups, such as the Baltic Start-up Hub, which brings together the entrepreneurial communities of the Baltic countries. In all the Baltic countries, there is a noticeable strong investment activity in start-ups, especially in sectors such as technology, e-commerce, financial technology, medical technology.

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DEVELOPMENT OF THE CIRCULAR ECONOMY IN POLAND AND THE CZECH REPUBLIC – A COMPARATIVE ANALYSIS *

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Abstract. The Circular Economy (CE) concept has gained significant traction in recent years, both in the academic and industrial sectors. Recognised as a potential game-changer in addressing the escalating environmental challenges posed by the linear economic model, the CE proposes a sustainable alternative that maximises the value of resources while minimising waste. Despite its increasing relevance, there needs to be more consensus on the definition and appropriate indicators for assessing the CE. This paper addresses these gaps by presenting an integrated analysis of various definitions of the CE and proposing a set of indicators. Five common elements across definitions of the CE were identified, and ten key indicators associated with these five elements were selected. Based on these indicators, the development of the Circular Economy in the Czech Republic and Poland was analysed. The findings show that Poland needs to concentrate its initiatives on streamlining waste management and preserving stability in dependency on imports of raw materials. Simultaneously, the Czech Republic should mitigate its burgeoning dependency on imports of raw materials and augment its resource efficiency. The research methods utilised in this study include literature review, content analysis, comparative analysis, and statistical analysis. The findings reveal significant insights into CE practices in the countries studied, leading to an improved understanding of CE from a theoretical and practical perspective.

Keywords: circular economy; resource efficiency; sustainable development; green economy; economic development

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JEL Classifications: Q56, O44, Q01

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1. Introduction

The Circular Economy (CE) concept has emerged as a pivotal paradigm shift in recent years, attracting the attention of the academic and industrial sectors. With the linear economic model increasingly becoming unsustainable in the face of increasing environmental challenges, the CE offers a promising alternative framework that not only seeks to reduce waste but also strives to optimise the value of resources. This shift towards circularity underscores the urgency to transition from a 'take-make-waste' approach to a more sustainable and regenerative system. However, as the CE gains in prominence, there is reason for critical concern arising due to the lack of consensus regarding its precise definition and the appropriate indicators for

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evaluating its implementation (Korhonen, 2018; Corvellec, 2021; Koval et al., 2023). The vagueness surrounding the definition of the Circular Economy has given rise to a multiplicity of interpretations, adding complexity to both academic discourse and practical implementation (Blomsman, 2020). While the fundamental principles of the CE emphasise resource efficiency, waste reduction, and closed-loop systems, variations in interpretation have created ambiguity in its operationalisation.

This paper aims to fill these gaps by presenting a comprehensive analysis of various definitions of the CE and proposing a set of indicators that can holistically assess initiatives in the area of the CE. Additionally, this study introduces a novel approach by conducting a comparative analysis using quantitative methods to explore the implementation of the CE in Poland and the Czech Republic. By combining data from expert interviews and extensive secondary sources, this research provides insights into sustainable practices. It is further supported by a systematic literature review that highlights its academic relevance and identifies research gaps. This methodology ensures a nuanced understanding of the CE's challenges and advancements toward more sustainable practices, emphasising the importance of this comparative study.

These elements serve as a foundation for constructing a unified understanding of CE and facilitate the subsequent development of a set of key indicators for evaluating its progress in two distinct countries, Poland and the Czech Republic. By applying the developed indicators, we aim to shed light on the challenges and opportunities facing each nation on its journey towards a more Circular Economy. Through a meticulous blend of literature review, content analysis, comparative analysis, and statistical examination, this study endeavours to contribute theoretically and practically to the discourse on the CE, offering valuable insights into its implementation and implications within these unique contexts.

Despite the comprehensive approach, this study is limited by its reliance on quantitative data, which may not capture the full scope of socio-cultural factors influencing CE practices. Focusing solely on Poland and the Czech Republic may also limit the applicability of our findings to other contexts. Furthermore, the temporal scope of the data may not reflect ongoing or future developments.

In the next part of this paper, we review existing theoretical definitions of the Circular Economy. Based on this overview, we then develop a set of five key elements of the Circular Economy and 10 indicators of implementation of the Circular Economy at a national level. The empirical study presented in the third part of the paper conducts a comparative analysis to identify the differences between Poland and the Czech Republic in the approach to and level of implementation of principles of the Circular Economy. The paper concludes with a discussion of the main results.

2. Theoretical background

Corvellec (2021) observed that the Circular Economy (CE) frequently demonstrates conceptual fragmentation due to varied interpretations and applications (Korhonen, 2018; Blomsma, 2020), potentially leading to a perceived deficiency in paradigmatic coherence (Inigo, 2019). As documented, over a hundred interpretations of circularity have surfaced, indicating that the term possesses a range of meanings contingent on individual perspectives. This variation in interpretation leads to different conceptions of the Circular Economy across various theoretical settings (Kirchherr, 2017; Andronicean et al., 2021). From a practical point of view, the concept focuses on the minimisation of waste, where the end of a product's lifecycle requires retaining its constituent materials within the economic system, as much as possible, through recycling (Parliament, 2023). The concept of a Circular Economy (CE) has gained significant attention in both the academic and practical spheres. Previous reviews of the concept of the Circular Economy have been undertaken by many authors, such as Ghisellini et al. (2016), Lieder and Rashid (2016), Sauvé et al. (2016), Murray et al. (2017) and Lewandowski (2016). CE is a departure from the traditional linear economic model and is increasingly embraced as a viable alternative.

One can conceptualise a Circular Economy as an economic system that champions the prudent utilisation of resources through waste reduction, preservation of value over the long term, minimising the use of primary

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resources, and the promotion of closed-loop products, components and materials, with a keen focus on environmental protection and socio-economic benefits (Morseletto, 2020). In such an economy, emphasis is placed on creating products engineered for longevity, reusability, and recyclability and sourcing raw materials from pre-existing products. In essence, this model promotes reuse, remanufacturing, recycling, and energy recovery and treats disposal as a last resort. The realisation of a Circular Economy pivots on the adherence to the principles of the 3Rs - reduction, reuse, and recycling of materials. It manifests in production and consumption activities due to the interpenetration of material and energy flows within these sectors (Heshmati, 2015). A significant proliferation can be observed around the "Rs" framework, leading certain investigators to expand the waste hierarchy to encompass up to 10Rs (Charef et al., 2022). Currently, the Circular Economy concept is garnering widespread popularity as a potential framework for sustainable future development, and is being championed by the European Union, as well as several national governments. In a report from 2014, the European Commission posited that transitioning towards a Circular Economy in EU countries could yield up to 600 billion euros in annual economic benefits for the EU manufacturing sector alone (European Commission, 2014). Moreover, the European Circular Economy Stakeholder Platform showcases more than 150 significant practices, innovative processes, and experiential learnings related to the implementation of the Circular Economy concept across Europe (European Circular Economy Stakeholder Platform, 2018). Academic interest in the Circular Economy has also surged, with a notable uptick in articles and journals focusing on this topic in the past decade (Geissdoerfer, 2017; Zecca et al., 2023).

However, the definition of the Circular Economy is not fixed. Still, it encompasses a wide range of principles and proposals that have been articulated over the years, including 'regenerative design', 'performance economy', 'Cradle-to-Cradle' and 'industrial ecology'. In Table 1, selected definitions of the Circular Economy are presented.

Table 1. Selected definitions of the Circular Economy

Author	Definition
Preston (2012), p. 1	A 'circular economy' (CE) is an approach that would transform the function of resources in the economy. Waste from factories would become a valuable input to another process – and products could be repaired, reused or upgraded instead of thrown away.
Ellen MacArthur Foundation (2013), p. 7	A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models (Foundation, Towards the circular economy. Economic and business rationale for an accelerated transition., 2013)
Chinese National People's Congress, (2013)	*The term "circular economy" […] is a general term for the activity of reducing, reusing and recycling in production, circulation and consumption* (China, 2013)
European Environment Agency (2014)	Circular economy "refers mainly to physical and material resource aspects of the economy […] it focuses on recycling, limiting and reusing the physical inputs to the economy, and using waste as a resource, leading to reduced primary resource consumption (Agency, 2014).
European Commission (2015)	An economy *where "the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste is minimised"* (Commission, Circular Economy, 2015)
Kirchherr et al., p. 221-232 (2017)	A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations (Kirchherr, 2017).
Figge et al., (2023), p. 2	The circular economy is a multi-level resource use system that stipulates the complete closure of all resource loops. Recycling and other means that optimise the scale and direction of resource flows contribute to the circular economy as supporting practices and activities. In its conceptual perfect form, all resource loops will be fully closed. In its realistic, imperfect form, some use of virgin resources is inevitable (Figge et al., 2023)

Source: Own elaboration

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Although there are numerous proposals for defining a Circular Economy in the literature, most definitions share some common elements. Firstly, **systemic nature**: the Circular Economy is described as a system operating at multiple levels – micro, meso, and macro, encompassing all stages of the economic process, from production to consumption. Secondly, the **3R principle**: reduction, reuse, and recycling are key components of the concept, emphasising waste minimisation and optimisation of resource utilisation. Thirdly, **resource loop closure**: the overarching idea is to close the resource loops, aiming to maintain the value of products, materials, and resources in the economy for as long as possible while minimising waste generation. Fourthly, **transformation**: the Circular Economy is presented as an approach intended to transform how resources function in the economy, moving from an "end-of-life" concept towards business models and strategies enabling continuous value utilisation and recovery. Fifthly, **sustainable development**: all definitions underscore the goal of a Circular Economy to promote environmental quality, economic prosperity, and social equity, contributing to sustainable development for current and future generations (Fig. 1).

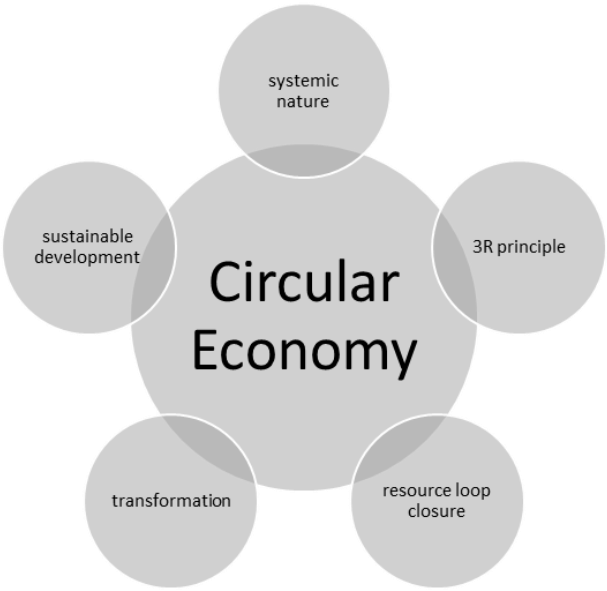


Figure 1. Key components of the Circular Economy
Source: Own elaboration

Based on the verified five components of CE, ten indicators were selected that are connected with them:

- **Systemic nature**: this aspect speaks to the integrated and holistic nature of the Circular Economy. It relates to indicators such as "Greenhouse gas emissions from production activities" and "Share of renewable energy in gross final energy consumption", which signify the interconnectedness of production, consumption, and energy use within the system. "Material import dependency" also falls into this category, showing the extent to which the system relies on external inputs.
- The **3R principle** (Reduce, Reuse, Recycle): this principle encapsulates the essence of the Circular Economy and directly connects to the “Recycling rate of municipal waste” indicator. This principle also relates to “Generation of plastic packaging waste per capita”, measuring the success of reducing and recycling initiatives specifically related to plastic waste.
- **Transformation**: this element corresponds to the transition from a linear to a Circular Economy. The “Circular material use rate” indicator reflects this transition, quantifying the percentage of material usage following circular practices.
- **Sustainable development**: indicators such as “Resource productivity”, “Consumption footprint”, and “Material footprint” pertain to this principle. They evaluate whether economic activities are sustainable and resource-efficient. The indicator 'Waste generation per capita' also relates to sustainable development, gauging the degree to which waste reduction is achieved.

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By connecting these indicators to the common elements of a Circular Economy, we can evaluate the implementation and effectiveness of a Circular Economy in the Czech Republic and in Poland in a more comprehensive and systematic manner. The crucial issue is monitoring the implementation of the Circular Economy. Many sets of indicators have been proposed for this purpose in the literature. For instance, The OECD Inventory of Circular Economy Indicators proposed 474 circular-economy-related indicators (OECD, 2020), UNECE categorised 17 indicators into four groups (UNECE, 2021), the European Commission proposes 26 indicators (Commission, Measuring progress towards circular economy in the European Union – Key indicators for a monitoring framework, 2018) and the French Minister for the Ecological Transition proposes 11 indicators (Transition, 2021). The indicators used to measure the CE also are based on the developments of sustainable development indicators (e.g., Sustainable Development Indicators by UNEP, Sustainable Development Goals by UNDP or Little Green Data Book by the World Bank (EASAC, 2016), as well as green economy indicators (Green Growth Indicators by the OECD, Green Economy Indicators by UNEP or Global Green Economy Index by Dual Citizen (Daniek, 2020).

Ten indicators were selected for the analyses (Table 2), and based on these, the development of the CE in the Czech Republic and Poland was examined. The indicators were selected based on a literature review. They are also proposed in the EUROSTAT Circular Economy indicators category.

Table 2. Selected indicators to compare the Circular Economy in the Czech Republic and Poland

Recycling rate of municipal waste	This metric quantifies the percentage of municipal waste that is recycled. It is calculated by dividing the total weight of recycled municipal waste by the overall amount of municipal waste produced. Recycling in this context includes the processes of material recycling, composting, preparation for reuse, and anaerobic digestion. Municipal waste primarily originates from residential sources but can also encompass waste from small businesses and public institutions that is collected by municipal services. The composition of this waste can differ significantly across various municipalities and countries, reflecting local variations in waste management practices. For regions lacking municipal waste collection services, the generated waste quantity is typically estimated.
Resource productivity	This indicator calculates the efficiency of material use in relation to economic output, expressed as the ratio of Gross Domestic Product (GDP) to Domestic Material Consumption (DMC). DMC measures the total amount of materials an economy utilises directly. It encompasses the total of raw materials mined or harvested within the country, added to all physical imports, and subtracted by all physical exports. In this context, 'consumption' within DMC denotes apparent consumption, which does not include final consumption, and it does not account for the upstream processes related to the international trade of raw materials and products.
Circular material use rate	The metric assesses the proportion of reclaimed material reintegrated into the economy, thereby curbing the necessity for extracting new primary resources. Known as circular material use (CMU) or circularity rate, it denotes the ratio of recycled materials to total material consumption. Total material consumption is derived from aggregating domestic material consumption (DMC) and recycled materials, with DMC delineated in economy-wide material flow records. The circular use of materials is estimated by subtracting imported recyclable waste from domestically recycled waste and adding exported recyclable waste. A heightened circularity rate implies greater utilisation of secondary materials over primary ones, consequently mitigating the environmental repercussions of primary resource extraction.
Greenhouse gas emissions from production activities	This metric presents the greenhouse gas emissions stemming from all production operations within the EU economy. It notably encompasses emissions from international air travel by EU-based airlines while excluding emissions from individual households. Quantified in kilograms of CO2 equivalents per capita, it provides insight into the environmental impact of economic activities within the EU.
Share of renewable energy in gross final energy consumption by sector	The indicator measures the share of renewable energy consumption in gross final energy consumption according to the Renewable Energy Directive. The gross final energy consumption is the energy used by end-consumers (final energy consumption) plus grid losses and self-consumption of power plants.
Consumption footprint	The consumption footprint indicator assesses the ecological impact of consumption within the EU and its member states. It achieves this by amalgamating data on consumption levels and the environmental impacts of representative products. This indicator covers five key consumption areas: food, transportation, housing, appliances, and household goods. Consumption intensities are determined based on statistics related to consumer behaviour.

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Material import dependency	The dataset furnishes the percentage ratio of imports (IMP) to direct material inputs (DMI). Described as 'material import dependency,' it quantifies the degree to which an economy depends on imports to fulfil its material requirements. Material import dependency values cannot be negative or exceed 100%. A 100% value signifies that no domestic extractions occurred during the reference year.
Material footprint	The indicator quantifies the global demand for raw material extraction resulting from EU consumption and investment. Known as Raw Material Consumption (RMC), this metric illustrates the volume of raw materials necessary to manufacture consumed goods, accounting for both direct and indirect extractions worldwide. It is calculated by subtracting exports (measured in raw material equivalents, RME) from the total raw material input. The RMC provides valuable insights into the quantity and nature of materials required to satisfy the EU's demand for products.
Waste generation per capita	The indicator is formulated as the quotient of total waste, including major mineral wastes, produced within a country (encompassing all NACE activities and residential waste) and the country's average population.
Generation of plastic packaging waste per capita	This indicator concerns plastic packaging waste, where 'packaging' encompasses all items made of any materials intended for the containment, protection, and transportation of goods from producers to consumers. It includes non-returnable items serving the same purposes as packaging. 'Packaging waste' refers to any packaging or packaging material classified as waste according to the Waste Framework Directive 2008/98/EC, excluding production residues..

Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database, accessed: 01/07/2023).

3. Research objective and methodology

The aim of this research is to conduct a comparative analysis of the development and implementation of the circular economy in Poland and the Czech Republic. This study seeks to identify key drivers, challenges, and progress towards achieving a sustainable economic model that emphasises resource reduction, reuse, and recycling.

This research adopts a mixed-methods approach, combining quantitative data analysis with an in-depth examination of policy, cultural, and technological aspects to provide a comprehensive overview of the circular economy's status in both countries. This methodology was chosen for its ability to capture the complexity of economic systems and the multifaceted nature of the circular economy.

Primary data were collected through interviews with experts in the field of circular economy from both Poland and the Czech Republic, including policymakers, business leaders, and academics. Secondary data were sourced from government reports, industry analyses, scholarly articles, and international databases on recycling rates, waste management, and sustainability indicators.

The analysis involves comparing these data sets to identify trends, patterns, and disparities in the implementation of circular economy practices. Statistical tools and content analysis methods are employed to analyse quantitative data and qualitative information, respectively.

A systematic literature review was conducted as part of the methodology to understand the current state of research on the circular economy in Poland and the Czech Republic and globally. This review helped to frame the research within the broader academic discourse, identify gaps in the current literature, and justify the need for a comparative study. The literature review focuses on studies that examine policy frameworks, economic impacts, societal attitudes, and technological innovations related to the circular economy.

4. Results and discussion

This section presents the results of the comparative analysis concerning the development and implementation of circular economy practices in Poland and the Czech Republic. By examining a range of indicators, such as recycling rates, waste management efficiency, and material consumption patterns, the study sheds light on the achievements and challenges faced by each country in its transition towards a circular economy. The findings highlight the nuances of policy effectiveness, societal engagement, and the environmental impacts of current practices, offering a comprehensive overview of the progress and areas needing further action. Through this analysis, we aim to contribute valuable insights to the ongoing discourse on sustainable development and

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provide actionable recommendations for enhancing circular economy initiatives in the context of Poland and the Czech Republic.

4.1 Recycling rate of municipal waste

One of the pivotal indicators to assess the progress of a Circular Economy is the recycling rate of municipal waste, as it reflects how effectively an economy is capable of reclaiming and reutilising resources. Data analysis for the "Recycling rate of municipal waste" indicator for Poland and the Czech Republic from 2008 to 2021 reveals that both countries have made significant strides in municipal waste recycling, yet the pace and trajectory of progress varied somewhat.

In Poland, the rate of municipal waste recycling initially stood at 10.5% in 2008 but increased to 16.3% by 2010. However, in 2011, this figure dipped to 11.4%, possibly due to changes in waste management policies or fluctuations in the volume of waste generated. From 2012 onward, the rate began to rise steadily, reaching 26.5% in 2014. This could suggest that during this period, effective measures were implemented to promote recycling. Since then, the rate remained stable until 2019, subsequently increasing to 38.7% in 2020 and 40.3% in 2021.

In the Czech Republic, the municipal waste recycling rate consistently rose from 10.4% in 2008 to 43.3% in 2021. This rate experienced a particularly strong increase between 2011 and 2012, hinting at the introduction of effective policies or recycling-related technologies during this period. Aside from a slight drop to 32.1% in 2017, the Czech Republic displayed a steady increase in municipal waste recycling rate over the years analysed.

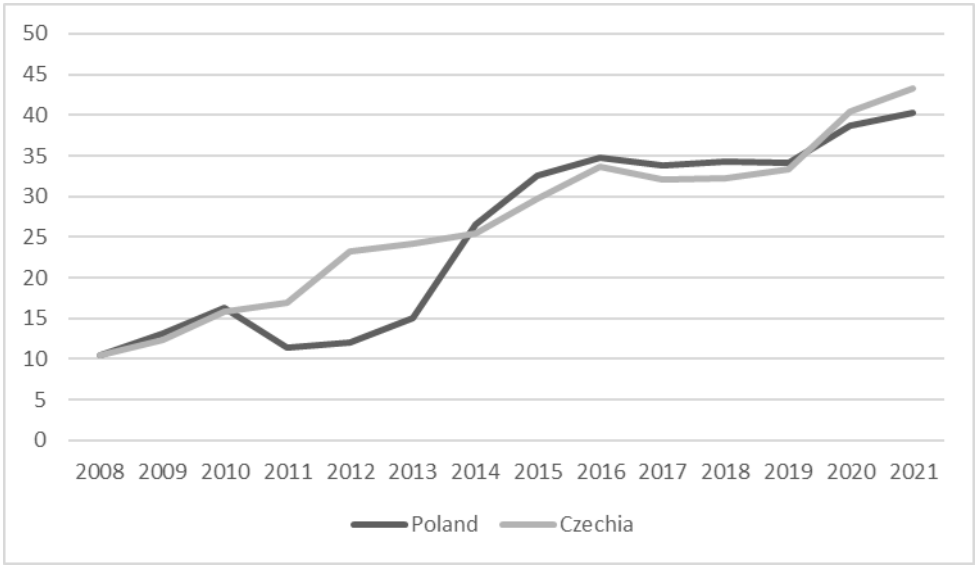


Figure 2. Recycling rate of municipal waste (%) in Poland and the Czech Republic, 2008-2021
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database, accessed: 01/07/2023).

In summary, while both countries demonstrated significant advancements in municipal waste recycling, the Czech Republic exhibited a slightly more stable and linear growth trend. Nonetheless, both countries have made considerable progress in this realm, a vital element of transitioning to a Circular Economy. Still, there remains room for improvement to achieve the European Union's goal of recycling 65% of municipal waste by 2035 (Commission, Circular Economy: New rules will make EU the global front-runner in waste management and recycling. Press release., 2018).

These outcomes may be associated with various factors, including differences in public policies, economic conditions, infrastructure, and societal awareness regarding recycling and the Circular Economy. For instance, the more stable growth trend in the Czech Republic could stem from earlier and more consistent implementation of policies promoting recycling and waste minimisation. Despite the initial variability in recycling rates, Poland

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has shown significant progress in recent years, potentially reflecting the effects of introduced reforms and growing societal awareness.

4.2 Resource productivity

In the context of a Circular Economy, resource productivity is a key indicator that measures how effectively an economy can generate value from available resources. Specifically, this indicator is defined as the ratio of Gross Value Added (GVA) to Domestic Material Consumption (DMC), and is expressed in euro/kg. Analysing data from 2008 to 2021 shows an upward trend observed in resource productivity for both Poland and the Czech Republic. This is an encouraging sign, suggesting that both countries are becoming increasingly efficient at deriving value from their resources.

Despite this general upward trend, differences in the pace and level of resource productivity between these two countries are also observed. Throughout the period under review, resource productivity in the Czech Republic consistently outperformed Poland, suggesting that the Czech economy was more efficient in generating value from its resources. The uncertainty observed in the data for Poland, particularly visible in 2010-2011, could point to certain structural issues that impacted resource productivity during this period. Despite this, the upward trend for Poland is sustained and has become more stable in recent years.

For the Czech Republic, while a generally stable upward trend is observed, data from 2021 shows a slight decline in resource productivity compared to the previous year. This could signal potential challenges or changes in resource management that may warrant further investigation. Resource productivity, as a measure of an economy's efficiency in utilising raw materials, is a crucial indicator within the context of a Circular Economy. Economies with higher resource productivity are capable of generating more value with less resource consumption, which aligns with the fundamental principles of a Circular Economy – minimisation of consumption of resources and maximisation of their utilisation.

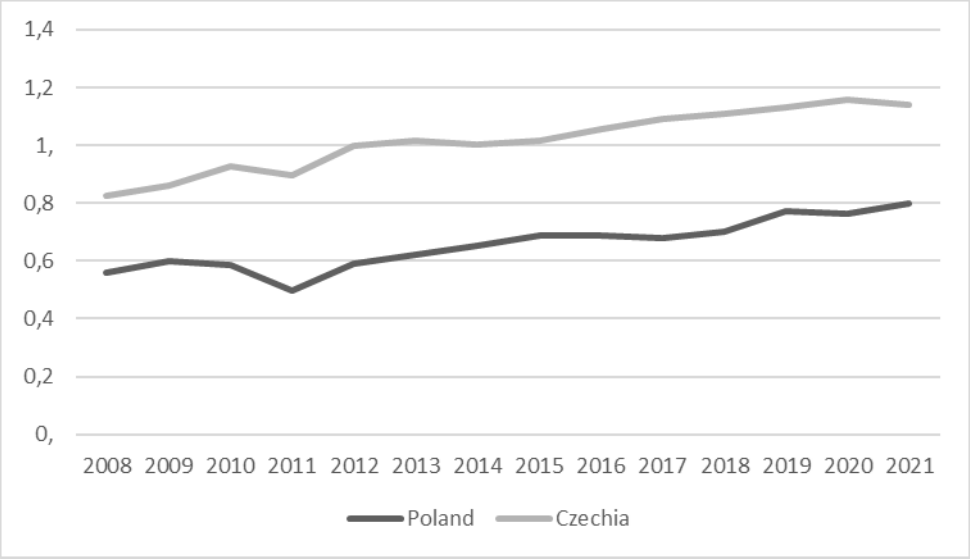


Figure 3. Resource productivity (euro per kg) in Poland and the Czech Republic, 2008-2021
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database, accessed: 01/07/2023).

The increasing resource productivity indices for Poland and the Czech Republic indicate positive changes in these economies' efficiency in using raw materials. This could suggest heightened innovation through support for the creation of start-ups (Redlichová and Chmelíková, 2012), the introduction of technologies providing greater efficiency, as well as effective resource management strategies.

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4.3 Circular material use rate

The Circular Material Use (CMU) rate is a significant indicator in the context of a Circular Economy. It measures the extent to which recycled materials are reintroduced into the economy, instead of procuring new resources, which is crucial for minimising resource consumption and waste.

An analysis of the data for the years 2010-2021 shows that both Poland and the Czech Republic demonstrate variability in terms of CMU.

For Poland, the CMU rate initially rises, peaking in 2014 (12.6%), after which a downward trend is observed until 2021 (9.1%). This variability could be attributed to several factors such as changes in economic policy, waste and recycling regulations, as well as changes in economic and market practices. The decline in the CMU rate in recent years could indicate challenges in maintaining the level of recycling and reintroduction of materials into the economy, which might require further analysis and policy interventions.

In the case of the Czech Republic, despite an initially lower level of CMU compared to Poland, a general upward trend is observed. In 2021, the CMU rate of the Czech Republic was 11.4%, which is higher than the result for Poland in the same year. This could suggest that the Czech Republic is more effective in reintroducing recycled materials into the economy.

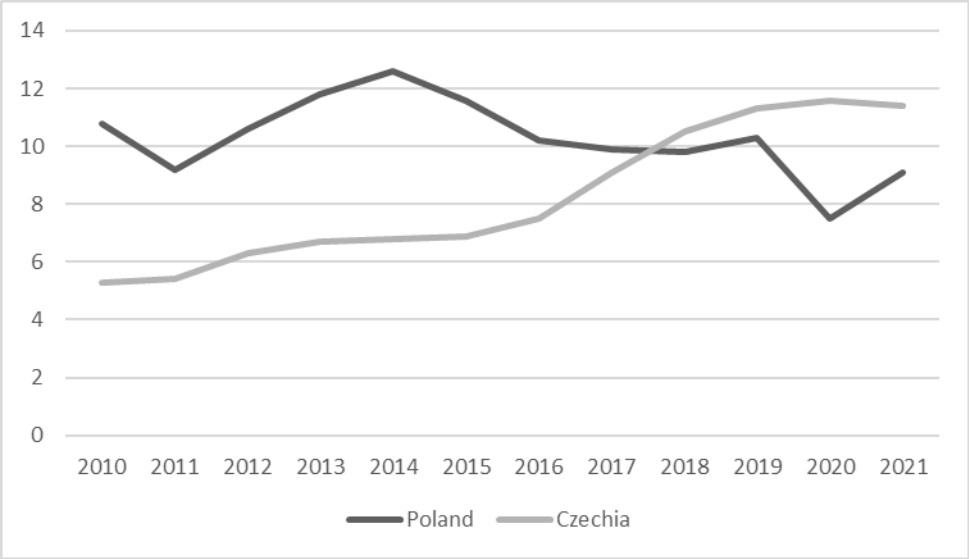


Figure 4. Circular material use rate (%) in Poland and the Czech Republic, 2010-2021
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database, accessed: 02/07/2023).

These results could have significant implications for the further development of a Circular Economy in both countries. In Poland, the decline in the CMU rate indicates the need for further actions to increase the reintroduction of recycled materials into the economy. In the Czech Republic, the continuation of the upward trend could yield further benefits in terms of reducing resource consumption and waste. In both cases, an effective Circular Economy policy promoting recycling and the reintroduction of materials will be key to further development.

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4.4 Greenhouse gases emissions from production activities

This indicator presents the emission of greenhouse gases from all production activities carried out in the EU economy. Data for Poland and the Czech Republic from 2008-2021 indicates certain trends and differences between these two countries.

In Poland, greenhouse gas emissions per capita from 2008 to 2021 show some degree of variability, but generally remain at a similar level. The highest indicator values are observed in 2008, 2010, 2017, and 2021, while the lowest value of the indicator is recorded in 2020. This trend may suggest that, despite the evolution in the economy and industry, greenhouse gas emissions per capita in Poland still remain at a relatively stable level.

Similarly, in the Czech Republic, some variability can also be seen in greenhouse gas emissions per capita for the years 2008-2021, but there is a clear general downward trend. The highest indicator values are observed in 2008, 2010, and 2011, while the lowest indicator value is recorded in 2020 (likely due to the outbreak of the pandemic and implemented restrictions). As for Poland, the trend of stability, despite some variability, suggests that the Polish economy, although experiencing changes over the period from 2008 to 2021, may not have made significant progress in reducing greenhouse gas emissions from production activities per capita. This situation may reflect Poland's maintaining of an intensive industrial sector based on traditional energy sources such as coal, which is known for high greenhouse gas emissions. Although Poland has made some efforts to diversify its energy sources and increase energy efficiency, these results suggest that these efforts may not have been sufficient to decisively change the emissions trend. The downward trend in the Czech Republic may suggest that this country is making more progress in reducing greenhouse gas emissions per capita, probably due to the implementation of more efficient technologies and production practices and a greater emphasis on ecological energy sources.

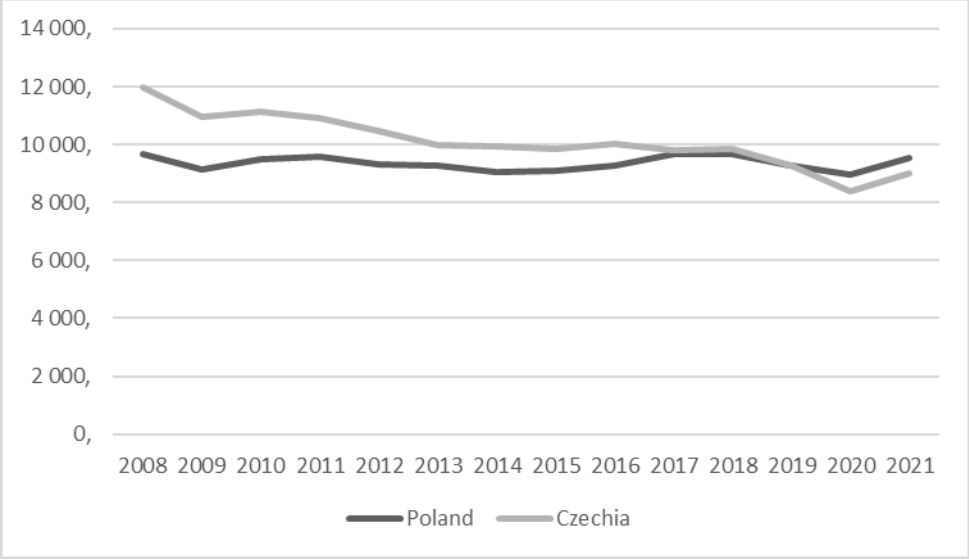


Figure 5. Greenhouse gases emissions from production activities (kg per capita) in Poland and the Czech Republic, 2008-2021
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database, accessed: 02/07/2023).

In general, these results indicate that both countries have different dynamics and effects in managing greenhouse gas emissions from production activities. This indicator is particularly significant in the context of a Circular Economy, where the aim is to minimise greenhouse gas emissions through efficient resource and waste management, recycling and reuse of raw materials, and promoting ecological energy sources.

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4.5 Share of renewable energy in gross final energy consumption

From the data, both Poland and the Czech Republic have significantly increased the share of renewable energy in their final energy consumption from 2008-2021. In 2008, the share of renewable energy was 7.686% in Poland and 8.674% in the Czech Republic. By 2021, these figures had increased to 15.624% and 17.667% respectively. This suggests that both countries have made substantial progress in replacing fossil fuels with renewable energy.

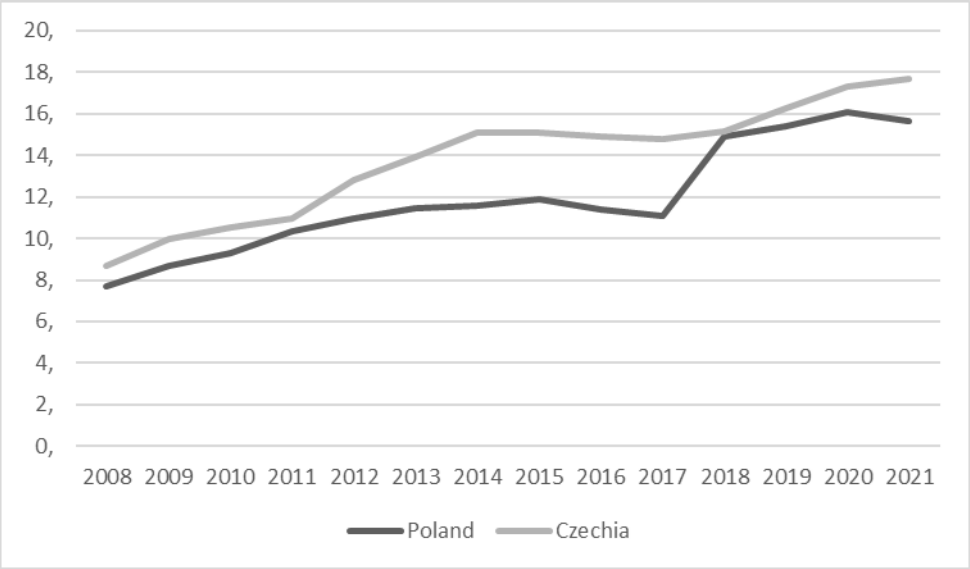


Figure 6. Share of renewable energy in gross final energy consumption (%) in Poland and the Czech Republic, 2008-2021
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database, accessed: 08/07/2023).

The differences between Poland and the Czech Republic may stem from various factors such as energy policy, the availability of renewable resources, and the technological and economic capabilities to exploit them. The Czech Republic shows a slightly higher level of renewable energy use, which may result from better infrastructure, more investment in renewable technologies, or differences in energy policy.

From the perspective of a Circular Economy, an increased share of renewable energy is beneficial as it allows for a reduction in dependency on fossil fuels, which are a non-renewable resource and cause the emission of greenhouse gases. Renewable energy sources such as wind, solar, or biogas allow for the 'closing of the loop' of energy where energy is not only consumed but also regenerated.

Despite the positive trend in both countries, it is worth noting that the average share of renewable energy in final energy consumption in the European Union was 22.4% in 2020, indicating that both countries still have some catching up to do compared to some other EU countries.

4.6 Consumption footprint

The Consumption footprint indicator, which measures the ecological footprint associated with consumption, shows that both Poland and the Czech Republic experienced an increase in this index from 2012-2021, indicating an increase in the environmental impact of consumption. This is consistent with the global trend related to the growing influence of human activity on the environment.

In Poland, this index increased from 100 in 2012 to 120 in 2021, indicating a 20% increase in consumption intensity over these years. In the Czech Republic, this increase was slightly lower, from 95 in 2012 to 108 in 2021, indicating a 13.7% increase. This increase is mainly due to a rising level of consumption in both countries,

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which could be the result of income growth, changes in consumption preferences, or a growing population. This indicator takes into account five areas of consumption: food, mobility, housing, household appliances, and household goods.

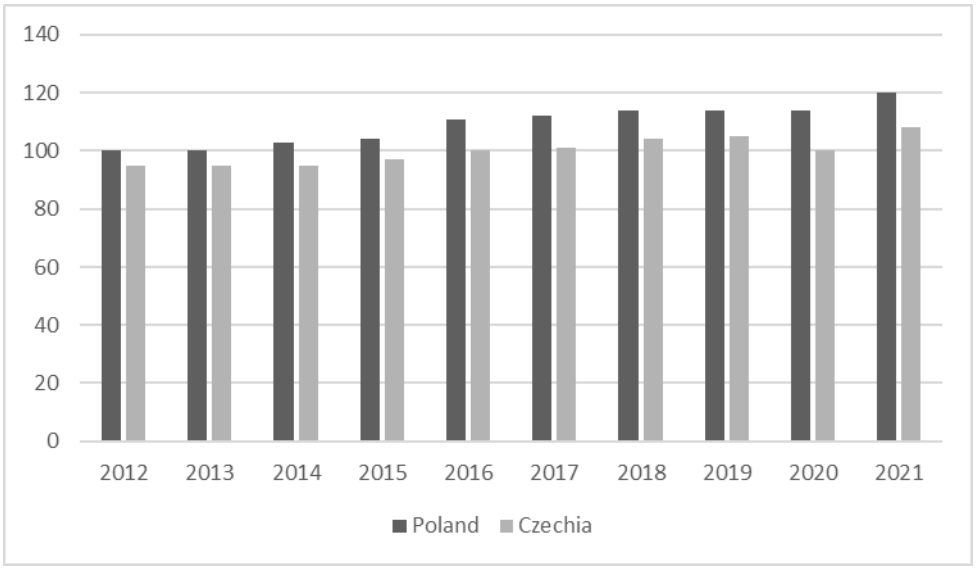


Figure 7. Consumption footprint (Index, 2010=100) in Poland and the Czech Republic, 2012-2021
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database , accessed: 10/07/2023).

However, it is worth noting that a Circular Economy aims to reduce the impact of consumption on the environment by promoting sustainable consumption and production, minimising waste, and maximising reuse and recycling. In the context of this indicator, strategies such as eco-design of products, extended producer responsibility, or encouraging changes in consumption patterns can contribute to reducing Consumption footprint.

Comparing these results with other EU countries, it's important to note that the average Consumption footprint for the EU in 2019 was 101.7, indicating that both Poland and the Czech Republic show a higher level of consumption impact on the environment than the EU average. This suggests that both countries could benefit from further investments and policies supporting sustainable consumption and production.

4.7 Material import dependency

The "Material import dependency" indicator measures the extent to which a country's economy depends on imported raw materials to meet its material needs. It is a key indicator for the Circular Economy, where the principle is to minimise resource consumption and maximise their reuse.

Over the years 2008-2021, we observe that Poland maintained a relatively stable level of dependence on imported materials, with a slight increase from 17.3% in 2008 to 19.7% in 2021. This indicates that despite ongoing economic development, Poland is able to maintain its dependence on imported materials at a comparable level, which may result from a relatively large amount of materials available domestically. In the Czech Republic, in contrast, we see an increase in dependence on imported materials from 26.3% in 2008 to 33% in 2021. This indicates an increase in the Czech Republic's dependence on imported materials, which could result from a limited amount of materials available domestically, increased consumption, or changes in the structure of the economy.

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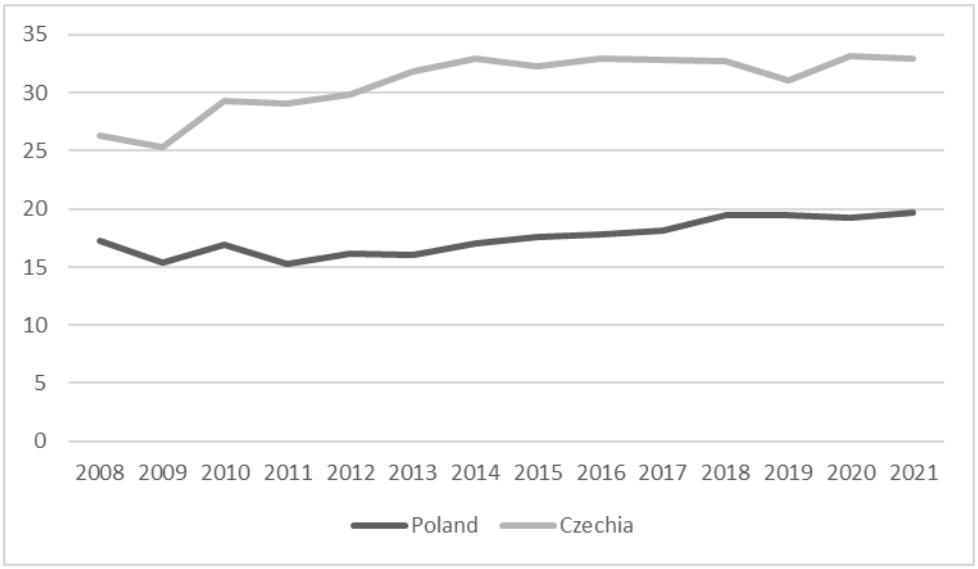


Figure 8. Material import dependency (%) in Poland and the Czech Republic, 2008-2021
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database , accessed: 10/07/2023).

From the perspective of the Circular Economy, a lower dependence on imported materials is preferred, as it indicates a country's greater ability to meet its material needs through recycling and reuse of materials. Therefore, both countries should aim to further increase resource efficiency and promote recycling to reduce their dependence on imported materials. In the context of previous studies, according to a 2020 Eurostat report, the average dependence on imported materials in the EU was 18.6%, suggesting that the Czech Republic is above and Poland is close to the EU average (Eurostat, 2020, "Material flow accounts and resource productivity").

4.8 Material footprint

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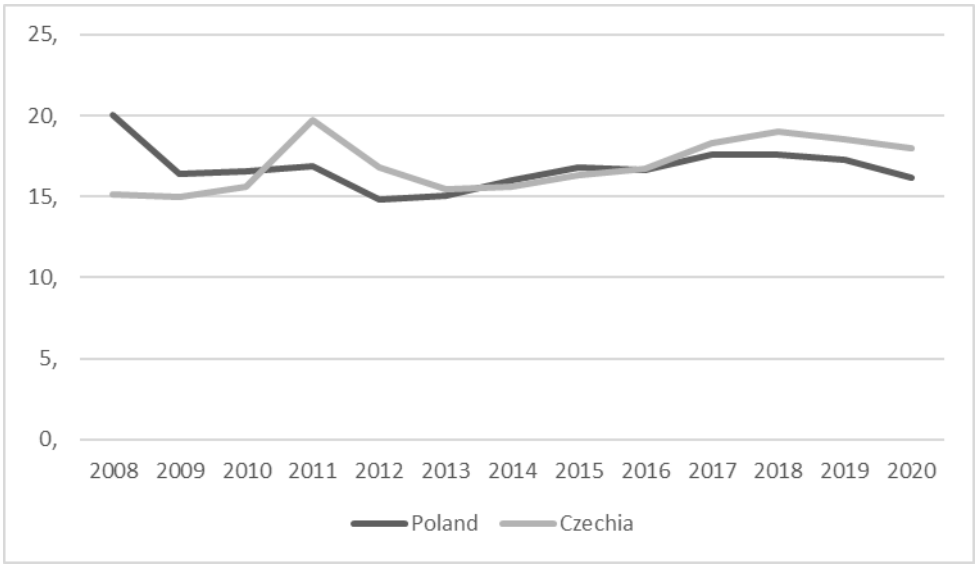


Figure 9. Material footprint (tonnes per capita) in Poland and the Czech Republic, 2008-2020
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database , accessed: 12/07/2023).

This indicates an increase in the Czech Republic's dependence on imported materials, which could result from a limited amount of materials available domestically, increased consumption, or changes in the structure of the economy.

4.9 Waste generation per capita

Waste generation indicators are instrumental in evaluating the progression towards a Circular Economy. They reflect resource efficiency, indicating how optimally an economy uses its resources, with an ideal Circular Economy minimising waste through efficient use and recycling. These indicators also highlight a commitment to sustainability, with reduced waste generation alleviating pressure on natural resources and potentially mitigating climate change. Furthermore, they illuminate potential environmental challenges, including waste management and pollution. Crucially, they aid in crafting economic strategies and environmental policies by identifying areas in need of intervention and measuring policy effectiveness, thereby guiding a sustainable economic trajectory in a Circular Economy.

This indicator shows the total waste generated per capita, inclusive of major mineral waste, in a specific country, emanating from all NACE activities and households, and is calculated as a quotient of the total waste produced and the average population of the country.

From 2008 through 2020, Poland manifested an increasing trajectory in waste generation per capita, rising from 3,645 kilograms per inhabitant in 2008 to 4,492 kilograms per inhabitant in 2020. This indicates an escalation in the intensity of waste generation per capita, potentially attributable to a plethora of factors such as increased consumption, shifts in economic structure, or an evolution in production technologies.

By contrast, the Czech Republic, albeit subject to certain fluctuations, maintained a predominantly stable level of waste generation per capita until 2016, starting from 2,448 kilograms per inhabitant in 2008 and achieving a slight reduction to 2,402 kilograms per inhabitant in 2016. Nevertheless, a substantial rise has been observed from 2016 onward, reaching 3,598 kilograms per inhabitant in 2020. This recent surge may indicate shifts in economic structure, amplified consumption, or other determinants influencing waste generation.

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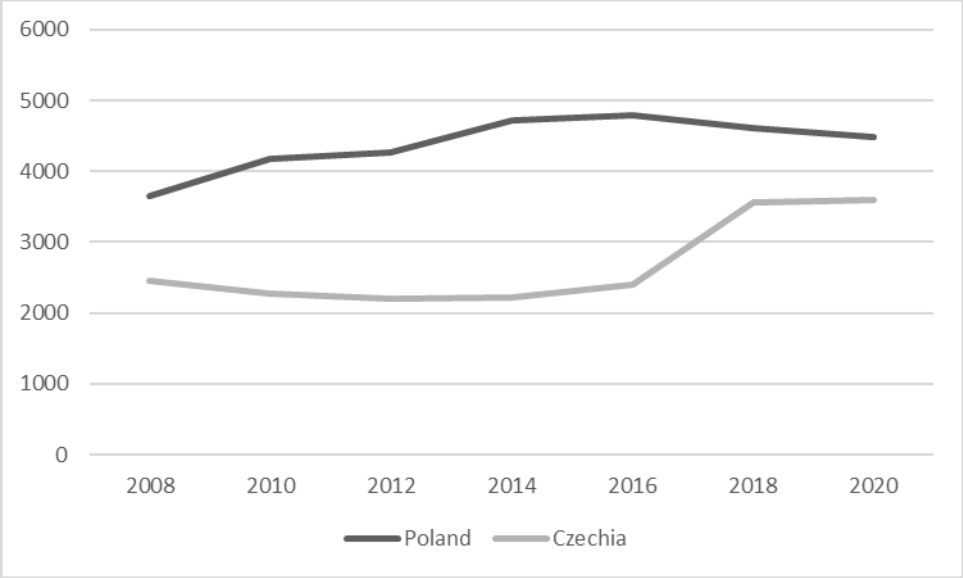


Figure 10. Waste generation (kg per capita) in Poland and the Czech Republic, 2008-2020
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database , accessed: 12/07/2023).

Comparatively, Poland evidently generates a significantly higher volume of waste per capita than the Czech Republic, potentially resulting from variations in economic structure, waste management strategies, or levels of consumption. In 2020, Poland generated approximately 25% more waste per inhabitant compared to the Czech Republic. Nonetheless, the rapid growth of waste generation observed in the Czech Republic in recent years suggests that additional measures may be necessary to manage this expansion.

4.10 Generation of plastic packaging waste

The "Generation of plastic packaging waste per capita" indicator, encompassing all non-returnable items and packaging waste as defined by the Waste Framework Directive 2008/98/EC, provides an important metric to gauge plastic waste output at an individual level.

A deep dive into the presented data reveals intriguing patterns and significant increases in the generation of plastic packaging waste in both Poland and the Czech Republic from 2008 to 2019.

In Poland, the figures reveal a persistent increase in per capita plastic packaging waste generation, rising from 17.57 kg in 2008 to a notably higher 34.19 kg in 2019. This represents almost a doubling in plastic packaging waste generation per capita over this 12-year period. This marked increase may indicate several underlying phenomena, such as a rise in consumption of consumer goods, an increase in the use of plastic packaging in commercial activities, or possibly less efficient waste management practices.

In the Czech Republic, while the increase is not as stark, there is still a discernible upward trend from 20.82 kg per capita in 2008 to 24.76 kg in 2019. The somewhat steadier progression in the Czech Republic suggests that the country may have different consumption patterns, possibly better waste reduction strategies, or more widespread use of alternative packaging materials.

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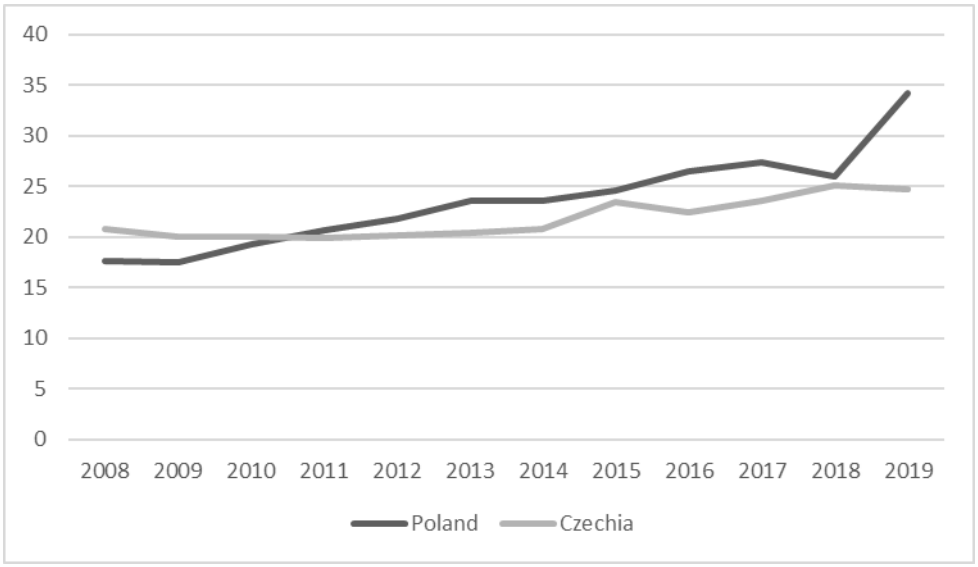


Figure 10. Generation of plastic packaging waste (kg per capita) in Poland and the Czech Republic, 2008-2019
Source: Own elaboration based on Eurostat (https://ec.europa.eu/eurostat/web/main/data/database , accessed: 14/07/2023).

These significant increases underscore the need for comprehensive strategies to address the proliferation of plastic packaging waste. These could include stringent waste management policies, initiatives to promote sustainable consumption habits, technological innovation in packaging, and a broader transition towards a Circular Economy where resources are used more efficiently and waste is minimised. Furthermore, this data provides critical input for policymakers to benchmark progress and adjust policies accordingly.

Conclusions

The comprehensive evaluation of material and waste metrics reveals significant insights into progressing towards a Circular Economy within Poland and the Czech Republic. Poland exhibits relative stability concerning its material import dependency, which suggests an enduring and balanced management of raw material resources despite its escalating economic development. Conversely, the Czech Republic displays an escalating trend in this respect, indicating potential constraints of domestic resource availability or a modification in its economic structure necessitating greater raw material imports. An examination of the 'material footprint' measure reveals an overall persistent trend with minor fluctuations in Poland, proposing a relationship between resource consumption and economic output that remains relatively consistent over time. The Czech Republic presents an upward trajectory with sporadic declines, which may indicate opportunities for amplifying resource efficiency. The generation of plastic packaging waste per capita reveals divergent trends in both countries. A significant upward trend is observed in Poland, underscoring the urgency of improving waste management strategies and bolstering recycling efforts.

In contrast, the Czech Republic shows a more moderate increase in this respect. The waste generation per capita, a consequential metric for the Circular Economy, suggests that Poland exhibits significantly higher waste generation per individual than the Czech Republic. This difference allows one to conclude that there is a greater requirement for efficient waste management strategies, such as recycling and resource recovery, in Poland.

Taken together, these data metrics show that the developmental trajectories of Circular Economies in Poland and the Czech Republic are characterised by unique challenges and opportunities. The evidence suggests that Poland needs to concentrate its initiatives on streamlining waste management and preserving stability in dependency on imports of raw materials. Simultaneously, the Czech Republic should aim to mitigate its burgeoning dependency on imports of raw materials and augment its resource efficiency.

Projecting these trends into the future, it is envisaged that additional targeted strategies will be required in order for these countries to continue to make progress in the area of the Circular Economy. For Poland, this might necessitate increased investments in recycling infrastructure and improving societal awareness of the benefits of recycling. The Czech Republic, in contrast, might need to focus on enhancing technological efficiency of resource usage and diversification of raw material sources.

Cooperation between Poland and the Czech Republic could stimulate their progress towards a Circular Economy. For instance, Poland could adopt strategies from the Czech Republic's expertise in managing raw materials, while the latter could benefit from Poland's proficiency in stabilising dependency on imports of raw materials. Collaborative endeavours in domains such as research, education, and policy development could substantially expedite their journey towards sustainable development.

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CRYPTOCURRENCY PRICE FORECASTING: A COMPARATIVE ANALYSIS OF AUTOREGRESSIVE AND RECURRENT NEURAL NETWORK MODELS

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Abstract. This article presents a novel approach to cryptocurrency price forecasting, leveraging advanced machine-learning techniques. By comparing traditional autoregressive models with recurrent neural network approaches, the study aims to evaluate the forecasting accuracy of Autoregressive Integrated Moving Average (ARIMA), Seasonal ARIMA (SARIMA), Long Short-Term Memory (LSTM), and Gated Recurrent Unit (GRU) models across various cryptocurrencies, including Bitcoin, Ethereum, Dogecoin, Polygon, and Toncoin. The data for this empirical study was sourced from historical prices of these specific cryptocurrencies, as recorded on the CoinMarketCap platform, covering January 2022 to April 2024. The methodology employed involves rigorous statistical and neural network modelling where each model's parameters were meticulously optimized for the specific characteristics of each cryptocurrency's price data. Performance metrics such as Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE) were used to assess the precision of each model. The main results indicate that LSTM and GRU models, leveraging deep learning techniques, generally outperformed the traditional ARIMA and SARIMA models regarding error metrics. This demonstrates a higher efficacy of neural networks in handling the non-linear complexities and volatile nature of cryptocurrency price movements. This study contributes to the ongoing discourse in financial technology by elucidating the practical implications of using advanced machine-learning techniques for economic forecasting. Importantly, it provides valuable insights that can directly inform and enhance the decision-making processes of investors and traders in digital assets.

Keywords: forecasting; prediction; cryptocurrencies; time series; ARIMA; SARIMA; RNN; LSTM; GRU.

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JEL Classifications: C22, C32, C45, C53, G17

Additional disciplines: Informatics Engineering, Computer Science, Mathematics, Data Science

1. Introduction

The need to predict cryptocurrency prices is an important area of academic interest and active research by numerous researchers and practitioners worldwide (Au et al., 2024; Apostolakis, 2024; Bâra et al., 2024; Singh et al., 2024; Kapur et al., 2024, Demirel, 2024).

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Indeed, as the market for cryptocurrencies advances with more complexity and scales of use, the necessity for even more precise forecasting models arises. This burgeoning field is dynamic, with established methods getting fine-tuned and polished while new, innovative techniques are constantly explored.

Traditional time series methods such as Autoregressive Integrated Moving Average (ARIMA), Seasonal ARIMA (SARIMA), and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models are mainstream in financial forecasting due to their effectiveness in modelling and forecasting time-varying data. These models, with a focus on understanding the historical volatility and trends, are constantly refined, improved, and enhanced to capture better the sophisticated behaviours of cryptocurrency markets, which are known for massive volatility and unpredictability (Ng et al., 2023; Satheesh & Sundararagan, 2022; Vo & Ślepaczuk, 2022; Corrêa et al., 2016).

In parallel, there has been a significant shift toward applying the deep learning approach in forecasting cryptocurrency prices. Neural networks, in particular Long Short-Term Memory (LSTM) models and Gated Recurrent Units (GRU), have proven to be highly capable of processing sequences with long-range dependencies (Respaty et al., 2023; Nosouhian et al. 2021; Zarzycki & Ławryńczuk, 2021; Zhang et al., 2021). These deep learning models are experts in processing and learning the vast amount of unstructured data generated in the cryptocurrency markets, hence representing value much larger than that projected by traditional statistical models.

A current and relevant problem in this area is the comparative analysis of traditional time series methods with these new deep-learning approaches. Scientists continue researching which methodologies yield the most accurate, reliable, and appropriate forecasts (Bielskis & Belovas, 2022; Sehrawat & Vishwakarma, 2022; Gopu et al., 2023). This includes rigorous testing, validation, and performance evaluation of historical data models with different cryptocurrencies and market conditions. It is these comparisons, therefore, that becomes very critical in the sense that they help to gauge the strengths and weaknesses of each method as it guides traders and investors in making decisions.

However, notwithstanding advancement, cryptocurrency prediction is still a very problematic issue. In this case, the volatility of cryptocurrencies, which is influenced by news of regulation, market sentiment, or changes in technology, is volatile and, therefore, difficult to predict. This has led to the development of hybrid models that combine the soundness of time series analysis and the adaptiveness of machine learning and deep learning models (Li & Zhao, 2022; Jisha et al., 2023; Si, 2023). In addition, the inclusion of sentiment analysis and blockchain analysis in forecasting models is an interesting area, as it can provide more nuanced insights into future price developments.

The dynamic nature of the cryptocurrency market makes sure the area of price forecasting will continue to evolve. Continued innovations in AI and machine learning, along with improved understanding and incorporation of market-specific dynamics, promise improvements in the accuracy and effectiveness of the forecasting models. Such constant development benefits not only individual investors or traders but also allows the market of cryptocurrencies to become more stable and mature.

2. Research objective and methodology

In the volatile domain of cryptocurrency markets, forecasting price movements presents a formidable challenge due to rapid shifts in economic conditions and the inherently noisy nature of financial data. This research aims to conduct a comprehensive comparative analysis of traditional time series forecasting models, such as ARIMA and SARIMA, against advanced deep learning approaches, including LSTM and GRU networks, for predicting cryptocurrency prices. By examining the performance of these models on various cryptocurrencies, we aim to identify the most accurate, reliable, and appropriate forecasting methodologies for highly volatile and complex cryptocurrency markets.

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2.1. Autoregressive models

ARIMA is a statistical analysis model that can handle non-stationary data and fits well within the mostly ambiguous market conditions experienced in cryptocurrencies. Meanwhile, the SARIMA model considers the effect of seasonality present in data, which is common in financial time series but often ignored by ARIMA models.

2.1.1. Auto-Regressive Integrated Moving Average (ARIMA)

The Auto-Regressive Integrated Moving Average (ARIMA) model was introduced by Box & Jenkins (1970) to analyze and forecast time series data. It is particularly efficient for non-stationary data and is prevalent in many real-world applications, such as stock prices, economic indicators, and cryptocurrency prices.

The model contains Auto-Regressive (AR), Integrated (I), and Moving Average (MA) components and, therefore, captures most structures and patterns present in the time series data. Auto-Regressive (AR) component assumes that the regressing variable of interest is regressed with some of its previous values. This component makes predictions because it specifies the future values as a function of past values. The integrated (I) component differentiates the observational data in the series to make the series stationary, meaning that the mean and variance of the series do not change over time. Stationarity is one of the statistical conditions. The Moving Average (MA) component models the error term as a linear combination of error terms happening simultaneously and different past lags. This combination of three components makes ARIMA capabilities a powerful tool in time series forecasting and, therefore, a reliable choice in scenarios where data has evidence for non-stationarity.

The ARIMA model is described by the notation ARIMA(p, d, q), where:

- p is the number of lag observations in the model (lag order).
- d is the degree of differencing (the number of past times values have been subtracted from the data).
- q is the size of the moving average window (order of moving average).

2.1.2. Seasonal Autoregressive Integrated Moving Average (SARIMA)

The Seasonal Autoregressive Integrated Moving Average (SARIMA) was introduced by Box & Jenkins (1976) in later revisions of their book. This model extends the standard ARIMA model to account for seasonal variations in time series data. The SARIMA model is highly recommended for datasets that show regular changes in the pattern at specified, definite intervals throughout the year and are ideal for forecasting seasonal economic, weather, and consumption data.

The SARIMA model is described by the notation SARIMA(p, d, q)(P, D, Q)s, where:

- p, d, and q are the non-seasonal parameters that describe the autoregressive, integrated, and moving average components of the model, as in a standard ARIMA model.
- P, D, and Q are the seasonal parameters that describe the autoregressive, integrated, and moving average components at the seasonal level.
- s denotes the length of the seasonal cycle, which could be quarterly, monthly, or weekly, depending on the context.

There is a need to explain what the P, D, and Q parameters are in more detail below:

- Seasonal Autoregressive Order (P): It reflects the use of the values of the previous seasonal periods to predict the future value. It is equivalent to the autoregressive component in an ARIMA model but applied on a seasonal scale.
- Seasonal Differencing Order (D): This would mean that the series is subjected to differencing at the seasonal period to ensure stationarity on the seasonal level, much like the integrated component in the ARIMA model.

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- Seasonal Moving Average Order (*Q*): This indicates the moving averages of the lagged forecast errors used to predict the current value, applied in the same manner as a moving average component of the ARIMA model but considering seasonal data points.

By using a seasonal component, the SARIMA model can provide more accurate and relevant forecasts for seasonal data compared to non-seasonal models, which might fail to capture the cyclical nature of the data. It is a handy tool in the arsenal of any analyst dealing with time series data affected by seasonality.

2.2. Recurrent Neural Network Models

Recurrent neural networks (RNNs) are exceptional in their ability to process sequential data because they can remember past occurrences and correlate them with current data. This makes them entirely up to the task in many applications where context is crucial, like text generation and forecasting of time series, but still not that easy to work with. This leads to the adjustment of weights during training. In other words, it results in problems of gradient vanishing since the alterations done in the model weights are too minimal, which makes the training procedure ineffective. On the contrary, if massive updates take place, there could be a gradient explosion that triggers the problem of learning instability. Both these are caused by the incredible complexity of how training RNNs must be done. Fortunately, Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) networks are much more advanced variations of the RNN that have been architected to solve these very issues.

2.2.1. Long Short-Term Memory (LSTM)

Long Short-Term Memory (LSTM) network, a pivotal innovation in the realm of neural networks, was first proposed by Hochreiter & Schmidhuber (1997). LSTM was designed to store information for long periods and retrieve it efficiently when needed. The idea was to subsume, within the architecture of the neural network itself, these so-called "gates" that would control the flow of information by giving explicit instructions on what to remember and what to forget.

LSTM consists of a series of memory cells that can store and update information over long time steps. Each memory cell has three types of gates: input gates, forget gates, and output gates. Input gates define which pieces of information will be considered worthy of storage in long-term firing. It thereby ensures that only the most relevant information is being treated as necessary. A forgetting gate in a cell decides when to forget information and when to keep information. Therefore, the output gates establish what the information in the current state of the cell is to be transmitted to the output of the network; the factors might be code of pertinent characteristics or characteristics of the feature that are significant at that time. In this way, the network can distribute information more accurately and efficiently. This would give the LSTM the power to handle much longer data sequences than the standard RNN.

2.2.2. Gated Recurrent Unit (GRU)

Gated Recurrent Unit (GRU) is another advancement in the field of RNNs, proposed by Cho et al. (2014). GRU was introduced as a simplified version of LSTM, designed to make the learning process more efficient while retaining the ability to capture dependencies in sequential data. GRU combines the hidden state and the cell state into a single state and uses gating units to control the information flow, similar to LSTM, but with fewer parameters. Therefore, GRU is less computationally intensive. This makes GRU faster to learn without a significant loss in performance.

GRU does not have a separate memory location like LSTM and it has only two gates: a reset gate and an update gate. The update gate helps the model decide how much of the previous hidden state should be retained. This is done by combining the past state and the new information. The reset gate determines which part of the past state is important for the current input, and the update gate uses this information to form the new hidden state. This allows the GRU to adjust the flow of information more flexibly than the LSTM. Also, GRU is easier to implement and requires fewer parameters.

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2.3. Data

For this research, five cryptocurrencies were selected: Bitcoin (BTC), Ethereum (ETH), Dogecoin (DOGE), Polygon (MATIC), and Toncoin (TON). This selection was made to explore different areas of cryptocurrencies. The first and second of them—Bitcoin and Ethereum—are fundamental cryptocurrencies. Bitcoin is the first one, and it is known as a classic of cryptocurrencies or digital gold. Bitcoin was introduced by Nakamoto (2008) as a decentralized digital currency that allows for peer-to-peer transactions without the need for a trusted third party. It operates on a blockchain, a distributed ledger technology that ensures transparency and security through cryptographic proof, enabling users to send and receive bitcoins securely over the internet.

Ethereum was introduced by Buterin (2013) as a decentralized platform that enables developers to build and deploy smart contracts and decentralized applications (dApps). Unlike Bitcoin, which primarily focuses on peer-to-peer transactions, Ethereum extends blockchain technology to handle more complex programmable transactions. It is a versatile foundation for various decentralized applications and financial instruments.

Dogecoin, introduced in 2013 by software engineers B. Markus and J. Palmer, started as a humorous take on the cryptocurrency phenomenon, featuring the Shiba Inu dog from the "Doge" meme as its logo. Despite its origins as a joke, Dogecoin quickly developed a dedicated community and became known for its use in tipping and charitable donations. Due to its ease of use and widespread appeal, Dogecoin maintains a significant presence in the cryptocurrency market (Brichta, 2023).

Polygon is a layer 2 solution used as a protocol and a framework for building and connecting Ethereum-compatible blockchain networks. It was established in 2017, and since then, its token MATIC has been traded on top cryptocurrency exchanges. The Polygon network is widely used for crypto asset transfers and is supported by most crypto exchanges, dApps, and crypto services.

Toncoin is a newer cryptocurrency for the TON blockchain used in Telegram messenger. The Toncoin community has its blockchain, a newer solution that has increased in the past year. Technically, the TON blockchain is also a layer 1 solution, and by the last tests, it is the fastest blockchain. Toncoin is a newer cryptocurrency with great prospects and a quickly growing ecosystem.

Price data was taken from CoinMarketCap (https://coinmarketcap.com) – the biggest platform that provides information about cryptocurrencies, their prices, capitalization, rank, and others. For this research historical data of mentioned cryptocurrencies was taken from 2022-01-04 to 2024-04-17. It is a little bit more than two years, ending on a research date. Historical data for the CoinMarketCap platform has these fields: *timeOpen*, *timeClose*, *timeHigh*, *timeLow*, *name*, *open*, *high*, *low*, *close*, *volume*, *marketCap*, and *timestamp*. In research *timeOpen* (time, when trading starts) and *open* (price on trading starts) fields were used.

Before the experiment, all data was prepared using best practices and splitting it into two sets: train (80%) and test (20%). For LSTM and GRU, test and train data were also split into parameters and feature data at a time step of 100. So, the input data for LSTM and GRU was reshaped into sequences of length 100, where each sequence contains 100-time steps and 1 feature per time step. Each sequence is fed into the model during training, with the model learning to predict the next value in the sequence.

2.4. Parameters and architectural settings

Table 1 shows the parameters *p*, *d*, and *q* used in the ARIMA model for each cryptocurrency. They are different for each cryptocurrency because they were chosen with the *auto_arima()* method from the *pmdarima* statistical library in Python, which automatically discovers the optimal order of *p*, *d*, and *q* for the ARIMA model.

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Table 1. ARIMA model parameters for each cryptocurrency

	p	*d*	*q*
Bitcoin	2	2	1
Ethereum	2	2	2
Dogecoin	4	2	1
Polygon	2	2	3
Toncoin	2	2	1

Source: own processing

Table 2 shows the parameters *p*, *d*, *q*, *P*, *D*, *Q*, and *s* used in the SARIMAX model for each cryptocurrency. These parameters were also selected using the *auto_arima()* method.

Table 2. SARIMAX model parameters for each cryptocurrency

	p	*d*	*q*	*P*	*D*	*Q*	*s*
Bitcoin	1	2	4	2	0	2	12
Ethereum	4	2	4	2	0	0	12
Dogecoin	2	2	3	2	0	1	12
Polygon	2	2	3	1	0	0	12
Toncoin	4	2	1	3	0	0	12

Source: own processing

Table 3 shows the architecture and parameters used for the LSTM model. Specifically, it details the layer types, output shapes, and the number of parameters for each layer in the model:

- Layer type indicating the type of neural network layer (LSTM or Dense).
- Output shape showing the dimensions of the output tensor at each layer.
- Parameters indicating the number of trainable parameters associated with each layer.

Table 3. LSTM model architecture and parameters

Layer type	Output shape	Parameters
LSTM	(none, 100, 50)	10,400
LSTM	(none, 100, 50)	20,200
LSTM	(none, 50)	20,200
Dense	(none, 1)	51

Source: own processing

Table 4 shows the architecture and parameters used for the GRU model.

Table 4. GRU model architecture and parameters

Layer type	Output shape	Parameters
GRU	(none, 100, 50)	7,950
GRU	(none, 100, 50)	15,300
GRU	(none, 50)	15,300
Dense	(none, 1)	51

Source: own processing

LSTM and GRU model architectures were selected using best practices and doing some initial experiments with different architectures. Each prediction was made using its parameters and calculations. For the ARIMA and SARIMA models the own model parameters were used for each cryptocurrency, and for the LSTM and GRU models, the same architectures were used for all cryptocurrencies. Models were prepared and programmed using Python and its libraries (*numpy*, *pandas*, *tensorflow*, *statsmodels*). After the experiment was finished, all results were collected and provided.

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2.5. Estimating the accuracy of predictions

This research uses the Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE) to provide a holistic assessment of the performance of each model:

- MSE measures the average of the squares of the errors between predicted and actual values, providing a sense of the magnitude of prediction errors. It is susceptible to significant errors due to the squaring process, which can highlight considerable discrepancies between predicted and actual values.
- MAE calculates the average absolute differences between predicted and actual values, offering a straightforward interpretation of prediction accuracy. Unlike MSE, it does not square the errors, making it less sensitive to outliers and significant errors.
- RMSE is the square root of the average of squared differences between predicted and actual values, combining the benefits of MSE and providing error magnitude in the same units as the original data. It helps understand the model's prediction error more interpretably.
- MAPE measures the average absolute percent error between predicted and actual values, offering a normalized measure of prediction accuracy. It is beneficial for comparing the predictive accuracy across different datasets and scales since it expresses error as a percentage.

By incorporating all these metrics, the research identifies which model is more precise and how each model performs in varying magnitudes of data. This approach to error estimation makes the analysis much more detailed, providing deeper insights into which models are best suited for specific types of data and forecasting needs.

3. Results

After evaluating the experiment's results, it became evident that traditional time series forecasting models are significantly inferior to RNNs. In all cases, RNN models provided much better forecasts than traditional time series models, as illustrated in Table 5.

Table 5. Comparative analysis of cryptocurrencies forecasting models

Cryptocurrency	Forecasting model	MSE	MAE	RMSE	MAPE
Bitcoin	ARIMA	287296754.8864	12712.0440	16949.8305	0.2180
Bitcoin	SARIMA	247012237.4136	11418.5642	15716.6230	0.1928
Bitcoin	LSTM	17658797.9000	3311.6718	4017.0880	0.0527
Bitcoin	**GRU**	**12537535.3988**	**2896.3915**	**540.8382**	**0.0450**
Etherium	ARIMA	1032049.4497	815.4652	1015.8983	0.2708
Etherium	SARIMA	1672989.5835	1061.8292	1293.4410	0.3562
Etherium	LSTM	50373.9706	190.8614	224.4415	0.0574
Etherium	**GRU**	**30878.1696**	**136.5649**	**175.7219**	**0.0410**
Dogecoin	ARIMA	0.0040	0.0453	0.0633	0.3375
Dogecoin	SARIMA	0.0014	0.0256	0.0379	0.1859
Dogecoin	**LSTM**	**0.0003**	**0.0116**	**0.0165**	**0.0746**
Dogecoin	GRU	0.0003	0.0127	0.0166	0.0808
Polygon	ARIMA	0.1193	0.3088	0.3454	0.3308
Polygon	SARIMA	0.0737	0.2385	0.2715	0.2533
Polygon	LSTM	0.0059	0.0611	0.0771	0.0639
Polygon	**GRU**	**0.0808**	**0.0482**	**0.0634**	**0.0500**
Toncoin	ARIMA	1.9613	0.7338	1.4005	0.1673
Toncoin	SARIMA	1.7605	0.7163	1.3269	0.1704
Toncoin	LSTM	0.4158	0.4798	0.6448	0.1139
Toncoin	**GRU**	**0.2178**	**0.3259**	**0.4667**	**0.0731**

Source: own processing

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When comparing ARIMA and SARIMA models, Ethereum and Ton were better predicted with the ARIMA model, while Bitcoin, Dogecoin, and Polygon were better predicted with the SARIMA model. However, the differences between ARIMA and SARIMA are not substantial, and we can say that they generally produce similar forecasts. The most noticeable difference is for Dogecoin, where the MAPE for ARIMA is 0.34 compared to 0.19 for SARIMA. For Ethereum, ARIMA provided a better prediction than SARIMA, and for Ton, their performance is practically the same.

The most important observation, seen in Table 5, is that RNN models did a better job of predicting the data. The best predictions are mostly from the GRU model, except for Dogecoin, where the LSTM model performed better. Although, if we look at MAPE, the differences between LSTM and GRU models for Dogecoin are very small.

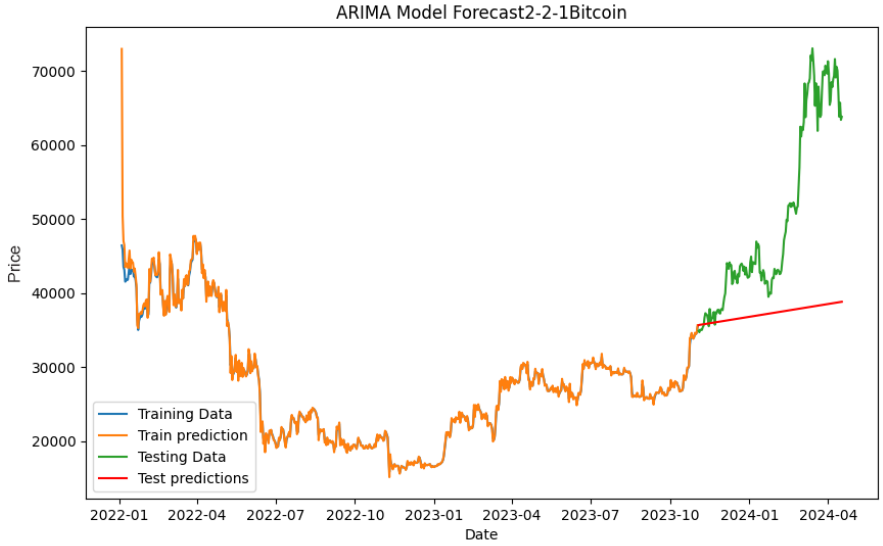


Figure 1. Example of an ARIMA model for forecasting the Bitcoin price

Source: own processing

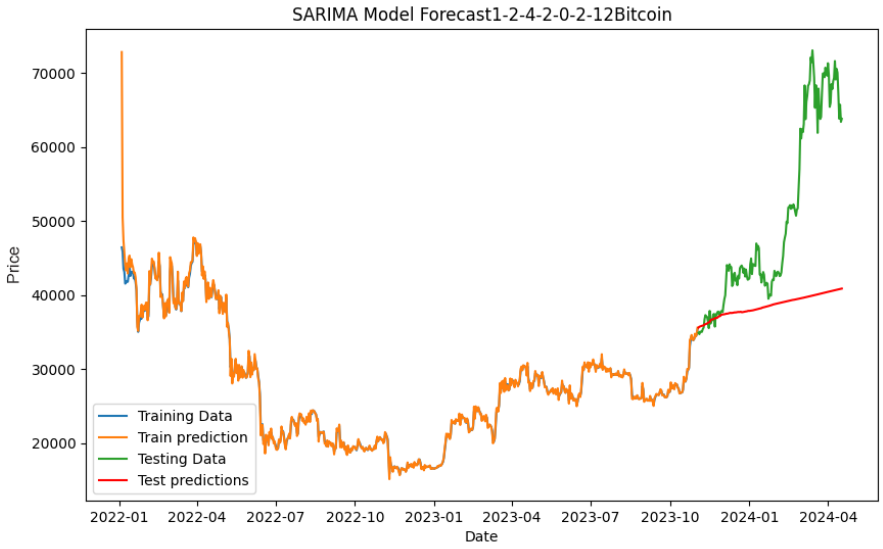


Figure 2. Example of a SARIMA model for forecasting the Bitcoin price

Source: own processing

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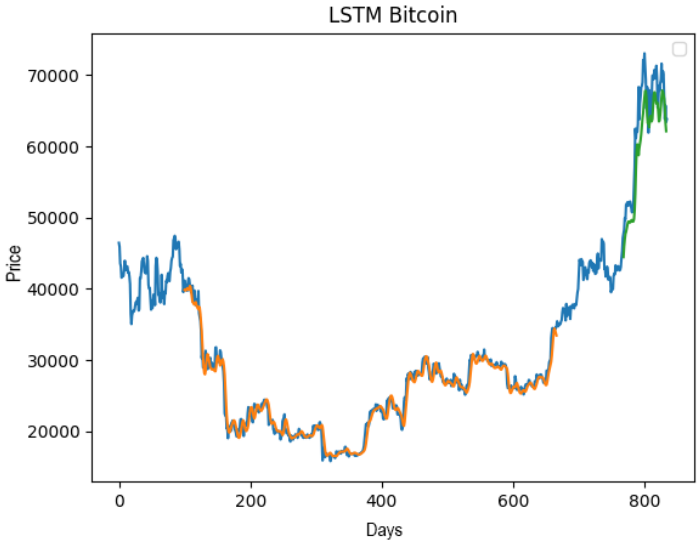


Figure 3. Example of an LSTM model for forecasting the Bitcoin price

Source: own processing

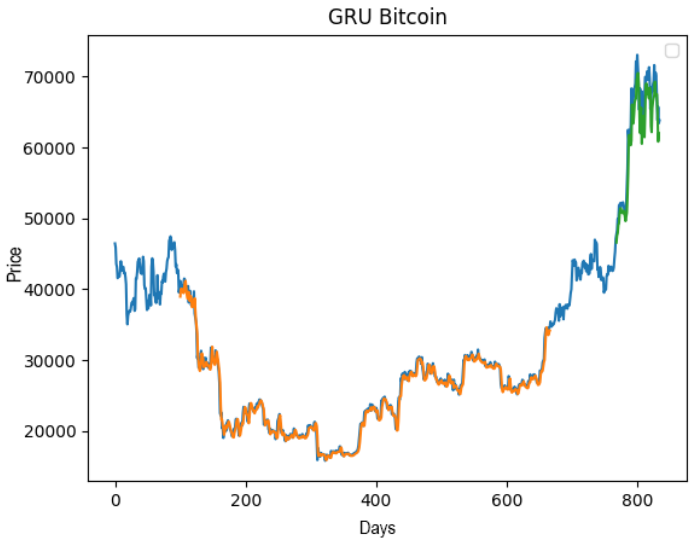


Figure 4. Example of a GRU model for forecasting the Bitcoin price

Source: own processing

The advantage of RNNs is particularly apparent in Figures 1-4. The autoregressive models presented in Figure 1 and Figure 2 predict the future price of Bitcoin almost linearly, regardless of fluctuations. The same tendency has been observed in figures for other cryptocurrencies, so they have not been included in this work to avoid duplication. In contrast, the RNN models in Figure 3 and Figure 4 predict the future price of Bitcoin while taking fluctuations into account, resulting in much more accurate predictions compared to the autoregressive models.

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Conclusions

The fact that ARIMA and SARIMA models gave similar results suggests that there is no significant seasonality in the data. Since cryptocurrency prices are highly volatile and lack pronounced seasonal patterns, ARIMA and SARIMA models are not suitable for predicting cryptocurrency prices. The accuracy of ARIMA and SARIMA models diminishes, especially over longer periods. While their forecasts may be reasonably accurate over short periods, their accuracy drops significantly over longer horizons due to the high volatility. ARIMA and SARIMA models tend to overfit historical data, resulting in poor performance on new data. This overfitting is particularly problematic in conditions of high volatility, where it leads to a substantial deterioration in forecast accuracy, especially when the new data exhibits new trends.

Meanwhile, RNNs are much better at predicting data, especially in the context of highly volatile and complex time series such as cryptocurrency prices. RNNs can capture long-term dependencies and patterns in data, making them particularly well-suited for handling the non-linear relationships and abrupt changes often seen in cryptocurrency markets. Furthermore, recurrent neural networks are less prone to overfitting compared to ARIMA and SARIMA models. They can generalize unseen data better, providing more reliable forecasts in real-world scenarios.

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COMBINED FEED PRODUCTION IN KAZAKHSTAN'S AGRO-INDUSTRIAL SECTOR*

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Abstract. Feed mills are among the most socially important organizations of the agro-industrial complex. The combined feed they produce has high nutritional value and allows growing animals and poultry as efficiently as possible. Among the food and processing industry enterprises, special attention should be paid to the organizations of a single technological chain of the agro-industrial complex, including feed mills. Activities of those agricultural companies embrace not only the processing of agricultural raw materials (grain) and food industry waste but also the manufacturing of products that form the basis for fattening animals and poultry in the agricultural sector. It is necessary to equip enterprises with highly efficient equipment, use progressive technological processes, skillfully organize personnel work, and make qualified managerial decisions to produce competitive products and solve food security issues successfully. In addition, at the state level, the expansion of combined feed production is associated with the solution of import substitution of livestock products and the development of other related areas of the economy. Implementing innovative projects, including resource-saving tools, can help enterprise management fulfil its duties more successfully. Sustainable development of domestic livestock breeding and poultry farming depends on the state of the feed industry, which is determined by the availability of this industry's key resources, primarily raw materials. Knowing how much of the combined feed products is produced with raw material resources is essential. Despite the gradual increase in the output of combined feed over the past decades, there are still challenges associated with providing balanced dietary feed, including high consumption of combined feed per one ton of meat and dairy products. Besides, the organizational and economic relations of organizations comprising the agro-industrial industry must be improved.

Keywords: combined feed industry; livestock breeding; agricultural production; organizational and economic relations; market; quality; implementation; placement; growth; production

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JEL Classifications: Q01, Q13

1. Introduction

The studies of the state of the domestic compound feed organizations demonstrate that one of the strategic objectives of the industry is to transfer it to the trajectory of sustainable development by increasing the competitiveness of products through improving quality, increasing production efficiency, and introducing innovations. A comprehensive assessment and analysis of the trends in the development of production and

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economic processes are required to implement these strategic objectives in practice in conditions of limited financial capacity and insufficient state support. The goal is the complete use of the available resource potential both among individual subjects of the industry and in the context of the implementation of the development strategy of the agro-industrial complex as a whole in the long term (Kaliev & Moldashev, 2021).

The uneven placement of the compound feed industry and its inconsistency with raw material resources for grain production conditions significantly affect the inter-regional transportation costs of raw materials and compound feed. It is necessary to improve the placement of compound feed factories, considering future trends in the development of animal husbandry in the country.

Combined feed production is a metrically intensive process. It uses more than 50 types of raw materials and, on their basis, produces the same number of kinds of combined feed. It involves highly complex relations with suppliers and consumers.

Production links need to be more regulated due to the shortage of protein supplements. Feed mills gradually increase the share of grain components in the structure of feed (Mizanbekova, Tireuov & Aitmukhanbetova, 2022). Enterprises supplying protein and vitamin additives, feed enrichment concentrates, and urea concentrates to the enterprises producing combined feed in farms provide only 25-30% of the required volume. The production of protein and vitamin additives in the industry for the last 15 years stayed the same, and, in very recent years, it has sharply decreased, which is the reason for the insufficient supply of protein components to feed enterprises.

As a result, the farms' production capacity is only 400-500 thousand tons of combined feed per year. It is necessary to increase the production of combined feed based on raw materials remaining in farms, using protein and vitamin additives of the industrial output and local protein resources.

The organisation of production of combined feeds of the required assortment directly in farms, based on the existing structure of the herd, according to scientists' estimates, is economically feasible when farms are 50 km or more away from combined feed enterprises. Developing a compound feed industry in farms will provide not only rational use of grain forage for agricultural enterprises but also the production of compound feeds at a lower cost compared with compound feeds for enterprises in the compound feed industry.

2. Literature review

The results of scientific achievements were accepted as an information-analytical and methodological basis in the analysis and assessment of the current state and trends in the development of the compound feed industry. Special attention in the studies was paid to production-technological and organizational-administrative processes of raw material base development (grain and leguminous crops), methods of solving scientific and production issues, formation of optimal market conditions, and activation of export supplies (Zakshevsky, Bogomolova & Vasilenko, 2020; Aduov et al., 2023; Pashkov et al., 2024; Taishykov et al., 2024).

The quantity of produced products, their quality, and their cost are the most critical factors that are detrimental to the feed industry development in Kazakhstan. The need to increase the production of feed and combined feed is related to the task of replacing imported livestock products.

Due to the number of obsolete machines and equipment used in the production of combined feed, feed milling enterprises, in most cases, are forced to import them. The imported machinery has high technological efficiency but is very expensive. In most cases, the prices of domestic technological machines and equipment for combined feed production are lower, but their quality needs to meet contemporary requirements. Increasing the scale of feed and compound feed production requires the resolution of import substitution difficulties and initiating growth in the economic sectors adjacent to this industry.

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This is confirmed by studies of various associations of flour-milling, cereal, agricultural and other enterprises (corporations, clusters, etc.). As a rule, such integrated structures offer better quality at lower prices. The advantages of creating vertical complexes in other industries were discussed in the works of scientists (e.g., Petrikov, 2018; Mazzoni, 2020).

The effect is achieved by reducing transaction costs by supplying raw materials directly and eliminating the network of intermediaries. However, such decisions must consider the combined interests of the various parties involved in the feed and feed industry and the livestock industry through implementation through contractual, price, credit and administrative regulation.

The problems of improving the organizational and economic mechanism of sustainable development of enterprises for the production of combined feed in rural areas have a role in connection with the strategic importance of the combined feed industry in providing industrial, agricultural enterprises, and individual farms, with quality combined feed, a commodity in demand in world markets (Altuhov, Drokin & Zhuravlev, 2016; Kokenova et al., 2021; Croitoru et al., 2021; Mizanbekova, Bogomolova, & Dzhumabaeva, 2023).

Among the problems that need to be solved, it is necessary to highlight the imperfect structure of the feed industry, technical and technological backwardness of enterprises, insufficient innovation activity, the level of product quality standardization, underdevelopment of market infrastructure, inconsistency of management (both state and corporate sectors) to the tasks of adaptation of the feed industry to the processes of globalization (Gridneva et al., 2019). The efficiency of grain raw material utilization in processing is conditioned not only by protein additives but also by the very structure of the grain allocated for processing (Petrikov, 2018; Tokbergenova, Kiyassova & Kairova, 2018). Innovations will be a critical factor for the competitiveness of feed production and the whole agricultural sector (Montoya-Martínez, Parra-Cota & de los Santos-Villalobos, 2022; Stathatou et al., 2023; Sun et al., 2024; Hancz et al., 2024).

3. Research methodology

In recent years, the state of the compound feed industry of the agro-industrial complex of Kazakhstan and new trends in its development have attracted the close attention of domestic economists. The domestic market of combined feed belongs to the agro-industrial complex's dynamically developing and promising sectors. More and more Kazakhstani enterprises working in the livestock industry realize the fact that the use of high-quality, balanced fodder affects the competitiveness of their products (Mizanbekova et al., 2017; Petrikov, 2018; Tireuov, Mizanbekova & Mizanbekov, 2020, Mizanbekova et al., 2021). The volume of fodder production, quality, and cost are the primary factors constraining the accelerated development of domestic livestock production. In addition, at the state level, the expansion of compound feed production is associated with the solution to the problem of the import substitution of livestock products and the development of other related areas of the economy.

Such interrelation of the combined feed industry with other spheres of agricultural production excludes the possibility of its one-sided study. Conducting a more detailed industry analysis as part of the organisational and economic relations system is necessary. Thus, as well as in several other spheres of economy, it is essential to consider the economic interests of subjects realized through contractual, price, credit and state regulation in these relations.

There are several economic problems in the fodder industry, the solution of which in the conditions of increasing economic opportunities in Kazakhstan, increasing state support of fodder producers, and a well-considered strategy of agricultural development based on intensification and technological renewal can lead to such growth of the fodder industry, which will allow to meet the internal needs of the agro-industrial complex and turn the country into the largest exporter of fodder and food.

It is necessary to align technical and organizational-technological factors with the institutional environment of the agro-industrial complex to achieve success and long-term and sustainable economic growth in the feed industry,

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4. Results and discussion

The study's relevance is predetermined by scientific and practical interest in the structure of organisational and economic relations in producing and selling combined feed products as a single system. Existing in a particular economic space, the development of organizational and economic relations in the production and sale of combined feed leaves open a need to work out provisions in this area of agro-industrial output fully.

Organizational and economic relations should be considered fundamental in the study and analysis of the functioning of any economic system, including the agro-industrial complex because its essential content is always the links through which they are implemented.

As a rule, three main groups of production relations are distinguished: socio-economic, organizational-economic and technological. They characterize both the appropriation and the organization of agro-industrial production, hence the whole range inherent in the agro-industrial complex.

Organizational and economic relations are the central link in the overall system of production relations, as they are formed and function not within but at the junction of production relations and productive forces.

The organizational and economic relations are most susceptible to changes in the technical and economic base of agro-industrial production and the forms of its organization. They are susceptible to them and, in turn, directly affect the improvement of productive forces. These relations are formed as a complex system of interaction between diverse subjects of economic activity (individual producers, collectives, social groups, regions, states) about various kinds of productive resources, including the appropriation and subsequent organization of their production, exchange, distribution and consumption. In contrast, the mechanism of economic relations is a system of interconnected organizational and economic levers and incentives, which have a legal basis and are between each other.

Organizational and economic relations in the agro-industrial complex have several peculiarities. Firstly, they reflect and improve the interaction at all stages of the production process and thus contribute to the orientation of each branch involved to the final goals. Secondly, these ties mediate not only relations of exclusive economic order but also relations of production organization and management. Moreover, this aspect of economic inter-sectoral ties is increasingly intensified with the deepening of the division of labor, specialization and concentration.

At the basic level, specialization and concentration of production determine the development of an extensive and complex system between production units - agricultural, industrial, procurement, trade and others, interacting to achieve a high final result and constituting the organizational and production basis of the agro-industrial complex.

Number of livestock and poultry as of 1 August 2023, thousand heads (Figure 1).

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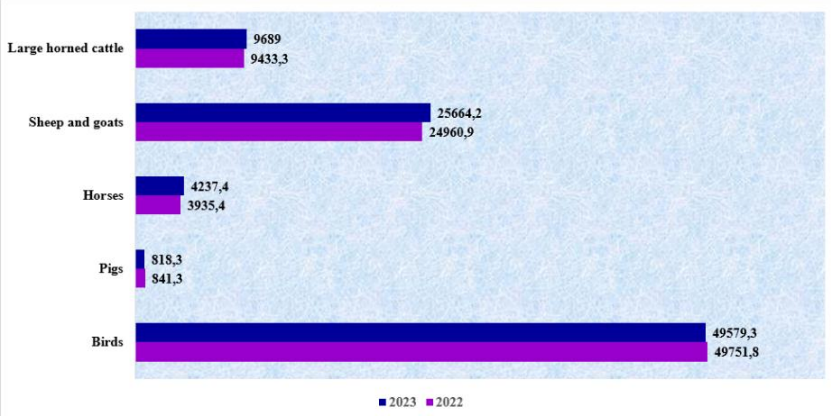


Figure 1. Number of livestock and birds
Source: Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan
https://www.gov.kz/memleket/entities/stat?lang=en

At the same time, enterprises that have economic independence and carry out their activities in the interaction process strive to achieve and realize internal interests. Consequently, the links between enterprises are designed to facilitate the implementation of the whole group of industrial-economic relations. Economic relations of economic entities in the agro-industrial complex, by the nature of their content, can be divided into relations of commodity producers with the state, relations between enterprises within the industry and relations between the spheres of the agro-industrial complex.

Improving inter-branch relations in the grain-product subcomplex is primarily associated with improving the gross grain harvest structure necessary to produce combined feed corn and legumes. The peculiarities of inter-branch relations of grain-product subcomplex are also determined by the fact that a significant part of production in the form of feed grain is directed to cattle and poultry directly or in the form of combined feed, i.e., inter-branch relations on the implementation of feed grain are closed within agricultural production.

However, fodder grain, which is a product of the grain-product subcomplex, can be partially replaced by fodder components coming from other subcomplexes: products of cultivation of perennial and annual grasses, wastes of fish, dairy, meat industry, etc., when producing combined feed.

Therefore, the need for feed grain and its efficiency depends on the feed industry's development level and its links with other sectors besides grain farming. An essential part of the relationship in agricultural production is the sale of feed grain to feed mills and combined feed to clients.

The conditions of these supplies are primarily determined by the size of feed mills, their location in the raw material base and consumers of combined feed. Combined feed enterprises and several others are among the most socially significant organizations of the agro-industrial complex. Their combined feed has a high nutritional value and maximizes efficiency in raising animals and poultry.

Among food and processing industry enterprises, special attention should be paid to the organizations of a single technological chain of the agro-industrial complex, including feed mills, whose activities are related not only to the processing of agricultural raw materials (grain) and food industry waste but also to the production of products that are the basis for fattening animals and poultry in agriculture.

To successfully solve food security problems and produce competitive products, it is necessary to equip enterprises with highly efficient equipment, use progressive technological processes, skillfully organize personnel work, and make qualified managerial decisions. The introduction of innovative projects, including the use of resource-saving tools, can help enterprise management to fulfil their duties more successfully.

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The directions for improving the management of innovation projects at the sectoral enterprise are presented in Figure 2.

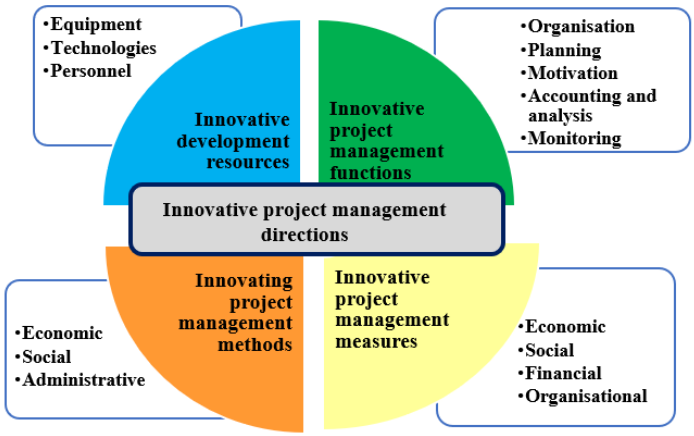


Figure 2. Directions for improving the management of innovation projects
Source: the authors

In the compound feed industry, more than one-third of the capacity falls to the share of enterprises with a capacity of 300-600 tons per day. In the country, the enterprises of the combined feed industry prevail, the share of which in production has reached almost 88%. At the existing distribution of grain and livestock production, raw materials for combined feed production are delivered mainly by farms in Northern Kazakhstan, and the main part of consumers of fodder grain-combined feed plants are located in other zones of the republic. In this connection, significant volumes of intra-republican transportation of grain forage are inevitable.

Placement of the feed industry does not correspond to the number of livestock in different regions, which leads to irrational, product-increasing transportation of combined feed. Constant targeting of enterprises to search for the most efficient production options is the main advantage of the competitive market system. The enterprises produce what the consumer demands, applying perfect technology and available product enrichment agents—the market system of economic management functions without state regulation.

The feed industry in Kazakhstan is one of the most dynamically developing industries. In 2022, a growth of about 260% (compared to 2021) was noted for feed exports (Bureau of National Statistics). The combined feed market in Kazakhstan has good prospects for development - both domestically and internationally. The prospects of the feed industry in Kazakhstan are more comprehensive than those of the domestic market. Among the opportunities for industry development are supplies to China, Central Asian countries, Iran and Turkmenistan.

The tools for the development of these markets include substitution of raw material exports (wheat, barley, maize) in importing countries with ready combined feed by refunding subsidies for transport costs, obtaining permission from the Chinese state services for the import of combined feed, development of appropriate infrastructure (pelleting) and diversification of recipes.

There was a twofold growth in the dynamics of external supplies in January-February 2023, while the industry has a vast unrealized potential, primarily in domestic consumption. The total capacity of 66 feed mills operating in the country is 2.2 million tons of products per year. These sites produce full-fed balanced combined feed for all farm animals and birds. At the same time, the workload of the enterprises is only 41.6% (Bureau of National Statistics).

The uneven placement of the combined feed industry and their inconsistency in relation to raw material resources of grain production leads to significant inter-oblast transportations of raw materials and combined feed.

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According to the updated Roadmap for the development of fodder production for 2023-2025, the country will have to achieve the following indicators: expand the sown area of fodder crops to 3.3 million hectares (3.1 million hectares sown in 2023); increase gross harvest of fodder crops to 5.1 million tons; increase the volume of combined feed production to 1.9 million tons in physical terms, in monetary terms - up to 140 billion tenge.

In 2023, two enterprises for producing ready-made animal feed were operated in Kazakhstan: in the Akmola and Zhambyl regions. The capacity of the facility in the Akmola region is 30 thousand tons per year, the amount of investment - is 1.3 billion tenge, and in the Zhambyl region - the capacity is 48 thousand tons per year, the cost is 4.5 billion tenge (Bureau of National Statistics).

In 2016, Hermes-4, together with foreign specialists, launched a feed mill in the city of Kostanai. The production facility is located in an industrial zone. It can fully supply the entire region and other regions of Kazakhstan, Uzbekistan and Turkey with combined feed.

Currently, the plant has reliable, productive equipment, elevators, drying facilities, research laboratories and warehouses for storing products. Resource tanks allow for storing of raw materials and finished products in large volumes and for a long time without quality reduction. The plant produces compound feeds of the highest quality for various animals, poultry and fish. The main products of the plant are combined feeds for feeding and fattening cattle, calves, pigs, horses, rabbits, broilers, chickens, fish, and bran and universal fodder mixtures. Combined feed production at the enterprise Hermes-4 is made in pellets and a placer, preserving all valuable substances in the mix. The laboratory researches popular recipes and produces compound feeds of its formulation. The assortment of feed mixtures is unlimited and depends on production needs and partners' needs.

In Kazakhstan, research has been conducted on quality animal feeds, and an innovative additive-product BioFeed for cattle feed has been developed, representing a phytobiotic feed mixture. The product is prepared to increase cattle productivity; it is a source of biologically active substances designed to stimulate the physiological processes of their digestion. Biologically active additives to feed are effective in increasing the immunity of animals; cattle eating this type of feed do not spend extra energy on digestion, and the productivity of the animal increases.

The extrusion method, a barothermal process that increases the feed's nutritional value and safety, is used to prepare feed. Extrusion is based on two processes - temperature and ultra-high pressure - which destroy harmful substances in the product and introduce the necessary feed vitamins with the utmost precision. If the extrusion method is not used, the efficiency of the feed is reduced by 50-55%, while the feeds in which the extrusion method was used are 95% efficient. The farms that will use this product can save twice as much feed. Phytobiotics are used in domestic products, and research and experiments are being carried out to replace feed antibiotics in recipes for productive animals since the use of phytobiotics in the formulation of fodder and feeds for productive animals is not a problem. Phytobiotics are plant extracts with antibacterial properties.

A food product intended initially for cattle is being developed for small and domestic animals.

It is necessary to improve the placement of feed mills, considering the perspective tendencies of the development of animal breeding in the republic, which needs deepening and specialization of feed mills.

Now, in the assortment of the produced products, combined feed for pigs (46%) and poultry (38.7%) prevails; more of it needs to be made for cattle (15%) and sheep (8%). This structure can be maintained if the needs of cattle breeding and sheep breeding are primarily met through the production of combined farm feed. However, the share of combined feed production shops located in the farms of the republic is only 0.4 per cent. As a result, about 5.0 million tons of concentrated fodder (50%) is fed to animals in crushed grain or unprocessed form (Bureau of National Statistics).

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Processing of grain forage into complete combined feeds is restrained by the lack of non-grain part of resources (fats, grotes, meat-bone, fish meal, COM, CMCM, vitamin additives, dry yeast) and other components, the share of which now makes up to 20 % in the composition of combined feeds.

Production of combined feed is a material-intensive process; it uses more than 50 types of raw materials, produces as many kinds of combined feed on their basis, and involves highly complex industrial economic relations with suppliers and consumers.

The volume of allocated protein and vitamin additives, COC and urea concentrate to the shops producing combined feed in farms provides only 25-30% of demand. The production volume of protein-vitamin additives in the industry for the last 15 years has remained the same. It has sharply decreased in recent years, which is the reason for the insufficiency of combined feed enterprises with protein components.

As a result, the capacity of the workshops available in the farms can produce only 400-500 thousand tonnes of combined feed per year, which is 10-15% of their all-republican production. It is necessary to increase the production of combined feed based on raw materials remaining in farms, using protein and vitamin additives for industrial output and local protein resource development - both within the country and in the export direction. The total demand for finished feed in the Republic of Kazakhstan is about 4 million tonnes.

At the same time, in regions with sufficient raw material opportunities, the capacities of feed milling enterprises differ from the needs of livestock breeding. Thus, in the Kostanay region, at a specific weight of grain from the total volume of its production on republic 18,7 % and conditional livestock 9,4 %, the share of production capacities of combined feed plants from all-republican make only 5,8 %, in the Ural region - accordingly 6,1; 5,8 and 20 %, in Akmola region - 12; 6,9 and 3,3 %. (Bureau of National Statistics)

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The organisation of production of combined feeds of the required assortment directly in farms, based on the existing structure of the herd, according to scientists' estimates, is economically feasible when farms are located at a distance of 50 km or more from combined feed enterprises. Development of a compound feed industry in farms will provide not only rational use of grain forage of agricultural enterprises but also the production of

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compound feeds of lower production cost in comparison with compound feeds of compound feed industry enterprises, as the estimation of grain in farms at costing of finished products is made at prices established based on the established production cost, which is much lower than the prices applied in industry.

The optimal solution is the creation of integrated formations that unite grain producers, feed mills, livestock complexes and poultry farms and establish direct links between grain producers and livestock producers based on contractual relations. This path, chosen by the country's poultry industry and individual pork complexes, allowed them to achieve a guaranteed supply of concentrated feed and reduce its purchase cost.

In recent years, dairy cattle breeding and poultry farming have been actively developing in Kazakhstan, so the demand for fodder will increase. A significant share of combined feed is consumed by poultry (53%), pork (39%), cattle and small ruminants (5% and 2%, respectively) (Bureau of National Statistics).

One of the main factors leading to low pig performance is their unbalanced nutrition. Such quantitative and qualitative indicators as the availability of energy, protein, amino acids (especially essential), vitamins and minerals characterize the completeness of combined feed and its optimality for each sex and age group of pigs.

Not only does the quality of the feed directly affect the productivity of pigs, but it also significantly impacts the composition of their waste and the environmental conditions for storing and utilizing it. For example, the limit of phosphorus in waste used for fertilizing agricultural land is 25 kg per 1 ha, and the concentration of phosphorus in waste depends on the composition of the feed. It can vary widely, including exceeding this figure. The application of ammonia also has its limitations - 135 kg of ammonia per hectare of agricultural land.

As a result, over-saturation of combined feed with phosphorus and deficiency of lysine and sulphur-containing amino acids of protein will significantly increase the phosphorus and ammonia content in the effluent. Consequently, using organic fertilizer with a significant imbalance of elements, especially its liquid fraction, may disturb the ecological balance in the soil.

Therefore, for Kazakhstan, the basis for the effective use of feed resources in the pig industry, along with the technology of their storage, preparation and distribution, is the improvement of nutritional standards of diets and their balance.

At the present stage of development of pig breeding in the country, when designing pig breeding enterprises, the advantage is given to complete combined feeds. It should be noted that granulated mixtures are more efficient in many respects than bulk mixtures. Until recently, a multi-component type of feeding was widely used: leguminous crops, backwash, cakes and meals, animal wastes, succulent fodder and potatoes. Because the latter kinds of forages require additional processing, this type of feeding is characterized by high resource intensity.

In the case of the proximity of a feed mill to the pig farm, the required stock of concentrated fodder can be reduced to 10 estimated days.

However, Kazakhstan's feed industry prospects are broader than the domestic market. Among the opportunities for industry development are supplies to China, Central Asian countries, Iran and Turkmenistan.

The tools for the development of these markets include substitution of raw material exports (wheat, barley, maize) in importing countries with ready combined feed by refunding subsidies for transport costs, obtaining permission from the Chinese state services for the import of combined feed, development of appropriate infrastructure (pelleting) and diversification of recipes.

Hungarian company UBM Group intends to build a feed mill in Kazakhstan. The enterprise's capacity will be at least 200 thousand tons of products; the country has great potential for launching production due to its strategic location, favorable conditions and availability of raw materials. The company can make a significant contribution to the development of production and management systems in the livestock sector in Kazakhstan.

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UBM Group is the leading feed manufacturer in Hungary; the company is engaged in animal husbandry and trades in cereals. The company comprises 18 subsidiary organizations that export products to 15 countries.

Ukrainian cat and dog food manufacturer Kormotech will expand production in the Lithuanian city of Kėdainiai. The company will invest more than €60m in four production phases to be commissioned during 2025-2028. Kormotech launched its first overseas plant in Kėdainiai in 2020.

The company says the expansion will double its workforce in Lithuania, adding 200 new jobs over five years. Kormotech plans to launch its first new production line by 2025, adding a line each year until the four production lines are fully operational in 2028. As it expands, the company will be interested in finding qualified engineers, technologists and other highly specialized specialists in Ukraine and Lithuania. The company's management calls Lithuania its ‘second home market’.

The successful experience of building and operating in Lithuania, favorable conditions in the free economic zone, support from InvestLithuania and a well-established network of partners and suppliers led to the decision to expand the company. The company employs around 1,300 people in five countries - Ukraine, Lithuania, Poland, Romania and the US. Kormotech is also expanding its production capacity. From 2022 to 2023, the company invested about $14 million in modernizing dry feed production and expanding wet feed production by almost 70%.

There is a massive potential for combined feed within Kazakhstan. Many farmers in their farms try to produce their animal feed, and its use is much more favorable: costs are lower, the digestibility of animals is higher, and as a result, the cost of meat is lower. It is more profitable for farmers to sell grain at high grain prices and purchase combined feed for animals, which will lead to the development of a market of combined feed in Kazakhstan; agricultural producers will earn on both grain and meat (by reducing the cost of production)

For the industry to develop actively and systematically, the government must encourage farmers to use industrial compound feed for some time. It is necessary for buyers to feel the benefits and returns from combined feed to create this market. In this regard, processors propose subsidizing farmers' purchase of industrial combined feed for the first time.

Earlier, the passport ‘Establishment of a feed mill’ was added to the subsidy mechanism to reimburse part of the costs incurred by an agro-industrial complex entity for investment investments. The share of reimbursement for investment investments was 25 per cent.

Many industries produce feed meals from various ingredients in the United States and Canada. All raw materials are delivered to feed mills in a crushed form suitable for introduction into compound feed. Cereals are processed at specialized milling plants. Cakes, meals, cakes and other by-products of the food industry are processed into feed flour directly at the enterprises where they are obtained. Food processing plants have special workshops for processing by-products. All ingredients are ground into fine flour and delivered to feed mills in packaged or unpackaged form by specialized transport if the distance is at most 200 km.

Feed mills in the United States and Canada install a minimal number of hammer crushers only for occasional operations when unmilled raw materials, mainly corn, arrive for one reason or another. Mineral ingredients - salt, chalk, limestone - are processed where they are mined and delivered to feed mills in a crushed and dry state in special packaging that protects the ingredients from moisture migration from the air.

It should be noted that in the USA and Canada, the milling of cereal crops is often carried out by livestock farms, which produce feed flour in large quantities and use it to feed animals in a mixture with protein, vitamin and mineral supplements obtained from feed mills. Sometimes, farms have milling equipment and appropriate dosing and mixing facilities. Thus, feed mills in the USA and Canada need to be more engaged in grinding raw materials, a significant difference from feed mills in Western Europe. In Western European countries, a substantial portion of raw materials is milled at feed mills.

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Conclusions

Feed production in Kazakhstan has good development opportunities, and these opportunities are well represented both inside and outside the country. It is not rational to use grain in pure form for animal feeding. It is more important than passing processing on combined feed; raw material can be enriched and is more saturated for full use when considering dependence between different branches: production - processing - consumption. The final goal is to provide the population with livestock products.

The formation and production of technological and technical innovations for the feed and compound feed industry is becoming the most critical direction for developing enterprises. Another necessary step is acquiring modern models of the essential technological equipment of high productivity to meet the needs of the largest agro-industrial companies with an expanded range of products with existing capacities for the production of feed for livestock farming.

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