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University of Novi Sad, Technical faculty "Mihajlo Pupin", Zrenjanin, Republic of Serbia

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15th International Symposium

ENGINEERING MANAGEMENT AND COMPETITIVENESS 2025 (EMC 2025)

SUSTAINABLE STRATEGIES FOR A COMPETITIVE FUTURE

Proceedings

20-21st of June 2025, Zrenjanin, Serbia

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Engineering Management and Competitiveness 2025 (EMC 2025) - Proceedings

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INTRODUCTION

Department of Management and Technical faculty "Mihajlo Pupin" from Zrenjanin have started the organization of International Symposium Engineering Management and Competitiveness (EMC) in 2011. Since 2013 the organization of the EMC symposium has been supported by the following foreign partners: Szent István University, Faculty of Economics and Social Sciences, Gödöllő, Hungary, Voronezh State University, Faculty of Economics, Voronezh, Russia and University of Montenegro, Maritime Faculty, Kotor, Montenegro. Since 2025 the partners are: Budapest University of Economics and Business, Faculty of Finance and Accountancy, Budapest, Hungary and Voronezh State University, Department of Economics and Organization Management, Russia.

The objectives of the Symposium EMC are: presentation of current knowledge and the exchange of experiences from the field of Engineering management, consideration of development tendencies and trends in Serbia and the world as well, gathering researchers from this field with the aim of expanding regional and international cooperation, raising the level of professional and scientific work at Technical faculty "Mihajlo Pupin" from Zrenjanin, expanding cooperation with economic and educational institutions and encouraging young researchers within this field. Taking into account that this Symposium is international, the importance of this event is obvious for the town of Zrenjanin, Banat region, Vojvodina and Serbia. Organization of EMC by the Technical faculty "Mihajlo Pupin" from Zrenjanin represents this scientific-educational institution as one of the major representatives of economic and social development in Banat.

Engineering management has evolved significantly over the past few decades. In today's globalized and interconnected economy, organizations are expected to operate not only efficiently but also ethically and sustainably. The subtitle of this year's Symposium "Sustainable Strategies for a Competitive Future" reflects this expanded scope of engineering management. It recognizes the need to integrate sustainability as a core component of competitiveness - not as a trade-off, but as a driver. This resonates deeply with modern management theory, which increasingly emphasizes triple bottom line thinking: people, planet, and profit. The subtitle aligns the symposium with the growing realization that sustainability is no longer optional - it is a strategic imperative. Leading companies are now using sustainability as a framework for innovation, discovering new markets, reducing operational risk, and strengthening brand loyalty.

Within this Proceeding all accepted papers received for the 15th International Symposium Engineering Management and Competitiveness 2025 (EMC 2025) are presented. This year at the symposium we have 36 papers. The authors come from 7 countries: Croatia, Hungary, Iran, North Macedonia, Russia, Slovenia, and Serbia. The papers are divided into six sessions: Plenary, Management and operation management, Human resource management, Marketing management, Economy, and IT Management.

We wish to thank the Technical faculty "Mihajlo Pupin" from Zrenjanin and the dean Prof. Ph.D Milan Nikolić for their active role concerning the organization of the Symposium. We are also expressing our gratitude to all authors who have contributed with their papers to the organization of our fifteenth Symposium EMC.

The EMC Symposiums become a traditional meeting of researchers in June, every year. We are open and thankful for all useful suggestions which could contribute that the next International Symposium Engineering Management and Competitiveness become better in an organizational and program sense.

President of the Programming Committee
Professor Edit Terek Stojanović, Ph.D.

Zrenjanin, June 2025.

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15th International Symposium Engineering Management and Competitiveness 2025 (EMC 2025)
20-21st June, Zrenjanin, Serbia

Plenary session

Papers (pp. 3-34):

ASSESSING THE CONFORMITY OF SADERAT BANK'S PERFORMANCE WITH THE EFQM EXCELLENCE CRITERIA

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ABSTRACT

Self-assessment can examine an organization from various aspects, identifying its strengths and weaknesses, and determining the organization's needs to reach optimal conditions. Therefore, organizational excellence models (EFQM) have been highly successful as a powerful tool in addressing the needs of organizations. The research method is descriptive and data were collected through a standardized questionnaire. For data analysis and hypothesis testing, inferential statistics and the t-test were used. The validity of the questionnaire was confirmed using the opinions of experts and managers, and its reliability was measured using Cronbach's alpha coefficient. For this purpose, 50 employees of Saderat Bank were randomly selected and responded to questionnaires related to the 9 criteria of the organizational excellence model. The results of the study show that Saderat Bank scored 411 out of a possible 1000 points, which is above the minimum required score (300 points) for an excellent organization. Additionally, the findings indicate that the hypothesis related to the strategy criterion was rejected, while the other hypotheses were confirmed. This research concludes with suggestions to enhance the excellence level of Saderat Bank branches.

Key words: Organizational Excellence Model, Performance Evaluation, Continuous Improvement, Quality Management, Competitive Advantage

INTRODUCTION

In today's competitive business world, organizations face numerous challenges in their pursuit of survival and progress. Rapid technological changes, globalization of markets, increasing customer expectations, and the complexities of the business environment all highlight the growing necessity of using efficient management models (Gómez et al., 2017). Among these, organizational excellence models, as comprehensive and systematic frameworks, play a crucial role in guiding organizations towards continuous improvement and achieving superior performance (Dahlgaard et al., 2013). Organizational excellence models are tools that help organizations evaluate their current status in comparison with industry best practices and chart a path for improvement (Escrig & de Menezes, 2016). By providing an integrated framework, these models enable organizations to systematically review all aspects of their performance and, through identifying strengths and areas for improvement, develop and implement appropriate corrective action plans (Calvo-Mora et al., 2018). The European Foundation for Quality Management (EFQM) Model, the Malcolm Baldrige National Quality Award (MBNQA), and the Deming Model offer principles and criteria for assessing organizational performance across various dimensions (Jaeger & Matyas, 2016). These criteria typically include leadership, strategy, people, partnerships and resources, processes, customer results, employee results, societal results, and key performance results. The implementation of organizational excellence models brings numerous benefits to organizations. Increased customer satisfaction, improved financial performance, enhanced productivity, higher employee motivation and satisfaction, improved business processes, strengthened creativity and innovation, and increased organizational agility are among the significant achievements of establishing these models (Boulter et al., 2013; Suárez et al., 2017).

However, despite the numerous advantages of organizational excellence models, their successful implementation requires senior management commitment, active participation of all employees,

adequate resource allocation, the establishment of a continuous improvement culture, and patience and perseverance (Gómez-López et al., 2019). Organizations that successfully implement these models usually take a long-term perspective on the matter, considering it not as a temporary project but as a continuous journey towards excellence (Raharjo & Eriksson, 2017). In 1988, the EFQM organizational excellence model was developed in response to the need to enhance the competitiveness of European organizations. It was agreed upon and signed by fourteen major European companies—including Bosch, Renault, Fiat, BT, Bull, Electrolux, KLM, Nestlé, Olivetti, Philips, Sulzer, Volkswagen, Razalt, and Ciba—within the European Commission. This bold initiative has since evolved into a powerful management network, currently boasting more than 800 members from 38 countries worldwide, spanning both the private and public sectors. Operating within a European community framework, this movement in quality improvement follows in the footsteps of the Malcolm Baldrige model from the United States and the Deming model from Japan (Jelodari Mamagani, 2006).

Recent studies indicate that traditional performance evaluation methods are inadequate. It can be argued that the goal of traditional assessment is to judge and recall past performance, whereas the modern approach focuses on growth, development, and forward-looking improvement. Considering that the managers and officials of Bank Saderat seek insights into the performance of their branches and aim to achieve organizational excellence, this study endeavors to evaluate the performance of Bank Saderat branches based on the organizational excellence model.

RESEARCH METHODOLOGY

This study employs a survey methodology, utilizing questionnaires for data collection. The analysis of data and hypothesis testing is conducted using inferential statistics and the t-test.
Inferential statistical tests are categorized into two groups:
Parametric tests: These analyze data measured on interval and ratio scales, with mean and variance as their primary statistical indicators.
Non-parametric tests: These analyze data measured on nominal and ordinal scales, using median and mode as their statistical indicators.
The t-test, a parametric test, is applied in the following cases:
−   Comparing a hypothetical number with the mean of a sample population
−   Comparing the means of two populations
−   Comparing a hypothetical ratio with a sample-derived ratio
−   Comparing two ratios from two populations

In this research, we apply the t-test to compare a hypothetical minimum score required for organizational excellence across nine criteria with the mean score of the given population. The minimum score is 30% of the total possible score for each criterion.

The analysis is conducted using SPSS software, followed by frequency distribution tables and charts to facilitate data interpretation. Finally, conclusions are drawn based on the findings, leading to recommendations aimed at improving the organizational excellence of Bank Saderat branches.

VALIDATION METHODOLOGY

Validity Assessment

The present questionnaire possesses validity, reliability, and is standardized, making it applicable across various organizational settings, including industrial, manufacturing, educational, and service sectors. To further ensure face and content validity, the questionnaire was reviewed by six experts, managers, and university professors, who provided their feedback. After analyzing their insights, necessary revisions were made, leading to the final version of the questionnaire. Upon receiving

managerial approval, it can be concluded that the questionnaire is valid and suitable for evaluating organizational excellence within different contexts.

Reliability Assessment

To measure the reliability of the questionnaire, Cronbach's Alpha coefficient, one of the most well-known methods for assessing internal consistency in measurement tools, was applied. Prior to the main evaluation, 20 employees were randomly selected from a total of 50 employees within the studied population to conduct a pilot reliability test. This allowed us to determine the internal consistency and overall reliability of the questionnaire before proceeding with the full assessment as following:

Table 1: Reliability and Case Processing Summary for Enablers, Results, and Overall Categories

Case Processing Summary

		N	%
Cases	Valid	20	00.0
	Excluded[a]	0	.0
	Total	20	100.0

Reliability Statistics

Cronbach's Alpha[a]	N of Items
.710	27

Enablers

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

Reliability Statistics

Cronbach's Alpha[a]	N of Items
.735	23

Results

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

Reliability Statistics

Cronbach's Alpha[a]	N of Items
.727	50

Overall

Table 1. presents the reliability statistics and case processing summary for different organizational assessment categories. Cronbach's Alpha values indicate the internal consistency of the items in each category, ensuring the validity and reliability of the measurements.

Statistical Results

Table 2. presents a structured evaluation framework for assessing organizational performance across various dimensions, including leadership, strategy, human resource management, collaboration, processes, customer satisfaction, employee satisfaction, community impact, and business results. Each criterion is associated with a specific number of questions, a total score, and a minimum score required for achieving organizational excellence.

Table 3. represents the results of T-tests for various categories, showing the test values, significance levels, and confidence intervals. The last two columns indicate the acceptance or rejection of two hypotheses per category.

Table 4. presents statistical values for Organizational Excellence, including the sample size (N), mean, standard deviation, and standard error of the mean.

Table 2: A detailed scoring framework for evaluating excellence across key dimensions, including Enablers and results

Dimension	Criterion	Questions	Number of Questions	Total Score per Criterion	Minimum Score Required for Organizational Excellence
Enablers	Leadership	1-5	5	100	20
	Strategy	6-10	5	100	20
	Human Resource Management	11-15	5	100	20
	Collaboration and Resources	16-20	5	100	20
	Processes and Procedures	21-27	7	140	42
Results	Customer Satisfaction	28-35	8	160	48
	Employee Satisfaction	36-40	5	80	24
	Community Results	41-44	4	80	24
	Business Results	45-50	6	120	36

Table 3: A T-test evaluation of key dimensions, including strategy, leadership, financial resources, and customer satisfaction, with significance levels and confidence intervals

Criteria	Test Value	T Test	Sig. (2-tailed)	Lower Bound	Upper Bound	First Hypothesis	Second Hypothesis
Strategy	30	-3.05	.004	-5.00	-1.05	0	1
Employee Satisfaction	30	9.00	.000	19.00	30.00	1	0
Customer Satisfaction	48	5.00	.000	7.00	16.00	1	0
Processes and Procedures	42	6.00	.000	7.00	13.00	1	0
Leadership	30	7.00	.000	8.00	14.00	1	0
Human Resource Management	30	12.00	.000	22.00	31.00	1	0
Community Results	24	2.06	.045	.05	4.00	1	0
Business Results	36	4.00	.000	7.00	18.00	1	0
Collaboration and Resources	30	6.00	.000	5.00	11.00	1	0

Table 4: A summary of sample size, mean score, standard deviation, and standard error, offering key insights into data distribution and reliability

One-Sample Statistics	N	Mean	Std. Deviation	Std. Error Mean
Organizational Excellence	50	411.0000	42.00000	6.04461

This analysis confirms that the organizational excellence mean score (411) is significantly higher than the test value of 300.

Based on the Table 5, it can be concluded that the hypothesis related to the strategy criterion is rejected, while the remaining hypotheses are accepted. The total score obtained by the organization is 411, which leads to the conclusion that this organization is excellent.

CONCLUSION

The results obtained from statistical analyses based on the EFQM Organizational Excellence Model indicate that the selected branches of Bank Saderat have performed satisfactorily in most of the

model's nine criteria. The t-test, used to examine the difference between the obtained mean score and the hypothetical value (30% of the total score), showed that in all criteria except "Strategy," the mean score was significantly higher than the minimum expected threshold. This suggests that the organization is progressing toward excellence and has achieved a reasonable level of maturity in various areas, including leadership, processes, human resources, and performance outcomes.

Table 5: One-Sample t-Test Results for Organizational Excellence

	Test Value = 300					
					95% Confidence Interval of the Difference	
Variable	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Organizational Excellence	18.000	49	.000	111.00000	99.0000	123.0000

The overall score of 411 obtained by the bank indicates that it falls within the category of excellent organizations. However, the relative weakness in the "Strategy" criterion suggests that revisions and improvements are needed in the process of strategy formulation and implementation to achieve greater alignment between long-term goals and operational actions.

Overall, it can be concluded that Bank Saderat is on the right path in terms of organizational excellence. However, for continuous improvement and reaching higher levels of excellence, focusing on underdeveloped criteria and strengthening areas such as strategic planning is essential.

RECOMMENDATIONS

Since the "Strategy" criterion did not meet the required threshold for excellence, the following recommendations are proposed:

– Redesigning Strategy Formulation and Implementation: The bank should refine its strategic planning by incorporating feedback from employees, analyzing the competitive environment, and assessing customer needs. Utilizing tools such as SWOT analysis and strategic planning based on measurable objectives can be highly effective.
– Active Employee Participation in Strategy Development: Encouraging employees to actively engage in the design and execution of strategies can lead to greater alignment between individual and organizational goals, ultimately enhancing organizational excellence.
– Developing Managerial and Strategic Training for Middle and Senior Managers: Empowering managers in strategic planning and change management is a key factor in ensuring the successful implementation of long-term strategies.
– Establishing a Continuous Performance Monitoring System: Designing periodic performance measurement systems, including Key Performance Indicators (KPIs), will aid in precise decision-making and course correction when necessary.
– Strengthening Customer and Stakeholder Engagement in Strategy Development: Gathering direct customer feedback and analyzing market behavior will support the formulation of more realistic and customer-oriented strategies.

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EDUCATION, ENVIRONEMNT, AND INTENTIONS: DIGITAL ENTPRENEURSHIP IN SOCIETY 5.0

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ABSTRACT

The study analyzes the relationships between entrepreneurial intentions, entrepreneurial education, and the entrepreneurial environment in the development of digital entrepreneurship within the framework of Society 5.0. Society 5.0 represents an evolution towards a human-centered, technology-driven society where digital solutions address economic and social challenges. The research focuses on how individual motivation, access to education, and supportive environments contribute to the growth of digital ventures. Data was collected from 137 participants using a structured survey with a seven-point Likert scale, measuring perceptions of entrepreneurial intentions, education, the business environment, and engagement in digital entrepreneurship. Descriptive statistics, correlation analysis, and regression analysis were employed to assess the relationships among variables. The results indicate that entrepreneurial intentions, education, and the business environment are significant contributors to digital entrepreneurship, with entrepreneurial education showing the strongest impact. The findings highlight the importance of supportive policies, digital infrastructure, and education programs that equip individuals with the skills and confidence needed for digital business development. This research provides insights into how digital entrepreneurship can be strengthened to meet the economic and social goals of Society 5.0, suggesting pathways for policymakers, educators, and business leaders to support technology-based business creation.

Keywords: Digital entrepreneurship, Society 5.0, Entrepreneurial education, Entrepreneurship intentions, Entrepreneurial environment.

INTRODUCTION

Digital entrepreneurship has emerged as a significant component of economic development and technological advancement. Unlike traditional forms of entrepreneurship, which rely on physical infrastructure and localized markets, digital entrepreneurship harnesses advanced technologies to create new business models and innovative solutions that operate in a global and interconnected environment (Berman et al., 2024; Sitaridis & Kitsios, 2024). Society 5.0 envisions a society where the integration of digital technologies, such as the Internet of Things (IoT), Artificial Intelligence (AI), big data, and robotics, enhances both economic performance and social well-being (Akman & Erdirençelebi, 2024; Bakator et al., 2024). This concept promotes the idea of technology serving people, optimizing resources, and solving complex societal challenges through smart solutions. Digital entrepreneurship, in this context, not only supports economic growth but also contributes to more

inclusive, adaptable, and resilient business ecosystems (Abduh et al., 2024; Lechevalier, 2024). The development of digital entrepreneurship in Society 5.0 is shaped by three main factors: entrepreneurial intentions, entrepreneurial education, and the entrepreneurial environment. Entrepreneurial intentions represent the motivation and willingness of individuals to initiate digital business ventures. This willingness is often influenced by perceived opportunities, self-efficacy, and the overall attractiveness of digital markets (Batz Liñeiro et al., 2024). Individuals with strong entrepreneurial intentions are more likely to recognize digital business opportunities and take the necessary steps to pursue them. Entrepreneurial education, on the other hand, provides the foundational knowledge and skills needed to navigate digital platforms, understand market dynamics, and manage technological tools. Educational programs focused on digital technologies, business planning, and innovation strategies help equip future entrepreneurs with the competencies required to succeed in a digital economy. The entrepreneurial environment includes the external conditions that impact digital business development, such as economic stability, regulatory frameworks, technological infrastructure, and societal support for innovation (Overwien et al., 2024). A supportive entrepreneurial environment provides access to capital, mentorship, technological infrastructure, and regulatory clarity, all of which are crucial for the establishment and growth of digital startups.

This study investigates the relationships between entrepreneurial intentions, education, and the business environment in the context of Society 5.0. Through empirical analysis, the research explores how these factors influence digital entrepreneurship and contribute to sustainable economic growth. Additionally, this research contributes to the understanding of how digital entrepreneurship can be leveraged to meet the economic and social goals envisioned in Society 5.0, creating a more connected, efficient, and resilient society.

THEORETICAL BACKGROUND

Digital entrepreneurship has gained significant attention as technological advancements reshape business landscapes. In the context of Society 5.0, digital entrepreneurship emerges as a crucial driver of economic development and social progress, blending technological innovations with human-centered solutions (Bansal et al., 2024). Society 5.0 envisions a highly integrated environment where technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and big data transform everyday life and business operations (Ziatdinov et al., 2024). This concept promotes the use of digital technologies to solve societal challenges, improve living standards, and create sustainable economic growth. Digital entrepreneurship can help build innovative business models that are capable of addressing modern economic and social needs. The evolution of digital business models enables entrepreneurs to operate within highly connected digital ecosystems. Digital entrepreneurship is influenced by several factors that shape an individual's decision to engage in entrepreneurial activities (Bansal et al., 2024). One of the key factors is entrepreneurial intentions, which represent the personal motivation and willingness to create digital business ventures. According to established theories of planned behavior, entrepreneurial intentions are critical predictors of business creation. In the context of digital entrepreneurship, these intentions are driven by perceived opportunities in the digital economy, technological readiness, and confidence in the ability to manage digital tools and platforms (Krivokuća et al., 2024; Taneja et al., 2024). Individuals with strong entrepreneurial intentions are more likely to explore digital opportunities, develop innovative solutions, and navigate the complexities of digital markets (Bansal et al., 2024).

Another important factor is the entrepreneurial environment, which encompasses the external conditions that support or inhibit digital business development. These conditions include economic stability, regulatory policies, technological infrastructure, and societal support for innovation. A well-structured entrepreneurial environment provides access to resources such as funding, technology, mentorship, and market information, which are necessary for launching and scaling digital ventures (Chahal et al., 2024). In the framework of Society 5.0, the entrepreneurial environment is further expanded to include digital infrastructure, such as high-speed internet, secure digital payment systems, and cloud-based platforms that allow for seamless business operations. When these components are

present, digital entrepreneurs are better positioned to overcome barriers, reduce operational costs, and access broader markets, thus increasing the chances of business success. Entrepreneurial education also plays a significant role in shaping digital entrepreneurship. It provides individuals with the skills and knowledge needed to understand market dynamics, develop business strategies, and apply digital technologies effectively (Otache et al., 2024). Entrepreneurial education includes training in digital marketing, platform-based business models, cybersecurity, and innovation management. These competencies are important for identifying business opportunities, understanding customer needs, and responding to market changes in the digital economy (Anubhav et al., 2024). In Society 5.0, where technology is deeply integrated into business and everyday life, entrepreneurial education enables future entrepreneurs to thrive in digital ecosystems.

The interaction between entrepreneurial intentions, the entrepreneurial environment, and entrepreneurial education creates the foundation for digital entrepreneurship within Society 5.0. These elements not only influence the willingness to engage in digital business ventures but also determine the ability to navigate digital markets and leverage technological advancements.

METHODOLOGY

The study was conducted to examine the relationships between entrepreneurial intentions, the entrepreneurial environment, and entrepreneurial education on digital entrepreneurship in the context of Society 5.0. A structured survey was designed to collect data from participants, targeting individuals with varying levels of entrepreneurial experience and familiarity with digital technologies. The survey included questions measured on a seven-point Likert scale, ranging from "strongly disagree" to "strongly agree," to assess respondents' perceptions of entrepreneurial intentions, the quality of the entrepreneurial environment, access to entrepreneurial education, and engagement in digital entrepreneurship.

A total of 137 respondents (enterprise managers) participated in the survey. The sample consisted of individuals from different educational and professional backgrounds, providing a diverse perspective on digital entrepreneurship. Data collection was conducted both online and through direct outreach to ensure a representative sample. Descriptive statistics were applied to summarize the data, while correlation and regression analyses were performed to evaluate the relationships among the variables. The reliability of the constructs was assessed using Cronbach's alpha, with all constructs demonstrating acceptable reliability. The findings from the analysis provide insights into how entrepreneurial intentions, education, and the environment contribute to digital entrepreneurship in a technology-driven society. Based on the analyzed literature and the research goals, the following hypotheses are noted:

H1:   Entrepreneurial intentions (EIN) positively affects Digital entrepreneurship (DENT).
H2:   Entrepreneurial environment (EEN) positively affects Digital entrepreneurship (DENT).
H3:   Entrepreneurial education (EDU) positively affects Digital entrepreneurship (DENT).

RESULTS

The results of the descriptive statistics are presented in Table 1.

Table 1: Results of the descriptive statistics(Source: Authors)

Variable	Mean	Standard deviation	Cronbach's alpha
Entrepreneurial intentions (EIN)	5.12	1.38	0.915
Entrepreneurial environment (EEN)	4.98	1.42	0.899
Entrepreneurial education (EDU)	5.32	1.28	0.922
Digital entrepreneurship (DENT)	4.86	1.32	0.930

The descriptive statistics provide an overview of the central tendencies and variability of the measured variables. As shown in Table 1., the mean values for the variables are relatively high, indicating a generally positive perception among respondents. Entrepreneurial education (EDU) recorded the highest mean score of 5.32, followed by entrepreneurial intentions (EIN) at 5.12, the entrepreneurial environment (EEN) at 4.98, and digital entrepreneurship (DENT) at 4.86. The standard deviations suggest a moderate spread of responses, while Cronbach's alpha values demonstrate strong internal consistency for all constructs, indicating the reliability of the measurement scales. The results of the correlation analysis are presented in Table 2.

Table 2: Results of the correlation analysis (Source: Authors)

	EIN	EEN	EDU	DENT
Entrepreneurial intentions (EIN)	1.000			
Entrepreneurial environment (EEN)	0.574	1.000		
Entrepreneurial education (EDU)	0.458	0.435	1.000	
Digital entrepreneurship (DENT)	0.566	0.622	0.584	1.000

The correlation analysis results, presented in Table 2., show significant positive relationships between the independent variables and digital entrepreneurship. Entrepreneurial intentions (EIN) show a correlation coefficient of 0.566 with digital entrepreneurship (DENT), suggesting a strong and positive association. Similarly, the entrepreneurial environment (EEN) and entrepreneurial education (EDU) display correlation coefficients of 0.622 and 0.584 with digital entrepreneurship, respectively. These findings suggest that individuals who perceive strong support from their environment, possess entrepreneurial knowledge, and have the intention to start digital ventures are more likely to engage in digital entrepreneurship. The results of the linear regression are presented in Table 3.

Table 3: Results of linear regression analysis (Source: Authors)

Dep. variable Y	Indep. variables X	β intercept: 1.964	p-value	R^2	F	F Sig.	MSE	RMSE	DW
DENT	EIN	0.322	<0.0001	0.587	154.841	<0.0001	0.198	0.422	2.054
	EEN	0.241	<0.0001						
	EDU	0.384	<0.0001						

The regression analysis, presented in Table 3., further examines the impact of each independent variable on digital entrepreneurship. The results indicate that all three factors significantly contribute to digital entrepreneurship, with entrepreneurial education (EDU) showing the highest standardized coefficient (β = 0.384, p < 0.0001), followed by entrepreneurial intentions (EIN) (β = 0.322, p < 0.0001) and the entrepreneurial environment (EEN) (β = 0.241, p < 0.0001). The overall model explains 58.7% of the variance in digital entrepreneurship, as indicated by the R-squared value (R^2 = 0.587), which points to a strong predictive capacity of the model.

Table 4: Results of logistic regression analysis (Suorce: Authors)

Dependent variable Y	Independent variables X	R^2 (McFadden)	R^2 (Cox and Snell)	R^2 (Nagelkerke)	AIC	SBC
DENT	EIN		0.742	0.744	1022.210	1320.322
	EEN	0.186				
	EDU					

The logistic regression analysis presented in Table 4., supports these findings by demonstrating the significance of entrepreneurial intentions, the entrepreneurial environment, and education in predicting digital entrepreneurship outcomes. The R-squared values for the logistic regression (McFadden = 0.186, Cox and Snell = 0.742, and Nagelkerke = 0.744) suggest that these factors collectively provide a substantial explanatory power for digital entrepreneurship engagement.

The results confirm the positive influence of entrepreneurial intentions, the entrepreneurial environment, and entrepreneurial education on digital entrepreneurship, aligning with the theoretical expectations and the context of Society 5.0. Therefore, the proposed hypotheses are failed to be rejected.

Next, based on the analyzed literature a theoretical model for improving digital entrepreneurship in the context of Society 5.0 is developed. The model is presented on Figure 1.
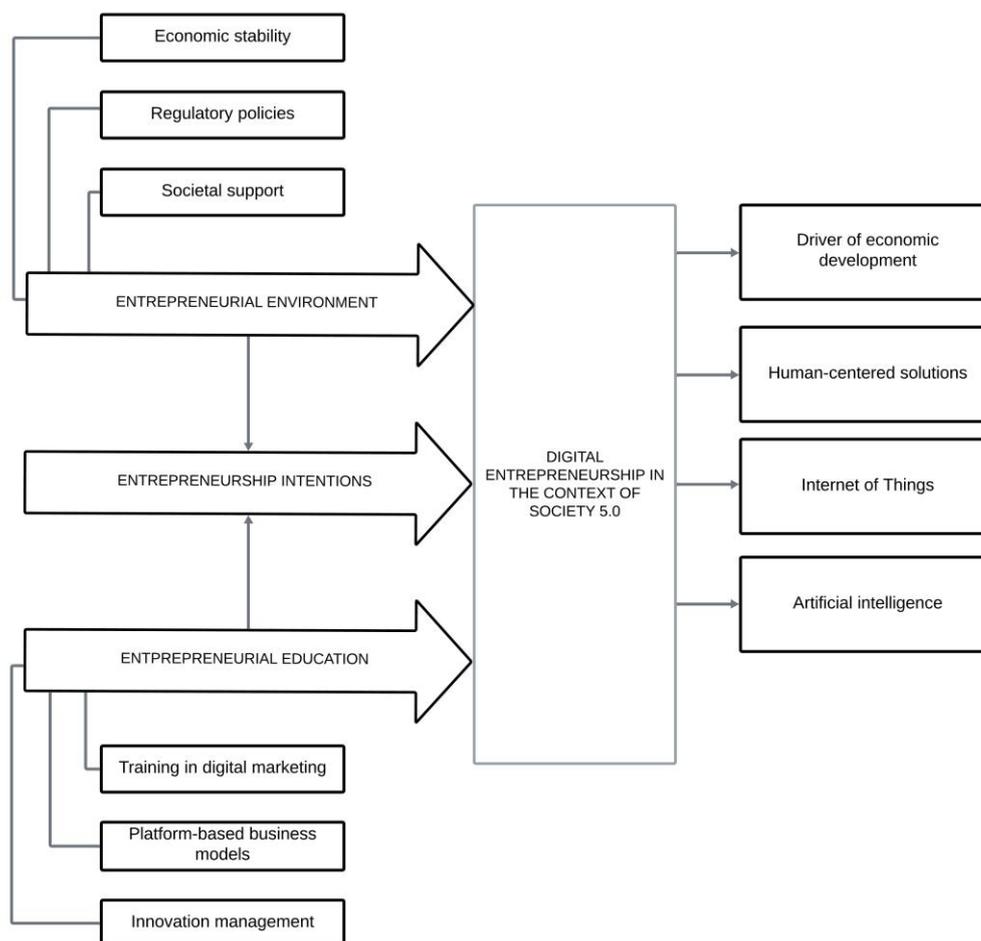
Figure 1: Model for improving digital entrepreneurship

The presented model describes the relationship between entrepreneurial intentions, entrepreneurial education, and the entrepreneurial environment in supporting digital entrepreneurship within the concept of Society 5.0. Entrepreneurial intentions represent the motivation and willingness of individuals to start digital ventures. This motivation is influenced by perceived opportunities and personal confidence in managing digital technologies. Entrepreneurial education provides individuals with the skills and knowledge necessary to understand the complexities of digital business models and market dynamics. The entrepreneurial environment includes external factors such as economic stability, regulatory clarity, technological infrastructure, and societal support, which contribute to the establishment and growth of digital ventures. The model emphasizes how these three factors work together to strengthen digital entrepreneurship in a technology-driven society. Individuals who have strong intentions, proper education, and operate in a supportive environment are more likely to identify digital business opportunities and successfully create innovative ventures. Additionally, technologies like the Internet of Things and Artificial Intelligence are seen as essential components for expanding market reach and optimizing business operations in this digital ecosystem.

The model also aligns with the principles of Society 5.0, which focuses on using digital technologies to address societal challenges while promoting sustainable economic growth. This alignment suggests

that enhancing entrepreneurial intentions, improving education, and ensuring a supportive environment can effectively contribute to the digital transformation of entrepreneurial activities. These elements are necessary for economic development and social progress in a technology-focused society. The findings from the model highlight the importance of building individual readiness, providing educational support, and creating an enabling environment to drive digital entrepreneurship forward.

SUGGESTION AND GUIDELINES

Based on the obtained results and the analyzed literature, the following suggestions and guidelines for improving digital entrepreneurship in the context of Society 5.0 are noted:

– Strengthen entrepreneurial intentions through digital education and practical experience.
– Provide mentorship programs and networking opportunities for aspiring entrepreneurs.
– Promote digital literacy, business planning, and technology-based problem-solving skills.
– Encourage enterprises to adopt innovative business models with IoT and AI integration.
– Invest in employee training for digital skills and support intrapreneurship initiatives.
– Establish partnerships between enterprises, startups, and technology incubators for knowledge sharing.
– Simplify regulatory frameworks to support the formation and growth of digital ventures.
– Invest in digital infrastructure such as high-speed internet and secure payment systems.
– Introduce government incentives for technology-based startups and research projects.
– Collaboration between government, academia, and industry to bridge innovation and market application.
– Create an environment that reduces barriers and provides access to resources for digital entrepreneurs.

CONCLUSION

The development of digital entrepreneurship in the context of Society 5.0 depends on the alignment of entrepreneurial intentions, education, and the business environment. Individuals equipped with digital skills and a strong understanding of market dynamics are more likely to recognize business opportunities and succeed in digital ventures. Enterprises that embrace technological advancements and invest in employee capabilities contribute to a more innovative business landscape. Government support through clear regulations, infrastructure investments, and incentives can further stimulate digital business growth. These combined efforts can lead to sustainable economic development, driven by technology-driven solutions that address societal needs and support economic progress in an interconnected digital environment.

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ON-PREM VS CLOUD LLMS FOR GDPR-COMPLIANT CUSTOMER-SERVICE CHATBOTS IN THE HOTEL INDUSTRY

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ABSTRACT

Mid-size hotels in Central Europe are increasingly adopting AI chatbots to enhance customer service. They must, however, balance innovation with strict GDPR requirements.This study compares a cloud-based large language model (OpenAI's GPT-4 API) against an on-premises deployment of an open-source LLM (Llama 3–13B) for hotel customer-service chatbots. We evaluate both solutions in the context of Cogniforce Labs deploying chatbots for regional hotels, focusing on GDPR compliance, operational cost, response latency, and customer satisfaction. Using three common use cases (booking modification, late check-in, and local recommendations), we simulate chatbot interactions and measure performance. The results show that the on-premises LLM offers superior data privacy (all guest data remains in-house, aiding GDPR compliance) and lower latency (up to ~35% faster responses), along with a more predictable cost structure. The cloud GPT-4 solution, however, delivers slightly higher answer quality, yielding greater customer satisfaction scores, at the expense of transmitting personal data to a third-party and incurring usage-based fees. Our findings suggest a trade-off between compliance/cost and service quality. Hotels prioritizing privacy may favor on-premise LLMs, while those emphasizing customer experience might opt for cloud AI with proper safeguards. We discuss hybrid strategies and provide recommendations for hospitality businesses navigating this choice.

Keywords: GDPR, Large Language Models, Chatbots, On-Premises AI, Cloud AI, Hospitality.

INTRODUCTION

The hotel industry increasingly leverages AI-powered chatbots to provide instant, round-the-clock customer service. Hotels use chatbots to handle frequent inquiries—such as booking changes or local amenity information—thereby improving responsiveness and freeing staff for complex tasks. Successful deployments have reported significantly faster query resolution and higher guest satisfaction (Capella Solutions, 2024). However, deploying such chatbot systems in Europe raises important concerns around privacy and data protection. The EU's **General Data Protection Regulation (GDPR)** imposes strict obligations on handling customers' personal data, including hotel guest information. Any AI solution must ensure compliance with GDPR requirements for data residency, consent, and security (Padilla Ojeda, 2024). This poses a challenge when using cloud-based AI services: sending guest data (e.g. names, dates, preferences) to external providers could violate data transfer rules or expose sensitive information.

One potential solution is to adopt **on-premises** large language models (LLMs) that run within the hotel's or vendor's own infrastructure, keeping data locally. Recent advances in open-source LLMs (e.g. Meta's Llama family) have made it feasible to self-host powerful language models without relying on big cloud providers. This study examines the trade-offs between a **cloud LLM** (OpenAI GPT-4 via API) and an **on-prem LLM** (a hypothetical Llama 3 with 13B parameters) for customer service chatbots in mid-size hotels. We focus on Cogniforce Labs' initiative to roll out AI chatbots across hotels in Central Europe, comparing the two approaches on four key dimensions: **GDPR compliance, operational cost, response latency, and customer satisfaction**. The goal is to provide

hospitality managers and engineers a data-driven basis for choosing an AI architecture that best fits their privacy obligations, budget constraints, and service quality goals.

LITERATURE REVIEW

AI Chatbots in Hospitality: Prior studies indicate that AI-driven chatbots can enhance service efficiency and guest experiences in hotels. Chatbots are capable of providing instant answers to common questions, handling booking requests, and offering personalized recommendations, which positively affects customer satisfaction and engagement (Chotisarn and Phuthong, 2025). In a case study of a hotel chain, the introduction of AI chatbots led to a 10-fold faster query resolution and a 22% increase in customer satisfaction scores, as well as reduced wait times during peak hours (Capella Solutions, 2024). These benefits stem from chatbots' ability to deliver 24/7 service and consistent responses, thereby improving operational efficiency and guest loyalty. Nonetheless, research also notes that guests value accuracy and a human-like conversational quality – factors which depend on the sophistication of the underlying AI (Chotisarn and Phuthong, 2025). This underscores the importance of choosing an LLM with adequate capability for the domain-specific tasks.

GDPR and Data Privacy Concerns: GDPR sets a high bar for data privacy in the EU, mandating that personal data of customers be handled with transparency, kept secure, and not transferred to jurisdictions without adequate protection (Padilla Ojeda, 2024). These regulations directly impact enterprise use of LLMs. If a hotel's chatbot transmits guest data (names, booking details, etc.) to a cloud AI service, the hotel remains the data controller responsible for GDPR compliance. Organizations must ensure either that the data stays within the EU or that any cross-border transfer meets strict conditions transferred to jurisdictions without adequate protection(Padilla Ojeda, 2024). Furthermore, some LLM providers historically have retained user prompts for model training or logging purposes, which raises additional compliance issues if not properly disclosed and consented. Due to such concerns, several companies – including banks and tech firms – have restricted employees' use of public chatbots like ChatGPT, fearing confidential data leaks (Matviishyn, 2024). In the hospitality context, guest trust and legal compliance are paramount; thus, minimizing third-party data exposure is a key consideration when deploying AI services (Matviishyn, 2024).

On-Premises vs. Cloud LLM Deployment: Deploying an LLM on-premises (or in a private cloud under the company's control) can address many data privacy issues. By self-hosting the model, businesses maintain full control over data flow and storage, ensuring that sensitive customer information never leaves their controlled environment (Matviishyn, 2024). This approach aids compliance by design, as data autonomy makes it easier to enforce policies like data retention limits and access controls. Indeed, organizations in regulated sectors often prefer self-hosted AI specifically to avoid the risk of data leakage to external servers (Akman, 2024). On-prem LLMs also eliminate ongoing API usage fees; while they require upfront investment in hardware and engineering, they can become cost-effective at scale by avoiding pay-per-request charges (Akman, 2024). Additionally, self-hosting allows greater customization (e.g. fine-tuning on proprietary data and integration with internal systems) without exposing that data to an outside vendor.

Conversely, cloud-based LLM services offer advantages in ease of deployment and raw performance. Providers like OpenAI, Google, or Microsoft supply powerful models (often more advanced or larger than what is feasible to run on-prem) and handle the heavy maintenance tasks such as model updates, scaling, and uptime. The GPT-4 model, for instance, is a state-of-the-art LLM known for its superior reasoning and fluency, which can translate into more natural and accurate chatbot responses. Using a cloud API requires minimal local infrastructure – essentially just an internet connection – and allows rapid development by leveraging pre-built AI capabilities. However, these benefits come with trade-offs: **higher operational expenses** (usage-based pricing) and dependency on the vendor's compliance measures. Enterprises can opt for business-focused offerings like Azure OpenAI or "ChatGPT Enterprise" which promise not to use data for training and to keep data within certain regions, as

partial mitigation (Matviishyn, 2024). Still, ultimate responsibility for GDPR compliance lies with the deploying company, and trust in the provider is required.

METHODOLOGY

Use Case Scenarios: We designed three representative customer-service scenarios in which a hotel guest interacts with a chatbot: (1) Booking Modification – the guest wants to modify an existing reservation (e.g. change dates or room type); (2) Late Check-in – the guest informs the hotel of a late arrival and requests check-in instructions; (3) Local Recommendations – the guest asks for suggestions on nearby restaurants and attractions. These scenarios cover a range of query complexity and sensitivity: from transactional (booking changes involve personal booking data) to simple notification, to open-ended informational queries.

LLM Solutions Evaluated: For each scenario, we built two chatbot prototypes:
- **Cloud GPT-4:** Using OpenAI's GPT-4 model via API (2025 version). The chatbot transmits the user's query to the cloud service and returns GPT-4's response
- **On-Prem Llama 3–13B**: Using a hypothetical open-source Llama 3 model (13 billion parameters) deployed on a local server.

Evaluation Metrics: We evaluated each chatbot in each scenario on four dimensions: GDPR Compliance, Operational Cost, Response Latency Customer Satisfaction. It should be noted that while the satisfaction evaluation provides insight into answer quality, it is somewhat subjective. We mitigated bias by randomizing the order of model responses for raters and ensuring the content of responses was based on consistent scenario assumptions. The benchmarking and evaluation were conducted in April 2025.

RESULTS

GDPR Compliance: The data flow analysis confirmed stark differences in privacy. With the **GPT-4 cloud chatbot**, any user query (which can include personal details) is sent over the internet to OpenAI's servers. In our tests, this meant guest data left the hotel's domain and went to a US-based service (OpenAI), implicating GDPR restrictions on data export. While encryption (HTTPS) is used in transit and OpenAI offers assurances (e.g. not using API data for training by default), the hotel must trust the provider's compliance and possibly sign a Data Processing Agreement. The cloud approach also made it challenging to guarantee data deletion on demand – an obligation under GDPR. In contrast, with the **on-premises Llama 3 chatbot**, all processing occurred locally; personal data stayed on Cogniforce Labs' server (physically in the EU). This setup inherently satisfied GDPR data residency requirements – no data transfer to third countries was needed. It also gave the deploying company direct control to delete or anonymize chat logs as required. Overall, the on-prem solution was judged **fully compliant by design**, whereas the GPT-4 solution required additional legal and technical safeguards (such as EU hosting options or anonymizing queries) to approach compliance. While on-prem hosting ensures data residency, hallucinated outputs may still risk privacy breaches if the model fabricates plausible but false personal details.

Latency and Cost Performance: Table 1 summarizes the measured response times and estimated costs for the two models across the three use cases. The **Llama 3–13B** on-prem chatbot demonstrated consistently lower latency. For straightforward queries like late check-in, it responded in about 1.8 seconds on average, compared to 2.5 seconds for GPT-4. In the more complex booking modification scenario, which involved multiple database lookups (e.g. checking availability) integrated into the chatbot flow, Llama 3 answered in ~2.8 s vs. ~4.0 s for GPT-4. The largest delay was observed in the local recommendations scenario: GPT-4 took ~5.5 s to generate a detailed answer listing restaurants and attractions (likely due to a longer, more creative response), while Llama 3 returned a more concise list in ~4.0 s. The on-prem model's speed advantage (approximately 30–35% faster replies) is

attributable to eliminating network round-trip time and possibly using a smaller model that generates tokens quicker. From the user experience perspective, this difference was noticeable: the GPT-4 chatbot sometimes had a short "typing" delay, whereas the Llama chatbot felt nearly instantaneous. In terms of **operational cost**, the cloud GPT-4 incurs usage fees for each request. Based on OpenAI's pricing and the token counts in our test dialogues, a single booking modification interaction (which averaged ~250 tokens in/out) costs roughly $0.015. Local recommendation queries, with lengthier answers, cost up to $0.03 each. Summing typical usage, a mid-size hotel might see a few hundred to a thousand such queries monthly, amounting to tens of dollars in API fees per month for GPT-4. The on-prem Llama 3 model has no per-query charge; its cost comes from infrastructure. We estimated that running the model (including hardware depreciation and electricity) would cost on the order of $0.002–$0.004 per query. This made the on-prem solution markedly cheaper per interaction in our scenario (see Table 1, last columns). These results support the expectation that on-prem LLMs can offer cost benefits for sustained high-volume use (Akman, 2024), though for very low volumes the difference might be negligible when weighed against the infrastructure overhead.

Table 1: Performance of cloud GPT-4 vs. on-prem Llama3-13B across use cases

Use Case	GPT-4 Latency (s)	Llama3 Latency (s)	GPT-4 Cost per 100interactions (USD)	Llama3 Cost per 100interactions (USD)
Booking Modification	4.0 s	2.8 s	$1.50	$0.20
Late Check-in	2.5 s	1.8 s	$0.50	$0.10
Local Recommendations	5.5 s	4.0 s	$3.00	$0.40

Customer Satisfaction: In our blind user evaluation, both chatbots achieved high satisfaction scores, but GPT-4's responses were rated higher on average. Figure 1. illustrates the mean satisfaction ratings (on a 5-point scale) for each scenario. In the late check-in scenario – a simple task – participants found little difference For the booking modification scenario, GPT-4 scored 4.5 vs. Llama's 4.2. Reviewers commented that GPT-4 responded with a slightly more fluent and reassuring tone, e.g. explicitly confirming the changes and apologizing for any inconvenience, whereas Llama3 (on-prem) provided a correct but more terse response. The largest gap was in the local recommendations scenario: GPT-4's rich, detailed answer (mentioning a few restaurants with specific cuisine notes and distance from the hotel) achieved about 4.6 satisfaction, compared to 4.0 for Llama3's answer, which was factual but less detailed. Participants appreciated the depth and natural language style of GPT-4's suggestions, which felt more "concierge-like." This result is not surprising – GPT-4, being a far larger model trained on vast data, excels at open-ended tasks and creative, context-rich responses. Despite GPT-4's advantage, it is worth noting that Llama3's performance was quite strong for routine queries This indicates that from a customer satisfaction standpoint, on-prem models can achieve parity in simple use cases, and the gap in more complex tasks might be narrowed through further fine-tuning or by augmenting the model with hotel-specific knowledge (e.g. integrating a database of local attractions for richer recommendation answers).

DISCUSSION

The findings reveal a classic trade-off between compliance & control versus raw performance & convenience when choosing between on-prem and cloud LLM solutions for hotel chatbots. We discuss each key dimension in turn and provide context for decision-makers:

Privacy and GDPR Compliance: The on-premises LLM clearly offers superior assurances for GDPR compliance. All guest interactions stay within the organization's own infrastructure, drastically reducing exposure to third-party risks. This aligns with enterprise trends noted by Matviishyn (2024), where data-sensitive companies lean toward self-hosted models to maintain data sovereignty. In our case, using Llama3 on-prem meant hotels could confidently tell guests that their personal details never leave the company's servers, potentially boosting customer trust in the service. In contrast, the cloud GPT-4 approach, while not insurmountable, requires careful legal and technical measures: e.g.

ensuring the cloud provider processes data in Europe or in compliance with EU Standard Contractual Clauses, and implementing features like prompt anonymization (removing or masking PII in queries).
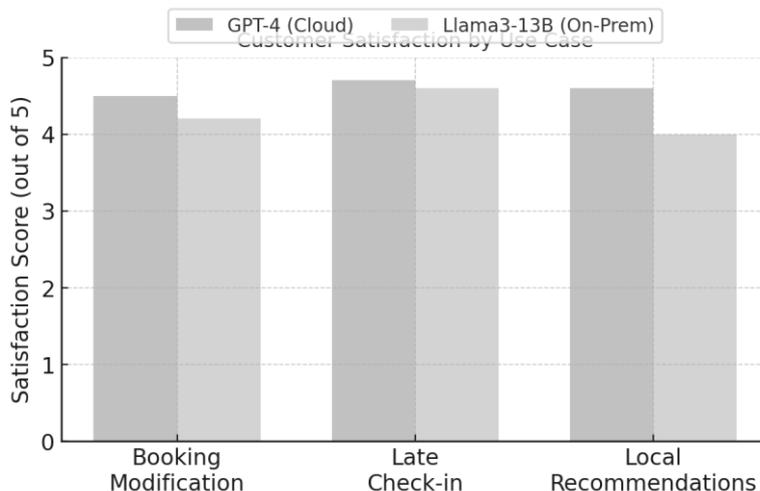
Figure 1: Average user satisfaction ratings (1–5 scale) for chatbot responses in each scenario, comparing GPT-4 (cloud) vs. Llama3-13B (on-prem). Higher values indicate better perceived quality and helpfulness of the response.

Operational Cost Considerations: Cost analysis showed that at scale, the on-prem model can be significantly cheaper per interaction than the pay-as-you-go cloud model. This echoes the point by Akman (2024) that avoiding ongoing API fees can yield long-term savings, especially for high-volume usage. For Cogniforce Labs deploying across multiple mid-size hotels, an investment in robust hardware and a single open-source model deployment could service all clients with only marginal incremental cost for additional queries. In contrast, using GPT-4 via API means costs grow directly with usage – which might be predictable and manageable for low volumes, but could become a budget concern if the chatbot becomes very popular or expands in functionality (e.g. handling multi-turn conversations, larger outputs, etc.). It is important to note, however, that on-prem is not "free": there are hidden costs such as system maintenance, updates, and the engineering effort to optimize the model. Smaller hotels with limited IT support might find the cloud model's zero-infrastructure approach more appealing despite the higher variable cost.

Latency and Performance: Our tests demonstrated a tangible benefit of on-prem deployment in reducing latency. In customer service, faster responses generally equate to better user experience – nobody likes waiting long for answers. A difference of a couple of seconds, as we saw in complex queries, might affect user perception: a near-instant answer feels like a snappy, efficient service, whereas a longer pause might cause users to wonder if the system understood them or is still working. Especially in hospitality, where guests may be in a hurry (e.g. asking a question on the go), responsiveness is key.

Customer Satisfaction and Quality of Responses: The satisfaction ratings highlight that GPT-4 currently holds an edge in delivering high-quality, eloquent responses. The larger model tends to have better grasp of nuanced language and broader knowledge, which shone through in tasks like making detailed recommendations. For hotels aiming to wow guests with a very polished AI concierge, the GPT-4 solution might be preferable. Guests could conceivably find the GPT-4-powered chatbot more "helpful" or even engaging, perhaps increasing their overall satisfaction with the hotel's service. On the other hand, our results also show that a well-implemented smaller model can be sufficient for many practical purposes. The differences were minor for straightforward Q&A.

Hybrid and Alternative Approaches: It is worth mentioning that the dichotomy of cloud vs. on-prem is not all-or-nothing. Some organizations pursue a hybrid strategy: for example, using the on-prem model for most queries to keep data local, but falling back to a cloud model for particularly hard

questions or off-topic queries (routing logic could decide if a query requires GPT-4's prowess). For instance, hotels could handle routine requests with an on-prem model and escalate unusual or complex questions to a cloud LLM via a secure relay, minimizing external exposure. This could maximize quality while limiting data exposure. Another approach is using cloud models through providers that offer EU data residency.

Limitations: A few limitations of our study should be noted. First, the Llama 3–13B model is hypothetical (projected based on trends from Llama 2); actual performance of open-source models in 2025 could vary. We assumed a certain level of fine-tuning and domain adaptation that may require expertise to achieve. If an open model were used out-of-the-box with no tuning, the satisfaction results might be lower. Second, our evaluation of GDPR compliance was qualitative; a real deployment would need a thorough legal assessment and possibly a Data Protection Impact Assessment (DPIA).

CONCLUSION

This study examined the deployment of customer-service chatbots in the hotel industry using two contrasting LLM approaches: a cloud-based GPT-4 API and an on-premises Llama 3–13B model. Using Cogniforce Labs' pilot across mid-size Central European hotels, we evaluated each approach on GDPR compliance, operational cost, response latency, and user satisfaction. The results highlight a clear trade-off. The on-premises LLM offers strong data protection and control, keeping guest information internal and simplifying GDPR compliance, as well as faster response times and lower variable costs. In contrast, the cloud GPT-4 solution provides superior AI capability, yielding more articulate and informative responses that slightly improve customer satisfaction, at the cost of relying on a third-party service and incurring ongoing fees. For hotel operators and tech providers, the choice depends on strategic priorities.

Ultimately, hotels implementing AI must weigh technical capabilities against ethical and legal responsibilities. This study provides an initial framework and evidence to support those decisions. By carefully considering the factors detailed here, hospitality businesses can deploy AI chatbots that delight customers while respecting their privacy and maintaining compliance in an era of strict data protection.

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EXTERNAL DETERMINANTS OF CORPORATE SOCIAL RESPONSIBILITY PRACTICES IN INDUSTRIAL ENTERPRISES OF THE VORONEZH REGION

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ABSTRACT

The paper examines the influence of external factors on the evolution of corporate social responsibility (CSR) within regional industrial enterprises. The research is grounded in qualitative data collection and analytical methods, which encompass surveys and in-depth interviews with leaders of industrial enterprises in the Voronezh region, alongside a review of statistical data and analytical reports at both national and regional levels. Consequently, the study highlights the role and potential of the state and the non-profit sector as pivotal external agents in fostering responsible practices in this historically industrialized area of Russia. It outlines the priorities for governmental engagement in promoting socially responsible initiatives among enterprises, as well as the regulatory mechanisms that support their advancement, particularly through tax incentives, credit facilities, and targeted subsidies. However, the non-profit sector remains a relatively weak player within the industrial landscape of the Voronezh region. Amidst a significant labor shortage, enterprises tend to engage consistently only with educational and scientific non-profit organizations.

Keywords: Corporate social responsibility, Sustainable development, Industrial enterprises, Government regulation, Non-profit organizations.

INTRODUCTION

CSR is influenced by various endogenous and exogenous factors. Among the external determinants of CSR development, the level of development of the country's economy, the intensity of competition, traditions, skills, customs of business communication, etc. are noted. However, historically, external pressure (Weiser and Zadek, 2000) has had a serious impact on the formation of CSR, the main actors of which were government and civil society institutions. In the 20s of the twentieth century, a powerful labor movement began in the United States, trade unions and business associations were formed. The labor legislation that was formed a little later, as a result of the social dialogue between employers, employees and the government, became the leading external factor directly influencing socially responsible practices. Steurer (2010) showed that CSR started out as a neo-liberal concept that helped to downscale government regulation, but that it has in turn matured into a more progressive approach of societal co-regulation.

Currently, the role of government is crucial in promoting CSR activities or programs (Verba, 2024). Depending on the degree of government involvement in the development of socially responsible behavior of enterprises and the regulatory methods used, two approaches to the implementation of relevant government policy can be distinguished (Nikitina and Pertseva, 2021):
−   An open model of CSR, in which regulatory instruments prevail, aimed at stimulating voluntary and independently determined social programs and projects of enterprises;

− A hidden model of CSR, in which enterprises are rather forced by society, represented by the state, to implement already accepted values. The regulatory instruments in this model are prescriptive and mandatory.

Within the framework of these two models, the dilemma is considered: is business capable of independently determining its contribution to the development of society, or should the state coordinate public interests and then transform them into official and unofficial requirements for business?

Non-profit organizations (NPOs) are among the most powerful civil society institutions that can influence the development of CSR. In particular, Arenas et al., (2009) note that NPOs are key players in CSR, but their role is still regarded as controversial and their legitimacy contested. NPOs play two roles in the development of CSR: they are both direct participants in confrontational development and joint development partners (Faroque et al., 2022). NPOs either push corporations towards voluntary development initiatives through coercion, or cooperate with them to facilitate the implementation of CSR projects that support the goals of socio-economic development.

This study is devoted to understanding the role and capabilities of the state and the non-profit sector, as the main external actors, in the development of socially responsible practices of industrial enterprises in the Voronezh Region.

MATERIALS AND METHODS

The object of this study is industrial enterprises of the Voronezh region engaged in raw material processing (manufacturing industry). Manufacturing ranks third in the region by the number of active legal entities, accounting for 8.38% of the regional economy's structure, and second by revenue, representing 22.9%. In 2024, the industrial production index in the Voronezh region reached 102.5% compared to 2023, with a significant contribution from manufacturing, where the index reached 104.2%. By the end of 2024, the total volume of state support for the region's industrial sector from federal and regional budgets amounted to 7 billion rubles.

The research relied on qualitative methods of data collection and analysis, including in-depth interviews, analysis of Russian and regional statistical data, analytical reviews, and media materials. The following data sources were used in the study:
− A standardized survey of managers of industrial enterprises in the Voronezh region on issues of social responsibility practices implementation, conducted in March 2021 and March 2024;
− Semi-structured interviews with general directors and deputy directors of industrial enterprises in the Voronezh region, conducted in July–August 2024;
− The official website of the ECG rating (https://экг-рейтинг.рф/), formed according to GOST R 71198-2023 "Business Reputation Index of Business Entities (ECG Rating). Assessment Methodology and Procedure for Forming the ECG Rating of Responsible Business," which is positioned as an analogue of ESG ratings but adjusted for state priorities. The ECG rating reflects the result of a comprehensive assessment by summing points across three areas: environment, personnel, and state. In the Russian Federation, more than 7 million companies are covered by this rating, including 90,000 from the Voronezh region. The rating scale ranges from 0 to 160 points. Based on the scores, companies are classified into four levels: "C" / "CC" / "CCC" (basic), "B" / "BB" / "BBB" (intermediate), "A" / "AA" (advanced), and "AAA" (leaders). Out of 102 enterprises included in the mailing list for the standardized survey ECG rating data were available for 61 on the official website. Many enterprises not included in the rating system operate in the defense industry are under sanctions and do not disclose data.

RESULTS AND DISCUSSION

Data triangulation enabled the formation of an objective picture regarding the implementation of socially responsible practices at manufacturing enterprises in the Voronezh region and the external factors shaping their development.

To assess the current level of socially responsible practices among Voronezh manufacturing enterprises, we analyzed the results of external evaluation based on ECG rating data. The average score in the sample was 70.19, which is at the boundary between "BB" and "BBB" ratings. Of the 61 enterprises, 30 scored above the average and 31 below. It was found that 69% of the sample enterprises are at the intermediate ECG rating level. Analysis of the scores in each rating area showed that the main focus is on the "State" block, with enterprises on average receiving 60.8% of the maximum possible points in this area. The least attention is paid to the "Environment" block, with enterprises on average receiving only 17.5% of the maximum possible points. For the "Personnel" block, enterprises received an average of 21.7% of the maximum possible points.

In 2021, only one-third of respondents (33.3%) were inclined to believe that social responsibility in Russia would develop and that an increasing number of enterprises would incorporate advanced environmental, social, and governance practices into their operations. By 2024, this number had doubled to 66.7%, while an additional 10% believed that the situation would remain at the current level (30% in 2021). Only one respondent in 2024 forecasted a decline in the development of socially responsible practices (there were none predicting such a decline in 2021).

The main obstacles to the development of corporate social responsibility (CSR), according to respondents, are outlined in Table 1.

Table 1: Key Challenges and Barriers to the Development of CSR in Russia (multiple responses possible)

Barriers to the Development of CSR	Share of Total Respondents, %	
	2021	2024
Lack of clear understanding of CSR and its effects by businesses	46,7	63,3
Underdeveloped regulatory framework	23,3	30,0
Insufficient financial resources for enterprises	63,3	63,3
Inadequate coverage of CSR issues in media and public discussions	26,7	36,7
Ineffective government policy in promoting/supporting socially responsible enterprises	33,3	36,7
Lack of CSR specialists in the labor market	6,7	23,3
Underdevelopment / passivity of non-profit organizations	6,7	6,7
Insufficient experience and skills among enterprises in developing and implementing social programs	20,0	43,3
Underdeveloped responsible investment tools	0,0	0,0

The lack of financial resources among enterprises remains the primary argument hindering the development of socially responsible practices, a situation that has not changed between 2021 and 2024. As noted in an interview: *"When a company is in a challenging situation and has to choose between investing in its further development or engaging in other projects related to ecology, social functions, or infrastructure development around it, the choice clearly favors internal growth"* (large enterprise, machinery and equipment manufacturing, not included in other groupings, July 2024).

In 2024, significant changes in the assessment of barriers and difficulties related to CSR development shifted towards a critical evaluation of companies' capabilities to implement socially responsible practices. Notable increases were observed in the following areas: lack of experience and skills among enterprises in developing and implementing social programs (+23.3%), unclear understanding of CSR and its effects by businesses (+16.6%), and the absence of CSR specialists in the labor market (+16.6%).

Overcoming these challenges is possible through the establishment of a multi-actor support system for socially responsible practices and ESG transformation. The characteristics of this system involve building vertical and horizontal connections among various types of actors (government, business, civil society), aggregated into sectors, organizational units, or individual/group entities. The scientific foundation of this system is rooted in concepts of managing the transition to sustainable development, particularly the Multi-Level Perspective (MLP) and Multi-Actor Perspective (MAP). Transition management is viewed as a long-term process focused on coordinating and influencing complex social change processes. Coordination and influence are considered the most feasible forms of control, where beliefs, feedback mechanisms, and achieving consensus among all participants play a crucial role. (Komleva and Sheveleva, 2021).

In our research, we sought assessments from enterprise representatives regarding the role and capabilities of the government and NPOs as primary external actors in the development of socially responsible practices. In 2024, 76.7% of respondents deemed government participation in the development of socially responsible practices at enterprises necessary, with only one respondent denying such necessity. In 2021, just over half of respondents (56.7%) supported government involvement, while three respondents considered it unnecessary.

Undoubtedly, government policy in the field of CSR is an integral element of its systemic development. This policy stimulates the dissemination of institutional norms of CSR and creates conditions for businesses to engage in social investments. The tools applied can either encourage voluntary, self-defined socially responsible practices by enterprises ("soft" approach, open CSR model) or compel businesses to implement societal values ("hard" approach, hidden model).

Enterprises are increasingly engaging with regional government and administrative structures. Consequently, the tangible results of cooperation between authorities and businesses in the area of social responsibility are more readily observable at the regional and local levels. The outcomes of social activities by business entities and their governmental regulation in the regions of Russia exhibit ambiguity regarding the overall development trajectory, key areas, and forms. In Russian regions, the practice of promoting CSR ideas, as well as developing corresponding regulations and evaluation methodologies, has not yet gained widespread traction. However, there are individual regional initiatives and developments in this field.

Voronezh Region has become the second subject of the Russian Federation to adopt Law No. 116-OZ "On the Development of Responsible Business Practices in Voronezh Region," dated December 1, 2023. According to this law, legal entities registered in Voronezh Region with an average employee count exceeding 15 and revenue exceeding 120 million rubles will undergo evaluation for inclusion in the ranking of responsible organizations. Companies will be assessed based on criteria such as environmental impact, use of best available technologies, wage levels and employee benefits, implementation of investment projects within Voronezh Region, tax efficiency, financial stability, and execution of projects aimed at improving the quality of life and comfort for the region's population. For enterprises achieving a score of at least 91 points in the ECG Rating, support measures will include:
−   Provision of land plots owned by the state or municipal authorities for lease without competitive bidding;
−   Priority consideration of appeals to regional executive bodies;
−   Assistance in prioritizing appeals to utility providers and various other preferences.

Our research indicated that opinions among respondents regarding the tools used to stimulate CSR activities were evenly split in 2024 between those advocating exclusively for advisory measures and those supporting a combination of prescriptive and advisory tools. In 2021, the distribution of these positions was somewhat different—58.8% favored the exclusive use of advisory tools by the government, while just over one-third (35.3%) indicated the appropriateness of combining prescriptive and advisory measures. No respondents supported a stringent approach to regulating socially responsible behavior by enterprises in either 2021 or 2024.

Respondents who deemed government participation necessary for promoting socially responsible practices among enterprises were asked to identify "soft" regulatory tools that would facilitate their development (see Table 2).

Table 2: "Soft" Government Regulatory Tools for CSR (multiple responses allowed)

Regulatory Tools	Percentage of Respondents Supporting Government Involvement in the Development of CSR, %	
	2021	2024
Preferential Lending	76,5	69,6
Preferences for Government Contracts	41,2	39,1
Development of Public-Private Partnerships	23,5	30,4
Conducting Training/Seminars on CSR Management	41,2	43,5
Tax Incentives	70,6	78,3
Development and Awarding of Ratings/Awards	12	30,4
Provision of Subsidies	70,6	73,9
Hosting Forums Dedicated to Social and Environmental Issues	47,1	39,1
Informing about Enterprises' Successes in Addressing Social Issues	35,3	43,5
Involving Leaders of Socially Responsible Enterprises in Expert Councils within Government Bodies	23,5	26,1

Respondents largely and predictably demonstrated a pragmatic perspective, favoring financial regulatory instruments such as tax incentives (78.3% in 2024 and 70.6% in 2021), provision of subsidies (73.9% in 2024 and 70.6% in 2021), and preferential lending (69.6% in 2024 and 76.5% in 2021). The expectation of recognition for their achievements in corporate social responsibility (CSR) is characteristic of all interviewees: "As of now, I feel neither hot nor cold. I have a document stating that we have a high rating. If the government were to say that you receive a rating and are eligible for preferential lending…" (large enterprise, manufacturing of finished metal products, excluding machinery and equipment, July 2024). Other desired support measures mentioned during the interviews included the possibility of reinvestment through tax reductions.

However, in 2024, enterprises showed greater interest in public initiatives aimed at enhancing their image and business reputation: media coverage of companies' successes in addressing social issues (43.5% in 2024 and 35.3% in 2021), and the development and awarding of ratings or prizes (30.4% in 2024 and 12% in 2021). This increase may be linked to the active implementation of ESG ratings and related government support measures (according to the survey, 60% of respondents are familiar with ESG ratings).

In international practice, among the strongest participants who can assist in implementing socially responsible practices and effectively influence their development, non-profit organizations (NPOs) are also highlighted alongside the government. For Russia as a whole, and particularly for the industrial sector of the Voronezh region, the NPO sector remains a relatively weak actor. According to the survey results (Table 3), the interaction between regional enterprises and NPOs is sporadic or non-existent.

Table 3: Non-profit organizations with which enterprises collaborate, and the frequency of their interactions (multiple responses possible)

/NPO	Share of enterprises in the sample, %					
	Constantly		Sometimes		Not Engaged	
	2021	2024	2021	2024	2021	2024
Charitable Organizations	20,0	16,7	50,0	60,0	30,0	23,3
Environmental Organizations	16,7	23,3	53,3	40,0	30,0	36,7
Scientific and Educational Organizations	56,7	56,7	30,0	36,7	13,3	6,7
Healthcare Organizations	26,7	23,3	43,3	53,3	30,0	23,3
Entrepreneurial Associations and Unions	33,3	33,3	36,7	60,0	30,0	6,7
Creative Organizations	6,7	6,7	26,7	40,0	66,7	53,3
Religious Organizations	6,7	3,3	20	23,3	73,3	73,3

A more in-depth analysis of the composition of non-profit organizations (NPOs) with which enterprises collaborate, as well as the frequency of their interactions, revealed that enterprises most actively and consistently engage with educational and scientific organizations (56.7%). This interaction likely focuses on employee training. In the current environment, there has been an increased interest in collaboration within entrepreneurial associations and unions. While this noted growth is currently supported by sporadic contacts, a total of 28 out of 30 enterprises reported such collaboration in 2024. Conversely, enterprises have established extremely passive relationships with environmental organizations, with approximately one-third of enterprises not engaging with them at all.

CONCLUSION

Respondents assessed the potential for participation and influence of external actors on the development of socially responsible practices over the next 3-5 years at 50% for government involvement. Notably, none of the respondents identified NPOs as key players shaping the agenda on this issue. This is largely attributed to the government support provided to the manufacturing sector in light of pandemic-related and sanctions-related restrictions. In general, the state policy in the field of CSR is an essential element of its systemic development. This policy encourages the dissemination of institutional CSR standards and creates conditions for businesses to make social investments. At the same time, according to the heads of industrial enterprises, the state's participation in promoting socially responsible practices of enterprises should be "soft", using, first of all, financial regulatory instruments. The introduction of the national ECG rating will allow for an informed selection of leading enterprises for additional government support. The issue of assessing the degree of influence of NPOs is very ambiguous. In conditions of a critical shortage of personnel in industry, enterprises cooperate most actively and on an ongoing basis only with educational and scientific NPOs that provide staff training. The low level of importance of the environmental direction of CSR for the enterprises under study, and the practical lack of regular interaction with environmental organizations, is of concern. Building partnerships between regional industrial enterprises and NPOs may involve harnessing the potential of the "third sector" to form norms and standards for socially responsible business. In particular, various associations of Russian entrepreneurs, whose importance has increased under the conditions of sanctions restrictions, can play a major role in this.

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ASSESSMENT OF THE VITALITY OF AI TOOLS IN EDUCATIONAL PROCESS FROM ACADEMIC STUDENTS PERSPECTIVE

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ABSTRACT

Learning performance is a complex phenomenon influenced by various factors such as the teaching environment and individual study behaviors. In today's increasingly dynamic education landscape, the integration of AI tools into the learning process presents a new paradigm that introduces exciting new possibilities. Consequently, this paper aims to assess student's preferences and concerns regarding the application of AI tools and their considerable power to the academic community. Specifically, this paper reports the evaluation of some of the most commonly used and popular AI platforms, among the academic level students. To address the research problem, a quantitative methodology was employed throughout the conduction of a survey. Through designing a structured questionnaire, data were collected from 131 students at University American College Skopje. Besides the AI assistance platforms for writing, generating ideas, or providing feedback on written content are evaluated as the most commonly used tools, collaboration in teamwork is highlighted as a pivotal feature of AI tool utilization. This paper can serve as a valuable guide for a better understanding of the AI-supported tool's contribution to the education area. Yet, learning is a dynamic ongoing effort that worth to be continuously reconsidering regarding the technology innovations.

Key words: learning performances, AI tools, students, academy, educational process, knowledge.

INTRODUCTION

The rapid growth of Artificial Intelligence technology (AI) has dramatically transformed various sectors, including the area of education. AI technology has a significant impact on students' learning performances by offering a blend of challenges and positive educational outcomes (Vieriu & Petrea, 2025). AI tools provide personalized feedback and support to students, helping them to identify zones of weaknesses and improve their skills in an adaptive way (Sinhaliz et al., 2023). By educating students about AI, universities empower them to actively contribute to its development and implementation, helping to ensure that AI serves the broader interests of society (Chan, 2023). Consequently, this is the main trigger in the paper, actually to examines the utilization of the most popular AI platform, like ChatGPT, Grammarly, Duolingo, Khan Academy, Socratic by Google and Elicit, among the academic level students. In this context, the brief explanation of the AI platforms' basic concepts will be considered as further.

One of the most popular AI tools is *ChatGPT*, as a variant of the GPT-3 (Generative Pre-trained Transformer 3) It is specifically designed to generate human-like text in a conversational style (Lund & Wang, 2023). ChatGPT can help students brainstorm ideas, outline essays, refine grammar, and improve clarity in academic writing (Cotton et al., 2024).

Utilization of *Grammarly* as a learning tool in educational settings foster better learning outcomes for academic students. This platform can enhance both the quality of academic writing and students' self-perceptions as writers. It can help learners identify the reoccurring writing problems, eliminate them, and monitor the progress (Temirgaliyeva et al., 2024).

Another helpful AI tool for educational purposes is *Duolingo*. Actually it is a web-based self-paced language teaching program that guides students step-by-step through a sequence of tasks, largely based on translation (García Botero et al., 2018). It is clearly aimed at conscious learning, although some subconscious acquisition of language is inevitable, as students hear and read samples of the language (Ajisoko, 2020).

Khan Academy, as one of the AI tools, provides various activities, instructional videos, and a personalized learning platform that allow students to learn according to their personal needs. Videos on Khan Academy usually last between 7-14 minutes, and provide opportunities for students to identify, explain, and practice different mathematics concepts using relevant software (Zengin, 2017). Moreover, *Socratic* is an AI educational tool that provides relevant educational resources, including step-by-step explanations, videos, and practice problems, to facilitate students learning and comprehension (Okpara et al., 2024). It allows students to engage with interactive quizzes, receive real-time feedback, request in-depth explanations of advanced concepts, and tailor the conversation to their own level of understanding. This platform enables students to input questions via text, voice, or images (Jabbour et al., 2025).

The next AI tool that can assist the learning process, specifically the research process, is *Elicit*. This tool enables text extraction and synthesis. Elicit pulls publications from Semantic Scholar and speed up the literature review process (Kung, 2023).

Yet, through literature assessment, the background of this topic is confirmed as a vague area, that worth to be investigated in certain learning environment in the further step. Accordingly, the assessment of the utilization of the most popular AI tools among the students on University American College Skopje in North Macedonia was conducted by survey. The goal of this paper is:

G: *Evaluation of the importance of inclusion of aforementioned AI tools in learning process by the university students.*

This paper is organized in few sections. As an initial phase of this research, the current literature review was accomplished. The third section introduces the research framework. The next section presents the results, whereas discusses the findings and finally, the conclusion is presented.

LITERATURE BACKGROUND

In recent period, there has been a growing concern in the academic settings about the use of text generative artificial intelligence (AI). Numerous researchers confirm that AI technology has a strong impact on educational process, starting from personalized learning experiences to intelligent tutoring systems that provide tailored guidance, support, and feedback based on individual learning patterns and knowledge levels (Hwang et al., 2020; Baashar, 2022; Shu, 2024: Lewis, 2022;).

In more details, the specific AI platforms features were researched by various researchers and the findings of the comprehensive literature review are explicitly presented in the following Table 1. In general, the performances, benefits, strengths and weaknesses of the investigated AI tools were explored, discussed and criticized by the identified authors.

RESEARCH FRAMEWORK

This paper attempts to identify the most used AI tools used by academic level students. The applied methodology employs a qualitative research method by means of a literature review and quantitive analysis by survey conduction. Technically, the conducted research included (1) comprehensive literature review, (2) questionnaire designing, (3) conducting survey and data collection, and (4) discussing the gathered results.

In terms of the first challenge, a comprehensive research of the literature based upon Emerald, Scopus, EBSCO, and other relevant bases, was conducted in the period from 1st November 2024 to 15th February 2025. A total of 22 papers in the area of AI utilization in learning process, published in English, have been found and present in Table 1, according to keywords: learning performances, AI tools, university students, educational process and knowledge.

Table 1. Literature sources supporting the use of AI tools in education

AI tools	Authors
ChatGPT	Sinhaliz (2023); Bommarito & Katz (2022); Mann et al. (2020); Chan (2023); Cotton et al. (2024); Lund & Wang (2023); Neumann et al. (2023); Irwin et al. (2023).
Duolingo	Ajisoko (2020); García Botero et al. (2018); Krashen (2014).
Grammarly	Temirgaliyeva et al. (2024); Tran (2025); Hadiat et al. (2022); Pratama (2020).
Khan Academy	Nguyen & Le (2020); Zengin (2017).
Socratic	Jabbour et al. (2025); Okpara et al. (2024).
Elicit	Kung (2023); Maloof & Stephens (2007); Whitfield & Hofmann (2023).

Regarding the remaining challenges, the questionnaire was designed to gather data connected with the benefits and concerns of AI tools utilization for learning purposes and overall importance of integration of AI tools into the learning process infrastructures. Actually, the questionnaire includes two types of questions, multiple-choice questions that allow respondents to select one or more answers and questions where participants rate the importance of a specific statement using a Likert scale (ranging from 1 to 5). Throughout developed structured questionnaire, data were collected from 131 students at University American College Skopje, starting from 1st December 2024, to 30th April 2025. Students of second year of 2024/2025 academic year of School of Business Economics and Management (34% of respondents) and School of Computer Science and Information Technology participated in this survey (64% of respondents). In doing so, the various AI tools were evaluated according to relevant criteria. This research and its findings are limited to the mentioned University located in North Macedonia (to epitomize a small developing country), but can still indicate the general directions concerning its main objective.

RESULTS AND DISCUSSION

By the analysis of the collected questionnaire data, valuable insights of this research are gathered and presented in Table 2. It is more than clear that the AI tool that enjoy in the highest popularity, is ChatGPT or other AI writing assistants. Only few students entered some specific AI tools like *Notebook LM, Gemini, Deepseek* and *Claude* in the *"Other"* category's field.

Table 2. Questionnaire results: Which AI tools do you currently use or have used for learning purposes?

Offered answers *(multiple selections allowed)*	Score (%)
ChatGPT or other AI writing assistants – Writing and generating ideas.	93.1
Grammarly – Assistting in checks grammar, spelling, punctuation, and writing style.	32.8
Duolingo – Language learning app that adapts to the learner's level.	27.5
Khan Academy with AI integration – Offering personalized learning experiences with AI.	9.2
Socratic – Helping with homework by providing explanations and solutions.	4.6
Elicit – Researching and data analysis for information organizing and synthesizing.	2.3
Other: Notebook LM/ Gemini/ Deepseek/ Claude	0.8/1.6/0.8/0.8

The assessment of the importance of inclusion of AI tools in education was assessed is given in the Figure 1. It is noticeable, all the respondents confirm the importance of integration of AI tools in learning process, as *important* (33.6%), *very important* (38.9%) and *extremely important* (26.0%). Only 1.5% of students choose *less important option*, as an offered optional answer. The gathered results indicate a broad acceptance of AI tools in the learning process among the surveyed students.

Figure 2 presents the results of the student evaluations concerning the claim that integrating AI tools into the learning environment enhances the learning process. Specifically, 34.4% of respondents stated they are *very likely* to believe in the positive impact of AI integration, 32.8% are *likely* to agree, while 27.5% remain *neutral*. This suggests in general positive perception among students regarding the role of AI in improving intended learning outcomes.
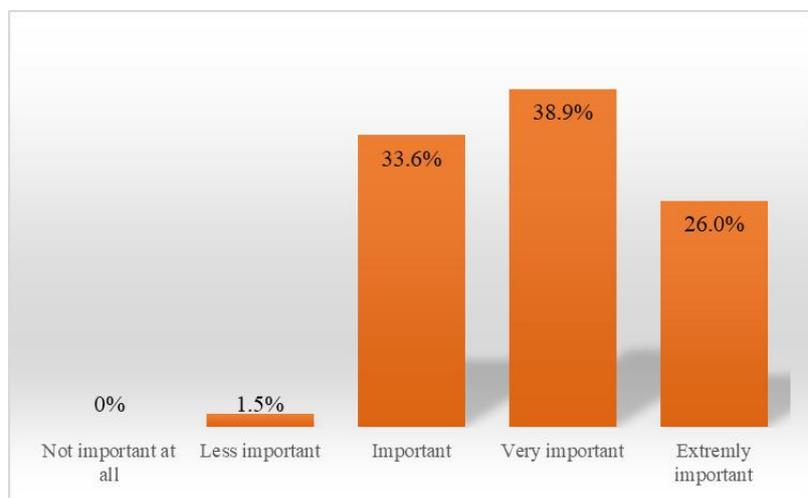
Figure 1. Questionnaire results: How important do you think it is to have AI tools integrated into your learning process?
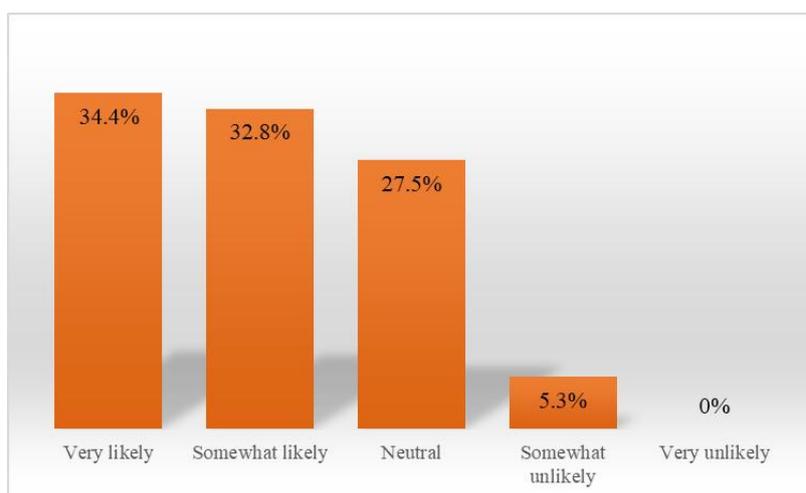
Figure 2. Questionnaire results: How likely are you to use AI tools to improve your academic performance if they were integrated into your learning environment?

Regarding the most beneficial AI tool in learning process presented in Table 3, 77.0% of students agreed that the writing and content creation tools, like *ChatGPT and Grammarly* were the most useful tool. It is interesting to notice, the *Khan Academy and Socratic* is recognized as a beneficial tool by the 44.3% of students, but regarding the findings presented in Table 2, only 10% of students use it for their learning purposes. Probably because of the different principles of function, actually Khan Academy often requires passing through full lessons and videos, which is more adequate for deeper learning but also it in the other hand it is time-consuming. On the other hand, Socratic depends on scanning a problem and corresponding it to solutions. Because ChatGPT provides instantaneous and express answers without requiring searching through videos or multiple-choice suggestions typical for aforementioned tools, this is the accepted explanation deals with the issue.

Furthermore, AI tools that assist in gathering, analyzing, and organizing research materials, like *Elicit or Semantic Scholar* were marked as beneficial for 29% of respondents. However, compared with the results presented in Table 2, only 2.3% of respondents utilize those Ai tools in learning process. Undoubtedly, Elicit and Semantic Scholar are designed for identifying scientific literature sources and both platforms are firstly convenient for researching, less for text writing, translating, and grammar checking. Since the respondents are students in their second academic year, most likely during the preparation of their capstone projects, these tools will be more than useful. The evaluations of the

remain AI tools are given in the Table 3. The remain treated AI tools, like *Data analysis and visualization tools, Collaboration and productivity tools virtual assistants and chatbots* and *Personalized learning platforms*, are rated 24.4%, 13.0%, 31.3%, and 10.7%, accordingly. It is interesting to mention that about the one-third of students surveyed (sample size 131) in the UACS have confirmed the importance of the AI tools intended for visualizing data and identifying research materials. Due to the fact, the surveyed students were in second academic year and the need for those platforms is expected to be developed in further years of their education. One can conclude, the advantages of using various AI platforms in education are broadly recognized, but still ChatGPT is treated as learning partner in text writing, grammar checking or coding.

Table 3. Questionnaire results: Which AI tool do you think would benefit your learning the most?

Offered answers *(multiple selections allowed)*	Score (%)
Writing and content creation tools (ChatGPT, Grammarly)	77.0
Learning and tutoring tools (Khan Academy, Socratic)	44.3
Research and information retrieval tools (Elicit, Semantic Scholar)	29.0
Data analysis and visualization tools (Tableau, IBM Watson)	24.4
Collaboration and productivity tools (Notion AI, Miro)	13.0
Virtual assistants and chatbots (Microsoft Copilot, Google Assistant)	31.3
Personalized learning platforms (Smart Sparrow, DreamBox)	10.7

The findings, related to the most beneficial features of AI tools to learning process, are presented in Table 4. Notably, *Personalized learning and tutoring* as a valuable feature stands out as the most highly rated feature, identified by 64.1% of students. This is followed closely by *Assistance with writing and content creation*, which 58.0% of respondents recognized as beneficial. Additionally, 45.8% of students highlighted *Research support* as an important advantage of using AI tools in the learning process, while 43.5% emphasized *Data analysis and interpretation*. Nevertheless, fewer students identified organizational features as impactful: only 19.1% rated *Collaboration and organization tools* as beneficial, and 26.0% selected *Task management and reminders* as helpful in their education. The interpretation of the gathered results is aligned with the respondents' status as not yet being employed, thus the both last mentioned platform are not prioritized.

Table 4. Questionnaire results: Which features of AI tools would be most beneficial to your learning?

Offered answers *(multiple selections allowed)*	Score (%)
Personalized learning and tutoring – Providing individualized support.	64.1
Assistance with writing and content creation – Writing, grammar, and generating ideas.	58.0
Data analysis and interpretation – Assisting with understanding and visualizing data.	43.5
Research support – Gathering and organizing research materials.	45.8
Collaboration and organization tools – Aassisting with project management and group work.	19.1
Task management and reminders – Helping with scheduling, reminding and managing tasks.	26.0

Table 5. presents the main concerns identified by students regarding the use of AI tools in the learning process. Almost all respondents acknowledged the significance of these concerns, reflecting a high level of awareness among students. In other words, this indicates on the high level of students' care that deals with *Privacy and data security, Dependence on technology, Accuracy and reliability,* and *Lack of human interaction.*

Table 5. Questionnaire results: What concerns, if any, do you have about using AI tools in your learning process?

Offered answers *(multiple selections allowed)*	Score (%)
Privacy and data security – How personal data and learning information are handled.	49.6
Dependence on technology – Becoming too reliant on AI for learning and task completion.	55.7
Accuracy and reliability of AI-generated content – Correctness of information.	43.5
Lack of human interaction –AI might reduce meaningful interactions with teachers or peers.	31.3

However, the goal of this research, to evaluate the most popular AI assisted platforms among the students on University American College Skopje in North Macedonia is fulfilled. Accordingly, this paper presents the findings based on the applied methodology.

CONCLUSION

To summarize, the influence of AI on education is transformative and ultimately meaningful. Actually, learning's AI tools offer substantial benefits such as personalized learning, improved engagement, and enriched access to scholastic resources. While most students view inclusion of AI tools as importantly, emphasizing its potential to enhance learning efficiency and academic performance, there remain critical concerns, regarding the privacy and data security, accuracy and reliability of outputs, the risks of lack of human interaction, and the dependence on technology. A conducted survey of university students found that ChatGPT, among all considered platforms as Duolingo, Elicit, Socratic, Khan Academy and others, that assist with writing, generating ideas, or providing feedback on written content were one of the most adopted AI tool for learning purposes. Since the assessment of the vitality of AI-assisted learning tools was conducted among the second-year students at the University American College Skopje, the main limitation of the research lies in the defined scope. Specifically, the results might differ if the survey were extended to higher-level students, such as master's students. In that point of view, further avenues of research should consider expanding the scope to encompass postgraduate students, consequently generating a second set of data and comparing findings based on the educational level, undergraduate students versus graduate students. In addition, the future research should include the new developed AI assisted learning platforms, due to the increasingly rapid growth of this field. However, the researched area should be a dynamic ongoing effort that deserve to be continuously monitored, analyzed and reassessed.

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Session A: MANAGEMENT AND OPERATION MANAGEMENT

DEVELOPING INDICATORS FOR ENERGY MANAGEMENT IN RESIDENTIAL BUILDINGS IN IRAN USING FUZZY DELPHI METHOD

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ABSTRACT

This study used the qualitative method based on the fuzzy Delphi method to compile energy management indicators in residential buildings in Iran. In order to achieve the objectives of the research in the qualitative part of the research, effective indicators in energy management in residential buildings were extracted and approved by experts in this field by studying the background of the research and from reliable sources and articles, and based on them, a questionnaire between 15 people from Experts in the field of energy management were distributed. Using the fuzzy Delphi technique, and performing three steps, the obtained data of the effective indicators in energy management in Iranian residential buildings have been evaluated and ranked. A total of 26 factors were identified based on the existing research background, and these factors became the final 14 factors after completing the three Delphi steps.

Key words: Energy management, Decision-making, Sustainability, Fuzzy Delphi Method.

INTRODUCTION

Energy management in residential buildings includes points related to the planning and operation of energy production and consumption units, to the proper distribution and storage of energy in the residential building. While users have constant access to the energy they need, other goals such as climate protection, resource protection, and energy saving should be pursued. Energy management of residential buildings is closely related to environmental management, production management, procurement and other business functions of construction management. Energy management is the systematic, active and organized coordination of the provision, conversion, distribution and use of energy to meet the needs of customers, taking into account environmental and economic goals. It is used for specific political, economic and environmental goals through the optimization of energy efficiency and the systematic use of engineering and management techniques (Khalil, 2021). Energy management decisions involve multiple knowledge bases, such as social, physical, technological, political, and economic, and generally have complex procedures. Energy management decision makers use several experimental tests, computational models, and tools for risks related to environmental issues, the effects of some strategies on reducing risks, evaluating human health, along with environmental stressors. With these descriptions, in such decisions to integrate heterogeneous and uncertain information, there is a need for expert judgment and a systematic framework for organizing technical information. Multi-criteria decision making (MCDM) provides a comprehensive method that helps decision makers combine these inputs with stakeholder information and perspectives in order to identify and rank all decision alternatives (Mardani et al., 2017).

In Iran, there is little research on sustainability assessment tools. For instance, Namini et al. (2014) introduced the sustainability assessment tool based on new criteria for residential buildings in Iran as a

reference for developing categories and a guideline for defining a framework for evaluating different stages of construction, considering the "project management body of knowledge". In addition, to describe the perspectives of sustainable architecture in Iran, Nemati et al. (2017) tried to develop a theoretical model. Finally, Kamranfar et al. (2022) implements a green construction development paradigm to identify and rank barriers for a case study in Tehran, Iran. To try to design a green building using clean energy and natural spaces, this paper proposes new solutions by reducing environmental problems.

ENERGY MANAGEMENT

In the past several decades, due to the rapid social and economic development, energy management problems have always been the concern of national and local governments around the world (Ming et al., 2013). When energy management issues increase, public health and regional sustainable development and ultimately the economic growth of countries are affected and their obligations increase. Demand for regional development progress has increased as well as public awareness of energy problems, thus placing increasing pressures on energy planners and decision makers to respond more strongly to a number of energy concerns. As a result, in order to promote effective energy management practices, it is useful and necessary to identify decision-making protocols with environmental and socio-economic efficiency. In environmental management systems, a number of factors must be considered by planners and decision makers, including issues such as environmental protection and resource protection, and social, economic, technical, institutional, and political issues. With the uncertainties in the related system components, the complexities in making the desired environmental management decisions may be exacerbated. Moreover, such uncertainties and complexities may be amplified by the potential for economic penalties and not only by interactions and dynamics among different subsystems.

FUZZY DELPHI METHOD

In this research, we integrated the Delphi method and fuzzy logic theory to create an evaluation model. First, we adopted the group Delphi method as a basis for quality analysis, for group decision-making, and then fuzzy logic theory was used to quantify human semantic technology, and it was used to complete the theoretical framework of the model. Delphi experts assisted in the development of the evaluation model during this study. Usually, the best alternative is selected based on the ranking order by decision makers with a selective MCDM method, while different MCDM methods often produce different results for ranking a set of alternative decisions. In evaluating indicators for Energy Management in residential buildings process in Iran, a new model that covered the most important criteria presented. The objective of this research is to develop an indicators ranking model. In this regard, used FDM to obtain the weight for indicators of the model by decision maker. In this article, for solving group decisions and document criteria screening, triangular membership functions and fuzzy theory are used using the fuzzy Delphi method. The fuzziness of the common understanding of experts in different scales can be solved and evaluated using fuzzy theory. In this study, Zariah Fazi entered the Delphi method by integrating with the views of many researchers. In this study, triangular fuzzy computing is used to improve the problems faced by the traditional Delphi method, to integrate experts' recommendations, and then test the convergence effect recognized by experts, which refers to the "Gray area test method".

FINDINGS

The panel of experts of this research includes experienced engineers and managers in Iran who have expertise and experience in energy management in residential buildings. Also, the size of the panel of experts based on the backgrounds of existing Delphi-based researches was obtained by 15 experts. The snowball sampling method was used to select experts. The questionnaire questions are related to

energy management. In the first stage of using the fuzzy Delphi method, experts should be selected and explained about the topic, method and duration of the research. To be According to the mentioned characteristics, 15 experts were selected as a sample and the initial preparation for the implementation of the plan was made for them. In order to respond, the most important indicators affecting the energy management of residential buildings were identified from the studied sources and articles. Then, a questionnaire based on the research literature with 26 primary indicators extracted from the studied sources was sent to the members of the expert group. These 26 indicators are shown in Table 1.

Table 1: Extracted Indicators

Indicators	
Energy consumers' participation	Buying energy at a lower price
Standardization of energy facilities	Insulation of building walls
Thermal energy recovery device	Optimization of materials for heating
Using modern electrical equipment	Apartment floor insulation
Reducing overall energy consumption	Time correlation between energy production and consumption
Building energy balance	Using the package in the building
Energy balance between buildings	Optimization in hardware and software
Double glazing windows	Energy meter for heating
More use of sunlight	Reduction of peak energy demand
More use of wind energy	Use of renewable energy
Energy optimization in the engine room of the building	Reducing energy losses
Optimization of building materials for cooling	Energy storage in the building
Increasing the efficiency of energy equipment	Reduction of greenhouse gases

Experts also have different mentalities, because they have different characteristics, the analysis of variables is worthless, if the options are answered based on different mentalities. But experts will answer the questions with the same mindset by defining the range of qualitative variables. Therefore, qualitative variables are defined as trapezoidal fuzzy numbers (Grzegorzewski & Mrówka, 2005) according to low (0,0,2,4), medium (3,4,6,7), high (6,8, 10,10). Although trapezoidal fuzzy numbers have a more complicated calculation process than triangular fuzzy numbers, they can carry more ambiguity in verbal and qualitative variables. The desired questionnaire was designed according to the proposed options and the definition of linguistic variables. Table 2 shows the results of the examination of the answers to the questionnaire. Based on the results of Table 2, the average importance of the indicators is calculated according to the following relationships (Cheng and Lin, 2002):

$$A^{(i)} = \left(a_1^i, a_2^i, a_3^i, a_4^i\right), \quad i = 1,2,3,...,n$$

$$A_m = \left(a_{m1}^i, a_{m2}^i, a_{m3}^i, a_{m4}^i\right) = \left(\frac{1}{n}\sum a_1^{(i)}, \frac{1}{n}\sum a_2^{(i)}, \frac{1}{n}\sum a_3^{(i)}, \frac{1}{n}\sum a_4^{(i)}\right)$$

At this stage, the experts have been asked to choose the importance of the Indicators in the form of low, high, medium options. We also converted the obtained fuzzy numbers into definite numbers through the Minkowski formula:

$$\mu_{df}(R) = \frac{a + 2(b + c) + d}{6}$$

Table 2: The results of counting the responses of the Round 1

Indicators	low	medium	high
Energy consumers' participation	0	1	14
Standardization of energy facilities	0	0	15
Thermal energy recovery device	3	4	8
Using modern electrical equipment	0	3	12
Reducing overall energy consumption	1	2	12
Building energy balance	1	2	12
Energy balance between buildings	3	6	6
Double glazing windows	1	2	12
More use of sunlight	2	3	10
More use of wind energy	3	4	8
Energy optimization in the engine room of the building	1	2	12
Optimization of building materials for cooling	0	3	12
Increasing the efficiency of energy equipment	0	3	12
Buying energy at a lower price	4	5	6
Insulation of building walls	1	2	12
Optimization of materials for heating	0	5	10
Apartment floor insulation	3	6	6
Time correlation between energy production and consumption	4	3	8
Using the package in the building	0	5	10
Optimization in hardware and software	0	0	15
Energy meter for heating	0	3	12
Reduction of peak energy demand	0	3	12
Use of renewable energy	3	6	6
Reducing energy losses	0	0	15
Energy storage in the building	3	6	6
Reduction of greenhouse gases	1	2	12

Table 3: The average opinions of experts from the Round 1

Indicators	Importance	De-fuzzified average
Energy consumers' participation	(5.8,7.8,9.7,9.8)	9.6
Standardization of energy facilities	(6,8,10,10)	9.9
Thermal energy recovery device	(3.8,4.5,5.8,7.7)	6.2
Using modern electrical equipment	(5.5,7.3,9.3,9.5)	9.1
Reducing overall energy consumption	(4,5.5,7.8,8.4)	7.3
Building energy balance	(4.8,6.4,8.4,8.8)	7.4
Energy balance between buildings	(3.1,4.7,6.2,7.9)	6.9
Double glazing windows	(4,5.5,7.8,8.4)	7.3
More use of sunlight	(3.8,5.7,7.1,8.2)	6.8
More use of wind energy	(3.8,4.5,5.8,7.7)	6.2
Energy optimization in the engine room of the building	(4,5.5,7.8,8.4)	7.3
Optimization of building materials for cooling	(5.5,7.3,9.3,9.5)	9.1
Increasing the efficiency of energy equipment	(5.5,7.3,9.3,9.5)	9.1
Buying energy at a lower price	(3,5.2,6.1,7.2)	6.3
Insulation of building walls	(4,5.5,7.8,8.4)	7.3
Optimization of materials for heating	(4.8,6.5,7.3,8.8)	8.1
Apartment floor insulation	(3.1,4.7,6.2,7.9)	6.9
Time correlation between energy production and consumption	(3.8,4.5,5.8,7.7)	6.2
Using the package in the building	(4.8,6.5,7.3,8.8)	8.1
Optimization in hardware and software	(6,8,10,10)	9.9
Energy meter for heating	(5.5,7.3,9.3,9.5)	9.1
Reduction of peak energy demand	(5.5,7.3,9.3,9.5)	9.1
Use of renewable energy	(3.1,4.7,6.2,7.9)	6.9
Reducing energy losses	(6,8,10,10)	9.9
Energy storage in the building	(3.1,4.7,6.2,7.9)	6.9
Reduction of greenhouse gases	(4,5.5,7.8,8.4)	7.3

According to Tables 2 and 3, the disagreement of each expert can be calculated according to equation (3) (Cheng and Lin 2002). In fact, based on this relationship, each of the experts can measure their opinion with the average opinion and adjust their previous opinions if they wish.

$$e = \left(a_{m1} - a_1^{(i)}, a_{m2} - a_2^{(i)}, a_{m3} - a_3^{(i)}, a_{m4} - a_4^{(i)}\right)$$
$$= \left(\frac{1}{n}\sum a_1^{(i)} - a_1^i, \frac{1}{n}\sum a_2^{(i)} - a_2^i, \frac{1}{n}\sum a_3^{(i)} - a_3^i, \frac{1}{n}\sum a_4^{(i)} - a_4^i\right)$$

Using equation (3), the difference of experts' opinions was calculated and adjusted in a questionnaire. Then, each of the experts announced new opinions based on the re-evaluation of their previous opinion. The result of this step is shown in Tables 4.

Table 4: The results of counting the responses of the Round 2

Indicators	low	medium	high
Energy consumers' participation	0	0	15
Standardization of energy facilities	0	0	15
Thermal energy recovery device	4	5	6
Using modern electrical equipment	0	3	12
Reducing overall energy consumption	0	3	12
Building energy balance	4	5	6
Energy balance between buildings	3	6	6
Double glazing windows	1	2	12
More use of sunlight	2	3	10
More use of wind energy	3	6	6
Energy optimization in the engine room of the building	1	2	12
Optimization of building materials for cooling	0	3	12
Increasing the efficiency of energy equipment	0	3	12
Buying energy at a lower price	4	5	6
Insulation of building walls	1	2	12
Optimization of materials for heating	4	5	6
Apartment floor insulation	4	5	6
Time correlation between energy production and consumption	4	3	8
Using the package in the building	0	3	12
Optimization in hardware and software	0	0	15
Energy meter for heating	0	3	12
Reduction of peak energy demand	0	3	12
Use of renewable energy	4	5	6
Reducing energy losses	0	0	15
Energy storage in the building	3	6	6
Reduction of greenhouse gases	4	5	6

According to the results of the differences obtained, it is clear that there is no consensus among experts on some Indicators; but in most cases consensus has been reached. Thus, in the case of Indicators whose de-fuzzified average is less than 7 and the difference is less than 0.2, which Indicator is removed, and in the case of Indicators whose de-fuzzified average is more than 7 and the difference is less than 0.2, it is Indicator is determined as final Indicator (Mirspasi et al., 2019). In the Table 5, the risks removed and confirmed up to this stage are specified.

According to the final comments determined in the above table, the assignment of 8 Indicators will be determined in the next round. Also, among the 18 assigned Indicators at this round, 7 Indicators were removed and 11 Indicators were approved. It can be concluded that there is a good consensus among the experts, because the average difference of all indicators is less than 0.2, so there is no need to refer the questionnaire again and finally the weight of the indicators is calculated (Table 6).

Table 5: The results obtained from the Round 2

Indicators	difference of opinion	Decision
Energy consumers' participation	0.3	Next Round
Standardization of energy facilities	0	Accept
Thermal energy recovery device	0.1	Reject
Using modern electrical equipment	0	Accept
Reducing overall energy consumption	1.8	Next Round
Building energy balance	1.1	Next Round
Energy balance between buildings	0	Reject
Double glazing windows	0	Accept
More use of sunlight	0	Reject
More use of wind energy	0	Reject
Energy optimization in the engine room of the building	0	Accept
Optimization of building materials for cooling	0	Accept
Increasing the efficiency of energy equipment	0	Accept
Buying energy at a lower price	0	Reject
Insulation of building walls	0	Accept
Optimization of materials for heating	1.8	Next Round
Apartment floor insulation	0.6	Next Round
Time correlation between energy production and consumption	0	Reject
Using the package in the building	1	Next Round
Optimization in hardware and software	0	Accept
Energy meter for heating	0	Accept
Reduction of peak energy demand	0	Accept
Use of renewable energy	0.6	Next Round
Reducing energy losses	0	Accept
Energy storage in the building	0	Reject
Reduction of greenhouse gases	1	Next Round

Table 6: The results of the Round 3

Indicators	difference of opinion	Decision
Energy consumers' participation	0	Accept
Reducing overall energy consumption	0	Accept
Building energy balance	0	Reject
Optimization of materials for heating	0	Reject
Apartment floor insulation	0	Reject
Using the package in the building	0	Accept
Use of renewable energy	0.1	Reject
Reduction of greenhouse gases	0.1	Reject

Among the 26 extracted Indicators, 14 cases made it to the final round of analysis and 12 cases were eliminated according to the opinion of specialists and experts, as follows:
- Energy consumers' participation,
- Standardization of energy facilities,
- Using modern electrical equipment,
- Reducing overall energy consumption,
- Double glazing windows,
- Energy optimization in the engine room of the building,
- Optimization of building materials for cooling,
- Increasing the efficiency of energy equipment,
- Insulation of building walls,
- Using the package in the building,

- Optimization in hardware and software,
- Energy meter for heating,
- Reduction of peak energy demand,
- Reducing energy losses.

CONCLUSION

In short, replacing energy requires decision-making, thinking and planning, and finally investment. It is also necessary for international institutions to provide appropriate financial support for new energy conversion programs. Apart from this, development requires more technological progress and this goal can be achieved through increasing research programs and also through extensive technical cooperation at the world level, and this requires intelligent thinking and correct ideas. The use of solar energy, wind, ground heat, etc. can be used not only individually but also in combination at the same time. Finally, fossil fuel subsidies are a global obstacle in the development of renewable systems.

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THE USE OF STANDARDIZED TECHNOLOGIES IN ENHANCING THE TOURIST CUSTOMER EXPERIENCE

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ABSTRACT

Global market conditions have necessitated significant changes in how companies within the tourism and hospitality industry operate, compelling them to adapt to emerging trends and evolving customer expectations in order to remain competitive. The customer experience reflects how tourists perceive the service provided by a chosen hotel, travel agency, or any other organization within the industry. The challenges faced by organizations in this sector are significant, and therefore, the application of both international standards and digital technologies, including artificial intelligence, must be used as strategic tools in business operations. The authors of this paper aim to highlight the importance of these tools in shaping a positive customer experience within the tourism and hospitality sectors. Implementing these strategic tools in the tourism and hospitality industry offers significant benefits, as they effectively tackle key challenges in delivering a high-quality customer experience — including user data security, the ability to create personalized customer experiences, physical and health safety of tourists and their peace of mind during their stay, food safety, minimizing the chances of lost luggage, streamlined transportation to desired destinations, and more. These are new growth models in the tourism and hospitality industry that must be fully embraced; otherwise, the market battle with competitors that have timely adapted to the new demands will be lost.

Key words: customer experience, standardized technologies, business quality, competitiveness

INTRODUCTION

Since the late 1990s, the business environment has been undergoing permanent changes driven by rapid technological development, shifts in competitive relations, and the effects of the global economic crisis of 2008. The world is entering a new stage of economic globalization, where national economies have become closely interconnected and must continuously monitor and respond to the challenges and dynamics of this evolving business landscape. At the micro level, business organizations must develop new operational models in response to observed and anticipated environmental changes in order to maintain long-term competitiveness and ensure sustained growth dynamics (Đorđević et al., 2016, p. 120).

Today, hotel organizations must prioritize top-quality service, technological innovation, and business digitalization, as well as sustainable operations, as these factors create the foundation for delivering a high-quality customer experience. Additionally, hotel organizations must place significant emphasis on the professional development of their employees, as this prepares them for emerging trends in the hospitality industry and enables them to contribute to a superior customer experience.

The use of ICT in the tourism and hospitality industry is on the rise, with the goal of achieving customer satisfaction through the quality of services offered. In practice, organizations in this industry are increasingly utilizing digital media, social networks, and similar tools to communicate more quickly and efficiently with end users and to enhance both the quality of the tourism product and the overall customer experience

The rapid digitalization of tourism and hospitality has revealed that many companies were unprepared for the new ICT trends in their operations. New customer demands related to Internet search capabilities and online accommodation booking have led to more flexible business practices in tourism companies compared to those in other industries. Additionally, new technological advancements and trends have influenced both end-user satisfaction and the quality of tourism services.

Customer experience (CX) is increasingly mediated—and even enhanced—by technology. Hotels are leveraging social media engagement and artificial intelligence to understand customer behaviour across various market segments and at different stages of the decision-making process. ICT also empowers hospitality companies to personalize their offerings based on contextual customer data collected through various electronic means (Buhalis et al., 2023, p. 702).

CHALLENGES OF CUSTOMER EXPERIENCE IN THE TOURISM INDUSTRY

CX, or customer experience, encompasses everything a company or organization does to put customers first—managing their journey and meeting their needs. At its core, CX involves all the actions an organization takes to create exceptional experiences, deliver value, and drive customer-focused growth. This has become crucial in an era where the way a company delivers its services is just as important—if not more so—than the actual products and services it offers. In today's digital world, where customers track information and share their experiences with companies on public platforms, it has become essential for businesses to connect with customers on an emotional level throughout their journey. (Mckinsey, 2022).

Customer experience is one of the fundamental pillars of business operations in the tourism and hospitality industry and is a decisive factor in a guest's decision to return to a particular tourist destination, hotel, restaurant, and so on. Hotel organizations continuously monitor customer experience and align their operations with guest expectations. According to Apostol et al. (2023, p. 17) exceptional customer experiences are essential in the modern hospitality and tourism sector for attracting customers and gaining a competitive advantage.

The business strategy of tourism and hospitality organizations must be focused on the continuous improvement of customer experience through the following three segments: innovation, personalized service, and the implementation of the latest trends in hospitality.

According to John Iwuozor (2024), achieving a good customer experience (CX) requires an understanding of its core components: a) empathy, b) personalization, c) a centralized technology group, d) value.

Personalization is an excellent tool for organizations in the process of enhancing customer experience. Many organizations in the tourism and hospitality sector address this issue by using digital technologies and artificial intelligence to better manage customer experience challenges. To create a strong customer experience, it is not enough for organizations to simply develop empathy or offer personalized services—they must also deliver substantial value. The term "value" refers to the benefits or advantages that a customer gains from a product or service. A good customer experience involves delivering exceptional value to customers, meeting their expectations, and building a positive brand image for the organization, and it often becomes a decisive factor for potential clients.

There are several key challenges that significantly impact the overall customer experience in the travel and tourism industry (Aslan Patov, 2024): a) the booking process, b) organizing and managing travel plans, c) the on-trip experience, d) post-trip customer support.

The booking process is extremely important for the operations of organizations in the travel industry and it faces numerous practical challenges. Complicated or unclear reservation procedures pose problems for users. Additionally, the lack of real-time updates is a significant shortcoming for

organizations. Hidden fees are a particular issue for customers, leading to high dissatisfaction, increased abandonment rates, negative reviews, and the loss of potential bookings.

Organizing and managing travel plans presents particular challenges, especially in the areas of poorly designed and executed travel plans, as well as weak communication and coordination among various service providers. These shortcomings often result in customer dissatisfaction, leading to negative feedback and missed activities.

The on-trip experience is an important aspect of the travel industry, particularly in terms of reliable transportation, suitable accommodation, and a sufficient number of additional activities that contribute to a positive tourist experience at a given destination. If this process is inadequate, organizations may face negative customer reviews and reduced loyalty, which in turn leads to a damaged brand image and decreased competitiveness in the market.

Post-trip support holds particular importance for customers, and organizations must approach it with care, as it shapes the customer's overall perception of the company in the travel and tourism industry. During their journey, travellers may encounter various issues, such as poor support when they wish to modify their travel plans or request a refund. Inadequate response from organizations can lead to customer dissatisfaction, resulting in negative reviews, a high volume of refund requests, and significantly reduced customer loyalty.

The tourism industry is closely linked to new technologies, which have significantly influenced its development. New trends in the tourism sector are characterized by the implementation of digitalization and transformation processes in the operations of organizations such as hotels, restaurants, tourism boards, and travel agencies. In today's market conditions, the focus of tourism organizations is on creating new tourism services and products based on the use of digital technologies.

Thanks to the application of new technologies, it is possible to enhance the customer experience in the tourism industry. According to (Barten Martijn), there are eight models for improving customer experience: Smart rooms, Chatbots and artificial intelligence, Personalization marketing, Virtual reality (VR), Augmented reality (AR), the Internet of Things (IoT), Robots, and User-generated content.

Destinations, tourism organizations, tour operators, hospitality businesses, theme parks, museums, event organizers, and other tourism-related enterprises are increasingly turning to digital and other forms of technology to streamline their operations, improve interaction with their markets, become more competitive, and increase their revenue. Such technologies in tourism are often used to add value to the customer experience, as value creation in tourism is strongly linked to customer experiences (Hadjielias et al. 2022, p. 4).

CUSTOMER EXPERIENCE FROM THE PERSPECTIVE OF ISO STANDARDS

In modern business, characterized by digital development, constant access to information and communication with organizations, as well as the public expression of opinions, views, and experiences through the Internet and social media platforms, the way an organization delivers its services has become just as important—if not more so—than the products and services themselves. Business success now depends on delivering an exceptional customer experience, value, and growth, while also forming an emotional connection with customers throughout the entire customer–organization interaction. A positive customer experience leads to higher customer satisfaction and also results in a threefold return for shareholders (Briedis et al., 2020).

Customer experience is the internal and subjective response of a user to any direct or indirect contact with a company. Direct contact occurs during the purchase or use of a product or service and is

typically initiated by the customer. Indirect contact usually involves unplanned interactions with the company's product, service, or brand presentations, and takes the form of word-of-mouth recommendations or criticisms, advertisements, news reports, reviews, and similar sources (Schwager et al., 2007). Customer satisfaction is the primary outcome of the customer experience and is defined as the fulfillment of expectations. The extent to which customer expectations are met is a fundamental indicator in the tourism and hospitality industry (Moliner et al, 2019). By applying standardized practices and continuously improving the customer experience, customer delight is achieved. As a business goal, this delight ensures that customers are satisfied and value every aspect of a product or every element of a service, as well as every point of contact with the company. The business value achieved in this way includes customer retention, loyalty, increased sales volume, higher revenue, and reduced average cost per unit of product or service sold (Antić Zorana, 2024, p. 182).

ISO standards serve as a foundation that enables organizations to create repeatable, scalable, and sustainable interactions with customers in the following ways (Myszkowski, M):
−   Global consistency: ISO standards provide a consistent framework that transcends cultural and regional differences in customer experience practices.
−   Benchmarking and improvement: They enable companies to measure their performance against best international practices, identifying areas for improvement.
−   Building credibility: Compliance with ISO standards can enhance a company's reputation, instilling trust among customers and stakeholders that the company takes the concept of customer experience seriously.

When discussing ISO standards in the tourism industry, they can be categorized into several interconnected groups. The fundamental standards in this industry include ISO 9001:2015 and ISO 14001:2015, which, in some hotel chains (e.g., Hilton), are mandatory for all hotels within the international chain. When it comes to customer safety, several standards address this issue from different perspectives: ISO 27001:2022 (data security), ISO 22000:2018 (food safety), and ISO 45001:2018 (occupational health and safety for both employees and customers). There are also standards that address the growing trend of digital technology implementation, such as: ISO/IEC 42001:2023 – Information technology — Artificial intelligence — Management system, ISO/IEC 20546:2023 – Information technology — Big data — Overview and vocabulary, ISO 17789:2014 – Information technology — Cloud computing — Reference architecture, among others. The second group of international standards relates specifically to the tourism sector, such as: ISO 18513:2021, ISO 13009:2015, ISO 13687:2017, ISO 18065:2015, ISO 17680:2015, ISO 13810:2015, etc. The third group of international standards focuses on customer satisfaction, and a portion of these will be presented in the following section.

The international standard ISO 9001 places customer requirements, needs, and expectations at its core. It promotes the principle of customer focus and specifies requirements primarily aimed at building confidence in the products and services provided by an organization, thereby enhancing customer satisfaction.

The ISO 10000 series on Quality Management – Customer Satisfaction encompasses standardized practices aimed at increasing customer trust in the organization, enhancing understanding of customer expectations, handling complaints within organizations, resolving disputes externally, monitoring and measuring customer satisfaction with guidance for improvement actions, boosting consumer confidence, improving the organization's ability to meet customer needs and reduce complaints.

Within the ISO 10004 standard – Guidelines for Monitoring and Measuring, customer satisfaction is defined as the gap between the customers' expectations and their perception of the product or service delivered by the organization, as well as other aspects of the organization as a whole. To achieve customer satisfaction, an organization must first understand customer expectations. These expectations may be explicit, implicit, or not fully articulated. They form the primary foundation for the products and services that are subsequently planned and delivered. The level of customer satisfaction is

determined by the extent to which the customer believes the delivered product or service, along with other organizational aspects, meets or exceeds their expectations (ISO, 2018).

When it comes to the customer experience of tourism services, it reflects a personal evaluation of multiple interactions with elements of the tourism service throughout all three stages: before, during, and after the use of the service (Lemon et al., 2016). Every step in the interaction with the tourism and hospitality industry (the tourist journey) influences the tourist's experience, and it is the result of mutual relationships and interactions between the customer, employees, and other stakeholders (Kandampully et al., 2018). Thus, the customer experience in tourism services does not stem solely from food, beverages, entertainment, or attractions, but also from countless supporting functions and processes (Kandampully et al., 2018), such as websites, technology, online communication, direct interaction, facility design, interactions with service staff and other guests, or the transportation required to reach the destination.

The concept of the travel experience, as represented through the customer experience of tourism services, is driven by the creation of memorable moments and the consumption of tourism and related products. These not only provide experiences for the traveler but also evoke emotions when travelers engage—either directly or indirectly—with the organization, the product, and the environment. Therefore, customer experience can be described as a combination of cognitive and affective components. (Adhikari et al., 2016).

The customer experience of tourism services is considered a key differentiating factor in markets where gaining a competitive advantage is a challenging task (Lemon et al., 2016). A study by Chapple, et al (2023, p.19), conducted by McKinsey, revealed that the primary reason customers cite when choosing a future travel operator is not value, quality, or convenience, but rather "positive past experiences with the brand."

Precursors of customer experience can be classified into five factors (Kim, H et al, 2022): motivational drivers, social and behavioural drivers, cognitive drivers, value-based drivers, and technological drivers.

The highest standards of customer experience are more easily established, maintained, and improved through the application of international standards, especially when delivering an exceptional customer experience is a strategic commitment of the organization.

CONCLUSION

A good tourist customer experience represents a significant challenge faced by organizations in the tourism industry. Customer experience represents the interaction customers have with the hotel they are staying in or with another tourism-related organization. Critical points for tourism organizations in delivering a good customer experience may include: the speed of booking accommodation or transportation, the level of travel coordination, on-trip experiences, and post-trip support.

These are the reasons why organizations in the tourism industry have found solutions both in the application of digital technologies and artificial intelligence, as well as in the implementation of international standards. The use of digital technologies and artificial intelligence has brought significant benefits to the tourism industry, including: the ability to quickly process user data and create a personalized user experience, reducing delays at border crossings, minimizing the risk of lost luggage, enhancing guest safety, and fostering a sense of ease and peace of mind during travel activities, among others.

In today's globally competitive environment, quality has become a crucial factor for businesses in the tourism industry. This growing emphasis on quality is influenced by several key trends: increasing consumer awareness of how user feedback shapes organizational success, the rapid integration of

digital technologies and artificial intelligence to meet customer expectations, and a heightened recognition among tourism organizations of quality as a vital source of competitive advantage and a powerful driver of positive customer experiences.

Implementing international standards for management systems offers numerous benefits to tourism organizations. These include a deeper understanding of the organizational context, effective measurement and continuous improvement of customer satisfaction, improved risk management, enhanced data security, and the development of employee competencies. Together, these elements play a pivotal role in improving the overall tourist experience and strengthening the competitive position of tourism enterprises.

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VEHICLE ROUTING OPTIMIZATION PROBLEM IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

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ABSTRACT

The Vehicle Routing Problem (VRP) is a fundamental optimization challenge in logistics and supply chain management, directly affecting transportation efficiency and operational costs. This paper provides a brief review of supply chain management (SCM) and its connection to logistics, emphasizing the importance of vehicle routing optimization. The study introduces VRP as a key optimization problem, outlining its role in minimizing delivery costs and improving distribution networks. Various VRP variants, such as Capacitated VRP (CVRP), are briefly presented to illustrate the problem's complexity and real-world relevance, followed by a mathematical model of the CVRP. The paper explores solution methods, comparing exact, heuristic, and metaheuristic algorithms, and evaluating their effectiveness in solving large-scale VRP instances. Additionally, recent advancements integrating machine learning (ML) techniques, including reinforcement learning and deep learning, are highlighted, demonstrating their potential for dynamic and real-time VRP optimization.

Key words: supply chain management, logistics, vehicle routing problem, metaheuristics

INTRODUCTION

In today's globalized economy, supply chain management (SCM) plays a crucial role in ensuring that goods and services are delivered efficiently from producers to consumers. SCM involves the coordination of raw materials, production processes, warehousing, and transportation to meet customer demands at minimal cost (Chopra & Meindl, 2019). A critical component of SCM is logistics, which focuses on the movement and storage of goods. Effective logistics systems reduce operational costs, improve service levels, and enhance overall supply chain efficiency (Christopher, 2016).

In the digital age, businesses face challenges such as rising fuel costs, delivery delays, and increasing customer expectations for fast shipping (Ghiani et al., 2013). These challenges highlight the need for intelligent transportation planning. One of the most critical optimization problems in logistics is the vehicle routing problem (VRP), which seeks to find the most cost-effective routes for a fleet of vehicles serving multiple customers (Laporte, 2007, Braekers et al., 2016). Focusing on the relationship between logistics and supply chain management, this paper delves into the influence of VRP on contemporary logistics operations.

Logistics encompasses the planning, implementation, and control of the movement and storage of goods. The key components of logistics include (Rushton et al., 2017):

–   Transportation: ensuring goods move efficiently between suppliers, manufacturers, and customers.
–   Warehousing: storing products before distribution to balance supply and demand.
–   Inventory: maintaining optimal stock levels to prevent shortages or overstocking.
–   Distribution: the layout of suppliers, warehouses, and delivery points.

A well-structured logistics system enhances cost efficiency, timely deliveries, and customer satisfaction. On the other hand, inefficient logistics can lead to higher costs, delays, and customer dissatisfaction.

Modern supply chains rely on advanced analytics and optimization techniques to enhance logistics operations. As transportation is a significant contributor to logistics costs, route optimization has become a key focus area, leading to the introduction of VRP.

OPTIMIZATION IN LOGISTICS

The transportation sector accounts for a significant portion of supply chain costs, making optimization a necessity (Coyle et al., 2016). Companies aim to reduce transportation costs by achieving the following goals (McKinnon et al. 2015, Chopra & Meindl, 2019, Crainic & Laporte, 2016):
–   Minimizing fuel consumption to enhance cost efficiency and reduce environmental impact
–   Reducing delivery times to improve customer satisfaction and meet just-in-time (JIT) demands
–   Optimizing fleet utilization by balancing vehicle capacity and demand to lower operational expenses
–   Enhancing last-mile delivery efficiency.

Two well-known optimization problems in logistics that address such challenges are:
–   **The Traveling Salesman Problem (TSP)**: Finding the shortest possible route that visits a set of locations exactly once before returning to the starting point. This classic problem serves as the foundation for many logistics and routing challenges (Applegate, 2006).
–   **The Vehicle Routing Problem (VRP)**: A generalization of TSP, where multiple vehicles must serve multiple customers while minimizing overall travel cost. VRP plays a critical role in large-scale distribution operations by improving operational efficiency, environmental sustainability, and customer service quality (Toth & Vigo, 2014).

The VRP is particularly relevant for businesses with large-scale distribution operations, as it directly impacts operational costs, environmental sustainability, and customer service quality (Konstantakopoulos, et al. 2020).

VEHICLE ROUTING PROBLEM (VRP)

Vehicle Routing Problem (VRP) is a combinatorial optimization problem that seeks to determine the most efficient routes for a fleet of vehicles delivering goods to a set of customers. As illustrated in Figure 1, each node represents a customer, and vehicles, starting from a central depot, must deliver goods to each customer before returning to the depot. Similar to the TSP, the VRP belongs to the class of NP-hard optimization challenges, meaning that as the number of customers increases, the computational complexity grows exponentially, making exact solutions impractical for large instances (Laporte, 2007, Braekers et al., 2016).
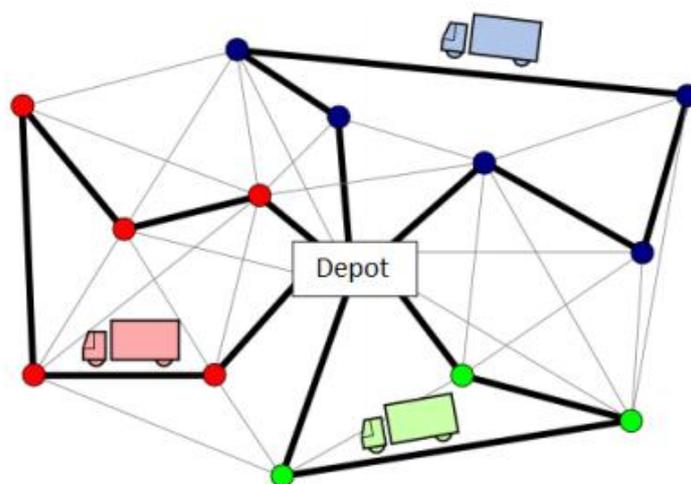
Figure 1: Vehicle routing problem (CVRP 2018)

According to the comprehensive reviews in Konstantakopoulos, et al. 2020 and Braekers et al., 2016, there are a number of variants of VRP that affect the complexity of the problem itself. Some of the most popular VRP variants are:

– Capacitated VRP (CVRP) – Classical VRP variant. CVRP seeks to determine the optimal set of delivery routes for a fleet of identical vehicles, each constrained by a maximum capacity. Each vehicle must serve a subset of customers, ensuring that: (i) every customer is visited exactly once, (ii) all routes begin and end at a central depot, and (iii) vehicle capacity is not exceeded. The objective is to minimize total travelling cost (Braekers et al., 2016, Chen et al. 2021).

– VRP with Time Windows (VRPTW) – Customers specify time slots for deliveries, requiring strict scheduling to avoid penalties.

– Split Delivery VRP (SDVRP) – Allows multiple deliveries to the same customer by different vehicles, increasing flexibility and load balancing.

– Heterogeneous Fleet VRP (HFVRP) – Uses a mixed fleet with different vehicle capacities and costs, optimizing vehicle selection and routing.

– Multi-Depot VRP (MDVRP) – Goods are dispatched from multiple depots instead of a single central hub, requiring depot assignment optimization.

– Open VRP (OVRP) – Vehicles do not return to the depot after completing deliveries, which is a useful variant for outsourced transportation services.

– Multi-Trip VRP (MTVRP) – Vehicles can perform multiple trips within a working day, maximizing efficiency under capacity constraints.

– VRP with Pickups and Deliveries (VRPPD) – Vehicles must transport goods both to and from customers, often applied in reverse logistics.

– Two-/Three-Dimensional VRP (2D/3D-VRP) – Accounts for package dimensions and stacking constraints, ensuring feasible vehicle loading.

– Truck and Trailer VRP (TTVRP) – Some customers require only a truck, while others can be served with a truck and trailer combination.

– Green VRP (GVRP) – Focuses on minimizing fuel consumption and CO_2 emissions, often employing electric or hybrid vehicles.

– Stochastic and Dynamic VRP (SVRP/DVRP) – Deals with uncertain demand or travel conditions, adapting routes dynamically in real-time.

– Periodic VRP (PVRP) – Routes are planned over multiple days or weeks instead of a single time period.

– Consistent VRP (ConVRP) – Aims to maintain consistency in vehicle assignments and delivery schedules, improving customer satisfaction.

– Collaborative VRP (CoVRP) – Involves multiple companies or logistics providers sharing transportation resources to reduce costs.

- Multi-Echelon VRP (MEVRP) – Goods pass through intermediate facilities (e.g., warehouses) before reaching customers, adding complexity to routing.

SOLUTION METHODS OF VRP

The VRP has been extensively studied in the literature, leading to the development of various solution methods categorized into exact, heuristic, and metaheuristic approaches (Zhang et al. 2021, Konstantakopoulos, et al. 2020, Braekers et al., 2016). **Exact algorithms** such as branch-and-bound guarantee optimal solutions but become computationally impractical for large-scale instances due to exponential complexity (Konstantakopoulos, et al. 2020).

To address the computational challenges, **heuristic algorithms** have been developed, including the nearest neighboring methods, and various local search techniques. These methods provide near-optimal solutions in reasonable time frames but do not guarantee global optimality (Konstantakopoulos, et al. 2020, Muriyatmoko et al. 2023).

The most effective approaches for large-scale VRPs are **metaheuristic algorithms**. Metaheuristic algorithms, or metaheuristics in short, represent the high-level optimization techniques designed to efficiently explore large solution spaces, balancing exploitation (local search) and exploration (global search) to avoid local optima. Unlike exact algorithms, metaheuristics are stochastic algorithms which do not guarantee an optimal solution but provide high-quality approximations within reasonable computational time, making them ideal for complex combinatorial problems such as the VRP (Talbi, 2009). Their adaptability and hybridization have led to state-of-the-art applications in logistics, scheduling, and artificial intelligence (Blum & Roli, 2003, Mirjalili, 2019). Metaheuristics encompass a wide range of algorithms, from traditional methods such as tabu search, simulated annealing, ant colony optimization, and genetic algorithms, to swarm intelligence-based methods, such as grey wolf optimizer, particle swarm optimization, whale optimization algorithm, and many others. According to (Mirjalili et al. 2020), all algorithms belong to the field of evolutionary computation, a subdomain of computational intelligence that focuses on nature-inspired optimization techniques.
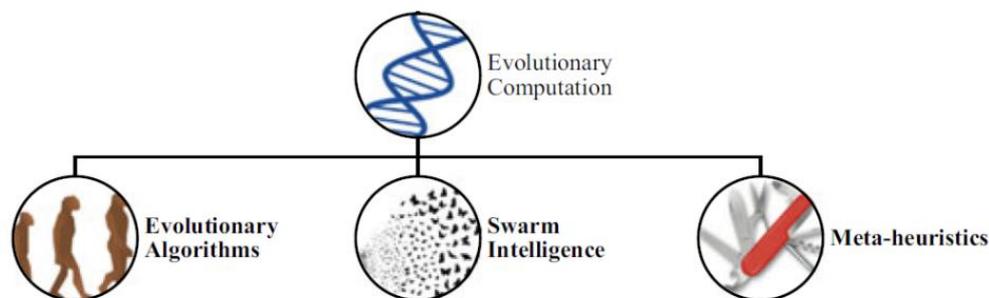
Figure 2: Metaheuristics as a part of evolutionary computation (Mirjalili et al. 2020)

Tabu search algorithm (Glover, 2003) utilizes a memory-based strategy to escape local optima. Simulated annealing mimics the gradual cooling of metals to probabilistically accept worse solutions in early iterations, enhancing global exploration (Kirkpatrick et al. 1983, Talbi, 2009). Genetic algorithms (Mirjalili, 2019) are inspired by natural selection, rely on crossover and mutation operators to iteratively evolve a population of solutions, making them highly effective for combinatorial problems such as the VRP (Baker et al. 2003). Particle swarm optimization (PSO) simulates the movement of particles in a search space, adjusting their positions based on individual and group best-known solutions (Tan et al. 2023). Additionally, hybrid heuristics that combine multiple algorithms have gained popularity, as they leverage the strengths of different approaches to improve solution quality and computational efficiency (Arifuddin et al. 2023).

Recent studies are increasingly considering **machine learning** (ML) techniques to solve the VRP, enhancing traditional optimization methods by learning from historical data and improving real-time

decision-making (Bengio et al. 2021, Mesa et al. 2025). In logistics, ML-driven VRP solutions help predict delivery times, optimize dynamic routing based on traffic conditions, and adapt to demand fluctuations, leading to cost and time savings (Nazari et al., 2018). Advanced techniques, such as reinforcement learning and deep learning, are now being integrated with metaheuristics to improve route planning in large-scale, real-world logistics networks (Nazari et al., 2018, Chen & Tian 2019, Kool et al. 2019).

CONCLUSION

This study provided a brief review of popular Vehicle Routing Problem (VRP) and its significance in logistics and supply chain management, focusing on optimization strategies to improve cost efficiency and service quality. As derived from the traditional travelling salesman problem from the point of its complexity, VRP is introduced with its different variants. Classical capacitated vehicle routing problem CVRP) is shortly described and its mathematical model is given. As solution methods for solving the VRP and its variants, techinques such as exact algorithms, heuristics and metaheuristics are proposed. While exact algorithms ensure optimality, their practical limitations in large-scale scenarios necessitate the use of heuristic and metaheuristic approaches, which offer high-quality approximations with reasonable computational effort. Recent advances introduced machine learning techniques to further improve VRP solutions, enabling dynamic and data-driven decision-making in modern logistics. As businesses face growing demands for faster and more sustainable transportation, future research should explore hybrid approaches combining metaheuristics, artificial intelligence, and real-time optimization techniques to address the complexities of evolving supply chain networks.

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SURVEYING THE INFLUENTIAL FACTORS ON WHOLE-BODY VIBRATION AT EARTHMOVING MACHINERY WORKPLACES

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ABSTRACT

The study aimed to measure whole-body vibrations exposure for operators of various earthmoving machines (bulldozers, dumpers, excavators, bucket wheel excavators, and loaders) using the V31-A triaxial accelerometer and to survey its influential factors. The study then compared the obtained results for the A(8) parameter which measures average exposure over an eight-hour day across different types of earthmoving machines. The comparison focused on determining the average values, value ranges, and deviations of A(8) m/s² values by machine type. Additionally, the study compared the measured results with the prescribed whole-body vibrations limit values set by existing regulatory standards. Furthermore, the dependence of the measured whole-body vibrations values on influential factors such as the age of the earthmoving machines, the power of the machines, the operators' age, experience, gender, and body mass index was analyzed. The research results indicated that bulldozers have the highest mean value of daily average exposure to vibration while excavators exhibit the widest range of daily average exposure to vibration. The findings also indicated that there is no correlation between the daily average exposure to vibration and the age of the earthmoving machine, the power of machines, or the operators' age or body mass index. Daily average exposure to vibration exceedances occurred in both older and newer earthmoving machines, regardless of their power, according to the ISO 2631-1 standard, with statistical significance. The obtained research results were analyzed using correlation analysis and nonlinear models, but none of the models showed a significant influence of the considered factors on the daily average exposure to vibration. The recommendation for further research is to expand the range of influencing factors as well as the sample size and to make additional efforts to identify significant predictors of whole-body vibrations.

Key words: whole-body vibrations, operator, earthmoving machinery, factor.

INTRODUCTION

Operators of earthmoving machines are exposed to vibrations in the workplace, which originate from various operational working conditions (drilling, excavating, crushing, etc.). The vibrations to which the operators are exposed are assessed by measuring hand-arm vibrations (HAV) and whole-body vibrations (WBV), whose permissible limit values are regulated by legal frameworks (EU Directive 2002/44/EC) and the ISO 2631-1 standard (1997). Numerous studies in the scientific and professional literature (Futatsuka et al., 1998; Cochrane et al., 2008; Dupuis & Zerlett, 1987; Nawayseh et al., 2019; Wikström et al., 1994; Fethke et al., 2018; Seidel, 1993) point to potential health problems among workers exposed to vibrations. Summarized reports can be found, for example, in the Society of Occupational Medicine report (2023), which outlines possible acute (postural control, vestibular dysfunction, muscle fatigue, headache, etc.) and chronic effects (spinal column–back pain, sciatica, lumbar disc degeneration, neurological, cardiovascular, etc.) of vibration exposure. Health and Safety Executive - HSE (2005) proposed a series of recommendations for employers to prevent the risk of back

pain due to vibration exposure. These include operator training, regular machine maintenance, selecting appropriate machines during procurement (e.g., with back-supporting seats, adjustable seating, control systems that do not require muscular effort, easy cabin access, etc.), work planning with job rotation, monitoring workers' health status, and using health monitoring results for work planning, among others. Management plays a key role in preventing health risks associated with the prolonged exposure of operators to harmful vibration effects. One of these roles involves monitoring vibration levels in existing machinery, especially in mines where vibrations represent one of the dominant potential risks to the health of operators (Bugarić et al., 2024; Spasojević et al., 2024; Misita et al., 2024). Numerous scientific research papers focused on WBV measurements indicate that, particularly in mining environments, the allowable exposure limits are often exceeded according to legal regulations (Eger et al., 2007; De La Hoz-Torres et al., 2017; Chaudhary et al., 2015; Chaudhary et al., 2015a; Bernardo et al., 2014). The next chapter provides a brief overview of recent WBV research and current research directions in this field. It then presents a study conducted on 31 earthmoving machines from five different open-pit mines. The aim of the study is to determine whether there are exceedances of the WBV exposure limits recommended by the EU Directive and ISO 2631-1 standard, which are related to health risks for operators at vibration-exposed workplaces. Additionally, the study seeks to explore whether there are statistically significant influencing factors on WBV. Given that the research sample includes machines of different types (bulldozers, dumpers, loaders, excavators, and bucket-wheel excavators), another goal of the study is to compare WBV across different machine types, which could support decision-makers in prioritizing WBV monitoring and operator health surveillance. In parallel, the research aims to examine whether there are dependencies between the measured WBV values and various influencing factors such as the MA, MP in kW, OA, YOE, and operator BMI. Identifying influencing factors that significantly affect WBV is a key research direction in finding potential ways to reduce WBV through manageable factors.

Previous research shows as follows. Akinnuli et al. (2018), Aye and Heyns (2011), Burström et al. (2016), Bernardo et al. (2014), and similar studies indicate that operators of earth-moving machinery are exposed to WBV levels that exceed the lower health threshold recommended by the ISO 2631-1 standard. In recent scientific literature, triaxial accelerometers are commonly used to monitor WBV, with sensors typically placed on the operator's seat. Professional triaxial accelerometers used for WBV measurement were applied by Tekin (2022), who used the SVAN 958 four-channel device, while Sakinala and Moparthi (2024) and Erdem et al. (2020) used the V106 model six-channel vibration analyser manufactured by Svantek Ltd. These and similar studies are focused on identifying factors influencing WBV, as well as examining the interrelations among these factors due to their synergistic effects. Some studies investigated the relationship between machine age and vibration intensity (Chaudhary et al., 2015; Mayton et al., 2014), while others explored the link between personal characteristics or poor posture of operators and WBV exposure (Upadhyay et al., 2021). Certain research efforts were directed toward improving suspension systems and seat designs to reduce vibrations (Mayton et al., 2014). Tekin (2022) focused on determining whether WBV values comply with current legal regulations, while Erdem et al. (2020) examined the same but across different work phases (e.g., loading, waiting, hauling). Tekin (2022) found that out of 41 heavy mining machines at three locations in Turkey, all operators were exposed to WBV below the permissible exposure limit prescribed by the EU Directive (1.15 m/s²). However, 44% of these operators were exposed to WBV above the action limit value of 0.5 m/s². Additionally, 49% of operators experienced WBV in the range of 0.45–0.90 m/s², which exceeds the lower health limit according to ISO 2631-1. Matsumoto et al. (2011) discussed the factors affecting perception thresholds of vertical whole-body vibration in recumbent subjects, including gender, age, and vibration duration. Shibata et al. (2012) examined gender differences in subjective responses to whole-body vibration in a standing posture, while Dewangan et al. (2013) investigated the effects of gender and anthropometric characteristics on the apparent mass response of the seated body to vertical whole-body vibration. In this context, Sakinala and Moparthi (2024) classified the factors influencing WBV into the following categories: (a) personal characteristics, such as experience and body mass;(b) ergonomic factors, such as the posture adopted by operators during work and seat thickness; (c) machine characteristics, including machine age, seat-effective amplitude transmissibility, and vibration damping systems; (d) operational characteristics, such as road condition and speed. All of these factors, which may contribute to WBV mitigation, as well as their synergistic effects, are the subject of numerous ongoing studies (Eger et al., 2007; De La Hoz-Torres et al., 2017; Bernardo et al., 2014; Fethke et al., 2018) aimed at identifying optimal working conditions and improving occupational health protection for operators of earthmoving machinery. It is evident that the issue of WBV, despite causing a wide range of health problems for operators and imposing significant costs on society, remains insufficiently researched. Therefore, the objective of this study is well justified. The abbreviations used in this paper are given in Table 1.

Table 1: Abbreviation list

Abbreviation	Meaning
HAV	Hand-arm vibrations
WBV	Whole-body vibrations
EU	European Union
HSE	Health, Safety, and Environment
BMI	Body mass index
AO	Age of the operator
MA	Machine age
MP	Machine power
H	Operator's height
W	Operator's weight
YOE	Year of experience
A(8)	Daily average exposure to vibration
Std	Standard deviation
CV	Coefficient of variation
R^2	Coefficient of determination
MSE	Mean squared error
KNN	K-nearest neighbors algorithm

Table 2: WBV measurement results

Earthmoving machine	MA	MP (kW)	AO (year)	H (cm)	W (kg)	BMI	YOE (year)	A(8)
Bulldozer	2011	268	59	186	95	27.45982	40	0.62
Bulldozer	2015	120	55	173	100	33.41241	20	0.45
Bulldozer	2020	406	34	174	75	24.7721	14	0.5
Bulldozer	2021	208	37	189	146	40.87232	20	0.71
Bulldozer	2023	160	51	180	116	35.80247	8	0.55
Bulldozer	2024	226	26	180	70	21.60494	7	0.52
Bulldozer	2024	337	53	178	82	25.88057	20	0.46
Dumper	2006	248	48	175	80	26.12245	23	0.45
Dumper	2008	250	50	195	108	28.40237	20	0.53
Dumper	2010	298	25	188	109	30.83975	6	0.44
Dumper	2010	298	42	180	104	32.09877	22	0.43
Dumper	2011	298	57	186	106	30.63938	32	0.29
Dumper	2011	386	28	186	99	28.61602	6	0.47
Excavator	2012	316	36	187	95	27.16692	18	0.53
Excavator	2017	370	33	170	83	28.71972	13	0.26
Excavator	2017	370	36	187	95	27.16692	18	0.4
Excavator	2018	123	38	178	77	24.30249	12	0.26
Excavator	2021	128.4	40	190	115	31.85596	20	0.38
Excavator	2023	220	51	185	95	27.75749	34	0.51
Excavator	2024	180	42	175	75	24.4898	17	0.31
Excavator	2024	180	39	182	96	28.98201	12	0.13
Loader	2001	162	56	172	84	28.39373	37	0.41
Loader	2017	140	53	178	80	25.24934	26	0.56
Loader	2017	246	23	170	110	38.06228	4	0.41
Loader	2017	251	52	192	112	30.38194	29	0.16
Loader	2018	129	58	175	103	33.63265	43	0.46
Loader	2020	129	47	198	98	24.99745	31	0.53
Loader	2020	250	28	173	100	33.41241	8	0.53
Loader	2020	250	44	192	108	29.29688	24	0.67
Bucket Wheel Excavator	1995	630	50	184	125	36.92108	30	0.25
Bucket Wheel Excavator	2000	630	51	188	80	22.63468	30	0.29

EXPERIMENTAL RESEARCH

In this study, a triaxial accelerometer V31, manufactured by Metra Mess und Frequenztechnik in Radebeul e.K., was utilized. This scientific device enables the calculation of the A(8) value, which represents the equivalent continuous acceleration over an eight-hour period. The sample consisted of earthmoving machines from five locations, specifically in open-pit mines extracting quartz sand, zinc and lead, coal, marble, and granite. Table 2 presents the results of WBV measurements using the V31 device, along with collected data on machine age (MA),

machine power (MP) in kW, operator age (OA), height (H) and weight (W) (used to calculate Body mass index - BMI), and years of experience (YOE). All operators in the research sample were male, so this variable was excluded from further analysis.

ANALYSIS OF RESULTS

For the 31 observed earthmoving machines from different locations, the descriptive statistics is as in Table 3, and the descriptive statistics by machine type are as in Table 4. In Figure 1, the data from Table 2 are presented to visualize the distribution of A(8) values among the earthmoving machines included in the study.

Table 3: Descriptive statistics for all earthmoving machines

	Count	Mean	Std	Min	Median	Max	CV (%)	Variable type
MA	31	2015.323	7.5648	1995	2017	2024	0.3754	nonparamater
MP	31	264.7548	127.9253	120	250	630	48.3184	paramater
AO	31	43.2903	10.6933	23	44	59	24.7013	paramater
BMI	31	29.3531	4.5812	21.6049	28.616	40.8723	15.6073	paramater
YOE	31	20.7742	10.5537	4	20	43	50.802	nonparamater
A(8)	31	0.4345	0.1387	0.13	0.45	0.71	31.9271	nonparamater

Table 4: Descriptive statistics for earthmoving machines by machine type

Earthmoving machine	Variable	Count	Mean	Std	Min	Median	Max	CV (%)
Bulldozer	MA (year)	7	2019.71	4.96	2011	2021	2024	0.25
	MP (kW)	7	246.43	99.57	120	226	406	40.4
	AO (year)	7	45	12.53	26	51	59	27.84
	H (cm)	7	180	5.86	173	180	189	3.26
	W (kg)	7	97.71	26.49	70	95	146	27.11
	BMI	7	29.97	6.89	21.6	27.46	40.87	22.98
	YOE (year)	7	18.43	11.04	7	20	40	59.92
	A(8)	7	0.54	0.09	0.45	0.52	0.71	17.07
Dumper	MA (year)	6	2009.33	1.97	2006	2010	2011	0.1
	MP (kW)	6	296.33	50.06	248	298	386	16.89
	AO (year)	6	41.67	12.72	25	45	57	30.53
	H (cm)	6	185	6.87	175	186	195	3.71
	W (kg)	6	101	10.88	80	105	109	10.77
	BMI	6	29.45	2.16	26.12	29.63	32.1	7.32
	YOE (year)	6	18.17	10.28	6	21	32	56.61
	A(8)	6	0.43	0.08	0.29	0.44	0.53	18.26
Excavator	MA (year)	8	2019.5	4.24	2012	2019.5	2024	0.21
	MP (kW)	8	235.92	102.25	123	200	370	43.34
	AO (year)	8	39.38	5.45	33	38.5	51	13.84
	H (cm)	8	181.75	6.88	170	183.5	190	3.79
	W (kg)	8	91.38	12.89	75	95	115	14.11
	BMI	8	27.56	2.46	24.3	27.46	31.86	8.91
	YOE (year)	8	18	7.15	12	17.5	34	39.73
	A(8)	8	0.35	0.13	0.13	0.34	0.53	38.85
Loader	MA (year)	8	2016.25	6.32	2001	2017.5	2020	0.31
	MP (kW)	8	194.62	59.3	129	204	251	30.47
	AO (year)	8	45.12	12.99	23	49.5	58	28.78
	H (cm)	8	181.25	10.96	170	176.5	198	6.05
	W (kg)	8	99.38	11.8	80	101.5	112	11.87
	BMI	8	30.43	4.46	25	29.84	38.06	14.65
	YOE (year)	8	25.25	13.37	4	27.5	43	52.95
	A(8)	8	0.47	0.15	0.16	0.5	0.67	32.28
Bucket Wheel Excavator	MA (year)	2	1997.5	3.54	1995	1997.5	2000	0.18
	MP (kW)	2	630	0	630	630	630	0
	AO (year)	2	50.5	0.71	50	50.5	51	1.4
	H (cm)	2	186	2.83	184	186	188	1.52
	W (kg)	2	102.5	31.82	80	102.5	125	31.04
	BMI	2	29.78	10.1	22.63	29.78	36.92	33.92
	YOE (year)	2	30	0	30	30	30	0
	A(8)	2	0.27	0.03	0.25	0.27	0.29	10.48
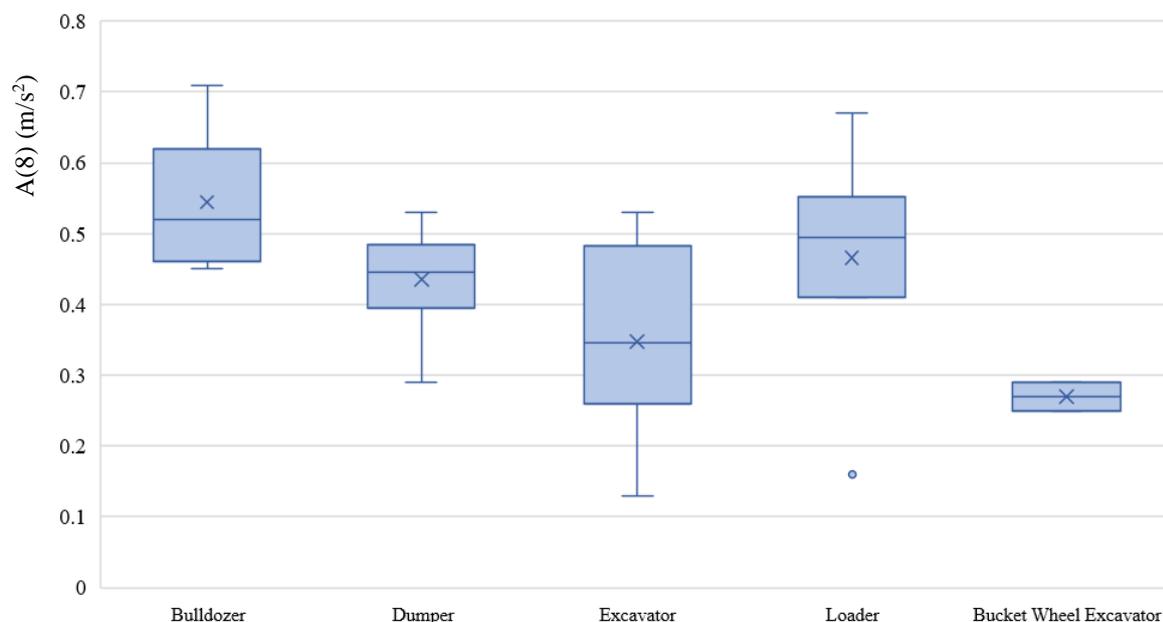
Figure 1: Distribution of WB vibrations for different types of machines

The comparative analysis of A(8) whole-body vibration exposure across different earthmoving machine types reveals notable differences in both intensity and variability. Bulldozers and loaders exhibit the highest average vibration levels, with mean values of 0.54 m/s² and 0.47 m/s², respectively, indicating a greater potential for long-term health risks. While dumpers show moderate exposure (mean: 0.43 m/s²), excavators display a wider range of values (0.13–0.53 m/s²) and the highest CV (38.85%), highlighting significant inconsistencies likely influenced by operational conditions. In contrast, bucket wheel excavators demonstrate the lowest and most stable vibration levels (mean: 0.27 m/s²; CV: 10.48%), suggesting they are the least hazardous in terms of vibration exposure. These findings underscore the importance of machine-specific assessments when evaluating occupational vibration risks. The analysis of the coefficients of variation for factors that may potentially influence of WBV indicates that the machine age (MA) does not exhibit significant variation across any machine type (despite observable differences in A(8) values), suggesting that MA likely does not have a substantial impact on vibration exposure. In contrast, the MP, BMI, AO, and YOE show notable variability. Interestingly, the BMI values consistently indicate that operators are generally overweight, with only 19.3% of operators falling within the normal body mass index range (i.e., below 25). The variables YOE and AO show collinearity (which was expected) (Pearson correlation: 0.834, p-value: 0.00000), so YOE was excluded from further analysis. Comparison of measured WBV values for the observed earthmoving machines in relation to the EU directive: According to EU Directive 2002/44/EC, the action limit for WBV is 0.5 m/s². When vibrations exceed this value, appropriate measures must be taken to reduce worker exposure. Additionally, a limit value of 1.15 m/s² is established, which must not be exceeded during an eight-hour work shift. Compared to other machine types, the bulldozer shows the highest average A(8) value of 0.54 m/s², with 71.4% of cases exceeding the EU Directive 2002/44/EC action limit, followed by the loader with an average of 0.47 m/s² and 50% of cases above the threshold.

The dumper and excavator exhibit lower average values of 0.43 m/s² and 0.35 m/s², with 33.3% and 28.6% of cases exceeding the limit, respectively. In contrast, the bucket wheel excavator presents the lowest average A(8) value of 0.27 m/s², with no cases surpassing the action value, indicating that operators of bulldozers and loaders are at the greatest risk and require the most immediate implementation of vibration-reducing measures. Comparison of measured WBV values for the observed earthmoving machines in relation to the ISO 2531-1 standard: According to the ISO 2631-1 (1997) standard for the assessment of WBV, two threshold values are defined to indicate potential health risks: the lower limit of 0.45 m/s² – exceeding this value signifies the possibility of a negative health impact, and attention should be given to the duration of exposure and working conditions – and the upper limit of 0.9 m/s² – which indicates that vibrations above this value represent a high health risk and may lead to serious consequences if the exposure is prolonged. The analysis of the WBV results shows that the bulldozers exhibit the most concerning results, with an average

A(8) value of 0.54 m/s² and 85.7% of cases exceeding the threshold, clearly indicating a high likelihood of health risks for operators. The loader follows, with an average of 0.47 m/s², and 50% of cases surpass the 0.45 m/s² limit, suggesting moderate exposure concerns. The dumper, with an average of 0.43 m/s², exceeds the threshold in 50% of cases, showing a comparable risk profile to loaders. The excavator has a lower average of 0.35 m/s², with 28.6% of cases exceeding the limit, while the bucket wheel excavator, with an average of 0.27 m/s² and 0% of cases above the threshold, presents the lowest risk. These results suggest that bulldozer and loader operators are most consistently exposed to potentially harmful vibration levels, warranting targeted risk management interventions. WBV influential factors: By testing the influencing factors (MA, MP, AO, and BMI) at a significance level of 0.05 using appropriate correlation tests, no significant impact on the occurrence of WBV was found, as shown in Table 5.

Table 5: Correlation analysis

Combination	Variable	Spearman	Spearman p	Kendall	Kendall p
All variables	MP, MA, AO, BMI, YOE	-0.1557	0.403	-0.1088	0.3945
1 variable	MP	-0.1532	0.4105	-0.099	0.4427
1 variable	MA	0.1943	0.295	0.1438	0.2729
1 variable	AO	0.0366	0.8451	0.0307	0.8113
1 variable	BMI	-0.0031	0.9867	0.0174	0.8916
1 variable	YOE	0.048	0.7977	0.0553	0.6693
2 variables	MP, MA	-0.1426	0.4441	-0.1005	0.4331
2 variables	MP, AO	-0.1545	0.4067	-0.1001	0.4334
2 variables	MP, BMI	-0.15	0.4205	-0.1045	0.4137
2 variables	MP, YOE	-0.1485	0.4252	-0.098	0.4434
2 variables	MA, AO	0.2143	0.2469	0.1207	0.3483
2 variables	MA, BMI	0.15	0.4205	0.1001	0.4334
2 variables	MA, YOE	0.1835	0.3231	0.0996	0.4423
2 variables	AO, BMI	0.0369	0.844	0.0283	0.8248
2 variables	AO, YOE	0.0071	0.9699	0.024	0.8513
2 variables	BMI, YOE	0.0734	0.6947	0.0545	0.6702
3 variables	MP, MA, AO	-0.1401	0.4521	-0.0871	0.4957
3 variables	MP, MA, BMI	-0.1472	0.4294	-0.1088	0.3945
3 variables	MP, MA, YOE	-0.1449	0.4367	-0.0938	0.4639
3 variables	MP, AO, BMI	-0.147	0.43	-0.1045	0.4137
3 variables	MP, AO, YOE	-0.1565	0.4005	-0.1024	0.4234
3 variables	MP, BMI, YOE	-0.1458	0.4339	-0.0958	0.4537
3 variables	MA, AO, BMI	0.2114	0.2536	0.1262	0.3233
3 variables	MA, AO, YOE	0.1366	0.4638	0.0941	0.4637
3 variables	MA, BMI, YOE	0.213	0.2499	0.1436	0.261
3 variables	AO, BMI, YOE	0.0381	0.8389	0.037	0.7722
4 variables	MP, MA, AO, BMI	-0.1551	0.4049	-0.1045	0.4137
4 variables	MP, MA, AO, YOE	-0.1497	0.4214	-0.1024	0.4234
4 variables	MP, MA, BMI, YOE	-0.147	0.43	-0.1001	0.4334
4 variables	MP, AO, BMI, YOE	-0.146	0.4333	-0.1001	0.4334
4 variables	MA, AO, BMI, YOE	0.1518	0.4148	0.1001	0.4334

Based on the results in Table 5, we can conclude that no variable stands out as a strong predictor—neither individually nor in combination. Since the linear models did not provide significant results, the analysis was extended to nonlinear models such as Random Forest Regressor, XGB Regressor, K Neighbors Regressor, and Support Vector Regressor. For each of the mentioned models, combinations of independent variables were tested in pairs, triplets, and all together, with the aim of finding the combinations that provide the best result in terms of predicting the A(8) value. The evaluation was conducted using 10-fold cross-validation, and the R^2 and MSE values were measured. The table with the results of applying the nonlinear models is not shown in this paper due to size constraints. According to the results, the K-nearest neighbors algorithm (KNN) model for the variables MP, OA, and BMI achieved the lowest mean square error (MSE) of 0.0206, but the R^2 was -0.8265, indicating that the model predicts worse than the simple mean value of the dependent variable. The same is true for the KNN model for the variables MP and OA, with a mean MSE of 0.0216 and a mean R^2 of -0.7802.

CONCLUSIONS

The conducted study on open-pit mining aimed to analyze whether different types of earthmoving machines (bulldozers, dumpers, excavators, bucket wheel excavators, and loaders) exceed WBV limits during an eight-hour work shift. The study included 31 earthmoving machines, comparing their average A(8) values as well as the range within which these values vary across different machine types. Special attention was given to analyzing WBV values within different machine groups in relation to the EU directive and the ISO 2631-1 standard. Exceedances of the permissible action value according to EU regulations were recorded in 12 out of 31 monitored machines, accounting for 38.71% of the study sample. The lower health risk threshold defined by ISO 2631-1 was exceeded in 16 machines, representing as much as 51.61% of the sample. Furthermore, the WBV study conducted among different types of earthmoving machines indicates that the occurrence of WBV is not correlated with either the MA or MP, nor the AO, the BMI of the operator, or YOE. Given the study's findings, which indicate that exceedances of both the lower health risk threshold defined by ISO 2631-1 and the action value for WBV prescribed by the EU directive occur in both older and newer machines, as well as across earthmoving machines regardless of their power in kW, it is essential to emphasize that monitoring operator exposure to WBV is a continuous process and one of the key aspects of ensuring occupational safety and health. In this study, we were unable to establish a significant (linear or nonlinear) relationship between various contextual factors and the occurrence of vibrations, such as the age of earthmoving machinery, MP, operator gender, AO, operator BMI, and YOE. It was found that operators had a high BMI (with only 19.3% of operators falling within the normal body mass index range), but no significant impact of BMI on A(8) was proven.

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THE APPLICATION OF MCDM METHODS IN IMPROVING THE PLANNING OF THE PRODUCTION PROCESS

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ABSTRACT

Continuous improvement of production planning and preparation is the main task of manufacturing companies in modern business. Enterprise production resource management is offered as one of the possible solutions. The complication is further aggravated by the unequal importance attributed to the criteria in decision-making. Therefore, it is crucial to apply an efficient and systematic approach to the selection of production machines for a given problem. The paper presents the application of MCDM methods for selecting the most favorable machines for the production process. The aim of this paper is to provide relevant information to engineers during production planning and preparation about machine capacity limitations, taking into account various criteria and product specificity. The paper will present a comparative analysis of two MCDM techniques for selecting the best alternative, based on criteria defined by experienced engineers from the production planning and preparation sector. By applying these methods, it is possible to achieve improved production process planning, increasing efficiency and enabling cost savings.

Keywords: COPRAS, VIKOR, Production capacity, Production planning.

INTRODUCTION

Demanding market conditions, as well as precise and changing customer requirements, have led to a great struggle to achieve a competitive advantage. Continuous improvement of production planning and preparation, along with the efficiency of the production process, is the main task of manufacturing companies. Management engineers are under great pressure to find ways to keep the company competitive in modern and changing business conditions. Enterprise production resource management is offered as one of the possible solutions. The complication is further aggravated by the unequal importance assigned to the criteria in decision-making. Therefore, it is crucial to apply an efficient and systematic approach to the selection of production machines for a given problem. The selection of appropriate production machines can be achieved by applying multi-criteria decision-making (MCDM) techniques. MCDM is a very suitable technique for analyzing complex real-world problems due to its ability to use certain criteria to evaluate different alternatives. These methods allow the decision maker to consider different criteria or objectives in order to reach a compromise between all potentially different machines. Consequently, the decision maker must consider and evaluate both quantitative and qualitative factors, while this approach can take into account both subjective and quantitative criteria.

For example, (Chakraborty & Chakraborty, 2022) emphasized the importance of applying various MCDM techniques to solve the optimization problem of drilling, and milling processes. As well as for material selection (Emovon & Oghenenyerovwho, 2020). The application of these techniques is used to achieve coordinated optimization of resource consumption, processing quality and production efficiency (Lv et al. 2020). A comprehensive strategy for improving performance in preparation for the implementation of Industry 4.0, which can also be realized by applying MCM techniques (Kumar et al. 2024). MCDM has a variety of tools and methods that can be applied in different areas of engineering

design (Taherdoost & Madanchian, 2023).The selection of manufacturing processes for a given application can be a complex multi-criteria decision-making problem, although there are several different approaches that can be used to select the appropriate alternative (Ghaleb et al. 2020).

This research aims at efficient production planning, using MCDM methods. The aim of this work is to inform engineers during production planning and preparation about the limitations of machine capacities, taking into account various criteria and product specificity. This approach improves the efficiency of the production process, as well as saves costs during production planning and preparation. The paper will present a comparative analysis of two MCDM technics for selecting the best alternative, based on criteria defined by experienced engineers from the production planning and preparation sector.

DEFINING ALTERNATIVES AND CRITERIA FOR SELECTING PRODUCTION MACHINE

The selection of the most important machines for the implementation of the production process was carried out by a team of experts from the production preparation sector. They are expected to review and analyze the competence of all production capacities to meet the main goal, which is to shorten the production cycle time and save costs. This team considered 25 machines used in the production process, which achieve a utilization rate of less than 100% (Table 1). Therefore, they represent serious limitations that affect the duration of the production process.

Table 1: Machines in the production process

ID	Machine (alternative)	ID	Machine (alternative)
f_1	UU-80739	f_{14}	Eight-spindle machine "TMZ 867/842 CNC"
f_2	Bullet lacing device UU-3373 R	f_{15}	Ferroflux
f_3	Lacing device UU-80626	f_{16}	Staining line Cu - Manual
f_4	Horizontal mechanical press "HERLAN"	f_{17}	Mechanical press "KARL HURT"
f_5	Interphase cutting machine 435.50-006/007	f_{18}	Mechanical drum mixer UPI-3937
f_6	Pass-through furnace "GERING" 479.90-02	f_{19}	WACKER device
f_7	Hydraulic press 60kN "MANURHIN"	f_{20}	Tape cutting device "SLOBODA"
f_8	Mechanical press "EPNS" 25t	f_{21}	EXCENTAR PRESS 16t
f_9	Mechanical press "KNEUSEL" 16t	f_{22}	Six-spindle automatic machine "TORNOS AS-14"
f_{10}	Finishing lathe "AUERBACH"	f_{23}	Horizontal milling machine "MACKERS"
f_{11}	Finishing lathe	f_{24}	Winding machine "SCHENKER"
f_{12}	EITEL FSD-3x8	f_{25}	SCHENKER spring grinder
f_{13}	Semi-automatic "INDEX E42"		

These experts also defined four most important criteria in the decision-making process, based on which the alternatives that have the greatest impact on the fulfillment of the main goal will be evaluated and ranked. The evaluation criteria system includes the following criteria: *Utilization capacity of machines (c1); Amortization (c2); Value-time efficiency capacity (c3); Organizational delays (c4).*

The calculation of the capacity utilization

Every serial production, especially according to customer requirements, is in some way conditioned by the available machine capacities (Stanisavljev et al. 2019). Table 2 shows the alternatives, in this case, the machines used in the production process. It also shows the level of utilization of production capacities for each machine. In this process, 25 machines were used with a load level ranging from 17.88% to 97.46%. Based on the data obtained from the technological processes on the monthly capacity of each machine, the capacity utilization rate for each machine was calculated. In practice, this criterion is considered one of the most influential when it comes to reducing the duration of the production process. The required production quantity, requested by the customers, is 10,000 pieces. Several available pieces of certain machines were used in the production process of this product. Also, based on the calculated values, the group capacity utilization rate can be determined, which is 61.35%, for all machines included in this production process.

The determination of the amortization of machines

Any production process requires the use of certain machines that may, to a greater or lesser extent, wear out during the process, so that their useful value gradually decreases. Depreciation of machines is the process of gradually reducing their value due to their physical wear and tear, as well as transferring the corresponding values in determining the costs of the final product. When calculating the depreciation of machines, they must be synchronized with the degree of their employment and utilization, as well as with the volume of production. To calculate the annual amount of depreciation of machines, this paper uses linear write-off depreciation method. In practice, this criterion has proven to be one of the most important when it comes to planning the costs of the production process. Table 2 shows the calculated values of the annual depreciation amount for each machine. To determine the annual depreciation amount, previously calculated values of the depreciation rate were taken, and the purchase price of each machine and the years of use were taken from the technological documentation (Radojicic et al. 2016).

The Determination of the Value-Time Degree of Capacity Utilization

This paper also presents the value-time degree of capacity utilization is determined. The application of the value-time efficiency rate of machines means a more efficient use of financial resources invested in production machines and an increase in the coefficient of trade, as well as a reduction in the costs of the final product, thus achieving more efficient and effective production. To calculate the value-time degree of capacity utilization, the values of the degree of time utilization of machines and the value of depreciation of machines are necessary (Radojicic et al., 2016). This criterion allows the decision maker to opt for the use of more expensive machines rather than cheaper ones.

COMPARATIVE ANALYSIS OF TWO MULTI-CRITERIA METHODS

The COPRAS and VIKOR methods were applied to evaluate alternative systems for improving the planning of the production process. The decision-making evaluation process considers the 25 alternative machines (f1 – f25), assigned in the system of 4 criteria. The results of the process of prioritizing the criteria, by the engineers, indicate that the most significant evaluation criterion is c1 (0.42). The criterion c3 was also considered significant with a relative weight of 0.28. The criterion c4 (0.19) was assessed as slightly less significant, while the criterion c2 (0.11) will have the least impact on the evaluation process. The relative importance of the criteria serves as input for an alternative evaluation process. The decision-making matrix for the problem of the machine selection evaluation (Table 2) is established.

Table 2: Decision-making matrix for the problem of the machine selection evaluation

Alternative		f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9	f_{10}	f_{11}	f_{12}	f_{13}
c_1	Max	50.62	50.62	43.33	58.04	73.48	76.33	32.02	69.19	79.98	87.19	94.90	54.85	51.95
c_2	Min	600	756.82	715.91	1384.62	511.36	6750	920.45	511.36	855	195.65	2250	734.69	1735.71
c_3	Min	303.71	383.09	310.24	803.69	375.77	5152.42	294.77	353.82	683.86	170.59	2135.29	402.96	901.69
c_4	Min	0	0	0	593.99	574.79	566.39	0	284.3	311.9	893.14	0	0	0
Alternative		f_{14}	f_{15}	f_{16}	f_{17}	f_{18}	f_{19}	f_{20}	f_{21}	f_{22}	f_{23}	f_{24}	f_{25}	
c_1	Max	70.35	74.21	41.46	82.90	24.18	19.10	17.88	69.50	70.36	97.46	54.01	89.88	
c_2	Min	2195.12	109.46	31500	90	1022.73	627.91	126.92	14594.59	4235.29	1038.46	150	61.36	
c_3	Min	1544.32	81.23	13059.92	74.61	247.28	119.93	22.70	10142.98	2979.95	1012.13	81.02	55.15	
c_4	Min	5102.35	5534.94	436.8	249.65	10355.9	89.8	350.9	87.6	1142.79	0	299.9	250.1	

Machine selection evaluation by COPRAS method

Zavadskas et al. (1994) introduced the Complex Proportional Assessment Method (COPRAS) as a Multi-Attribute Decision-Making (MADM) technique. This methodology provides a solution that establishes a ratio between the ideal and worst-ideal solutions. Below is an illustration of the COPRAS mathematical model.

Step 1.1: Let $X = \left[x_{ij}\right]_{n \times m}$ denote the decision matrix of the considered problem which includes m alternative $(f_1, f_2, ..., f_m)$ and n evaluation criteria $(c_1, c_2, ..., c_n)$, as specified in (1).

$$X = \left[x_{ij} \right]_{n \times m} = \begin{matrix} \\ c_1 \\ c_2 \\ \vdots \\ c_n \end{matrix} \begin{matrix} f_1 & f_2 & \cdots & f_m \end{matrix} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \qquad (1)$$

The decision matrix element x_{ij} indicates the jth alternative's rating related to the ith evaluation criterion.

Step 1.2: The normalized decision matrix ($\bar{X} = \left[\bar{x}_{ij} \right]_{n \times m}$) is established through the equation (2).

$$\bar{x}_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \qquad (2)$$

Step 1.3: The weighted normalized decision matrix ($\hat{X} = \left[\hat{x}_{ij} \right]_{n \times m}$) is established according to (3), where the w_i denotes the relative weight of ith evaluation criteria, obtained from the previous engineer's assessment process.

$$\hat{x}_{ij} = \bar{x}_{ij} \cdot w_i \qquad (3)$$

Step 1.4: Equations (4) and (5) compute the sums of weighted values for both beneficial (H_j) and non-beneficial criteria (Z_j). The weighted values for beneficial criteria are denoted as $\hat{x}_{+ij}$, whereas those for non-beneficial criteria are represented by $\hat{x}_{-ij}$.

$$H_j = \sum_{i=1}^{n} \hat{x}_{+ij} \qquad (4)$$
$$Z_j = \sum_{i=1}^{n} \hat{x}_{-ij} \qquad (5)$$

Step 1.5: Equation (6) can be used to determine the alternative relative significance, where R_{min} indicates the lowest value of Z_j. The alternative with the greatest relative significance value ($maxY_j$) is considered the optimal solution.

$$Y_j = H_j + \frac{Z_{min} \cdot \sum_{j=1}^{m} Z_j}{Z_j \cdot \sum_{j=1}^{m} Z_{min}/Z_j} \qquad (6)$$

Step 1.6: The utility values of each alternative are used to establish a comprehensive ranking. The priority assigned to an alternative is directly proportional to the value of N_j (7).

$$N_j = \frac{Y_j}{Y_{max}} \cdot 100\% \qquad (7)$$

The process of ranking compromise alternatives is based on the decision-making matrix shown in Table 2, based on the presented mathematical model expressed through the above steps. The final ranking is established by the utility degree of each alternative (N_j) derived from Equation (7), the relative importance of the alternatives (Y_j) driven by Equation (6), and the values of S_{+j} (4) and S_{-j} (5) are shown in Table 3. From Table 3, the ranking of the alternative machine is observed. Hence the best solution is the alternative f_{25}. The second-ranked alternative is f_{17},, while the last-ranked alternative is f_{18}.

Machine selection evaluation by VIKOR method

The multi-criteria optimization and compromise solution (VIKOR) method introduced by Opricovic (1998) addresses decision-making problems characterized by multiple conflicting criteria, identifying a solution that is closest to the ideal. The VIKOR ranking procedure is outlined below.

Table 3: Relative significance and utility values of the considered alternatives

Alternative	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9	f_{10}	f_{11}	f_{12}	f_{13}
S_{+j}	0.014	0.014	0.012	0.016	0.020	0.021	0.009	0.019	0.022	0.024	0.026	0.015	0.014
S_{-j}	0.003	0.004	0.003	0.012	0.007	0.049	0.003	0.005	0.008	0.008	0.018	0.004	0.009
Y_j	0.057	0.048	0.052	0.027	0.037	0.024	0.047	0.044	0.038	0.040	0.033	0.048	0.029
$N_j(\%)$	69.67	58.75	63.61	32.74	45.75	28.72	56.87	53.32	45.98	49.29	40.50	59.06	35.28
Rank	5	9	6	18	15	20	10	11	14	13	16	8	17
Alternative	f_{14}	f_{15}	f_{16}	f_{17}	f_{18}	f_{19}	f_{20}	f_{21}	f_{22}	f_{23}	f_{24}	f_{25}	
S_{+j}	0.019	0.020	0.011	0.023	0.007	0.005	0.005	0.019	0.019	0.027	0.015	0.025	
S_{-j}	0.049	0.039	0.138	0.002	0.076	0.002	0.003	0.091	0.034	0.008	0.003	0.002	
Y_j	0.022	0.024	0.012	0.076	0.008	0.059	0.050	0.020	0.023	0.042	0.059	0.082	
$N_j(\%)$	26.67	28.75	15.00	92.67	10.13	71.66	61.27	24.96	28.05	51.15	72.03	100.00	
Rank	22	19	24	2	25	4	7	23	21	12	3	1	

Step 2.1: Let define a decision-making problem that consider the m alternative $(f_1, f_2, …, f_m)$ and n evaluation criteria $(c_1, c_2, …, c_n)$; the decision-making matrix can be expressed as in (8), where $\tilde{d}_{ij}$ denotes the ratings of the jth alternative related to the ith evaluation criterion.

$$D = \left[d_{ij}\right]_{n \times m} = \begin{matrix} & \begin{matrix} f_1 & f_2 & \cdots & f_m \end{matrix} \\ \begin{matrix} c_1 \\ c_2 \\ \vdots \\ c_n \end{matrix} & \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1m} \\ d_{21} & d_{22} & \cdots & d_{2m} \\ \vdots & \vdots & \cdots & \vdots \\ d_{n1} & d_{n1} & \cdots & d_{nm} \end{bmatrix} \end{matrix} \tag{8}$$

Step 2.2: The identification of the ideal (d_{ij}^*) and the worst (d_{ij}^-) values for all involved evaluation criteria $(i = 1,2, …, n)$ is delineated in Equations (9) and (10), with B representing a group of benefit-type criteria and C indicating a group of cost-type criteria.

$$d_i^* = \begin{cases} max_{j=1,…,m} \quad d_{ij}, & i \in I^B \\ min_{j=1,…,m} \quad d_{ij}, & i \in I^C \end{cases} \tag{9}$$

$$d_i^- = \begin{cases} min_{j=1,…,m} \quad d_{ij}, & i \in I^C \\ max_{j=1,…,m} \quad d_{ij}, & i \in I^B \end{cases} \tag{10}$$

Step 2.3: In order to determine a compatible index ranking, the aggregate value of the jth alternative with a maximum group majority, denoted as S_i (11), and the aggregate value of the jth alternative with a minimum individual regret, denoted as R_i (12), must be computed.

$$S_j = \sum_{i=1}^n w_i \left(\left(d_i^* - d_{ij}\right) \Big/ \left(d_i^* - d_i^-\right) \right) \tag{11}$$

$$R_j = max_{i=1,…,n} \left| w_i \left(\left(d_i^* - d_{ij}\right) \Big/ \left(d_i^* - d_i^-\right) \right) \right. \tag{12}$$

Where $S^* = min_{j=1,…,m} S_j$; $S^- = max_{j=1,…,m} S_j$; $R^* = min_{j=1,…,m} R_j$ and $R^- = max_{j=1,…,m} R_j$.

Step 2.4: Equation (22) is used to determine the Q_j based on the S_j and R_j values.

$$Q_j = v \cdot \frac{S_j - S^*}{S^- - S^*} + (1 + v) \frac{R_j - R^*}{R^- - R^*} \tag{13}$$

The value v represents the weight of the decision-making strategy, classified as follows: $v > 0.5$ indicates that majority voting is standard; $v \approx 0.5$ signifies consensus voting; and $v < 0.5$ represents voting by veto.

The alternative ranking is achieved by arranging the values S_i, R_i and Q_i in descending order, the results are three ranking lists.

The alternative with $minQ_j$ is considered the compromise solution under the following conditions:
-   Acceptable advantage: $Q(f^2) - Q(f^1)/Q(f^m) - Q(f^1) \geq \frac{1}{m-1}$, where f^2 is the second-ranked alternative based on the $minQ_j$ criterion; m denotes the total number of alternatives
-   Acceptable stability in decision making: f^1 is also the best ranked alternative with $minS_j$ and/or $minR_j$ values.

Otherwise, a set of compromise solutions is proposed, which consists of:
-   the alternatives f^1 and f^2 if only the second condition is not satisfied;
-   alternatives f^1, f^2,..., f^m if the first condition is not satisfied, f^m is determined by the relation $Q(f^m) - Q(f^1) < \frac{1}{m-1}$

The compromise alternative ranking process is based on a decision-making matrix that is outlined in Table 2. Using relations (11), (12), and (13), the values S_j, R_j and Q_j, were calculated, respectively. Indicating that the decision-making strategy is majority rule voting , the value 0.9 was employed as the v value. The findings are shown in Table 4.

Table 4: Evaluation results for individual and group deviation and measure Qj

Alternative	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9	f_{10}	f_{11}	f_{12}	f_{13}
S_j	0.255	0.257	0.294	0.240	0.146	0.255	0.354	0.163	0.115	0.074	0.067	0.235	0.265
R_j	0.247	0.247	0.286	0.208	0.127	0.112	0.345	0.149	0.092	0.054	0.045	0.225	0.240
Q_j	0.367	0.370	0.429	0.337	0.190	0.333	0.525	0.218	0.139	0.075	0.062	0.335	0.378
Rank	15	16	19	13	7	11	20	8	6	4	3	12	18
Alternative	f_{14}	f_{15}	f_{16}	f_{17}	f_{18}	f_{19}	f_{20}	f_{21}	f_{22}	f_{23}	f_{24}	f_{25}	
S_j	0.277	0.226	0.694	0.083	0.585	0.419	0.427	0.417	0.242	0.025	0.236	0.045	
R_j	0.143	0.123	0.296	0.077	0.387	0.414	0.420	0.217	0.143	0.021	0.229	0.040	
Q_j	0.370	0.296	0.969	0.092	0.846	0.629	0.641	0.578	0.323	0.000	0.337	0.032	
Rank	17	9	25	5	24	22	23	21	10	1	14	2	

The obtained results indicate that the alternative f_{23} is the best-ranked alternative in terms of the $minQ_j$ and $minS_j$ criteria, while the alternative f_{25} is the second-ranked in terms of the value R_j, whereas the best-ranked alternative according to this criterion is the alternative f_{23}. Alternative f_{23} is chosen as a compromise solution due to its superior ranking in accordance with the $minQ_j$ criterion. Furthermore, it is the alternative with an acceptable advantage, as the condition $Q(f^2) - Q(f^1)/Q(f^m) - Q(f^1) \geq \frac{1}{m-1}$ is satisfied. The selected compromise solution that has been adopted is stable in decision-making since the f_{23} is the highest-ranked alternative based on the S_j and R_j values.

CONCLUSION

In this paper, 25 production machines were considered, and the results showed that this approach is suitable for the problems of machines selection, especially for supporting group decision-making and modeling uncertainty. The analysis of the selection of the most favorable alternatives was performed by comparing two MCDM methods. The COPRAS and VIKOR methods were more suitable for the problem of selecting production machines, in the production process of a complex product, in terms of agility during the decision-making process, the number of alternatives and criteria, and adequacy in supporting the group decision of engineers in the production planning sector. Moreover, the best machine obtained by the proposed COPRAS method is the "SCHENKER", while the second-ranked "KARL HURT". In addition, the VIKOR method showed that the best machine is the "MACKERS", while the second-ranked "SCHENKER". It can be concluded that both methods favored the

"SCHENKER", which proved to be the production machine that had the greatest impact on the efficiency of the production process. The main advantages of the proposed approach are that it can be applied to production machine selection, has a simpler structure compared to the used technique, and provides a comprehensive comparative analysis for evaluating different selection approaches. The limitation of the proposed method is that the proposed model can go through multiple layers of production machine selection criteria. For future work, it can be extended to include mathematical programming in the selection problem as well as a fuzzy environment can be incorporated in MCDM approaches. Indeed, the multiple layers of criteria can also be utilized in the forthcoming work.

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LEAN TRANSFERRED – LESSONS FROM HEALTHCARE

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ABSTRACT: Healthcare systems worldwide are facing increasing challenges, including rising costs, aging populations, and growing demands for accessible, efficient, and high-quality services. In response, healthcare institutions are seeking innovative approaches to improve performance and optimize resource use. One such approach is Lean Management - originally developed in the manufacturing sector - which has gained attention for its focus on reducing waste, improving process flow, and promoting continuous improvement. Although numerous examples demonstrate the successful application of Lean in healthcare, challenges remain regarding the adaptation of its principles and tools to the complexity of public services. Questions related to staff engagement, organisational culture, and context-specific implementation still need to be addressed. This paper aims to address the potential and limitations of Lean in healthcare through a review of existing literature. It explores how Lean principles have been applied, what benefits have been observed, and what barriers hinder its wider adoption. By synthesizing key findings, the paper contributes to the ongoing discussion on improving healthcare delivery using Lean and highlights areas for further research and practical attention.

Key words: Lean, healthcare, benefits, implementation barriers

INTRODUCTION

Globally, healthcare organisations, weather public or privately owned, are facing similar problems, such as limited human and material resources, increasing cost of treatment and care, aging population, and increasing patient expectations and demands (Poksinska, 2010; Marsilio et al. 2022). These challenges put pressure on healthcare organisations to reduce costs while improve the quality of services. In response, healthcare organisations have increasingly turned to innovative approaches to quality management, among which Lean has emerged as one of the most prominent. Lean, as a holistic, customer-centred management approach that spans all levels of an organisation, aims to create more value for the customer while using fewer resources by continuously improving processes and eliminating waste. In healthcare context, Lean provides a strategic framework and environment for enhancing process flow and waste elimination, empowering staff to identify and act on improvement opportunities that might otherwise remain unnoticed (Bevan et al., 2006).

Numerous studies highlight the benefits of Lean in healthcare, in the form of reduced waiting times, improved cycle times, greater process flexibility, enhanced employee engagement, etc. (Antony et al., 2019; Leslie et al., 2006; Doss and Orr, 2007). However, despite these advantages, several unresolved issues remain, including challenges related to adapting Lean principles and tools to the healthcare context, managing the complexity of healthcare systems, and overcoming resistance to cultural and organisational change.

This paper aims to explore the transfer of Lean from manufacturing to healthcare setting, addressing the three key points – specifics of Lean in service environment, benefits of adoption of Lean and potential barriers to its implementation. This is done by conducting a review of the literature on Lean in healthcare.

LEAN AS A QUALITY MANAGEMENT STRATEGY

Developed in the Japanese industry context after World War II - mostly in Toyota Production System (TPS) - to provide a possibility for a quick reaction to changing market conditions and fluctuating customer demands, Lean was established as a systematic approach that blended the good manufacturing practices of Western and Japanese automotive industries. It combined the strong features of both mass production and craft production, such as the ability to reduce costs per unit and improve quality while at the same time providing a wider range of products (Womack et al., 1990). In time, Lean proved to be a successful system for management and optimization of processes. Today, Lean remains one of the most dominant production systems for achieving operational excellence globally, continuously evolving through integrations such as Lean Six Sigma and more recently Lean 4.0, which aligns Lean principles with Industry 4.0.

Japanese Lean practitioners categorised operational inefficiencies into three interrelated forms: *muda* (waste or non-value-added activities), *mura* (unevenness or fluctuations), and *muri* (overburden of people or equipment). These elements are mutually reinforcing and can lead to cascading inefficiencies. Within *muda*, a further distinction is made between *necessary* and *unnecessary non-value-added activities*, the latter being the primary target for elimination. Thus, process improvement efforts in Lean focus on removing non-value-adding activities and ensuring value-adding processes flow smoothly towards the customer (Imai, 2012). Ohno (1988) and Shingo (1992), foundational figures in the TPS, identified seven primary types of waste: *overproduction* – producing more or earlier than needed; *waiting* – idle time during processing or movement; *transport* – unnecessary movement of products or materials; *over-processing* – redundant or excessive processing steps; *inventory* – holding excessive materials, WIP, or finished goods; *motion* – unnecessary movement of people or equipment; and *defects* – production of faulty goods requiring rework or replacement. An eighth waste, later recognised, is the underutilisation of human talent—failing to engage employees' skills and insights in improvement efforts (Womack & Jones, 1996).

Lean can be conceptualised as operating on two levels: (1) the strategic level and (2) the operational level; the strategic level encompasses the guiding principles and goals (Lean philosophy), whereas the operational level is represented by a set of operational tools, i.e. shop-floor tools, aimed at reducing or, at best, eliminating waste in all aspects of operations (Hines et al., 2004; Hasle et al., 2012). The foundation of Lean lies in five core principles, proposed by Womack and Jones (1996), which are widely used as a roadmap for implementation:
- (Understand) *Value* - understanding and defining value (from customer point of view)
- (Identify) *Value stream* - analysing the stream of value from concept to finished product.
- (Make products) *Flow* - obtaining an uninterrupted flow of people, information, and materials through the value chain.
- (Establish) *Pull* - producing only when there is an actual demand by the customer.
- (Seek) *Perfection* - continuous improvement, striving to zero waste in the production system.

These principles constitute a critical theoretical and practical foundation for Lean thinking. They offer a systematic framework for the design, evaluation, and continuous improvement of organisational processes. Value stream analysis and flow are central for identifying inefficiencies and enhancing value creation. By thoroughly analysing the value stream, organisations can detect activities that fail to contribute to customer value and detect various forms of operational waste. The emphasis on waste elimination is operationalised through the deployment of specific Lean methodologies and tools designed to identify waste, standardise processes, and support continuous improvement. These tools

are integral to operationalizing Lean principles and include methods such as Value Stream Mapping, Kaizen, 5S, Kanban, Just-In-Time production, and Root Cause Analysis techniques While the application of these tools can vary by sector, they collectively aim to enhance process visibility, reduce inefficiencies, and foster a culture of problem-solving across all levels of the organization.

The adaptation of improvement methods from manufacturing to the service sector began in the 1970s, with the growth of services and academic interest in the distinct management challenges posed by service organisations (Seddon et al., 2011). Globalisation and ICT developments intensified competition, prompting service providers to seek efficiency through Lean thinking. However, services possess unique features - intangibility, heterogeneity, simultaneity, and perishability (the IHIP model), making direct application of Lean complex. Service-Dominant Logic (Vargo & Lusch, 2004), on the other hand, highlight value co-creation, contextuality, and active customer involvement (Osborne et al., 2015; Lusch & Vargo, 2018). Unlike manufacturing, where standardisation is effective, services often require flexibility to manage high variability and human interaction. Over-standardisation may reduce flexibility and even increase failure demand, diminishing service quality (Seddon et al., 2011).

Given the co-productive nature of services, waste can originate from both providers and customers, commonly in the form of *delays*, *duplication*, *miscommunication*, or *underused human potential*. Imai (2012) and Sarkar (2008) argue the original seven manufacturing wastes remain relevant, but scholars such as Radnor et al. (2006, 2011), Bicheno and Holweg (2009), and Bonaccorsi et al. (2011) propose tailored classifications. Key recurring wastes include *delay*, *duplication*, *unclear communication*, *incorrect inventory*, and *unnecessary movement*. These insights underscore the importance of a dual Lean approach in services: tackling both operational inefficiencies and systemic issues through staff engagement and adaptive processes.

LEAN HEALTHCARE

Specifics
Healthcare institutions may be public or private, guided by differing principles. Public healthcare prioritises societal value, equity, and accessibility, while private providers focus on efficiency and patient satisfaction to ensure profitability. Despite this divergence, both operate in complex ecosystems involving regulators, professionals, patients, and the broader public (Jaakkola et al., 2015; Hodgkinson et al., 2017). Public systems face greater demands for transparency, accountability, and inclusive service design (Osborne et al., 2013), which adds to their complexity.

A key aim of public sector reform has been to place the patient at the centre of care. However, in public healthcare, the notion of the "user" is multifaceted, encompassing taxpayers, beneficiaries, and other stakeholders. Alford (2002) distinguishes between citizens, who benefit collectively, and clients, who receive individual services. Users may also be paying customers, beneficiaries, or obligatees (e.g., those under compulsory care). Their input, through feedback and cooperation, is essential.

This calls for an inclusive, service-dominant logic that views all stakeholders as value co-creators (Osborne, 2012). In this context, Lean offers a powerful framework, as it centres on user-defined value, reduces waste, and promotes continuous improvement in service delivery.

Benefits

Lean in healthcare is more than a process improvement method - it is a philosophy that fosters problem-solving, continuous learning, and stakeholder engagement. It offers a strategic framework for improving flow and eliminating waste, empowering staff to identify and implement value-adding changes (Bevan et al., 2006). Numerous studies confirm Lean's benefits in healthcare. Leslie et al. (2006) highlight reductions in waiting times, unnecessary movements, and greater flexibility, enabling more time for direct patient care. Doss and Orr (2007) report shorter cycle times, lower inventory, and better service delivery. From the workforce perspective, Poksinska (2010) stresses that Lean fosters daily improvements by empowering staff to contribute more effectively to their roles and to broader organisational objectives.

A review by Alnajem et al. (2019) identified key outcomes such as reduced patient waiting times, improved patient flow and admissions, more functional and orderly workplaces, enhanced employee morale, cost reductions, and improved patient satisfaction. Leite et al. (2019) expand this with evidence of reduced medication waste, quicker admissions, and improved clinical and patient-centred outcomes, including increased safety and lower mortality.

These findings illustrate that Lean has the potential to improve healthcare delivery on multiple fronts - clinical, operational, and experiential, as presented in Figure 1. These benefits have been observed across various healthcare systems and contexts, suggesting that Lean can be a valuable tool for addressing the operational and strategic challenges faced by modern healthcare institutions. However, despite these promising results, the implementation of Lean in healthcare can face a range of barriers. The following section explores these barriers.

Figure 1: Detected benefits from implementation of Lean in healthcare

Possible Barriers to Implementation of Lean in Healthcare

Implementing Lean in the healthcare sector can present several challenges that may hinder its success. Healthcare systems are often characterised by complex processes, diverse stakeholder interests, and deeply rooted professional cultures, all of which can make the adoption of new management approaches a challenge. Overcoming these barriers requires strong leadership, a shared commitment to change among staff and management, and a willingness to invest time, resources, and training in the effective application of Lean principles and tools. A systematic review conducted by Melo et al. (2022) identified the most frequently cited obstacles to Lean implementation in healthcare, based on the number of studies in which each barrier was mentioned (Table 2). These barriers illustrate that Lean adoption in healthcare requires not only technical adjustments but also deep organisational and cultural change.

De Souza and Pidd (2011), based on literature review, identify key barriers to Lean implementation in healthcare to be: *perception* – related to Lean's roots in manufacturing and a limited comprehension of Lean principles; *terminology* – challenges in introduction of new terminology from Japanese background; *personal/ professional skills of health care professionals* – the intrinsic differences in personal and professional skills between health and manufacturing professionals; *organizational momentum* - the frequent changes in local improvement strategies and national government policies; *professional and functional silos (compartmentalization)* - fragmented structures inhibit cross-functional collaboration; *hierarchy and management roles* - rigid hierarchies impede communication and bottom-up engagement; *cultural challenges* related to the hierarchical structure of healthcare staff and the allocation of management roles often-present barriers to improvement initiatives.; *data collection and performance measurement* -poor-quality data and lack of relevant metrics hinder

performance tracking; and r*esistance to change/scepticism.* They find that out of these eight barriers, *perception*, *personal/ professional skills of health care professionals*, and *hierarchy and management* are unique to healthcare and the rest are shared with manufacturing.

Table 2: Ranking of most cited barriers, adapted from Melo et al. (2022).

Rank	Barriers	No. of studies
#1	Resistance to change habits and fear of the unknown.	11
#2	Low level of staff involvement and management.	6
#2	Departments work in a silo approach.	6
#2	Low level of staff training and education.	6
#3	Misunderstanding of Lean and its potential benefits.	5
#4	No firm commitment to a cultural change.	4
#4	Resistance about origins of Lean	4
#5	Fear to lose jobs or something.	3

The literature clearly demonstrates that while some barriers to Lean implementation in healthcare are shared with manufacturing - such as committed leadership, siloed structures and measurement issues - others are sector-specific. Cultural perceptions, professional autonomy, and hierarchical governance are deeply entrenched in healthcare and have to be addressed carefully. Equally important are the enabling factors: inter-professional collaboration, experiential training, and a strong foundation in quality improvement culture. Addressing these context-specific barriers and activating enablers can significantly enhance the effectiveness and sustainability of Lean initiatives in healthcare institutions.

CONCLUSION

Lean philosophy, originating from manufacturing practices, has been successfully applied to improve operational efficiency and quality in various sectors, including healthcare. This holistic approach, grounded in principles such as customer value, optimized value streams, smooth flow, pull production, and the pursuit of perfection, has demonstrated significant potential for improving operational efficiency and service quality. The extension of Lean principles to public services, marked by complex interactions and different values, demands nuanced adaptation. In healthcare, where challenges like resource limitations and rising costs persist, Lean has emerged as a valuable strategy that prioritizes patient-centricity, waste reduction, and continuous improvement. The scholarly literature acknowledges multiple benefits from a proper and successful implementation of Lean thinking, such as: reduced costs, decreased waiting times for patients, better employee morale etc., which ultimately lead to improved overall service quality.

However, the realization of these benefits largely depends on effectively addressing key barriers in Lean implementation within healthcare. These include resistance to change, low staff involvement, departmental silos, and a lack of understanding of Lean principles. Overcoming these barriers demands a commitment to cultural change, staff empowerment, and effective training on Lean. Importantly, recognizing the unique challenges in healthcare, such as hierarchical structures and data collection issues, is crucial for successful Lean implementation. In light of the barriers identified, it is evident that Lean methodology can be applied in healthcare with necessary modifications. The journey towards Lean implementation in healthcare requires an understanding of sector-specific challenges and a strategic approach to address them effectively.

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ORGANIZATION AND OPERATIONAL MANAGEMENT OF MANUFACTURING COMPANIES

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ABSTRACT

Organization and operational management are essential for the efficiency and success of manufacturing companies. In today's global world, companies must be adaptable and ready for rapid changes in the market. This paper investigates the importance of organization and operational management in manufacturing companies, focusing on the Serbian economy, as well as the basic principles of these areas in manufacturing companies in general and their importance for achieving company goals. The work deals with the research of principles and tools that help in better management processes, increasing productivity and reducing costs. Also, the paper will prove that the organizational structure and operational processes intertwine and affect the efficiency and productivity of manufacturing companies. Through the analysis of theory and case studies, important challenges are identified and strategies to address them are proposed.

Key words: organization, production systems, operational management, productivity, optimization.

INTRODUCTION

Organization and operational management play the most important role in the successful operation of manufacturing companies. In the modern turbulent business environment, which is characterized by ever-present globalization and growing competition, companies must definitely constantly improve their business processes in order to survive on the market and become competitive in the long term. Effectively and efficiently organized business production systems enable better use of available material and immaterial, primarily human resources, achieve cost reduction while increasing customer satisfaction and market needs. In doing so, it is important that operational management ensures that the set goals are implemented through precise planning and control of production processes.
The aim of this research is to:
– Identifies the basic principles of the organization of production systems.
– Analyzes the role of operational management in the optimization of production processes.
– Provide recommendations for improving efficiency and effectiveness.

The research will use a combination of qualitative and quantitative methods. Qualitative methods will include literature analysis and case studies of selected manufacturing companies, while quantitative methods included surveys and questionnaires sent to managers employed in manufacturing companies, which focused on identifying challenges and successful practices in the implementation of operational management.

THEORETICAL FRAMEWORK

In modern business, organization and operational management are key elements for the success of manufacturing companies. Operational management deals with the management of processes that produce and deliver products and services, while the organization must be structured to support the efficient functioning of these processes. According to research, the flexibility and adaptability of the organizational structure are of vital importance for success in changing market conditions (Bryson, 2020). Namely, organization in manufacturing companies means structuring resources, people and processes in order to achieve the desired goals. Key aspects

of the organization of production business systems include (Stošić Mihajlović, 2022): Hierarchical structure and delegation of responsibilities, and Design of workplaces and optimization of work flows. Some conducted studies have shown that companies with clearly defined organizational structures achieve up to 20% higher productivity (Slack et al., 2019). Precise organization enables better alignment of teams and individuals with the company's strategic goals. For example, clearly defined information flows reduce opportunities for communication errors, while process standardization enables consistency in production. In addition, companies with an organization adapted to modern market needs can react more quickly to changes in demand, which is especially important in industries with a high degree of variability. As a result, research shows that such companies not only increase productivity but also achieve a higher rate of customer satisfaction, leading to long-term sustainability and competitive advantage. In addition, proper resource allocation reduces production costs and increases system flexibility.

The organization of a manufacturing company involves designing an organizational structure that enables efficient achievement of goals. Basic organizational structures include functional, divisional and matrix structures. Each of these structures has its advantages and disadvantages, but together they strive to ensure optimal coordination and communication within the organization. According to Henry Mintzberg, the organizational structure can be viewed as a system consisting of five components: strategic top, middle management, technical base, support and ideological base. "The organization must be designed to support the company's strategy and enable its execution." (Mintzberg, 1979). The organizational structure represents the basic framework for the functioning of any organization. The choice of an appropriate organizational structure is of vital importance because it can affect the efficiency and effectiveness of the business. According to organizational theory, "organizational structure should be designed to support the organization's strategic goals" (Hill & Jones, 2022). Modern businesses often require structures that enable quick responses to market changes.

The basic principles of organizing manufacturing companies refer to (Pećanac, 2023):
1. Determining and dividing work - complex tasks into less complex jobs that will be distributed among employees,
2. Departmentalization: Dividing the organization into separate departments or units based on functions, products, geographical areas or markets,
3. Establishing a chain of command and span of control: Defining the hierarchy and responsibilities within the organization.

On the other hand, operations management deals with managing the daily activities of the company, including production, quality control and inventory management. The main goal of operations management is to ensure the efficient and effective production and delivery of products or services (Tarlak, 2016). Therefore, operations management includes planning, organizing and controlling production processes in order to ensure the efficient use of resources.

The implementation of modern operational management tools, Six Sigma and ERP systems, contributes to reducing defects in production and increasing profitability (Stevenson, 2020). The Six Sigma methodology uses statistical tools to identify and eliminate variations in processes, which directly contributes to increasing product quality and reducing waste. For example, companies that have implemented Six Sigma have recorded an average reduction in errors by 50%, which has been reflected in significant savings in operating costs.

ERP (Enterprise Resource Planning) systems integrate various functions of a company, such as production, procurement, sales and finance, enabling easier coordination and better visibility into business processes. For example, Siemens, through the implementation of an ERP system, was able to reduce the reaction time to changes in demand by 30%, thereby increasing flexibility and competitive advantage in the market.

In addition to these tools, the use of real-time monitoring systems, such as SCADA systems, allows managers to make faster decisions and manage production capacities more efficiently. These systems reduce the risk of production interruptions and enable better management of equipment maintenance, which further reduces costs and increases profitability.

Operations management is concerned with establishing, maintaining and changing the processes used to create products or provide services. It includes production planning, inventory management, quality control, materials handling and maintenance policies.

Operations management focuses on managing the daily activities of a company to ensure efficient and effective operation. This includes the management of human resources, materials, equipment and information. In manufacturing companies, operations is vital to maintaining product quality, reducing costs, and improving production management. According to Slack et al. (2020), operations management is key to transforming inputs into outputs that meet customer needs. Operations management is responsible for managing the resources that produce and deliver products and services. This includes activities such as the design process, production planning, inventory management, quality control, and equipment maintenance. According to Chase et al. (2020), "operations management is key to achieving efficiency and effectiveness in manufacturing processes." Operations managers must set up and organize business processes so that products or services are delivered on time, with the required quality, and in accordance with customer needs. "A matrix organizational structure represents a compromise between functional and divisional structures, allowing for flexibility and adaptability in complex environments" (Chase, Jacobs, & Aquilano, 2006).

In manufacturing companies, operational management aims to ensure maximum productivity and product quality. Operations management is key to the transformation of inputs into outputs, which includes the management of resources such as people, machines and materials. "Operations management is key to the transformation of inputs into outputs, which includes the management of resources such as people, machines and materials" (Heizer & Render, 2014).

Integration of Organization and Operational Management

Seen together, efficient organization and operational management of manufacturing companies play a key role and contribute to the achievement of company goals. Flexibility and the ability to adapt to market changes have been identified as the main advantages of modern manufacturing companies (Nikolić, 2007). At the same time, it is important to emphasize that a clear distribution of managerial roles and responsibilities is necessary, as a basic prerequisite for the successful functioning of the organization. Namely, the implementation of efficient organizational structures and operational strategies enables companies to more easily adapt to constant changes in the market and to achieve their business goals in turbulent economic and market conditions.

Some authors (Latin, Jevtič, Živanović, 2022) point out that management plays a key role in achieving an optimal and efficient model of a modern organization. This means that management should fulfill the following goals in its work:
– understanding the characteristics of modern organization and organizational structures,
– Examining the key factors that influence the organization of modern companies,
– study of factors that influence the organizational structure of companies in the modern environment,
– defining the factors of one's own company that must be taken into account when organizing business in a modern environment.

The integration of organization and operational management is key to achieving success in manufacturing enterprises. Successful integration of operational management and organizational structure is the key to achieving the goals of a manufacturing company. The organization must be structured to support the efficient functioning of operational processes. This includes clearly defining roles and responsibilities, as well as creating an environment that encourages innovation and process improvement. According to research on the topic of organizational processes, "determining the context of business processes is crucial for successful integration" (Kerzner, 2020).

The matrix organizational structure, which combines functional and divisional elements, enables flexibility and adaptability in complex environments. This structure supports interdisciplinary cooperation and decentralized decision-making, which is especially important in dynamic markets.

Modern manufacturing companies face numerous challenges such as changes in the market, technological advances and the need for sustainable business. Operational management must be flexible and able to adapt to these changes. The use of information technologies and process automation are just some of the ways in which the efficiency and effectiveness of operational management can be improved. According to Porter (2020), "technological advances enable manufacturing companies to improve their competitive advantages". The benefits of integrating the organization and operations management include improved flexibility, better

coordination, and decentralized decision-making. However, there are also disadvantages such as potential frustrations due to a double chain of command and the need for a high level of interpersonal skills among employees. According to Kamauff (2020), effective operational management requires well-designed systems and processes that support the company's strategic goals.

CONTROLLING AND MEASURING ACHIEVED OPERATIONAL GOALS

Controlling and measuring the achievement of operational objectives involves several key steps performed within the control function carried out by managers at the operational level. This function is critical to ensuring that the activities that the organization needs to proceed in accordance with pre-planned objectives. The most important steps in controlling and measuring the achieved goals are:
1. Defining standards - establishing standards (or goals) that will serve as reference points for comparison. These standards can be quantitative or qualitative and should be clearly defined and communicated to all employees involved in the process,
2. Performance measurement - determining the performance that is significant for achieving the organization's goals. Measurement must be carried out continuously in accordance with pre-defined measurement standards,
3. Comparison with standards - after measurement, a comparison of real performance with established standards is carried out. This comparison makes it possible to determine whether the actual performance is in line with the planned or possibly, there are deviations,
4. Taking corrective actions - in cases where it is determined that there are deviations, operational managers must take preventive and/or corrective measures, to correct errors or perceived weaknesses, as well as to ensure that activities are carried out in accordance with the predefined reference plan sizes.

Depending on the selected criteria, the control itself can be divided in several ways. One of the most prevalent types of control is strategic, tactical or operational, and technical control (Simeunović, 2015): Strategic control: its focus is on measuring the achievement of the company's development strategy. It includes the monitoring of financial indicators, market conditions and other strategic goals; Operational control: it deals with the ongoing activities of the company (such as production, quality, financial liquidity). Operational control is important for ensuring efficiency in business; Technical control: it is oriented towards controlling the technical performance of production and ensuring that the produced utility values (ie products) correspond to the desired, predetermined standards and design solutions.

CHALLENGES AND RECOMMENDATIONS IN THE ORGANIZATION AND OPERATIONAL MANAGEMENT OF PRODUCTION ENTERPRISES

Key challenges in the organization of operating companies most often relate to:
– Insufficient flexibility of production processes;
– Bad communication between individual departments or plants;
– Incomplete digitization of the process.

The lack of flexibility in production processes causes a decrease in the company's ability to respond to changes in the market. For example, according to Womack and Jones (1996), organizations that have not adopted Lean methodology face greater losses due to production downtime. "The implementation of the philosophy of Lean production is one of the most important concepts that helps companies to gain a competitive advantage in the world market. Although many companies have begun to apply the Lean concept, and the number of Lean tools, techniques and technologies available to improve operational performance is growing rapidly, only ten percent or less of companies have achieved significant results" (Stojanović, Stanisavljev, Kavalić, 2021).

For example, the company "Toyota" managed to reduce costs by 15% within two years through the application of lean principles. This strategy can also be adapted to smaller companies through employee training and process optimization. Khamidullina and Puryaev claim that in the modern world, the vast majority of companies that are world leaders in their industries actively apply the Lean production system. They point out that the Lean production system includes a large number of tools and techniques, but emphasize that the composition of the applied tools will depend on the conditions of certain company-specific goals.

In this sense, we can point out that companies that have successfully implemented the following strategies have shown a significant increase in productivity:
– Lean methodology for waste elimination in production processes.
– Application of ERP system for integration of business functions.
– Continuous education of employees.

Recommendations for promotion:
– Introduction of advanced technologies such as IoT and artificial intelligence.
– Developing a culture of continuous improvement (kaizen).
– Strengthening cooperation with suppliers and customers through transparent processes.

The application of IoT technologies can contribute to better inventory control and monitoring of production processes in real time. For example, General Electric uses IoT solutions for predictive maintenance, which has enabled them to reduce unplanned downtime by 25%.

In manufacturing companies, organization and operational management must be aligned with the company's goals. This includes the application of different organizational structures, such as a matrix structure, which allows for flexibility and interdisciplinary cooperation. However, this structure can lead to frustrations due to the double chain of command. For example, the Tesla company has implemented a flexible production line that enables rapid adaptation to changes in demand and technology. Tesla uses advanced technologies such as automation and robotics in its factories, which enables high efficiency and product quality. According to Tesla's reports, this flexibility is key to their success in the rapid production of electric vehicles and batteries. Another example is the Toyota company, which has developed a Just-in-Time (JIT) production system, which enables the minimization of inventories and the maximization of production efficiency. This approach allowed Toyota to become one of the leading car manufacturers in the world. According to Toyota's documents, the JIT system is based on the principle of producing only what is needed, when it is needed, which reduces costs and improves quality. For the purposes of this paper, we selected three manufacturing companies in Serbia and analyzed their organization and operational management.
1. Copper and aluminum rolling mill in Sevojno - one of the most important producers of copper and aluminum in Serbia. This company managed to survive difficult economic conditions and today is one of the most stable manufacturing companies in the country. The company has a clearly defined organizational structure with appropriate departments for production, quality control and sales. A hierarchy has been established that enables efficient functioning. Operational management focuses on continuous improvement of production and quality control. The company uses modern technologies for production and has a well-developed inventory management system.
2. Ironworks in Smederevo - one of the largest steel producers in Serbia. This company has gone through numerous challenges, but managed to maintain itself as an important player in the market. The ironworks has a complex organizational structure with numerous departments dealing with various aspects of production and management. There is a clear distribution of roles and responsibilities among employees. Operational management in Železari focuses on efficient steel production and resource management. The company uses modern technologies to improve production and reduce costs.
3. Sojaprotein Bečej - the leading producer of soy products in Serbia. This company is known for the high quality of its products and efficient management. The company has a well-organized structure with clearly defined roles and responsibilities. There is a strong focus on innovation and new product development. Operational management at Sojaprotein deals with production improvement and quality control. The company uses modern technologies for production and has a well-developed inventory management system.

CONCLUSION

Organization and operational management in manufacturing companies must be aligned in order to achieve maximum success. The organizational structure should support the efficient functioning of operational processes, while the operational management must be flexible and able to adapt to changes in the market. Through continuous process improvement and investment in technology, manufacturing companies can realize competitive advantages and achieve long-term success. In modern manufacturing companies, success depends

on the effective integration of organization and operational management. Understanding organizational structures and operational processes enables businesses to adapt to changes in the market and maintain competition. Through the application of a matrix organizational structure and the improvement of operational management, companies can achieve high productivity and product quality. Research has shown that organization and operational management have a decisive influence on the success of manufacturing companies.

Creativity and corporate culture are essential elements that can improve operational management in manufacturing companies. Implementing these elements can help companies achieve better results and adapt more easily to changes in the market. The combination of creativity and corporate culture can be crucial for achieving better efficiency in manufacturing companies. Implementing these elements can help companies achieve better results and adapt more easily to changes in the market. Controlling and measuring the achieved operational goals is essential for the success of the organization. The implementation of these steps enables the activities to take place in accordance with the planned goals and to undertake the necessary corrective actions in case of deviations. Organization and operational management are necessary for the successful operation of manufacturing companies. Focus on continuous improvement and implementation of modern technologies enables better results and long-term competitive advantage. Future research should be focused on the impact of digital transformation on the efficiency of operational processes.

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BARRIERS TO THE IMPLEMENTATION OF QUALITY 4.0: THE CASE OF THE REPUBLIC OF SERBIA

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ABSTRACT

Through the implementation of Quality 4.0, numerous benefits can be achieved, ranging from cost optimization and improved efficiency of production processes to enhanced product and service quality, increased supply chain flexibility, and more. However, the implementation of Quality 4.0 is a long-term, highly complex, and costly endeavor. The barriers that companies face during this process include limited material and technical resources, insufficient knowledge and skills among managers, unfavorable characteristics of organizational culture, among others. The purpose of this paper is to identify the most influential barriers to the implementation of Quality 4.0, as perceived by quality professionals operating within the territory of the Republic of Serbia. The aim is to offer insight into the practical expectations of the business environment and highlight the challenges that are considered the most significant in this region when it comes to the implementation of Quality 4.0. The research included 184 companies of various sizes and industries. The requirement for participation was a valid ISO 9001:2015 quality certification. The sample represents 5% of the total number of certified companies in the Republic of Serbia, which is deemed satisfactory for this type of research.

Key words: Barriers, Implementation, Quality 4.0, Republic of Serbia

INTRODUCTION

The application of modern technologies in the service of quality management is the simplest definition of Quality 4.0. However, the implementation of Quality 4.0 is highly complex and comprehensive. Companies often face a wide range of barriers when introducing this concept, and in many cases, the process is abandoned even before it begins due to discouragement or fear of failure. For this reason, it is essential to expand knowledge about the challenges companies may encounter, to explore potential solutions for overcoming these barriers, and to share ideas that can contribute to greater efficiency in the implementation of Quality 4.0.

The aim of this paper is to present the specific barriers that hinder companies in the Republic of Serbia from implementing Quality 4.0. By identifying the most influential challenges in this regional context, it becomes possible to provide a foundation for strategically planning the transformation of quality management systems within organizations. For this reason, insights gained from the research findings may have practical value. Understanding these barriers enables companies to critically assess their current state and consider effective ways to overcome the obstacles in the path toward successful implementation.

The research was conducted as part of a doctoral dissertation focused on the readiness of companies in the Republic of Serbia to implement Quality 4.0 (Tadić Stanić, 2025). Participants in the study were companies holding a valid ISO 9001:2015 quality certification. The respondents were professionals with relevant roles in the field of quality (including directors, engineers, and quality managers), to ensure a representative overview of the obstacles faced by companies in the country. A total of 184 companies participated in the study, representing 5% of all ISO 9001:2015 certified companies in the Republic of Serbia (ISO, 2022).

The structure of this paper, in addition to the introductory section, includes an overview of the importance and relevance of Quality 4.0, as well as the benefits that companies may achieve through its implementation. This is followed by a presentation of the barriers to implementing Quality 4.0 encountered by other companies, as identified in previous studies. The paper then provides an insight into the five most influential obstacles to the adoption of Quality 4.0 in the Republic of Serbia. The final section includes the conclusion and references.

SIGNIFICANCE AND BENEFITS OF IMPLEMENTING QUALITY 4.0

The benefits of implementing Quality 4.0 are numerous, highlighting the significance of adopting this concept. For some authors, three key advantages of Quality 4.0 are cost optimization, shorter production times, and improvements in the quality of products and services (Liu et al., 2023). In addition to this set, other authors have added the use of reliable information derived from Big Data (Sony et al., 2021), the minimization of discrepancies, and supply chain flexibility (Antony et al., 2023). A third group of authors (Arsovski, 2019) emphasizes the benefits of Quality 4.0 in decision-making speed and quality, more efficient traceability and transparency in production, the ability to predict changes, and faster adaptation to new situations.

Technological data collection is carried out efficiently and comprehensively (Illés et al., 2017), regardless of volume, ensuring security in making optimal decisions. The usefulness of technologies in processing incomplete and uncertain data is particularly emphasized. Furthermore, its application also finds purpose in clarifying customer needs and finding appropriate responses to their demands. The speed of data processing enables real-time quality management, which represents one of the key differences between Quality 4.0 and traditional quality management.

Personalization is one of the key characteristics of Quality 4.0, which involves mass customization for customers by creating products and services tailored to their individual preferences. The role of collected data related to production personalization is particularly significant, as advanced software can predict future market demand. Additionally, personalized production is considered strategically important, as, when viewed in the long term, it can influence customer loyalty (Haleem & Javaid, 2019).

Based on the application of analytics, it is possible to predict deviations in quality, machine downtimes, the occurrence of defective products, and so on, allowing for preventive actions to avoid such issues. In this way, resource and energy wastage is reduced, and savings are generated through better product alignment, as well as a reduction in costs due to fewer errors, scrap, and waste. Thus, the advantage is not only reflected in making timely decisions but also in the availability of information regarding the potential for errors to occur. For this reason, it is said that Quality 4.0 is based on prediction.

According to Maganga and Taifa (2022), Quality 4.0 represents a significant improvement in the quality inspection process, achieved through automatic quality monitoring. This involves real-time monitoring of the production flow, the application of intelligent quality controls, and comprehensive inspections, as well as the use of systems designed for predicting failures (Christou et al., 2022), digitizing results, and integrating them with the entire production system (Zulfiqar et al., 2023). These advancements enhance the performance and effectiveness of quality management (Sader et al., 2022); production processes are shorter, product alignment is improved, and customer satisfaction is increased (Liu et al., 2023). For this reason, it is believed that the application of modern technology in quality management can ensure guaranteed quality in production, without deviations (Balouei Jamkhaneh et al., 2022).

Revolutionary technological capabilities, in addition to enhancing quality management methods, also promote human capabilities (Dias et al., 2022). The intellectual and creative power of humans, combined with advanced technologies whose capabilities reach extraordinary levels, can ensure personalized products and services with high alignment and minimal waste. This approach to quality management opens numerous opportunities for individuals to engage in more innovative forms of work, which will increase their job satisfaction and contribute to the growing significance of their role as employees.

It is considered that the foundation of Quality 4.0 lies in the integration of people, technologies, and processes (Santos et al., 2021; Tadić Stanić, 2025), which provides production units with a new dimension of operation that can be referred to as modern business functioning. Processes related to quality management are smart, automatically performed, self-controlled, carry out inspection supervision, and are integrated with humans through digitalization. Based on this, the significance and advantages of Quality 4.0, achieved through its implementation, can be clearly seen.

IDENTIFIED BARRIERS TO THE IMPLEMENTATION OF QUALITY 4.0

An essential barrier to the implementation of Quality 4.0 is the lack of awareness and knowledge of the concept itself, as well as the skills needed to implement this concept within the company (Chiarini, 2020; Tadić et al., 2021). The role of leadership and management support is crucial in encouraging other employees to adopt a new approach to quality management. The success of integrating the Quality 4.0 concept with the corporate strategy and objectives of the company depends on the management team. In case there is resistance to change, the leadership must take actions to explain to employees why the introduction of Quality 4.0 is necessary, what benefits and advantages the company will gain if the implementation is successful, what tasks the employees will have, what their future role in the company will be, what they can expect during the implementation, and how this will affect them. However, if the management lacks the knowledge, will, or desire to transition from traditional to modern quality management, it can be said that this represents an insurmountable obstacle until the situation changes.

In line with the above, if the company's leadership does not possess a compelling leadership style, if it does not actively promote transformation and change, and fails to create a collective vision, inaction of this kind will constitute an obstacle to establishing optimal communication with employees and motivating them to engage in the upcoming challenge of implementing Quality 4.0.

Characteristics of organizational culture can also pose a significant obstacle to the successful implementation of Quality 4.0 (Sony et al., 2021; Tadić et al., 2021). If a hierarchical management style is cultivated within the company and the execution of established procedures is preferred, there is a higher likelihood of resistance to change. Employee skepticism towards the successful functioning of digital transformation can significantly slow down or even prevent the application of new systems. Fear of job loss or insecurity about one's own competencies can also result in resistance to change. In companies where teamwork, transparent communication, and continuous learning are not encouraged, managers, despite their knowledge, strong desire, and will implement Quality 4.0, will face a difficult-to-overcome obstacle.

The lack of financial resources, in terms of high initial investments (Antony et al., 2023; Chiarini, 2020; Sony et al., 2021; Tadić et al., 2021), is also one of the major obstacles to the implementation of Quality 4.0. The acquisition of modern technology, software solutions, data analysis and storage systems, as well as the integration of the existing system with all the, presents a significant challenge, especially for small and medium-sized enterprises. Additionally, part of the funds is necessary for investing in employee training. It is crucial for employees to understand the essence of the new work approach, to acquire the appropriate knowledge and skills to manage modern technologies, and to apply enhanced quality management tools in accordance with technological capabilities, among other things. However, if a company does not have the resources to establish and implement them, there is a high likelihood that the implementation of Quality 4.0 will not even take place.

In addition to the, an unreliable internet connection can also pose an obstacle (Chiarini, 2020). In regions where digital infrastructure is underdeveloped, the implementation of Quality 4.0 can be significantly hindered. A stable and fast internet connection is a fundamental prerequisite for the operation of modern systems and their integration. If a company is unable to provide this, achieving technological transformation will not be possible.

Furthermore, countries and regions that fail to keep up with the pace of technological development often have restrictive legal regulations, which can present significant challenges for businesses to overcome. These legal frameworks may relate to data protection, access to information, accountability, and standards in the digital environment, among other aspects.

In line with the, one of the obstacles is certainly cyber threats (Chiarini, 2020). Data protection is crucial for any business. However, with the increase in digitalization, the risk of cyberattacks also grows. Unauthorized access to critical data and assets on one hand, and an underdeveloped security policy and strategy on the other, can significantly influence the perception of whether a company is ready for the implementation of Quality 4.0.

In accordance with the above, one of the obstacles is certainly cyber threats (Chiarini, 2020). Data protection is of crucial importance for any company. However, with the rise of digitalization, the risk of cyberattacks increases. Unauthorized access to critical data and assets on one hand, and an underdeveloped security policy and strategy on the other, can significantly influence the perception of whether a company is ready for the implementation of Quality 4.0.

BARRIERS TO THE IMPLEMENTATION OF QUALITY 4.0 IN THE REPUBLIC OF SERBIA

As part of a study examining the readiness of companies in the Republic of Serbia to implement Quality 4.0, respondents were asked to identify the barriers to its implementation. Out of 184 companies that participated in the research (one respondent per company), 60 respondents answered this question. Of these, 40 responses (22%) were deemed acceptable and relevant. The collected responses were grouped thematically and sorted by frequency of occurrence. The five most mentioned answers represent the most influential barriers to the implementation of Quality 4.0 in this country (Figure 1).
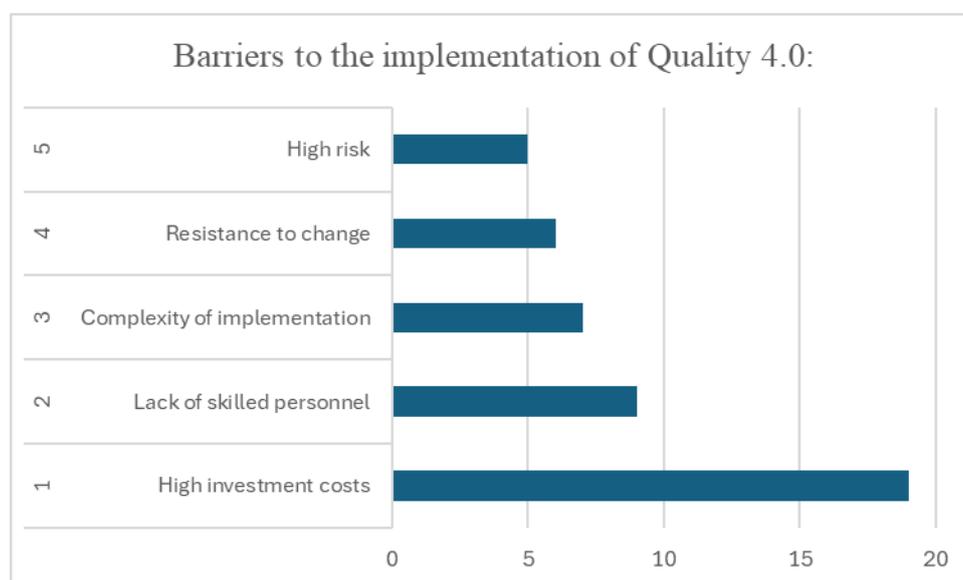
Figure 1: The Most Influential Barriers to the Implementation of Quality 4.0

The most frequent response indicated high investment costs as a barrier to the implementation of Quality 4.0. The entire transformation process, including the acquisition of modern technologies, their establishment, and training employees to use them optimally, integrating the acquired technology with the existing system, the time required for a complete transformation, production stoppages due to changes and implementation of modern equipment, etc., are just some of the factors that cannot be realized without financial support.

In addition to recognizing that high costs are a significant challenge for the successful implementation of Quality 4.0, the respondents also identified the lack of qualified personnel to carry out this

transformation. The participants in this study were in managerial positions related to quality. The indication that they lack sufficient knowledge about the concept of Quality 4.0 and need assistance from an external expert speaks volumes about their readiness for such a change.

The third most significant barrier identified was the complexity of implementation. The fact that the company lacks sufficient resources for implementation, as well as an adequate team of people to lead the changes, creates a certain degree of reluctance to engage in a challenge that they seemingly feel unprepared for.

In accordance with the previous, resistance to change arises. These changes should not be viewed solely from a technical perspective, as they may also point to characteristics of organizational culture and mindset. Doubt, fear of the unknown, and resistance to anything that does not follow the established routine can seriously undermine the success of implementing Quality 4.0.

Finally, all the points indicate that the implementation of Quality 4.0 is a significant risk. The failure of implementation of wasted resources, data loss, and the failure to establish optimal collaboration with employees are just some of the risks that could arise and which these companies fear.

CONCLUSION

In addition to the numerous advantages that can be achieved through the implementation of Quality 4.0, there are many barriers that companies must overcome. In the Republic of Serbia, the greatest challenge is the initial investment, i.e., the establishment of an automated-integrated system. Apart from the costs associated with purchasing advanced technology, there are also costs related to the complex implementation, employee training, and other factors. In addition to the awareness that they cannot easily approach transformation (financially), the lack of expert personnel is the next obstacle that companies face. The insufficient knowledge of the Quality 4.0 concept, as well as the lack of relevant positive experiences with implementation, significantly influence the belief that the presence of external experts is necessary for this undertaking. The third most frequently mentioned barrier was the complexity of implementation. Everything unfamiliar appears difficult and unfathomable, and accordingly, the implementation of Quality 4.0 seems like a challenging and demanding project. Resistance to change was the next most important obstacle. In line with the previously mentioned, employees' resistance to embracing change seems expected. Finally, the last identified obstacle, though no less important, was the risk. From the perspective of the respondents, the implementation of Quality 4.0 is very costly, and they lack enough qualified and trained personnel who could lead the implementation. Furthermore, the process itself is complex, and employees will resist change. Ultimately, it seems like a great risk under such conditions to undertake such a challenge.

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ENHANCING GAS TRANSPORT EFFICIENCY THROUGH THE INSTALLATION OF THE THREE-STAGE COMPRESSOR UNIT RAM 54

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ABSTRACT

This paper presents a comprehensive analysis of enhancing gas transport efficiency in high-pressure pipeline systems through the integration of the RAM 54 three-stage reciprocating compressor unit. The study outlines the selection process and operational modeling of the compressor using GE Power Flow simulation software, which enables detailed analysis based on gas composition, operating pressures, flow rates, and energy requirements. Key technical parameters of the RAM 54 unit are defined, including suction/discharge pressure ranges and maximum flow capacity. The compressor's modular design, high durability, and accessibility for maintenance contribute significantly to operational reliability and cost-effectiveness. Simulation results validate the unit's performance under varying conditions, highlighting its adaptability and efficiency gains in real-world applications. The implementation of the RAM 54 compressor ultimately enhances gas delivery stability and supports the sustainable development of gas infrastructure systems.

Key words: Compressor station, GE Power Flow, performance analysis, optimization, energy efficiency, gas pressure, simulation

INTRODUCTION

To ensure the efficient delivery of gas to the refinery, it is necessary to increase its pressure, which is achieved through the use of compressor stations [Brown, 2018]. The reliable and continuous operation of these stations is essential for preventing production interruptions and avoiding potential losses caused by compressor shutdowns [Smith and Taylor, 2020].

Compressor stations, which are integral components of gas gathering and dispatch systems, enable the compression of gas for further distribution [Klett, 2019]. Modern container-type compressors are increasingly replacing earlier models due to their smaller footprint, ease of maintenance, and the ability to quickly and efficiently replace parts in the event of a malfunction [Mokhatab, et al., 2019]. Their implementation contributes to higher operational efficiency and reduced exploitation costs [Dempsey, 2019].

Stable pipeline operation requires maintaining a constant gas pressure at the intake, which in turn demands the autonomous operation of compressor units [Dixon and Hall 2017]. Next-generation compressors are designed to minimize the need for manual supervision, leaving operators responsible

primarily for setting operational parameters, checking working fluids, and performing visual and acoustic system inspections [Kreith and Goswami, 2021].

In the event of a compressor unit failure, gas dispatch to the refinery may decrease, while the unused gas may be flared or redirected to another compressor station [GE Power Flow Technical Report, 2022]. To prevent such occurrences, proper compressor management and the implementation of preventive maintenance are essential [American Petroleum Institute, 2021]. By analyzing data on potential defects and utilizing established fault trees, system vulnerabilities can be identified in a timely manner, allowing for the implementation of corrective measures.

Container-type compressors are designed to operate under demanding conditions and are adaptable for compressing gases of varying compositions. Their service life is not limited, provided that proper maintenance is conducted. The advantages of these compressors are numerous, and a more detailed analysis of their characteristics and benefits is presented in the following sections.

MATERIALS AND METHODS

RAM 54 Compressor Unit

This study focuses on improving the efficiency and safety of gas transportation through the main gas pipeline. The planned enhancement is to be achieved by installing a three-stage reciprocating compressor unit at a location where two identical units have already been deployed. To enhance the efficiency and safety of gas transport in the main pipeline, the installation of a new container-type, three-stage compressor unit, RAM 54, has been proposed. The RAM 54 compressor (Figure 1) is designed for continuous and reliable operation under demanding conditions, with minimal likelihood of failure. Its construction ensures durability at high speeds and pressures, while all key wear components are easily accessible, thereby reducing downtime during both regular maintenance and unforeseen breakdowns [General Electric, 2018].

Figure 1: RAM 54 Compressor Unit

RAM 54 compressors are most commonly used in the oil industry but are also applied in cogeneration and electric power generation systems [General Electric, 2018].

PID Diagram of the RAM 54 Compressor

The PID (Piping and Instrumentation Diagram) of the RAM 54 compressor provides a schematic representation of all key system components, including pipelines, valves, sensors, and control instruments. This diagram offers a detailed insight into the compressor's operation, pressure and temperature regulation, as well as the flow of the process through different stages of compression.

The RAM 54 compressor is a three-stage reciprocating compressor, meaning the compression process is carried out in three successive stages, during which the gas pressure is gradually increased before being delivered into the gas pipeline.

The RAM 54 compressor PID diagram enables operators and engineers to more easily monitor and optimize system performance, promptly identify potential issues, and carry out preventive maintenance.
The RAM 54 is a three-stage reciprocating compressor, as illustrated in the diagram (Figure 2).
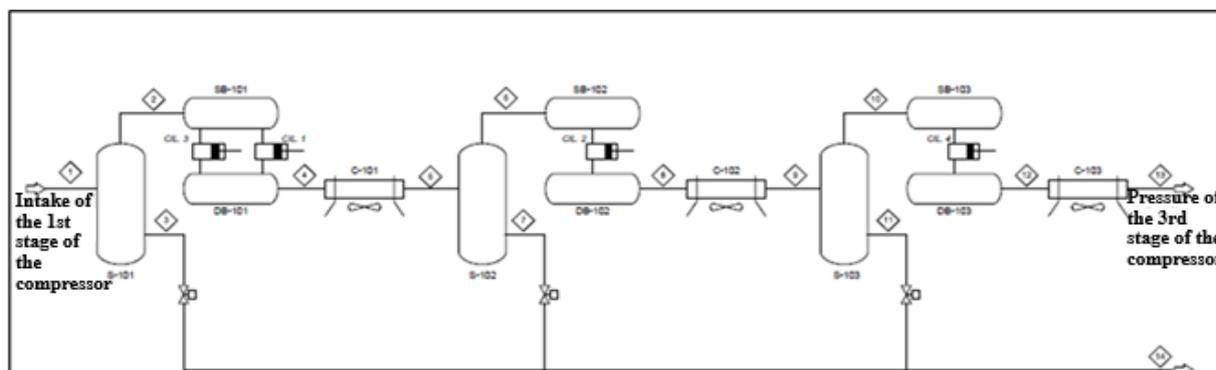

Figure 2: PID Diagram of the RAM 54 Compressor [General Electric, 2018].

Operating Parameters of the Compressor Unit

The new three-stage reciprocating gas compressor is designed with the following operational parameters:
−   Suction pressure of process gas is 2–3 barg, discharge pressure of process gas is 42–50 barg, maximum gas flow rate is 180,000 Sm³/day
−   The compressor is powered by a gas engine that uses fuel gas of the same composition as the process gas. The characteristics of the fuel gas are:pressure 25–30 barg, temperature 25–55 °C.
−   In addition to the main gas compressor, the system includes an air compressor. This air compressor serves to initiate the operation of the three-stage compressor and to supply instrument air. Its operating characteristics are: suction pressure is equal to atmospheric pressure, operating pressure 8–11 barg, maximum flow rate 630 Sm³/day.
−   Compressed air is used for starting the compressor's gas engine and as instrument air for the compressor units. The air compressor is driven by an electric motor.
−   The process gas, which also serves as the fuel for the compressor's drive engine, has an identical composition and physico-chemical properties. Molar Composition of the Gas: Methane 83.39%, Ethane 5.62%, Propane 2.78%, i-Butane0.99%, n-Butane 1.08%, i-Pentane 0.48%, n-Pentane 0.44%, Hexane   0.82%, Nitrogen 2.50%, Carbon Dioxide 1.90%
−   Physico-chemical properties of the gas: molecular weight 20.4 kg/kmol, density 0.8661 kg/Sm³, lower heating value 39,175 kJ/Sm³.
−   Due to variations in gas production from different reservoirs, fluctuations in the gas composition and its physical properties of up to ±2% are possible. Additionally, the gas entering the compressor is fully saturated with moisture.

Based on the defined operating parameters—such as suction and discharge pressures, gas properties, and temperature—the compressor unit is modeled and its performance is calculated. Following the modeling, key compressor components are selected, including the housing type, cylinders, pistons, valves, and the corresponding drive motor.

Most reputable compressor manufacturers utilize specialized software for computer-based design and performance calculation of compressor units, which ensures precise sizing and system optimization. In

this study, the GE Power Flow software was employed for the design and modeling of the RAM 54 three-stage reciprocating compressor (Figure 3).

The PID diagram, generated using specialized software, allows for tracking fluid flow through the compressor system and serves as a foundational document for the manufacturing of the compressor.
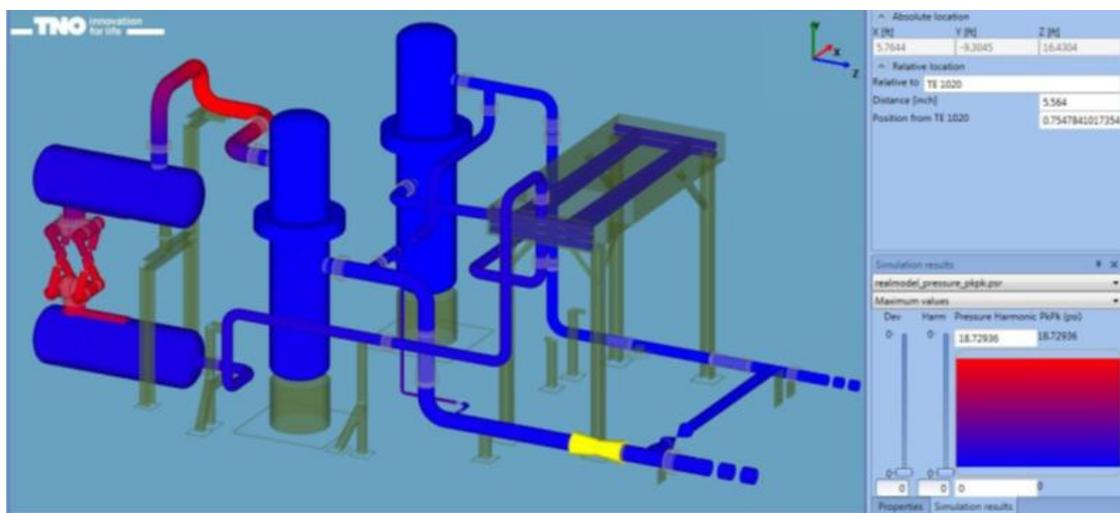

Figure 3: Load Model of the Compressor Unit [Trifunović, 2022]

RESULTS AND DISCUSSION

Functional Verification of the RAM 54 Compressor Unit Using GE Power Flow Software

To evaluate the proper functioning of the compressor under specified operating conditions, a software simulation is conducted using the GE Power Flow program. This software allows for the input of gas parameters, including its chemical composition, while enabling the user to select a compressor model from a database of available manufacturers. Once the compressor assembly is defined, a suitable electric motor is selected. If the selected combination is incompatible, the software will indicate an error—one common issue being shaft overload. Since electric motors vary in power ratings, it is essential to select an optimal configuration to avoid unnecessary system oversizing and increased costs.

Before initiating the compressor design process, it is necessary to define the parameters of the gas to be compressed, as well as that used as the energy source. During gas selection, the software provides standard values for commonly used gases, enabling the design of the compressor based on predefined data. Since most exploited gases exhibit similar chemical compositions, such calculations can serve as a reference basis for further design work [Obrenović, 2018].

One of the key parameters entered into the software is the specific gas density. For the gas compressed using the RAM 54 compressor, the specific density is 0.8661 kg/Sm³, which differs significantly from the natural gas often used as a reference. Specifically, the specific density of natural gas in its gaseous state is 0.7 kg/m³, and in its liquid state 0.4 kg/m³ [Obrenović, 2018]. The process of entering the gas composition—i.e., the individual components and their relative proportions—is illustrated in Figure 4.

Accurate definition of gas composition is of great importance in compressor design, as the presence of impurities in the fuel gas can induce pulsations during operation. The intensity of these pulsations is directly related to the amount of contaminants, which can negatively impact compressor performance (Obrenović, 2018).
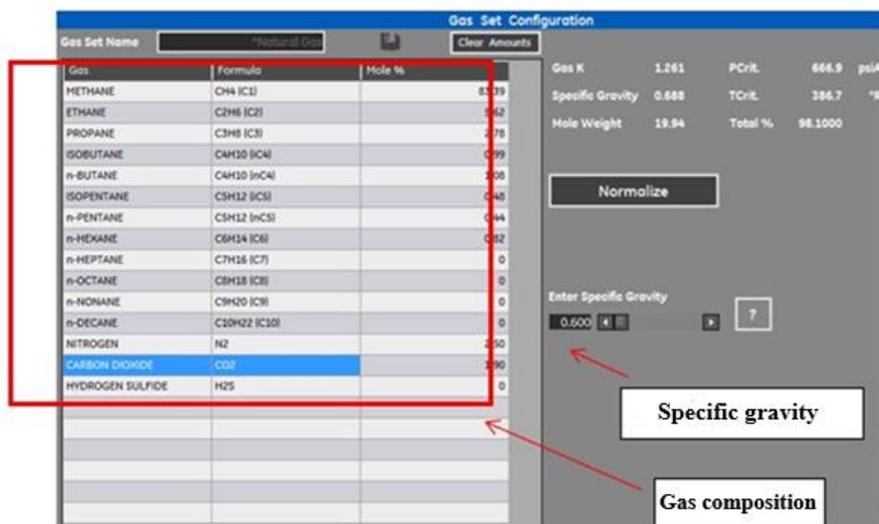
Figure 4: Input of Gas Parameters [Trifunović, 2022]

The selection of the appropriate compressor frame, along with all relevant characteristics, is shown in Figure 5. When choosing the compressor model, its nominal power and rotational speed are specified. In addition, further technical data are displayed, including the number of cylinders, which is a critical factor for the efficiency and operational stability of the unit (Obrenović, 2018).
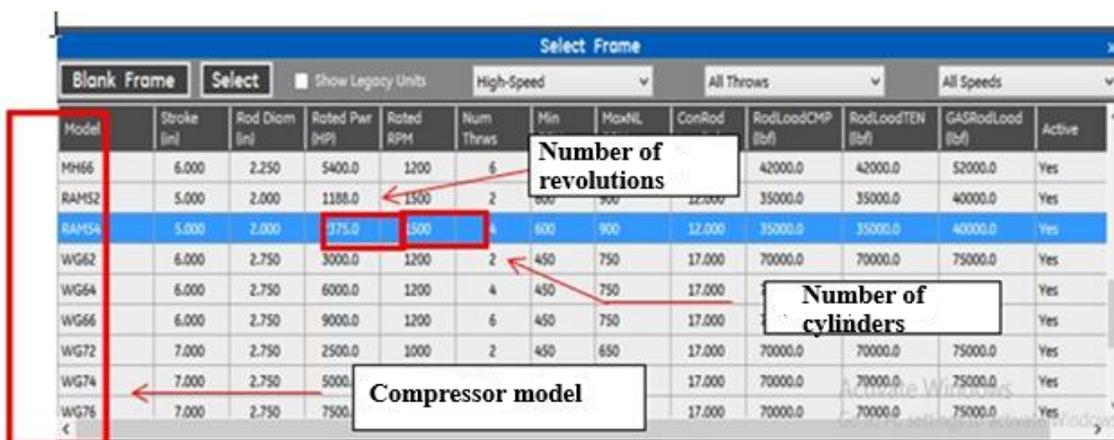
Figure 5: Display of Compressor Model Selection [Trifunović, 2022]

During cylinder selection, it is essential to avoid oversizing. Subsequently, the appropriate compression ratio for each cylinder is defined, along with the inlet and outlet pressures for each stage. The overall inlet and outlet pressures for the compressor are also specified (Figure 6).

During the compressor design process, attention must be paid to the compression ratio (C), which not exceed a value of 4. For example, for C = 2:
– 1st cylinder – inlet: 3, outlet: 6
– 2nd cylinder – inlet: 6, outlet: 12
– 3rd cylinder – inlet: 12, outlet: 24
– 4th cylinder – inlet: 24, outlet: 48

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Figure 6: Input of Inlet and Outlet Gas Parameters

Once all parameters have been entered, the next step is the selection of the drive system. When selecting the gas engine, it is crucial to account for the minimum and maximum power requirements of the compressor. These values can only be determined after the compressor design process is completed. The selection procedure for the gas engine is shown in Figure 7.

Figure 7: Selection of Gas Engine

CONCLUSION

The installation of the RAM 54 three-stage reciprocating compressor unit in the gas transmission system has proven to be a highly effective solution for enhancing transport efficiency, operational reliability, and system sustainability. Through detailed analysis of the compressor's mechanical design, operating parameters, and instrumentation layout, as well as simulation using GE Power Flow software, the study demonstrates that the proposed configuration meets the performance requirements of modern gas pipeline networks.

Precise modeling of gas composition, thermodynamic properties, and compression stages enabled the optimal selection of compressor components—including the housing, cylinders, valves, and drive motor—while also allowing prediction of system behavior under various process conditions. The

modular and maintainable design of the RAM 54 ensures reduced downtime, extended service life, and improved safety during both planned and unplanned interventions.

Simulation results confirm the compressor's ability to operate stably across a wide range of pressures and flow rates, providing valuable insight for preventive maintenance strategies and long-term infrastructure planning. The integration of the RAM 54 unit ultimately supports higher energy efficiency and greater adaptability of gas transport systems to dynamic operational demands.

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REVERSE LOGISTICS AS A STRATEGIC TOOL FOR COMPETITIVE ADVANTAGE IN MANUFACTURING

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ABSTRACT

This paper explores reverse logistics as a strategic instrument for achieving competitive advantage in the manufacturing sector. Rather than viewing reverse logistics solely as a cost recovery mechanism, the study positions it as a multidimensional capability embedded within strategic, operational, technological, and sustainability domains. A conceptual model is developed to illustrate how reverse logistics contributes to competitiveness through four interlinked pillars: strategic integration, operational optimization, digital innovation, and sustainability-oriented value communication. Each pillar is supported by critical sub-elements that enhance the effectiveness and impact of reverse logistics systems. The model emphasizes dynamic interactions, including feedback loops, that support continuous improvement and adaptive decision-making. Reverse logistics is shown to generate value through resource efficiency, enhanced customer relationships, regulatory compliance, and brand differentiation. The findings highlight the potential of reverse logistics to serve as a foundation for circular manufacturing practices and to support resilience in complex supply chain environments.

Key words: Reverse logistics, Competitive advantage, Circular economy, Digital supply chain

INTRODUCTION 1 [FONT NAME TIMES NEW ROMAN, SIZE 11, BOLD, ALL CAPS]

In an increasingly dynamic and resource-conscious industrial landscape, reverse logistics has emerged as a strategic instrument for enhancing competitiveness within manufacturing sectors. Far from being a peripheral operational concern, reverse logistics has become an integral component of value creation strategies, particularly in environments where efficiency, sustainability, and customer satisfaction determine long-term viability(Mishra et al. 2023). Its evolution reflects broader shifts in manufacturing priorities, including the need for lifecycle thinking, circular economy integration, and responsiveness to complex market and environmental demands. As manufacturers strive to maintain a competitive edge, the ability to effectively manage product returns, waste flows, and end-of-life asset recovery plays a pivotal role in shaping performance outcomes across financial, operational, and reputational dimensions.

The strategic potential of reverse logistics is rooted in its capacity to influence core aspects of manufacturing operations. Rather than functioning solely as a cost center, reverse logistics enables firms to recapture value from returned or obsolete goods through remanufacturing, refurbishment, recycling, and parts harvesting(Che Hassan and Osman 2025). These activities allow companies to reduce raw material dependencies, optimize inventory turnover, and lower disposal costs, all while generating secondary

revenue streams. Additionally, manufacturers can mitigate supply chain disruptions by utilizing recovered components as buffer stock or reintroducing them into production(Salas-Navarro et al. 2024). This creates a closed-loop flow that enhances resource efficiency and operational resilience. In industries such as electronics, automotive, and textiles, where return rates and material complexity are high, strategic reverse logistics becomes an essential capability for maintaining profitability and compliance.

Value recovery, however, does not occur in isolation. It depends on the effective integration of reverse logistics with broader manufacturing systems and technologies. As digitalization reshapes industrial processes, reverse logistics is increasingly supported by real-time tracking systems, automated inventory control, and predictive analytics(Banihashemi, Fei, and Chen 2019). These tools enable better visibility into return flows, improved diagnostics of product failures, and faster turnaround times in repair or remanufacturing cycles. Moreover, lean manufacturing principles—traditionally applied to streamline forward flows—can be extended to reverse processes to minimize waste, reduce cycle time, and standardize reprocessing routines. The convergence of lean and digital approaches supports a more agile and transparent reverse logistics network, facilitating rapid decision-making and continuous improvement(Alejandro-Chable et al. 2024). This integration not only boosts efficiency but also strengthens interdepartmental coordination, particularly between production, procurement, and after-sales service functions.

Beyond operational and financial considerations, reverse logistics also plays a significant role in advancing corporate sustainability objectives and brand positioning. Regulatory frameworks such as the Waste Electrical and Electronic Equipment (WEEE) directive, Restriction of Hazardous Substances (RoHS), and emerging ESG reporting standards have increased the pressure on manufacturers to manage their reverse flows responsibly(Ahi and Searcy 2013). Compliance alone, however, is no longer sufficient to meet stakeholder expectations. Consumers, investors, and business partners increasingly evaluate companies based on their environmental impact and transparency. Reverse logistics practices that support take-back programs, recycling partnerships, and reduced landfill disposal demonstrate a manufacturer's commitment to sustainability. These practices can differentiate a brand in crowded markets, attract eco-conscious customers, and open access to sustainability-linked financing mechanisms (Zhuravleva and Aminoff 2021).Strategic reverse logistics contributes to competitive advantage not only through internal optimization but also through its external signaling value(Singh 2022).

STRATEGIC ORIENTATION AND VALUE RECOVERY IN REVERSE LOGISTICS

Reverse logistics has increasingly gained recognition as a key strategic dimension in manufacturing, moving beyond its traditional role as a corrective or reactive function. Historically perceived as a cost burden associated with product returns and waste management, reverse logistics now occupies a more proactive position within strategic planning frameworks.(Afum, Agyabeng-Mensah, and Baah 2024) As market dynamics grow more complex and consumers demand greater transparency and environmental responsibility, manufacturers are compelled to rethink the boundaries of logistics. This shift has led to the integration of reverse flows into mainstream manufacturing strategies, where they contribute to enhancing customer satisfaction, improving resource efficiency, and creating differentiation in competitive environments.

The strategic value of reverse logistics is grounded in its ability to align operational activities with broader business goals. Rather than treating returned products, surplus stock, or end-of-life materials as liabilities, manufacturers increasingly view them as opportunities for value creation and system optimization. Reverse logistics enables firms to shorten feedback loops between the market and production systems(Govindan and Hasanagic 2018). It offers timely insights into product performance, failure modes, and customer behavior, which can inform design improvements, quality control, and forecasting accuracy. These feedback mechanisms allow firms to refine their operations and product offerings, ultimately contributing to a more agile and responsive organization.

Moreover, reverse logistics enhances supply chain adaptability, which is critical in today's volatile environments. Whether facing disruptions in global supply networks, changing regulations, or fluctuations

in raw material availability, manufacturers with mature reverse logistics capabilities are better equipped to respond flexibly(De Boni et al. 2022). The ability to retrieve, refurbish, or remanufacture goods reduces dependence on external suppliers and shortens the supply chain. This capacity is particularly important for high-tech industries, where component scarcity can halt production. Furthermore, efficient return systems support service-based business models such as leasing, product-as-a-service, or trade-in programs, all of which are gaining traction across multiple sectors. In these contexts, reverse logistics not only supports operational needs but also underpins the strategic transformation of business models.

Another important aspect of reverse logistics as a strategic tool is its contribution to brand equity and corporate responsibility. Increasingly, consumers associate product returns, recycling options, and after-sales service with the overall quality and integrity of a brand. A company that handles returns efficiently and transparently can strengthen customer trust and loyalty(Joy et al. 2012). Additionally, organizations that proactively communicate their efforts in managing returned goods or reducing waste can enhance their reputation and align with environmentally and socially conscious stakeholders. This reputational value has direct implications for competitiveness, especially in sectors where branding and public perception play a central role in market positioning.

In addition to its strategic role, reverse logistics facilitates the recovery of value across the product lifecycle, which has profound implications for manufacturing profitability and sustainability. When managed effectively, the return and recovery of products provide manufacturers with multiple pathways to extract residual value(Rehim, Mostafa, and Mohamed 2021).

In many cases, reverse logistics operations form the backbone of remanufacturing systems. Remanufacturing allows manufacturers to restore used products to a condition equivalent to new, using a fraction of the energy and material inputs required for original production. Industries such as automotive, electronics, and heavy machinery have embraced this model, realizing both economic and ecological benefits(Tiwong et al. 2024). Furthermore, reverse logistics supports the expansion of modular design strategies, where products are intentionally engineered for easier disassembly and part replacement. This synergy between design and reverse logistics reinforces a circular approach to manufacturing, enabling companies to maintain control over product cycles and retain value within the system.

TECHNOLOGICAL INTEGRATION AND SUSTAINABILITY IMPLICATIONS OF REVERSE LOGISTICS

The integration of reverse logistics with digital and lean manufacturing systems has emerged as a transformative approach to optimizing return flows and strengthening overall supply chain performance(Gavalas, Syriopoulos, and Roumpis 2022). As manufacturers increasingly adopt Industry 4.0 technologies, reverse logistics processes have benefited from advances in data analytics, sensor-based tracking, and interconnected platforms. These technologies allow for real-time visibility into the condition, location, and movement of returned goods, enabling more accurate and timely decision-making. For instance, the deployment of RFID tags and IoT-enabled devices facilitates seamless monitoring of returned products, helping firms assess product conditions quickly and route them to the appropriate recovery stream—whether repair, refurbishment, or recycling. Such real-time insights reduce bottlenecks, lower processing costs, and enhance the responsiveness of reverse logistics networks(Ha et al. 2013).

Digitalization also supports predictive analytics and machine learning applications that can forecast return volumes, identify root causes of product failures, and optimize inventory planning(Saoud, Kourentzes, and Boylan 2021). These tools enable firms to shift from reactive to proactive management of reverse flows.

In parallel with digital integration, the application of lean manufacturing principles to reverse logistics has proven to be a significant driver of efficiency and waste reduction. Traditionally focused on streamlining production and minimizing excess, lean thinking is increasingly applied to reverse processes to eliminate unnecessary handling, reduce lead times, and standardize return procedures(Del Giudice et al. 2022). Tools such as value stream mapping, 5S, and kaizen can be adapted to evaluate and improve the flow of returned goods. For instance, lean techniques can help redesign reverse logistics layouts to minimize transport distances, organize

return inspection stations more efficiently, or reduce inventory holding costs in return centers. This systematic approach contributes to better use of resources, improved process consistency, and enhanced service levels in handling returns.

Another benefit of lean-oriented reverse logistics is the creation of standard operating procedures for diverse return scenarios. Manufacturers often face a high degree of variability in the quality, condition, and origin of returned products, which can lead to inconsistent processing and decision-making(Rossini, Powell, and Kundu 2023). Lean methodologies encourage process standardization and continuous improvement, which help in establishing clear return protocols and quality criteria. This reduces ambiguity, enhances employee productivity, and lowers the error rate in reverse operations. When combined with digital dashboards and feedback loops, lean principles enable real-time monitoring and process refinement, fostering a culture of agility and operational excellence.

As environmental concerns rise and regulatory pressures intensify, manufacturers are expected to implement responsible end-of-life product management systems. Reverse logistics serves as a foundational mechanism for collecting, sorting, and processing returned items in compliance with environmental laws such as the Waste Electrical and Electronic Equipment (WEEE) directive, Extended Producer Responsibility (EPR) programs, and ESG disclosure requirements(García and Rivas 2022). These frameworks demand that companies take accountability for the environmental footprint of their products beyond the point of sale, and reverse logistics enables this accountability through traceability and control over post-consumer goods.

Manufacturers that implement robust reverse logistics systems demonstrate their commitment to sustainable practices and responsible resource use. This contributes not only to compliance but also to corporate identity and consumer perception. In highly competitive markets, sustainability can serve as a differentiating factor that attracts environmentally conscious customers, secures investment from socially responsible funds, and strengthens relationships with stakeholders.(Ugrinov et al. 2024)

Furthermore, reverse logistics facilitates circular economy initiatives that align with global sustainability goals. Through processes such as remanufacturing, component reuse, and material recovery, reverse logistics supports the decoupling of economic growth from resource consumption. Manufacturers can close material loops, reduce dependence on virgin inputs, and lower greenhouse gas emissions associated with raw material extraction and production. These outcomes are increasingly valuable as companies face pressure to align with international sustainability frameworks such as the United Nations Sustainable Development Goals (SDGs) or Science Based Targets (SBTs) for climate action(Pieroni, McAloone, and Pigosso 2019).

THEORETICAL MODEL

Figure 1 illustrates a conceptual model for achieving competitive advantage through reverse logistics in manufacturing. The framework is structured around four interrelated pillars: Strategic Integration and Organizational Alignment, Operational Optimization and Circular Flow Enablement, Digitalization and Innovation in Return Systems, and Sustainability Orientation and Value Communication. Each pillar encompasses five key sub-elements that represent critical enablers or practices required to operationalize reverse logistics in a strategic and value-driven manner.

The model begins with the strategic alignment of reverse logistics activities with broader corporate objectives. This includes embedding reverse logistics in cross-functional governance, customer relationship management, and regulatory compliance structures. From this foundation, reverse logistics capabilities are translated into operational practices through lean management, modular product design, and network optimization, all of which support circular flow principles.

Technological innovation plays a central role by enabling visibility, automation, and data-driven decision-making within reverse logistics systems. Digital tools such as IoT sensors, predictive analytics, blockchain, and AI are positioned as enablers that reinforce both operational efficiency and sustainability performance.

The fourth pillar emphasizes sustainability as a competitive differentiator. It highlights the integration of reverse logistics into ESG reporting, stakeholder engagement, and brand communication. This orientation supports both regulatory compliance and market positioning, enhancing the firm's reputation and long-term value proposition.
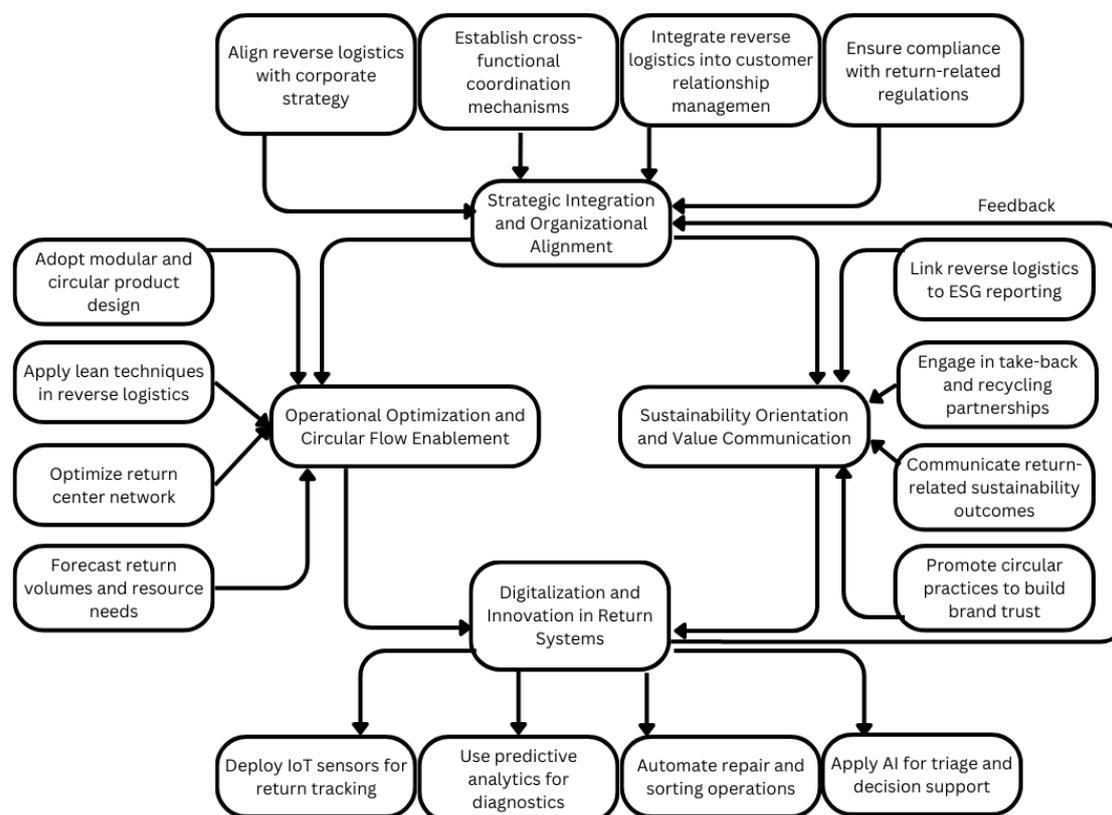

Figure 1: theoretical model for achieving competative adventage through reverse logistics

CONCLUSION

Reverse logistics has evolved into a critical component of manufacturing strategy, contributing not only to cost efficiency but also to long-term competitive advantage. This paper explored how reverse logistics, when strategically integrated and supported through operational, technological, and sustainability-focused practices, can become a value-generating function. The integration of sustainability practices into reverse logistics extends its contribution beyond internal gains. It fosters stakeholder trust, improves brand perception, and aligns manufacturing operations with the increasing expectations of regulatory bodies and environmentally conscious markets.

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Session B: HUMAN RESOURCE MANAGEMENT

ANALYSIS OF BURNOUT SYNDROME AT THE LEVEL OF MIDDLE MANAGEMENT IN SERBIAN COMPANIES

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ABSTRACT

In today's business environment, middle managers face significant challenges that make them vulnerable to burnout. The aim of this research was to examine the presence and severity of burnout symptoms among mid-level managers in companies operating in Serbia. The research was conducted using a quantitative method on a sample of 200 respondents from different sectors, using a standardized questionnaire and descriptive statistics analysis. The results indicate a moderate level of burnout, where emotional exhaustion dominates, while the symptoms of depersonalization and frustration are less pronounced. Of particular concern is the impact of burnout on the private life of employees, which indicates a disturbed balance between the business and personal segments. Based on the findings, the authors recommend the introduction of systemic measures such as education on stress management, optimization of workload and strengthening of institutional support for middle-level managers in order to prevent burnout and preserve organizational efficiency.

Keywords: Burnout syndrome, Middle management, Emotional exhaustion, Work stress, Organizational support

INTRODUCTION

In the modern business environment, middle management is the link between the strategic top and the operational part of the organization. At this level, managers balance between the implementation of business decisions and the day-to-day coordination of teams, often under the pressure of high expectations, tight deadlines and limited resources. Also, constant market changes and the rise of digitization in workplaces are transforming the way work is managed, presenting both advantages and challenges for the psychological safety and health of employees (Pinto et al., 2024). This leads to psychosocial risks, such as burnout syndrome, which significantly affects the motivation, productivity and mental health of employees (Pike et al, 2025).

Employee burnout syndrome is a frequent occurrence today and represents a professional phenomenon, which leads to individual burdens and difficulties in the health system (Andras et al., 2015). Burnout at work is a negative professional outcome that develops due to long-term chronic stressors during work, and its prevention is of fundamental importance both at the individual and at the organizational level (Berg-Beckhoff et al., 2018). Although this syndrome has been studied in detail in the context of occupations with high emotional load such as health, education and social work, its presence and consequences in middle management are insufficiently investigated (Muller & Kubatova, 2025), especially in the context of the Serbian economy.

The aim of this paper is to examine the presence of burnout syndrome among mid-level managers in domestic companies, as well as to identify its manifestation and potential consequences. Through the analysis of the collected data, the paper aims to offer recommendations that could contribute to the prevention and mitigation of this syndrome, with the aim of preserving the work efficiency and well-being of the managerial staff.

THEORETICAL BACKGROUND

Workplace stress and psychosocial risks, together with negative health and business consequences, affect a significant number of European workplaces. Despite this, a large number of companies do not have systems in place to deal with work stress (Prodromou et al, 2019). Workplace stress and burnout syndrome are closely related, with long-term stress being one of the main causes of the development of this syndrome. While stress in itself is a normal reaction of the body to challenging situations and can have a stimulating effect, continuous lack of control over sources of stress, with high expectations and limited resources, leads to key elements of burnout (Gluvakov et al., 2022). Also, specific organizational characteristics such as high work load, role conflicts, poor interpersonal relations and lack of recognition further increase the effect of stress and accelerate the occurrence of burnout (Schaufeli & Taris, 2013). Therefore, the burnout syndrome is not only an individual problem, but also an organizational one, because it indicates dysfunctional working conditions that affect the health and efficiency of employees in the long term.

In 2000, the World Health Organization identified burnout syndrome as an occupational risk factor characterized by emotional exhaustion, depersonalization, and a reduced sense of personal efficacy, resulting in lost productivity and increased costs due to sick leave. It is safe to say that burnout has reached epidemic proportions in workplaces around the world. Although the signs of burnout are not difficult to identify and mitigate, its actual impact is not easy to measure, creating numerous risks for companies from the loss of human talent to reduced productivity and reduced quality of life (Sanchez-Segura et al., 2023). Burnout syndrome is a reaction to chronic, i.e. long-term work stress, especially in professions that require intense emotional engagement. According to Maslach et al., this syndrome is characterized by three key dimensions: emotional exhaustion, depersonalization or cynicism, and a reduced sense of personal efficacy (Maslach et al., 2001). Emotional exhaustion refers to the feeling of being overwhelmed and depleted of emotional resources, depersonalization implies distancing and a negative attitude towards work or clients, while a reduced sense of personal effectiveness represents the perception of a reduced ability to achieve professional goals.

Middle management employees find themselves in a specific position between senior management and operational staff, which exposes them to pressures from both sides. According to research published in the journal *Workplace Health & Safety*, managers who experience all three dimensions of burnout are 5.3 times more likely to leave their positions, indicating the severity of the problem (The Wellbeing Project, 2025). Factors such as lack of support, unclear roles and conflicts between professional and personal obligations further contribute to the risk of burnout in this group of employees (Macias-Velasquez et al., 2019). Burnout syndrome can have multiple consequences that include physical, psychological and professional aspects. Physical symptoms may include chronic fatigue, headaches, and sleep disturbances. Psychological effects include depressive symptoms, anxiety and reduced motivation. On the professional front, burnout can lead to reduced productivity, increased absenteeism and higher employee turnover (Salvagioni et al., 2017). In the context of middle management, these consequences not only affect individuals but also the teams they lead, which can lead to a reduction in the overall effectiveness of the organization. Therefore, the identification and prevention of burnout syndrome is crucial to maintaining a healthy and productive work environment.

METHODOLOGY

Subject and problem of research:

Burnout syndrome at work is recognized as a global challenge, especially in occupations that require high emotional involvement. Nevertheless, the phenomenon of burnout among employees at the middle management level remains insufficiently researched, even though this group represents an important part of the organizational structure. Middle managers balance the demands of senior management with day-to-day operational responsibilities, making them particularly vulnerable to chronic stress and burnout. Additionally, in the context of the Serbian economic system, which is burdened with structural challenges, inadequate institutional support and rapid market changes, this phenomenon requires a deeper study. The lack of systemic solutions for the identification and prevention of burnout among this category of employees can have long-term consequences for organizational efficiency and decision-making quality.

The subject of this research is the examination of the expression and determinants of burnout syndrome among middle-level managers in companies operating in Serbia. The research also deals with comparative analyses, with the aim of identifying groups that are particularly at risk when it comes to the occurrence of this syndrome.

Research method

The research was conducted using a quantitative method through a structured questionnaire (Kristensen et al., 2005) that relies on standardized statements to measure burnout syndrome. A Likert scale from 1 to 7 was used. The data were analyzed using descriptive statistics in the SPSS program.

Research goal

Research goals are as follows:

1. To quantify the presence and intensity of burnout symptoms in middle-level managers.
2. To provide recommendations for the prevention and mitigation of burnout in management, based on empirical findings.

Research questions

RQ1: To what extent are symptoms of burnout syndrome present among middle-level managers in Serbia?

RQ2: What are the most pronounced dimensions of burnout in the examined sample?

Research procedure

The survey was conducted during 2024 among employees in Serbian companies. The sample consists of 200 middle-level managers from companies of various activities and ownership structures. Respondents participated voluntarily and anonymously, and data collection was done online.

Research population and sample

The target population consists of middle-level managers employed in companies in Serbia (N=200). The sample is non-stratified, but includes respondents of different ages, genders, education levels and work sectors (service and manufacturing), thus ensuring basic representativeness.

RESEARCH RESULTS AND DISCUSSION

Descriptive analysis of burnout

In order to assess the general state of burnout among mid-level managers, a descriptive analysis of all seven questionnaire items, as well as the total burnout score, was conducted. Based on the results shown in Table 1, several key observations can be made.

Table 1: Descriptive statistics

Items	N	Minimum	Maximum	Mean	Std. Deviation
I feel exhausted at the end of the work day.	200	1,00	7,00	**4,5050**	1,68647
I feel exhausted in the morning just thinking about another day at work.	200	1,00	7,00	3,1800	1,82875
I feel that every working hour is hard and tiring.	200	1,00	7,00	3,0100	1,87817
When I have free time, I feel that I lack energy for family and friends.	200	1,00	7,00	3,5750	2,00612
My job is emotionally draining.	200	1,00	7,00	3,3300	1,90506
My job frustrates me.	200	1,00	7,00	**2,7050**	1,94858
I feel like I am burning out because of my work.	200	1,00	7,00	3,0900	2,02792
Job burnout	200	1,00	7,00	**3,3423**	1,63568
Valid N (listwise)	200				

By analyzing seven statements that measure the burnout syndrome at work, it was determined that in the examined sample of middle-level managers there are different levels of expression of individual burnout symptoms, with the component of emotional exhaustion dominating.

1. „I feel exhausted at the end of the work day." - This statement has the highest average value (M = 4.51; SD = 1.69), which clearly indicates that the majority of respondents feel very tired at the end of the working day. This finding can be interpreted as a consequence of high demands and insufficient resources, characteristic of the position of middle management, which balances between operational and strategic tasks. Emotional exhaustion is recognized as a central dimension of burnout in the Maslach model (Maslach et al., 2001), and in this research it is shown to be the dominant component.

2. „I feel exhausted in the morning just thinking about another day at work." - The average value of this statement (M = 3.18; SD = 1.83) indicates that some respondents experience anticipatory stress, which can be an indicator of long-term emotional pressure and lack of motivation. This result is important because it shows that exhaustion is not only limited to the end of the work day, but also affects the beginning of the work routine.

3. „I feel that every working hour is hard and tiring." - With a mean of M = 3.01 (SD = 1.88), this statement indicates the presence of feeling overwhelmed, but not in the majority of respondents. This result may mean that managers manage to organize work tasks within acceptable limits, although there is a significant group that perceives daily duties as exhausting.

4. „When I have free time, I feel that I lack energy for family and friends." - This statement (M = 3.58; SD = 2.01) indicates the transition of the effects of burnout from professional to private life, which is characteristic of the burnout syndrome in an advanced stage. Lack of energy in free time disrupts the life balance and can contribute to the development of chronic stress and reduced quality of life.

5. „My job is emotionally draining." - With a mean of M = 3.33 (SD = 1.91), this statement confirms the emotional component of burnout. Although the average value is not high, in combination with previous findings it indicates the presence of cumulative pressure affecting the mental and emotional capacity of employees.

6. „My job frustrates me." - The lowest score in the questionnaire was recorded for this statement (M = 2.71; SD = 1.95), which suggests that frustration is not a dominant symptom among the surveyed managers. This may mean that respondents still have a certain degree of professional satisfaction or a sense of control over tasks, thus mitigating the development of depersonalization.

7. „I feel like I am burning out because of my work." - The average value is M = 3.09 (SD = 2.03), which indicates that the respondents somewhat recognize the presence of burnout symptoms. Although not highly expressed, this statement reflects an awareness of the initial signs of burnout, which can be useful in the context of early response and preventive action.

The average value of the total burnout score at work is M = 3.34 (SD = 1.64), which indicates a moderate level of burnout in the examined group. This result indicates that middle-level managers in

Serbia are not in a state of complete exhaustion, but clear signs of psychological stress and disturbed emotional balance can be observed. Despite the moderate average value, pronounced emotional exhaustion and a drop in energy in private time are early risk indicators for the development of more serious forms of burnout. The high average value of the feeling of exhaustion at the end of the working day further confirms the dimension of emotional exhaustion as a key indicator of psychophysical burden among this category of employees.

The values indicating depersonalization and frustration are lower, which may mean that despite the psychological exhaustion of the respondents, there was no significant loss of professional motivation or development of a negative attitude towards work. This may indicate a developed professional identity and a sense of responsibility that is often associated with a managerial position. Also, there is a transfer of the effects of burnout to private life, which indicates an insufficient possibility of recovery and an imbalance between the business and personal life of employees. This result may be worrying in the long term because burnout outside the workplace leads to cumulative effects that negatively affect psychological health and long-term work efficiency.

In the context of the domestic economy, the results of this research indicate an organizational problem that requires a systemic approach. Middle managers are often both implementers and communicators of decisions, which makes them a vulnerable group. The lack of institutional support and systematic mechanisms for the preservation of mental health can worsen the situation. Accordingly, companies should introduce stress management training and workshops, as well as periodic evaluations of employees' psychological well-being. Also, it is recommended to optimize the workload through the delegation of responsibilities, the provision of adequate resources and a culture of open communication, especially when it comes to senior management.

CONCLUSION

The results of this research confirm that the burnout syndrome among middle-level managers in Serbian companies is a real and present phenomenon, which requires the attention of not only researchers but also decision-makers within the company. The identified patterns of emotional exhaustion and reduced energy in private time indicate a gradual deterioration of the mental resilience of employees in this segment. Although the results do not indicate extreme levels of burnout, the presence of early symptoms should be seen as a signal for intervention, and not ignored until more serious consequences appear. The contribution of this work is reflected in the empirical confirmation of the need for systemic support to middle management, as well as in the definition of concrete measures that can improve their professional and personal well-being. Implementation of the recommended measures can contribute to the creation of a sustainable work environment that will increase the resilience of employees in the long term, reduce turnover and raise the level of organizational efficiency. In this sense, further research should include longitudinal studies and extended samples, in order to take a deeper look at the consequences and effectiveness of the proposed solutions.

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MENTAL MODELS AS CHANGE CATALYSTS IN EDUCATIONAL LEADERSHIP

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ABSTRACT

In contemporary educational management, there is an increasing need to redefine the role of educational leaders—from administrative figures to facilitators of change and catalysts of professional learning. This theoretical paper examines how educational leaders' mental models—their underlying beliefs and assumptions—influence leadership styles, organizational culture, and the development of learning communities. Drawing on key literature, it highlights the role of participative and transformative leadership in fostering reflective and collective inquiry. Using frameworks by Senge, Fullan, and Spillane, the paper argues that redefining leaders' mental models is essential for sustainable educational change and proposes a conceptual framework for future research. The paper concludes that the awareness and redefinition of leadership mental models are essential prerequisites for successful and sustainable change in educational institutions. As a contribution, it proposes a conceptual framework to guide future empirical research in this domain

Key words: Educational leadership, Mental models, Participative leadership, Learning organization, Cognitive transformation

INTRODUCTION

In the 21st century, the governance of educational institutions requires more than adherence to administrative rules and procedures. Contemporary research increasingly highlights that the effectiveness of leadership and educational management is closely tied to the internal mental models of educational leaders—their beliefs, assumptions, and ways of thinking about learning, knowledge, authority, and change. These cognitive frameworks shape how leaders interpret reality, make decisions, and influence the intitutional culture and professional relationships.

Modern educational leadership is moving away from static, hierarchical models toward more dynamic, participative, and learning-oriented approaches. This shift demands cognitive flexibility, emotional intelligence, and the capacity to guide collective growth. Leaders are now expected not only to manage systems but to inspire change by fostering shared understanding and critical reflection among staff.

Central to this transformation is the awareness and evolution of the leaders' own mental models. These internal maps affect how they define their roles, enact authority, and lead others. Without confronting and adjusting these patterns of thought, leadership risks reinforcing outdated norms rather than supporting meaningful progress.

This paper provides a theoretical exploration of how mental models influence leadership styles, decision-making, and the development of educational institutions as learning communities. It emphasizes cognitive leadership, where the leader's role includes shaping collective thinking through reflection, dialogue, and behavioral modeling. Concepts such as mental agility, adaptive thinking, and situational awareness are discussed as essential components of this process.

The guiding research question is: **"How do educational leaders' mental models shape leadership styles, and how do these models contribute to—or constrain—the development of educational institutions as learning communities?"**

METHODOLOGICAL FRAMEWORK

This theoretical study is based on a qualitative analysis of relevant sources in the fields of educational leadership, organizational learning, and cognitive psychology. The purpose is not to collect new empirical data, but to develop a theoretical framework that can serve as a foundation for future empirical research on the role of mental models in educational leadership.

The study is situated within an interpretive paradigm, which conceptualizes mental models as subjective and context-dependent constructions of meaning, shaped by leaders' professional experiences. The analysis employs comparative and interpretive approach, drawing upon the theoretical work of Peter Senge (1990) and models of transformational and participative leadership (Fullan, 2007; Leithwood, 2003; Spillane, 2006).

The main objective is to map out the key theoretical relationships between mental models and leadership styles, thereby forming a conceptual lens where educational leadership is viewed as a process involving both cognitive and emotional reflection. The limitations of this study stem from the absence of empirical data and the potential for subjective interpretation of theoretical sources.

THEORETICAL FRAMEWORK OF MENTAL MODELS

Mental models, as defined by Cabrera and Cabrera (2015), are internal cognitive structures—deeply rooted assumptions and generalizations—that influence how individuals interpret the world, make decisions, and act within complex environments. In educational leadership, these mental frameworks shape how leaders perceive their roles, interpret challenges, and build relationships within institutions.

Peter Senge (1990), within the theory of learning organizations, identifies mental models as one of five key disciplines essential for organizational learning and adaptation. According to him, these models—formed through professional experiences and institutional norms—significantly influence how individuals and organizations evolve. Critically examining and adjusting these internal representations is, therefore, crucial for fostering meaningful and lasting change. Senge emphasizes that leadership transformation starts with the capacity to recognize and challenge one's own assumptions.

Fullan (2007) builds on this idea by stressing that mental models are not static—they are shaped through dialogue, reflection, and continuous learning. Leaders who maintain flexible and conscious thought patterns are more likely to cultivate environments of trust, professional growth, and collaboration. Their leadership enables institutions to become dynamic learning communities rather than rigid bureaucracies.

In contrast, leaders who operate from narrow or rigid mental models may resist innovation and unintentionally reinforce outdated practices. Spillane (2006) and Leithwood & Riehl (2003) argue that such leaders often overlook the collective cognitive dynamics of their teams, limiting opportunities for shared learning and reform. Mental models not only influence decision-making and communication, but also determine how open an organization is to change.

This paper's theoretical framework positions mental models as foundational to effective educational leadership. Moving beyond technical management, leadership is viewed here as a reflective and cognitively engaged practice—where internal belief systems shape institutional culture and the capacity for collective transformation.

COGNITIVE LEADERSHIP AND TRANSFORMATIVE PRACTICE

Leadership in education is increasingly understood as a cognitive and emotional process that shapes how teachers respond to change, innovation, and professional growth. Mental models—leaders' internal frameworks—inform their leadership style, communication, and decision-making. These models reflect not just

personality traits but deep-seated beliefs about people, authority, and learning (Fullan, 2007; Leithwood et al., 2005).

Leadership styles emerge from these cognitive foundations. Transformational leaders believe in growth and shared vision, while authoritarian leaders operate from assumptions of control and predictability. Participative leaders, by contrast, see knowledge as collective and promote collaboration. As Table 1 illustrates, these styles result in distinct effects on organizational culture and trust.

Table 1: Comparative Overview of Leadership Styles and Belongign Mental Models in Education

Leadership Style	Leader Characteristics	Mental Model (Cognitive Basis)	Effects on the Collective
Autocratic	Directiveness, centralized control	The world is unpredictable → stability is maintained by a firm hand	Passivity, resistance, decreased trust
Transformational	Vision, emotional motivation	People are capable of growth and change	High engagement, innovation, collective synergy
Participative	Dialogue, inclusion, shared authority	Knowledge is collective → change is built collaboratively	Trust, professional autonomy, shared learning

Empirical studies support this view. Wu et al. (2024), Ning & Chaisirithanya (2024), and Rahimzadeh & Heidari Raziabad (2025) show that servant, empowering, and ethical leadership styles contribute to teacher well-being, learning-oriented mindsets, and collective engagement. Leaders who foster reflective dialogue and psychological safety enable more adaptive and resilient cognitive patterns among staff.

Cognitive leadership involves more than influencing behavior—it includes guiding how people think and interpret their environment. Senge (1990) emphasizes that leaders must recognize and revise their own mental models to lead effectively in learning organizations. Rather than perceiving resistance as opposition, reflective leaders interpret it as a signal of systemic or cultural misalignment. They create environments in which mistakes become opportunities for learning, not failure.

Fullan (2007) further asserts that effective leaders uncover cognitive barriers to change—those embedded in thinking patterns, not policy. In participative and distributed leadership models (Spillane, 2006), leaders mediate collective meaning-making. Through dialogue, they help construct shared mental models that align values, goals, and practices.

This process of **cognitive transformation** requires self-awareness, humility, and openness. Leaders act not as authorities, but as co-learners who nurture curiosity and reflective practice. As Quatrunnada et al. (2025) and Zargar & Horoub (2022) suggest, leadership behaviors influence team cognition, creating "mental crossover" where values and thought models are subtly shared across professional teams.

Ultimately, cognitive transformation and mental models are inseparable. Transformative leadership begins with leaders themselves—those who question their assumptions, encourage collaboration, and cultivate learning communities. Such leadership turns education institutions into adaptive, trust-based institutions capable of sustainable change.

PARTICIPATIVE LEADERSHIP AND COGNITIVE ALIGNMENT

Participative leadership is a key model in contemporary education, especially in institutions that prioritize collective learning, dialogue, and shared decision-making. According to Magzan (2011), by "fostering collective wisdom and collaborative action, it is an essential tool for social and organisational development during times of uncertainty." At the core of this approach lies the leader's willingness to involve teachers and other members of the educational community in goal-setting, problem-solving, and the development of strategic directions. However, these processes are not merely procedural—they are deeply rooted in cognitive patterns, or mental models, that shape how individuals interpret and act within the educational institution environment (Spillane,

2006). Therefore, effective participative leadership requires cognitive alignment—a process where team members recognize and harmonize their mental models. This isn't about full consensus, but sufficient overlap of values, assumptions, and reasoning patterns that allows shared understanding and coherent action (Leithwood & Riehl, 2003). Rather than imposing change, participative leaders cultivate it through open dialogue, reflection, and psychological safety. They ask questions that encourage collective meaning-making, such as "What does quality education mean to us?" or *"What values should guide our educational institutions?"* (Senge, 1990; Magzan, 2011).

On the other hand, cognitive alignment occurs both formally—through team meetings and peer feedback—and informally, through everyday communication. Cognitive alignment is not passive agreement, but a mutual adaptation through dialogue. Unlike simple decentralization, participative leadership promotes co-construction of meaning and shared vision (Spillane, 2006). *Table 2* summarizes four key mechanisms that support this process within educational institutions.

Table 2: Mechanisms of Cognitive Alignment in Educational Institutions

Mechanism	Description	Practical Examples
Reflective Dialogue	Collective questioning of underlying assumptions	Workshops on organizational institions values, group discussions
Professional Communities	Teams for exchanging knowledge and pedagogical practice	Peer mentoring, micro-reflection sessions
Collective Decision-Making	Involving staff in strategic processes	Innovation teams, co-created educational institutions' development plans
Culture of Psychological Safety	Environment that tolerates mistakes and encourages dialogue	Open feedback, valuing diverse perspectives

These mechanisms are not isolated actions but part of a broader strategy for building a shared understanding of educational reality. Leaders who foster such processes make hidden mental models visible and open them to alternative perspectives which is the key for meaningful organizational learning.

Claiming that in the social cognitive view, people are neither driven by inner forces nor automatically shaped and controlled by the environment but rather, "human functioning is explained in terms of a model of triadic reciprocity in which behavior, cognitive and other personal factors, and environmental events all operate as interacting determinants of each other," More contemporary research further conforms this, as Leithwood et al. (2006) show that inclusive decision-making strengthens both engagement and cognitive flexibility among teachers. Likewise, Yollu and Korkmaz (2024) report that participative leadership positively affects teachers' psychological capital—boosting their resilience, trust, and openness to change. These are essential factors for redefining existing mental patterns and fostering new models of professional practice. Furthermore, in learning-oriented educational institutions, this form of leadership fosters cognitive cohesion by encouraging collective reflection and rethinking of unconscious mental patterns. Though it demands emotional intelligence and patience, it supports long-term educational transformation and stronger professional communities.

Finally, since participative leadership is grounded in cognitive frameworks that emphasize collaboration and shared meaning-making, such leaders act as facilitators, supporting teacher autonomy and promoting learning across the organization (Spillane, 2006).

RESULTS

Although this is a theoretical study without empirical data, its main findings are presented as recommendations based on the analysis of mental models and their impact on leadership styles, organizational culture, and cognitive transformation in education. These recommendations serve as strategic directions for developing reflective and participative leadership practices.
The main results—presented here as practical recommendations—are as follows:

- **Integration of reflective practices and professional supervision** into educational leadership processes, with the aim of enhancing leaders' self-awareness and encouraging critical examination of personal mental models and leadership behavior.
- **Use of introspective tools and dialogue-based techniques** in leadership training, allowing leaders to uncover underlying assumptions, engage in meaningful professional dialogue, and promote collective meaning-making.
- **Creation of a culture of psychological safety** within educational organizations, enabling cognitive change to take place without fear, judgment, or punitive reactions—thus fostering an environment where experimentation, reflection, and innovation are encouraged.

These recommendations offer practical steps for applying theoretical insights and provide a foundation for future research on leadership and educational transformation.

DISCUSSION

In today's complex and uncertain educational landscape, leadership must be understood not as a technical or administrative task, but as a process of initiating and guiding collective transformation (Fullan, 2007; Hallinger, 2003). Central to this process are the mental models of leaders—their internal beliefs and assumptions—which shape leadership styles, decision-making, and institutional culture (Senge, 1990; Cabrera & Cabrera, 2015). Leaders who engage in reflection and demonstrate cognitive flexibility are more likely to foster collaborative environments and drive sustainable change (Spillane, 2006; Leithwood & Riehl, 2003). In contrast, leadership rooted in control and rigid hierarchies often hinders innovation and generates resistance (Leithwood et al., 2006).

Modern leadership theories—such as transformational, participative, and distributed leadership—emphasize emotional intelligence, shared vision, and collective learning (Fullan, 2007; Wu et al., 2024). Effective leaders act as facilitators of reflection and cognitive transformation, beginning with awareness of their own mental models (Senge, 1990; Epitropaki & Martin, 2017). Empirical studies confirm that psychological safety, ethical leadership, and reflective dialogue support cognitive change at the institutional level (Rahimzadeh & Heidari Raziabad, 2025; Quatrunnada et al., 2018). To enable true transformation, it is essential to abandon outdated mental models based on authority and control. Only through such a shift can meaningful and lasting change take root in educational institutions (Fullan, 2007; Leithwood & Jantzi, 2005).

CONCLUSION AND IMPLICATIONS: RETHINKING LEADERSHIP THROUGH MENTAL MODELS

This study highlights the central role of mental models in shaping leadership practices and influencing the culture and adaptability of educational institutions. Rather than being fixed styles or techniques, leadership approaches emerge from deeper cognitive patterns that determine how leaders perceive people, change, and organizational dynamics. The findings emphasize that fostering reflective, participative, and psychologically safe environments depends largely on leaders' ability to recognize and critically reframe their own mental models. Leadership grounded in cognitive awareness is more likely to promote innovation, trust, and meaningful engagement within the educational communities.

While conceptual in nature, this paper offers a solid theoretical foundation for future empirical research. To further explore the practical relevance of these ideas, future studies should investigate how specific leadership interventions—based on cognitive awareness—impact educational improvement processes. Mixed-methods research across diverse educational contexts could provide valuable insights into how mental model shifts contribute to sustainable change. Ultimately, educational transformation begins with internal transformation of leaders themselves. Rethinking leadership from a cognitive perspective is not only necessary—it is imperative for building responsive, collaborative, and future-oriented educational institutions.

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THE IMPACT OF BURNOUT AT WORK ON HOTEL COMPETITIVENESS IN THE REPUBLIC OF SERBIA

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ABSTRACT

The study examines the impact of burnout at work, or rather its dimensions, on the competitiveness of hotels in the Republic of Serbia. It starts from the position that the impact of burnout at work on the competitiveness of hotels is reflected through the performance of employees at work, as well as the fact that one of the key factors in the occurrence of burnout at work in hotels is the dysfunctional behavior of hotel guests. The study was conducted on a sample of 130 hotel employees. The data were collected using a structured questionnaire. SEM methodology was used for data analysis. The results show that all dimensions of burnout at work have a negative impact on the competitiveness of hotels, i.e. emotional exhaustion has the greatest impact.

Key words: burnout at work, hospitality industry, Republic of Serbia, hotel competitiveness, SEM

INTRODUCTION

In today's tourism and hospitality sector, the increase in competition and rising customer expectations lead to more complex interactions between guests and hotel staff. Dysfunctional guest behavior, such as aggression, unreasonable complaints, and obsessive criticism, is becoming increasingly common, which can have serious consequences for the psychological well-being and work efficiency of hotel employees. In this context, burnout at work represents a significant issue that arises from daily pressures and stressors in the workplace. Burnout is characterized by physical and emotional exhaustion, depersonalization, and a diminished sense of personal accomplishment. Given that hotel employees frequently encounter unfavorable guest behaviors, it is crucial to understand how these interactions can contribute to burnout and the general decline in work motivation and satisfaction, which ultimately influences employee behavior.

On the other hand, satisfied employees are highly motivated, which has positive effects on their performance at work. The ultimate outcome of this is the improvement of productivity and efficiency in the workplace, which in turn reflects on the competitiveness of hotels. Therefore, the aim of this paper is to examine the impact of employee burnout in hotels in the Republic of Serbia, because of dysfunctional guest behavior, on the competitiveness of hotels. This topic emerges as important because dysfunctional guest behavior impacts employee burnout in hotels, which can significantly reduce their work motivation and satisfaction. Given that the hospitality sector is highly competitive, decreased efficiency and productivity among employees can lead to reduced competitiveness of hotels in the market. Understanding these interactions can assist management in developing strategies to improve the work environment, preserve employees' mental health, and enhance the overall quality of service, thereby strengthening the reputation and success of hotels.

THEORETICAL FOUNDATIONS OF THE RESEARCH

Based on the research findings that dysfunctional guest behavior significantly impacts employee burnout in hotels in the Republic of Serbia, on one hand, and the fact that burnout affects employees' motivation and readiness to work, which reflects on hotel performance, there is a need to examine the impact of employee burnout on the competitiveness of hotels. This need extends beyond merely assessing the overall burnout; it is also essential to investigate the effects of its individual dimensions. Authors such as Moreno-Jimenez et al. (2000) and Garrosa et al. (2008) have identified four dimensions of burnout: physical exhaustion, emotional exhaustion, depersonalization, and a reduced sense of personal accomplishment at work (a belief that one is no longer capable of effectively performing their job). In the literature, this fourth dimension is referred to as the Lack of Personal Achievement. Physical Exhaustion is aspect of burnout refers to the feeling of physical fatigue that can result from intensive work and continuous engagement in job tasks.

Physical exhaustion arises from overexertion, lack of rest, and unhealthy working conditions, all of which can lead to a significant decrease in efficiency and productivity. Employees experiencing this dimension may become more susceptible to injuries and illnesses, further deteriorating their overall well-being and reducing job satisfaction (Harjanti & Todani, 2019). Emotional exhaustion is dimension of burnout which associated with a feeling of being overwhelmed and drained of emotional resources. Employees who experience emotional exhaustion often feel stressed and incapable of adequately responding to challenging situations, which can lead to increased frustration and conflict at work. This exhaustion can negatively impact relationships with colleagues and guests, reducing the quality of services provided and overall job satisfaction (Sexton et al., 2022). Depersonalization as dimension of burnout describes the process of feeling detached from job responsibilities and a lack of empathy towards others, including colleagues and clients (Stojilkovic & Malenović Nikolić, 2023). Employees who have experienced depersonalization often become cynical and distant, which can significantly negatively affect the quality of service they provide. Such an attitude can lead to decreased customer loyalty and a decline in guest satisfaction. The fourth dimension of is Lack of Personal Achievement. This dimension refers to the belief among employees that they are no longer capable of effectively performing their job tasks, leading to feelings of inadequacy and a sense of unfulfilled potential in their careers (Erkan, 2018). Employees experiencing a lack of personal achievement often feel disconnected from their successes and may struggle with low self-esteem and motivation. This sense of failure can cause them to withdraw from their responsibilities, avoid taking on new challenges, and ultimately contribute to a decline in overall job satisfaction. As a result, this dimension not only affects the individual employee's well-being but can also have a broader impact on team dynamics and the quality of service provided within the organization.
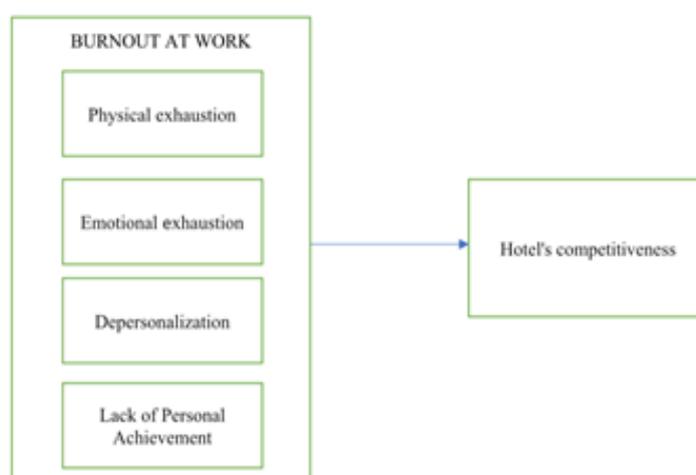

Figure 1 The reseach model

Each of these dimensions contributes to the impact of employee motivation, which is reflected in their workplace performance. The end result is an impact on the hotel's performance, i.e. its competitiveness. The above can be represented through the following model – Figure 1.

Based on the presented model, it is possible to set the basic hypothesis H1: burnout of hotel employees in the Republic of Serbia negatively affects the competitiveness of hotels. In addition to this hypothesis, it is possible to set the hypothesis H2, which states that emotional exhaustion as a dimension of burnout at work has the greatest negative impact on the competitiveness of hotels. Hypothesis H2, thus set, allows us to answer the question of which dimension of burnout at work has the greatest negative impact on the behavior of hotel employees, and thus a negative impact on the competitiveness of hotels.

METHODOLOGY AND RESEARCH VARIABLES

The study was conducted with a sample of 132 employees across 16 hotels in the Republic of Serbia. Participants were employed at three organizational levels: strategic level (16 participants), middle management level (46 participants), and operational level (70 participants). The sample size was determined based on the overall population size, the desired confidence level, and the acceptable margin of sampling error. Employees completed the questionnaire during the year 2024, and all questionnaires were filled out validly. The research involved a sample of 16 hotels in the Republic of Serbia, with capacities varying from 20 to 450 accommodation units and ranging from 1 to 5 stars. Data collection took place in 2024 using a structured questionnaire based on relevant theoretical frameworks found in existing literature. Specifically, the questionnaire items were developed with consideration to previous studies about, the process of burnout. More specifically, the questionnaire includes four sub-scales designed to measure the previously described dimensions of workplace burnout, as well as a sub-scale that evaluates employee performance. In total, the questionnaire consists of 21 items: 4 items related to workplace performance, 4 items addressing physical exhaustion, depersonalization, and lack of personal accomplishment, and 5 items focused on emotional exhaustion among employees. These items are presented in Table 1.

The validity of the questionnaire was assessed using factor analysis (FA). Participants rated the statements on a five-point Likert scale, ranging from (1) "strongly disagree" to (5) "strongly agree." The adequacy of the sample was evaluated through the Kaiser-Meyer-Olkin test (test value = 0.828). Additionally, Bartlett's test of sphericity was performed ($\chi2(210) = 1099.7$). The results of the questionnaire validation are outlined in Table 1, indicating that Promax rotation was utilized. The findings from the FA indicate that the items are grouped as expected, with factor loadings exceeding 0.3. The average extracted variance (AVE) for each sub-scale is greater than 0.5, which suggests convergent validity of the questionnaire. Furthermore, the reliability coefficient is above 0.7, indicating the questionnaire's reliability. Additionally, the collected data were processed using the statistical package for social sciences (JASP) and the AMOS software for structural equation modeling (SEM).

Although hotel competitiveness can be expressed in different ways, that are not always and fully linked to financial metrics, they are most often represented in terms of financial results, namely realized profit, for the purposes of this research it is expressed through the coefficient of technical efficiency. Technical Efficiency Gap (TEG) was used because it is a measure of success that takes into account all inputs and outputs. The hotel business performance is expressed through technical efficiency which represents a comprehensive measure of hotel business success as it takes into account all inputs and outputs (Assaf et al., 2015), and mathematically it can be expressed as follows:

$$\hat{\delta}_i = \max_{\hat{\delta}_i \lambda} \left\{ \delta > 0 \big| \hat{\delta}_i, y_i \leq \sum_{i=1}^{n} y_i \lambda : x_i \geq \sum_{i=1}^{n} x_i \lambda; \sum_{i=1}^{n} \lambda = 1; \ \lambda \geq 0 \right\} \tag{1}$$

where $\hat{\delta}_i$ is the technical efficiency indicator of the ith hotel, y_i the output vector of the ith hotel x_i the input vector of the ith hotel and λ is the n x 1 vector of model constants. The research utilized a technique called data envelopment analysis (DEA) to determine the parameter values of the model. In particular, the study employed the DEA double bootstrapping procedure.

Table 1: Questionnaire on the impact of burnout at work on the performance of hotel employees on hotel performance

		Item	Source	Factor loadings	AVE	Reliability
Dimensions of burnout at work	Physical Exhaustion (FE)	In the last month, I still felt tired after finishing work.	Stojilkovic & Malenović Nikolić (2023)	0.775	0.57	0.84
		In the last month, I still feel headaches when I face work tasks.		0.563		
		In the last month, I still have sleep disorders.		0.873		
		In the last month, I felt that there was a change in my diet.		0.784		
	Emotional Exhaustion (EI)	I have been feeling anxious for the past month.	(Harjanti & Todani, (2019).	0.798	0.63	0.89
		In the past month, I have lost my enthusiasm for doing everyday activities.		0.813		
		In the past month, I have had difficulty concentrating.		0.784		
		In the past month, I have had difficulty getting out of a problem I am facing.		0.747		
		In the past month, I have always felt like I am working under duress.		0.833		
	Depersonalization (DE)	In the last month, I have not cared about colleagues who have problems at work.	Erkan (2019)	0.703	0.63	0.81
		In the last month, I often ignore conversations when colleagues start a conversation.		0.863		
		In the last month, I have been reluctant to socialize with colleagues.		0.694		
		In the last month, I have felt reluctant to work in teams.		0.901		
	Lack of Personal Achievement (LPA)	In the past month, I have felt unable to complete work tasks.	Walters & Raybould (2007)	0.673	0.58	0.85
		In the past month, I have felt insecure about the development of my competencies.		0.784		
		In the past month, I have felt pessimistic about the goals I will achieve.		0.736		
		In the past month, I have felt that I will never be able to achieve success in the future.		0.863		
Workplace performance (EII)		I always do my work carefully.	Stojilkovic & Malenović Nikolić (2023)	0.742	0.59	0.85
		I managed to complete the task well.		0.699		
		I am sure that my work tasks are in line with the expertise I have.		0.711		
		I can do several tasks at once.		0.898		

ANALYSIS AND DISCUSSION OF THE OBTAINED RESULTS

The results of the research are shown in Table 2. As can be seen from Table 2, the model met all the goodness-of-fit indices. This further means that the analysis of the obtained data can be started. All coefficients are statistically significant. The testing was performed at a confidence level of 0.05. Since

all coefficients have a negative sign and are statistically significant, it can be concluded that the hypothesis H1 can be accepted as valid.

Table 2: Research results

Latent factor	Coefficient	St. error	Z-test	p-value
TEG - FE	- 0.231	0.021	-11.000	0.000
TEG - EI	-0.288	0.013	-22.154	0.000
TEG - DE	-0.175	0.022	-7.955	0.000
TEG - PLA	-0.161	0.017	-9.471	0.000
Fit index: CFI = 0.992; TLI = 0.901; NNFI = 0.898; RNI = 0.895; RMSEA = 0.017; SRMR = 0.033				

Source: Authors

The research results also show that hypothesis H2 can be accepted as valid, since emotional exhaustion has the greatest negative impact on hotel competitiveness. The research results also show that hypothesis H2 can be accepted as valid, since emotional exhaustion has the greatest negative impact on hotel competitiveness. Next comes physical exhaustion, then depersonalization. Lack of Personal Achievement has the most significant negative impact on hotel competitiveness.

CONCLUSION

The obtained results have a number of implications. The research findings reveal a significant negative relationship between employee burnout dimensions - specifically emotional exhaustion, physical exhaustion, depersonalization, and lack of personal achievement - and hotel competitiveness, with emotional exhaustion having the most pronounced detrimental effect. Consequently, it is imperative for hotel management to prioritize employee well-being by implementing support systems such as counseling and stress management programs, promoting work-life balance through flexible policies, and providing professional development opportunities to enhance skillsets. Additionally, recognizing and rewarding employee contributions can mitigate feelings of depersonalization and inadequacy, while regular assessments of employee satisfaction can enable proactive management strategies to combat burnout. By adopting these measures, hotels can improve staff morale, reduce burnout, and strengthen their competitive position in the market. The implications of these findings underscore the need for hotel management to address the root causes of dysfunctional guest behavior and create a supportive work environment that can help mitigate the adverse effects on employee burnout. By recognizing the correlation between guest behavior and staff well-being, hotels can implement strategies that foster healthier interactions, thereby enhancing both employee satisfaction and overall competitiveness in the industry.

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THE INFLUENCE OF LEADERSHIP AND ORGANIZATIONAL CULTURE ON EMPLOYEE CREATIVITY

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ABSTRACT

Modern business requires employees, in addition to professional competences, to easily adapt to changes and to be creative. Employee creativity is a key factor for innovation and long-term success of organizations. For this reason, it is necessary to stimulate creativity among employees. The role of leaders in organizations is to motivate and encourage their employees to be creative. Also, the organizational culture should be such that it stimulates creativity among employees. By reviewing the literature, this paper will show the mutual influence of leadership and organizational culture, as well as their influence on the creativity of employees.

Keywords: Creativity, Leadership, Organizational culture.

INTRODUCTION

The characteristics of the modern business environment are rapid technological changes, global competition and the constant need to adapt to market requirements and constant innovation. For this reason, creativity is a key characteristic required from employees. Employee creativity is the ability to generate new and useful ideas related to products, services and ways of working (Amabile, 2013). Creativity in the workplace is a critical ability of an organization to innovate, gain competitive advantage, increase success and improve long-term organizational performance.

The creativity of employees largely depends on the environment in which they work. The environment is primarily formed by leadership and organizational culture. Leaders by their example, but also by the way they lead their followers, encourage or stifle their creativity. The task of leaders should be to inspire, support and encourage employees to think outside the established framework, to freely express their opinion, present ideas and not be afraid of mistakes (Holinger, Gerard & Peter 2025). On the other hand, organizational culture defines what is acceptable and desirable in the collective and individual actions of employees. That is why cultures that foster openness, flexibility, do not have a strictly established hierarchy and have tolerance for mistakes encourage creativity and innovation in employees (Egide, 2024).

Leadership and organizational culture are interdependent. When there is alignment between the leader's values and the organizational culture, employees are more motivated to innovate and take initiative, that is, they are more creative. This synergy is the basis for the organization's sustainable creativity and competitive advantage (Maj, 2023).

THE CONCEPT AND IMPORTANCE OF EMPLOYEE CREATIVITY IN MODERN BUSINESS

One of the most important components of competitiveness, sustainability and innovativeness of organizations in modern business is the creativity of employees. Creativity can be defined as the ability of an individual or a team to generate ideas that are new, original and useful for solving problems, improving products or services (Amabile, 2013). Creativity is not only related to the domain of art, but today it is becoming an increasingly important aspect of business decision-making, strategic development and change management. As organizations operate in conditions of rapid social and technological change, the need for creative employees is growing. Employee creativity enables organizations to better respond to change, as well as to recognize new business opportunities, develop products, improve services, and generally respond to new consumer demands (Zhang & Zhao, 2021). The importance of employee creativity is multifaceted. Employees who can express their creativity are involved in the generation and realization of ideas. As a result, their emotional connection with the organization grows, which further leads to greater productivity, loyalty and job satisfaction (Arthur, et al., 2022). Within teams, creativity contributes to better cooperation, problem solving and decision making, because everything is viewed from multiple angles. Teams that successfully combine different opinions and perspectives often come up with original solutions that individuals would not have developed on their own. Also, the creativity of employees affects the reputation, brand and market success of the organization (Zhang & Zhao, 2021). Organizations that foster a culture of creativity and innovation attract creative and talented individuals, as well as partners and investors, which leads them to leadership positions in their industry.

Modern research emphasizes that creativity is not just an innate trait, but rather a skill that can be developed through practice, training, and a supportive work environment. The development of employees' creative potential is facilitated by a work environment that encourages diversity and exchange of opinions, values ideas, and allows and does not punish mistakes. Therefore, leaders and organizational culture play a key role in the development of creativity in employees (De Clarcq, & Pereira, 2020; Carmeli, & Reiter-Palmon, 2010). Digitization and work in virtual teams have brought new challenges and opportunities for employees to express their creativity. Digital tools not only speed up work processes, but also free employees from repetitive tasks, leaving them more time for creative problem solving. . In an environment that uses modern technologies, employees have access to rich sources of information and inspiration, which further encourages the development of innovative solutions (Ali Taha, Sirková, & Ferencová, 2016). Tools such as visual platforms, design software and collaborative applications encourage team creativity and the exchange of ideas in real time. When digital literacy is combined with open access to ideas, a space is created where employee creativity can truly flourish and contribute to the progress of the organization.

It is also important to point out that creativity is not reserved only for individuals in an organization, such as creative directors or members of research and development teams, it can (and must) be present in all parts of the organization (Amabile, 2013).

LEADERSHIP AND CREATIVITY

Defining leadership

Leadership is the process of influencing others to achieve common goals. It is a complex organizational process, which is realized through the interaction of the leader and his followers, in which the leader supports and modifies the attitudes of the followers (Sajfert, 2012). It represents the ability to inspire and motivate people, not just manage or command them. Leadership is reflected in responsibility and the ability to direct the team towards a common vision. Being a leader means recognizing the potential in others, empowering them and building mutual trust. A true leader is not one who builds authority through his position, but through personal example, integrity and consistency. Effective leadership

requires emotional intelligence, courage and readiness for continuous personal development. Leaders should not (and must not!) avoid challenges, but must embrace them and lead followers through them. Through his actions, the leader encourages change, promotes cooperation and contributes to the realization of a common vision (Siswanti, & Muafi, 2025).

In the literature, one can find numerous divisions into leadership styles, such as: democratic and autocratic or directive and participative, but the following leadership styles are most often analyzed (Gelaidan, Al-Swidi, Al-Hakimi, 2024; Shafique, Ahmad, Kalyar, 2020; Siswanti, & Muafi, 2025):

- transformational leaders - inspire their followers to put common interests and goals before personal interests. They create a strong vision for the future and motivate the team to develop and constantly improve. Transformational leaders act as mentors, encouraging creative thinking and taking initiative. Their leadership is effective in times of constant change;
- transactional leaders - they rely on clear structures, that is, they act on the principle of reward and punishment, in order to motivate followers. This style of leadership is reflected in clearly and precisely defined goals, with precisely defined rules and time frames that must be respected. For transactional leaders, the most important thing is that the work is done accurately and efficiently, with strict adherence to the rules, while creativity and innovation are on the second plan;
- laissez-faire leaders - actually represents a leaderless style of driving, that is, in this case, leaders leave their followers with great autonomy and independence in their work. They show great confidence in the abilities of their followers, however, this can lead to a drop in motivation, poor organization, a drop in productivity, etc. This style is most often present in creative industries or in research teams;
- authentic leaders - they lead based on their personal values, attitudes and beliefs, so they are often called ethical leaders. Their leadership is based on ethics, integrity and concern for the well-being of the team. Authentic leaders encourage open communication, respect for diversity and creating a positive work climate and healthy work environment.

The impact of leadership on creativity

Leadership is one of the most powerful factors influencing employee behavior and performance. For this reason, it can be said that it has a very strong influence on encouraging or inhibiting creativity among employees. A leader is the one who directs employees, or their followers, towards achieving goals. He should create an atmosphere that supports openness, communication and the exchange of ideas (Vukadinović, 2022). The role of leadership in encouraging creativity is reflected, first of all, in its ability to develop a climate of psychological safety. Psychological safety means the feeling that employees can express their ideas, ask questions or admit mistakes without fear of punishment, ridicule and belittlement. Leaders who encourage this kind of atmosphere influence employees to freely explore, learn from their own mistakes, which is a basic prerequisite for creativity. Leaders also show us by their example what is valued in the organization. If a leader emphasizes the importance of creativity and innovation, sets challenging goals, and provides support to employees, they will be more motivated to express themselves in this way. In addition, the leader himself must show curiosity, flexibility, a willingness to change and solve problems in a different way, that is, he must be creative (Holinger, Gerard & Peter, 2025).

Research has shown that different leadership styles have different effects on creativity. A transformational leader has a visionary approach and works to encourage employee creativity. On the other hand, a transactional leader tends to complete tasks according to strictly defined rules and lacks the flexibility that is crucial for expressing creativity. A laissez-faire leader is minimally involved in managing employees and therefore often misses the opportunity to motivate and stimulate employees towards creativity and innovation. Authentic leaders build a relationship of trust with employees and thus encourage open communication and thus positively influence the expression of employee creativity (Gelaidan, Al-Swidi, Al-Hakimi, 2024; Shafique, Ahmad, Kalyar, 2020; Siswanti, & Muafi, 2025). Leaders who successfully encourage creativity in their employees apply the following strategies (Holinger, Gerard & Peter, 2025):

− setting challenging goals - high, but achievable goals that will motivate employees to think outside the box;
− enabling autonomy - assigning tasks, without precisely defining how to solve them;
− developing team diversity - creating a team of people with different knowledge, skills, experiences and perspectives;
− recognizing and rewarding ideas - motivating all employees to participate in expressing ideas;
− creating a space for learning - organizing workshops in which knowledge and ideas will be exchanged.

ORGANIZATIONAL CULTURE AND CREATIVITY

Defining organizational culture

Culture is a social category that exists only within social groups, such as nations, professions, social classes, organizations, etc. The concept of culture unites a number of elements from which stand out: tradition, customs, value system, habits, beliefs, attitudes, understandings, norms of behavior and others. Organizational culture generally refers to a system of assumptions, beliefs, values and norms of behavior developed and adopted by members of an organization through common experience, which are manifested through symbols and which guide their thinking and behavior (Egide, 2024). Employees understand organizational culture based on what they see, hear and experience within the organization. There are seven dimensions that go into the essence of organizational culture. Based on these seven dimensions, a complex picture of organizational culture is obtained (Luo, Cai, & Zhang, 2024):
− attention to detail - it means the degree to which employees are expected to be precise, analytical and detailed;
− ultimate orientation - the degree to which managers are concerned with the results and outcomes of work, and not with the way in which the results were achieved;
− human orientation - the degree to which management decisions have an impact on people in the organization;
− team orientation - the degree to which work is organized around teams and not individually;
− aggressiveness - degree of aggressiveness and competitive spirit of employees and their uncooperativeness);
− stability - the degree to which organizational decisions and procedures support the maintenance of the status quo;
− innovation and risk-taking - the degree to which employees are encouraged to be innovative and take risks.

All successful organizations have a strong culture, made up of certain values and beliefs. Organizational culture affects the success of the organization in many ways, the most important of which are: influence on making strategic decisions, influence on changes in adaptation to the environment, influence on coordination in the organization, influence on the mechanism of control of employee behavior, influence on the reduction of conflicts in the organization, and influence on motivation (Lukić, et al., 2014).

The influence of organizational culture on creativity

Organizational culture has a strong and immediate influence on the creativity of employees, because it creates a framework within which ideas are born, developed and/or discarded. It determines what is desirable behavior in the organization, how to react to mistakes and failure, what is the relationship between different hierarchical levels, etc. When an organization encourages openness, experimentation, and collaboration, the potential for developing creative ideas increases. Organizations that have organizational social orders that develop versatility, adaptability and energize movement are more conducive to creative ability. In such an environment, laborers feel free to propose headways and viably take portion in handling issues (Ahmed, 2023). Another imperative viewpoint of the affect of organizational culture on creative energy is the level of communication and straightforwardness. Organizational social orders that enable data sharing make an environment where creative energy gets to

be a shared quality. In this way, more high-quality and germane courses of action are gotten. In separate to such organizations, organizations with an organizational culture that advocates control, formal procedures, and similitude cover creative energy among agents. As well as organizations where a strict chain of command is built up and where mistakes are rebuked. In such cases, agents favor to remain calm or possibly than appear an thought that appear be disdained or rejected (Luo, Cai, & Zhang, 2024). Organizations that successfully develop a culture of creativity typically invest in (Ahmed, 2023):

−   clearly communicated values that favor innovation and experimentation;
−   reward systems that recognize and encourage creative initiatives;
−   trainings and workshops for the development of creative thinking and problem solving;
−   infrastructure that enables rapid testing and implementation of ideas (eg internal incubators, innovation laboratories);
−   the role of leaders as cultural architects who shape norms and expectations with their behavior.

There is no single organizational culture that can be considered universally ideal for all organizations. Modern approaches to management emphasize the importance of the alignment of the organizational culture with the strategy and structure of the organization, because this connection directly affects its efficiency and competitive ability. In this context, organizations are obliged to shape and continuously adapt their culture in accordance with industry dynamics and market specificities. Such adaptability allows not only better integration of organizational goals and employees, but also creates an environment that encourages innovation and creative thinking among team members (Egide, 2024).

THE SYNERGISTIC IMPACT OF LEADERSHIP AND ORGANIZATIONAL CULTURE ON EMPLOYEE CREATIVITY

Leaders have the key decision in shaping the organizational culture, because with their values, beliefs, and behavior they determine the direction the organization takes. Leaders shape culture through symbolic actions and rituals, that is, the way they treat successful and unsuccessful ideas. Also, through communication, management style and the way they resolve conflicts, leaders convey messages about what is acceptable and what is not. Those who emphasize the importance of open communication influence the building of a positive organizational culture (Carmeli, & Reiter-Palmon, 2010). On the other hand, the limiting culture itself shapes leadership. Organizational culture sets limits, but also possibilities. More open and flexible cultures give leaders more freedom to experiment, encourage collaboration and recognize innovative initiatives. Thus, there is a feedback loop between leadership and organizational culture (Ali Taha, Sirková, & Ferencová, 2016).

When leadership style and organizational culture are mutually supportive, the effect on employee creativity is very strong. A leader who stimulates his followers to express ideas in a culture where flexibility, risk-taking is represented further increases the creative potential of employees, through inspiration, vision and support. The joint strength of leaders and organizational culture, which stimulate the creativity of employees, will achieve the highest goals (Rabbani, Imran, & Kamal, 2014; Maj, 2023).

CONCLUSION

The interaction of leadership and organizational culture has a decisive influence on the creativity of employees. When leadership and organizational culture are aligned to support creativity, organizations become dynamic and innovative places, where employees are not afraid to express their ideas. In order to create such conditions, leaders must first of all be the ones who will show by their example what the true values are. They must be the ones who are ready to take risks, change, enable freedom of thought, as well as provide support mechanisms for the implementation of new ideas. It is also important for organizations to develop a two-way communication system, where ideas and feedback do not flow only from the top down, but from the bottom up. In this way, a culture is encouraged in which employees are encouraged to contribute to creative problem solving. It is also recommended to use digital tools that enable collaboration and exchange of ideas. Encouraging creativity in employees is not a simple, easy

one-time job. It requires long-term commitment and a strategic approach. Organizations should develop a culture of continuous improvement and systematically monitor the effects of their initiatives on creativity.

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EFFECTS OF THE APPLICATION OF ARTIFICIAL INTELLIGENCE ON TIME AND COST SAVING IN THE SELECTION PROCESS

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ABSTRACT

In modern business, companies face the challenges of increasingly complex and time-consuming recruitment processes along with an unstable labor market. Artificial intelligence takes a significant place in the work of the human resources department, in order to bridge this gap above all. This paper investigates the effects of the application of artificial intelligence in the recruitment and selection of candidates, with special reference to the possibilities for saving time and costs of employment. Research in a trading company analyzed the effects of applying artificial intelligence for the automatic review of candidate biographies on a sample of 1000 applications. The results indicate significant advantages of artificial intelligence in terms of speed of selection and efficiency of the process compared to the traditional way of reviewing applications by recruiters. The goal of the paper is to show HR leaders how and to what extent artificial intelligence contributes to saving time and costs and to provide them with an insight into the significant benefits of the proper application of artificial intelligence in human resource management. The results confirm the hypothesis that companies have significant benefits and savings in time and costs, using artificial intelligence in the selection of candidates. Based on the findings, the paper offers concrete recommendations for the practical application of artificial intelligence in human resources, with an emphasis on the need for further research on the degree of concordance between artificial intelligence ratings and recruiter ratings for the same set of candidate resumes.

Keywords: Artificial intelligence, Selection, Candidate resume, Recruitment costs, Time saving.

INTRODUCTION

Due to the digitization of business processes and the optimization of costs and time in work processes, artificial intelligence has also found significant application in the area of human resources. In their operations, companies have recognized all the benefits that artificial intelligence brings in cost savings. In the daily work tasks of human resources employees, the application of artificial intelligence in the part of recruitment and selection significantly reduces the workload of recruiters and contributes to the optimization of time, in order to enable the best selection of candidates among hundreds of applicants (Triola et al., 2023). Also, artificial intelligence tools reduce the fatigue of recruiters when reviewing candidate resumes using certain programmed algorithms with a certain number of defined metrics and characteristics, which are highly reliable (Burk-Rafel et al., 2021). Companies have an interest in applying artificial intelligence in the recruitment of candidates, as long as the final outcomes of the selection process are expected to be part of the recruiter's decision and there will be no deterministic factor (Tulshian, 2024). The use of artificial intelligence in the part of evaluation of the biography and assessment of candidates is particularly convenient, because the selection process can be completed in a shorter time frame, without mistakes and with a smaller volume of administration. In this way, it is

possible to review a large database of candidate biographies with complete objectivity (Hassan et al., 2025).

On the other hand, the implementation of artificial intelligence in human resources processes raises other issues, which are related to ethics, control over systems and proper balancing. It is suggested that AI is best used as a complementary tool rather than a substitute for the recruiter who needs to make the final decision, to ensure a balanced and effective use of AI tools (Almeida et al., 2025). Companies are entrusted with the responsibility to properly establish a balance between all the benefits and challenges brought by the application of artificial intelligence in the field of human resource management.

THEORETICAL BASIS OF THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN THE FIELD OF HUMAN RESOURCES

The integration of artificial intelligence in human resource management is a significant challenge, especially in the area of selection where it is already widespread. The results indicate that the application of artificial intelligence can complement the traditional method of reviewing candidate resumes in a way that is reliable with clear identification of those candidates who match the required job requirements (Kim et al., 2025). Use of technologies such as voice analysis and visual recognition, artificial intelligence allows organizations to take a deeper look at the capabilities and potential of candidates during the interview process, thus opening up additional space for a more accurate assessment of relevant competencies (Salgado et al., 2013). The integration of artificial intelligence into human resource management needs to be transparent and reliable for all interested parties, which requires a certain balancing between all goals. Some research recommends a three-balance model, which offers a framework for aligning priorities and optimizing AI adoption (Zhang, 2025). This suggests that the application of artificial intelligence in cooperation with HR experts can significantly improve processes in human resource management.

The labor market is constantly changing at a high speed and the lack of employees is an obvious challenge for many companies, and the speed of recruitment, especially for low-skilled jobs, becomes one of the key factors for successfully finding qualified employees (Vetráková et al., 2018). Artificial intelligence can help the recruiter to reduce the time of the selection process, by being used in administrative and operational activities that take a lot of time and can be automated, as well as in the verification of resumes, allowing for faster and more efficient decision-making (Horodyski, 2023). In Koman's research (Koman et al., 2024), it is stated that the software company "Intelion Systems" from Canada reported that the use of artificial intelligence in recruitment will grow from 35% to 45% of companies in 2023 in the world, while in a research in Serbia conducted by the human resources agency „O.U.R. HR Fabrika" (O.U.R. HR Fabrika, 2025) states that 70.6% of companies in Serbia in 2025 use artificial intelligence in human resource management processes, of which 27.1% are in the field of selection. Also, 72% of resumes, which are sent to American companies, are not reviewed by recruiters but by artificial intelligence systems (Goretzko & Israel, 2022). The gradual integration of artificial intelligence in resume analysis is becoming a common and necessary tool that significantly improves the efficiency and accuracy of this process (Koman et al., 2024). Automated systems are being created, which scan resumes very quickly, analyzing various factors and ensuring a fair and objective selection of candidates without mistakes in the selection process.

Certain research proves that artificial intelligence also contributes to building a positive employer brand (Zhao et al., 2019), which is another significant benefit that companies have. What is necessary is to ensure the trust and transparency of candidates and recruiters, so that they clearly understand how artificial intelligence makes decisions and processes their data (Chowdhury et al., 2023). The results show that transparency is still unsatisfactory and that the inclusion of information asymmetry management in future human resource management research would contribute to its increase, thereby improving the framework for responsible and ethical decision-making (Mori et al., 2025). The use of artificial intelligence can significantly contribute to improving the performance of companies, especially when the human resources sector is actively involved in making and implementing key business

decisions (Zhou et al., 2021). Artificial intelligence, which is aimed at developing systems capable of solving complex tasks similar to human thinking, is increasingly recognized as one of the most promising solutions for improving human resource management functions - especially in the areas of recruitment and candidate selection (Van Esch & Black, 2019).

RESEARCH METHODOLOGY

This paper analyzes the effects of the application of artificial intelligence in the part of selection and the saving of time and costs in this process, using a literature review and the processing of new data through a case study conducted in a trading company. The subject of research is the role and application of artificial intelligence in the selection process in the automatic review of CVs and its impact on the duration and costs of the selection. The aim of this paper is to investigate the effectiveness of the application of artificial intelligence in the part of reviewing the candidate's biography and assessing the candidate's compatibility with the appropriate position. Also, the paper aims to examine whether, how and to what extent artificial intelligence contributes to saving time and costs in the selection process.

This work is based on a basic hypothesis from which two auxiliary hypotheses arise, which will be examined:

H0: By applying artificial intelligence in the selection of candidates, companies have significant benefits and savings.

H1: The total time of the selection process is significantly reduced by applying artificial intelligence.

H2: Selection costs are reduced by automating resume analysis.

The research includes quantitative methods, which are related to the analysis and processing of the obtained data on the time and costs of the selection obtained through the conducted case study. The research methodology is designed so that through the analysis of relevant literature and the implementation of testing, the work provides insight into the current situation and creates proposals for the application of artificial intelligence in a certain part of the selection. The research was conducted in May 2025 in the trading company BB Trade doo - DTL PerSu Marketi, which has over 1350 employees and publishes an average of 46 job advertisements per year. The number of applications received through advertising in 2023 was 5,827 CVs, in 2024, 5,021 candidates applied, and for the first 4 months of 2025, the number of advertisements was 21 and 2,542 candidate CVs were received. The time of an experienced recruiter (who has more than 10 years of work experience in selection) needed to review 1000 received resumes for specific ads was measured. After that, the time required by the artificial intelligence software to review these applications and rate them was measured. Also measured was the time it takes the recruiter to read the summary of CVs, which was created by artificial intelligence, and to evaluate the received applications based on them, without reading the entire CV of the candidate. After that, a comparative analysis of the time spent reviewing CVs was performed.

RESEARCH RESULTS

This section of the paper presents the results of the research and the effects on saving time and costs when applying artificial intelligence in the process of reviewing candidate biographies in relation to the recruiter. When reviewing the resume, the evaluation parameters were defined: work experience, knowledge of the consumer goods market, analytical and organizational skills, team management, knowledge of standards and technical specifications. The advertisements for which the CVs were reviewed were for positions in middle management.

Figure 1 shows the time it takes for a recruiter to review 1,000 applications, the time it takes for a semi-automated process where an AI summarizes a candidate's resume, and the recruiter reviews only the resumes, and the time it takes for the AI software to review the candidate's resume.
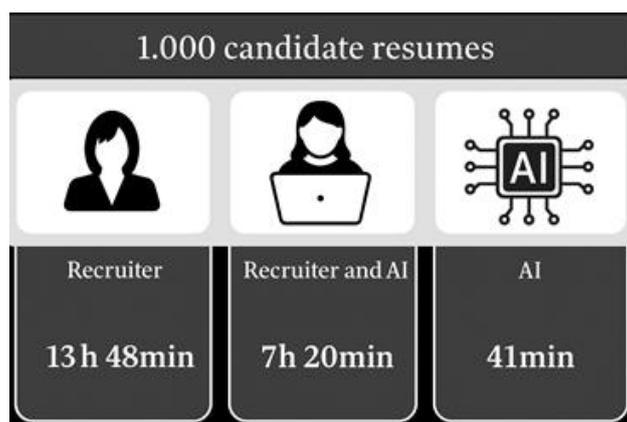
Figure 1: Comparative overview of the time spent by recruiters and artificial intelligence on reviewing 1000 candidate CVs in the selection process

The research confirmed the hypotheses that there are significant savings in time and costs when using artificial intelligence in the selection process. Compared to the traditional manual review of resumes, which is carried out by a recruiter and takes an average of 50 seconds per candidate resume, artificial intelligence systems review, sort and rate the same resume in less than 2 seconds, and perform an analysis of the resume with comments in less than 15 seconds. In this research on a sample of 1000 applications, the artificial intelligence system performed the categorization and initial selection of candidates in less than 41 minutes, while the recruiter needed 13 hours and 48 minutes for the same task. If we partially included artificial intelligence in the selection process to summarize candidate biographies for recruiters, the recruiters would recommend the time for reviewing applications to 7 hours and 20 minutes. The stated results of time saving confirm the auxiliary hypothesis H1: "The total time of the selection process is significantly reduced by the application of artificial intelligence."

The research also confirmed the auxiliary hypothesis H2 that there are reduced costs of selection through the use of artificial intelligence, but they are negligible in a small sample and a greater effect of savings in the recruiter's salary costs would be seen only in a large number of candidate applications for which he would need a greater number of working hours.

The key research findings are speed of review, reduction of administrative burden, reduction of selection costs and elimination of subjective bias and discrimination. This speed allows applications to be processed several times faster, especially in cases of mass tenders. The time of the selection process can be significantly reduced, because artificial intelligence is significantly faster than an experienced recruiter. This way the HR team can focus more on other parts of the selection process. The integration of artificial intelligence in the early stages of candidate selection enables companies to save significant time and operations, while maintaining or improving objectivity in decision-making, which confirms hypothesis H0: "By applying artificial intelligence in candidate selection, companies have significant benefits and savings."

DISCUSSION

The research results clearly indicate significant time savings brought by the application of artificial intelligence in the candidate selection process. Faster selection allows companies to shorten the overall duration of the hiring process, which makes them more competitive in the labor market, especially in conditions where quality candidates in retail find employment quickly. Also, an accelerated selection process can contribute to a more positive candidate experience, as it shortens the waiting time for feedback and increases the transparency of the process. In addition to time efficiency, additional benefits include consistency and standardization of selection criteria, reduction of subjective bias, and the ability to work with large volumes of data without increasing operating costs. Artificial intelligence systems use

algorithms, which apply equal parameters to all candidates, thereby contributing to the fairness of the process and minimizing the risks of discrimination.

However, in addition to the obvious advantages, it is important to point out certain limitations. Artificial intelligence tools are dependent on the quality of the input data. During the research, it was identified that artificial intelligence does not know the history of the companies where the candidates worked, their results, the size and specificity of the business. Also, artificial intelligence is not yet fully capable of accurately assessing the soft skills, cultural fit or motivation of candidates, which remains the domain of human judgment in the later stages of selection. In certain studies, results have shown that there is only a 7% overlap between the candidates selected by the recruiter and the candidates selected by artificial intelligence for the next round of selection (Hassan et al., 2025). Recruiters who over-rely on AI advice in candidate selection make poorer decisions, because they do not distinguish between correct and incorrect advice, even when it is explained (Cecil et al., 2024). Also, there is concern among recruiters regarding the potential loss of personal interaction (Almeida et al., 2025). Some research joins these claims from the point of view of the candidates stating that there is less interest in the selection process if the candidates know that artificial intelligence is involved in the process (Keppeler, 2024), while other research states that the candidates declared that they would participate in the selection process regardless of the application of artificial intelligence (Gopi Krishnan et al., 2022).

In this context, the most effective approach does not imply complete automation, but rather a hybrid model in which artificial intelligence takes over the initial selection, while the final decision is made with the involvement of HR recruiters. Specifically, the quality of selected candidates improves by 67% by adding just one recruiter assessment to the hiring process (Chakraborty et al., 2025).

CONCLUSION

The application of artificial intelligence in the human resources sector will increase even more in the coming period, so that the company can respond to all the changes brought about by the workforce and digitalization. Artificial intelligence can help recruiters to free up the operational part of their work, so that they can focus on candidates and use even more of the expertise they have. The application of artificial intelligence in areas such as automatic CV review and assessment of the candidate's match with the job brings significant benefits. The analysis of a specific case of the implementation of artificial intelligence in the selection process showed that there is a significant saving of time and a reduction in selection costs. On the other hand, the understanding, flexibility, empathy and intuition of recruiters will always have an important place in the selection process and cannot be replaced. When artificial intelligence is used correctly, the selection of good candidates can be achieved in a much more economical way for employers by more efficiently screening a large number of candidates. It is necessary to gradually integrate artificial intelligence tools into the existing HR process, starting with the simplest tasks, and then train HR employees to work on AI platforms, in order to maximize their functionality and reduce resistance to change. It is also necessary to educate candidates, in order to maintain trust and avoid ethical dilemmas. That is why transparency is very important in the process of applying artificial intelligence.

The research clearly shows that artificial intelligence has the potential to transform traditional candidate selection practices, especially in the context of mass recruitment and time-sensitive industries. Its integration into the decision-making process should be strategically designed, with continuous monitoring of effects and ethical implications. There is room for further research in the area of reliability and validity of artificial intelligence tools in the candidate selection process. In particular, one of the relevant questions is the extent to which the ratings provided by artificial intelligence match the recruiters' assessments of the same candidates. The research of that compliance can contribute to a better understanding of the limits and potential of the Artificial Intelligence System, but also help in their calibration and adaptation to the specifics of the organization. Such an analysis would enable an objective assessment of whether artificial intelligence can be an equal or complementary tool in making personnel decisions.

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OVERVIEW OF STUDIES RELATED TO GENDER EQUITY IN LEADERSHIP: ETHICAL CHALLENGES AND SOLUTIONS FOR BREAKING THE GLASS CEILING

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ABSTRACT

This research examines the persistent gender disparities in leadership roles and the pervasive glass ceiling effect. Through a theoretical approach, the study analyzes barriers contributing to these disparities and identifies ethical solutions to dismantle them. Key factors such as mentorship, leadership development, work-life balance, and corporate accountability are discussed as essential strategies for fostering gender equity. The findings emphasize that a comprehensive and inclusive approach by organizations, coupled with individual efforts, can create an environment conducive to women's advancement into leadership positions.

Key words: Gender equity, women in leadership, glass ceiling effect, organizational diversity, inclusive workplace solutions

INTRODUCTION

Throughout history, management and leadership roles have been predominantly occupied by men, establishing a long-standing gender hierarchy. Traditionally, men and women have had distinct societal roles, particularly in the workplace. For centuries, women faced gender discrimination, but progress has been made in breaking through the so-called "glass ceiling." The term "glass ceiling" was first introduced by Marilyn Loden during a panel discussion at the Women's Exposition in New York in 1978. It describes the invisible social and systemic barriers that prevent individuals, particularly women, from advancing to executive and senior management roles despite their qualifications. These barriers often stem not from a lack of competence but from implicit biases, cultural norms, and unwritten societal rules. The *Wall Street Journal* popularized this concept in 1986, shedding light on the structural challenges women face in climbing the corporate ladder. Although women today are entering the workforce in greater numbers than ever before, top management positions remain largely male-dominated across the globe. It is essential to recognize that women managers are often restricted to lower-level positions with limited authority. Additionally, they are disproportionately concentrated in traditionally "female" functional areas within organizations, such as human resources, corporate communications, community and government relations, marketing, and finance (Krivkovich et al., 2024). As discussed in „Women and Leadership: Real Lives, Real Lessons", systemic cultural biases"and leadership stereotypes continue to hinder women's advancement to top roles (Gillard & Okonjo-Iweala, 2020). Furthermore, The Glass Cliff explores how women are often appointed to precarious leadership positions in times of crisis, reinforcing failure narratives and undermining long-term gender progress (Williams, 2023). In *"Through the Glass Ceiling: Reflections on Feminism from the C-Suite"*, real executive experiences demonstrate how structural and cultural barriers still define the professional journeys of women in leadership (Whittaker, 2024). The subject of this research is the issue of gender inequality in leadership, with a specific focus on the glass ceiling and related ethical implications. The goal is to identify ethical and practical solutions to overcome these barriers in the 21st century by analyzing the most recent scholarly literature.

METHODOLOGY

The subject and the problem of research
The subject of this research is gender inequality in leadership, with a specific focus on the ethical challenges surrounding the glass ceiling effect. The core problem lies in the continued underrepresentation of women in

senior leadership roles, despite their qualifications and growing presence in the workforce. This disparity is often caused by a complex interplay of societal, institutional, and personal barriers that hinder women's advancement. These include implicit bias, lack of mentorship and sponsorship, rigid organizational structures, and unequal work-life expectations.

Research goal
The research aims to explore this problem by conducting a structured analysis of recent academic literature and case studies. Using a theoretical approach, the study will identify and evaluate ethical strategies that organizations and policymakers can adopt to dismantle these barriers and promote gender equity in leadership.

Research question
Based on the defined problem and research objective, the following research questions have been formulated:
RQ1: What are the primary barriers contributing to the persistence of the glass ceiling in leadership roles?
RQ2: What strategies can organizations adopt to actively identify and address the glass ceiling within their structure?

Research method
This study employs a theoretical research approach, utilizing literature review, analysis, synthesis, and deduction to draw conclusions. It examines various methodologies used by other authors, evaluates their findings, and compares results to derive universal conclusions.

CHALLENGES TO WOMEN'S LEADERSHIP

The interplay of internal and external barriers

Women in leadership continue to face a complex interplay of challenges, commonly divided into "pull" and "push" factors. Pull factors refer to internal barriers, such as self-doubt, perfectionism, and fear of self-promotion, that can discourage women from pursuing or advancing in leadership roles. Push factors, in contrast, are external structural and cultural obstacles, including societal expectations, workplace dynamics, and limited access to influential professional networks. These internal and external pressures often interact, compounding the difficulties women face in advancing their careers (Zhao, S., 2020). A survey conducted by the Center for Creative Leadership highlighted three predominant challenges for women in leadership: negotiating financial compensation, overcoming perfectionism, and managing self-criticism. These findings underscore the intertwined nature of internal insecurities and external barriers. For example, many women struggle with imposter syndrome, low confidence, reluctance to speak up, and challenges in building strategic relationships with senior leaders or decision-makers, all of which hinder their ability to perform and grow professionally. One illustrative case of how push and pull factors converge is salary negotiation. Although many women express a desire for higher compensation, equal to or even greater than that of their male peers, they often hesitate to negotiate. Common pre-negotiation thoughts include: "I am not good at negotiation," "I don't think I'll get what I want," or "I dislike negotiating." These reflect internal constraints like self-criticism and discomfort with assertiveness, which act as pull factors. At the same time, persistent gender pay disparities demonstrate the enduring impact of systemic push factors. Mentorship is another critical yet lacking support structure. According to the global study "Mentoring Women in the Workplace" by Development Dimensions International (DDI), 63% of women reported never having had a formal mentor, despite 67% recognizing mentorship as highly important for career development.

The absence of formal mentoring programs limits access to guidance, role models, and sponsorship, key drivers of upward mobility, higher earnings, and leadership readiness. Additionally, women often adopt diverse approaches to career advancement. Some prioritize professional growth, while others navigate a dual commitment to work and caregiving. This balance can come at the cost of career progression (Khumaera & Bakar, 2024). The burden is especially heavy for the "sandwich generation" (ages 41–55), who simultaneously care for children and aging parents, making it harder to remain active in the workforce (Lendák-Kabók, 2022). Traditional gender roles further exacerbate this, as women are still disproportionately expected to manage household responsibilities, shaping both their availability and trajectory in professional life.

Despite ongoing efforts to promote workplace equality, a noticeable gap between men and women's earnings remains. The 2024 Gender Pay Gap Report illustrates this disparity through both controlled and uncontrolled

measures, as depicted in the accompanying image (Figure 1.). In controlled environments, where men and women hold the same job, possess equal qualifications, and have comparable experience, women earned $0.99 for every $1.00 earned by men. This indicates that while direct pay discrepancies have narrowed, a small but persistent gap remains. However, the uncontrolled gender pay gap, which measures the median earnings of all men and women across various industries, positions, and experience levels without adjustments for specific roles or qualifications, tells a different story. In 2024, this gap stood at $0.83, meaning that, on average, women earned only 83 cents for every dollar earned by men. This larger disparity highlights systemic challenges, including barriers to leadership positions and higher-paying industries, which disproportionately affect women's overall earnings.
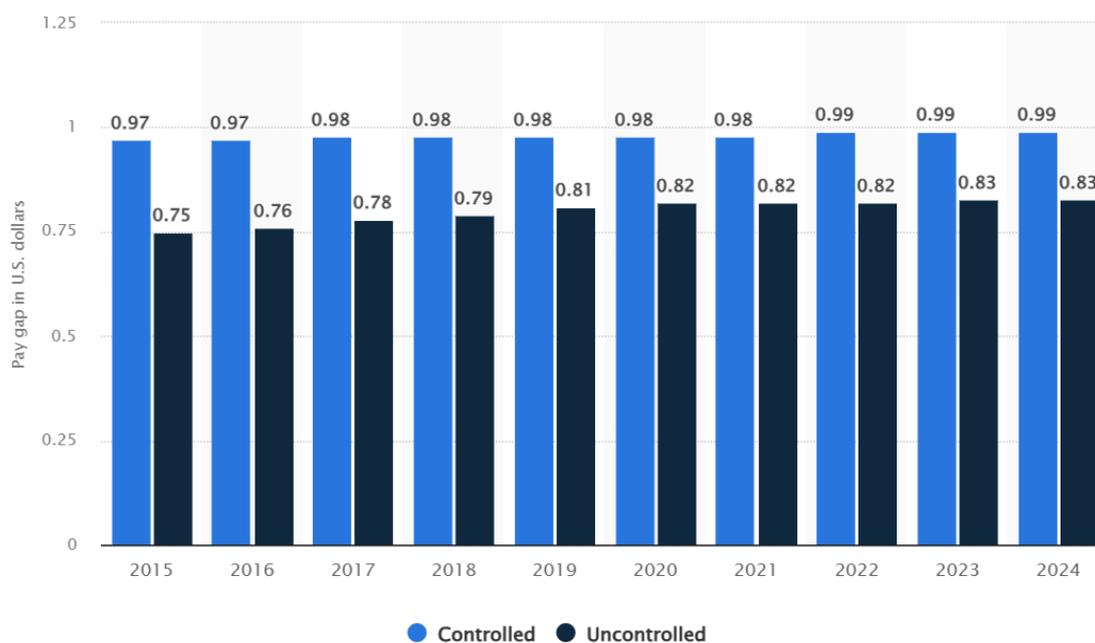

Figure 1. Global gender pay gap from 2015 to 2024, Source:Statista,
(https://www.statista.com/statistics/1212140/global-gender-pay-gap/#statisticContainer)

Overview of studies related to gender equity in leadership

Research on gender equity in leadership highlights a dual narrative of progress and persistent inequality. Since the mid-20th century, the global share of women in leadership roles has steadily increased, driven by broader societal and corporate efforts to enhance gender diversity. In selected countries, women held 33.3% of management positions in 2016, rising to 36.9% by 2022. However, the COVID-19 pandemic temporarily stalled this momentum, with representation stagnating at 35% between 2019 and 2020 before recovering to 36% in 2021 (World Economic Forum, 2022). In the EU-27, gender gaps are more pronounced at higher levels of leadership: in 2020, only 7.8% of CEO positions and 22.7% of management roles were held by women (Gender Equality European Institute, 2024). While women are relatively well-represented at entry- and mid-level positions, their numbers drop significantly in top-tier roles, demonstrating the continued presence of the "glass ceiling."

These structural patterns are clearly illustrated in the 2021 European Report by JRC and DG REGIO**,** which introduced two indices to map gender disparities in leadership across EU regions. The Female Achievement Index (FemAI) compares women's leadership success to top regions, while the Female Disadvantage Index (FemDI) shows how much women are disadvantaged relative to men. Both indices are constructed using 33 indicators across seven domains, including employment, education, and decision-making, and reveal wide regional variation. According to the European Commission's findings (Figures 2 and 3*),* women in metropolitan and economically developed regions tend to have greater access to leadership roles. In contrast, those in less developed or rural areas face more significant obstacles. This contrast underscores that gender inequality in

leadership is not only a question of individual advancement but also of regional opportunity and structural support.
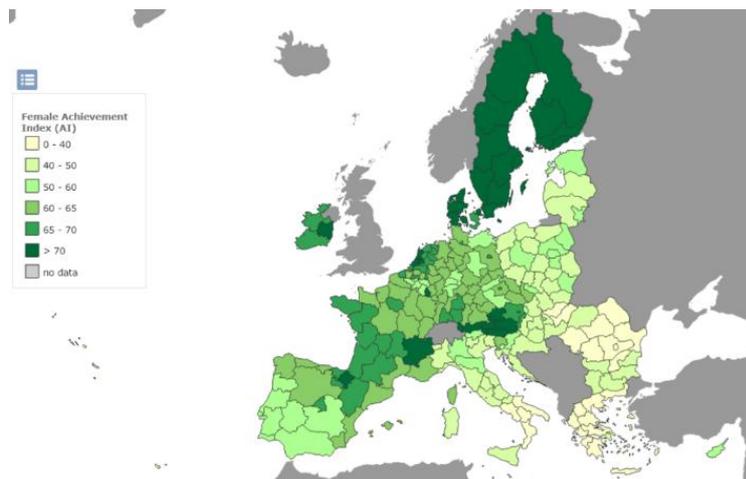

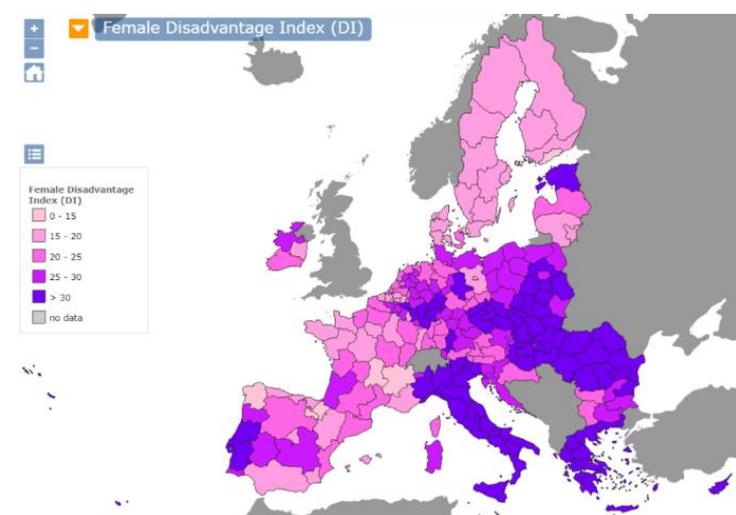*Figure 2: The EU regions where women thrive and where they are held back*

Figure 3: The EU regions where women thrive and where they are held back

Figure 4. highlights representation gaps across corporate ranks by gender and race (McKinsey & Company & LeanIn.Org, 2023). Women make up 48% of entry-level employees but only 39% of managers, 28% of senior vice presidents, and 29% of C-suite leaders—just 7% being women of color. White men, by contrast, hold 56% of C-suite roles. In 2024, for every 100 men promoted to manager, only 89 white women and even fewer women of color advanced. This imbalance limits women's leadership progression, underscoring the need for structural changes to foster diversity and inclusion.

RESULTS AND DISCUSSION

The glass ceiling continues to limit women's advancement into leadership roles, but targeted strategies grounded in ethical leadership and organizational commitment offer meaningful ways forward. While mentorship provides guidance, sponsorship, where influential leaders actively advocate for women's advancement, has proven to be even more effective. Recent data shows that women with sponsors are more likely to receive high-visibility assignments and experience faster career progression, although sponsorship programs have actually declined in recent years, highlighting the need for renewed attention to this area (McKinsey & LeanIn.Org, 2023). Leadership development programs that focus on strategic thinking, emotional intelligence (EI), and resilience have become increasingly important in preparing women for senior roles. Emotional intelligence, which the World Economic Forum ranked among the top leadership skills for 2024, supports inclusive communication, better team performance, and empathetic leadership. areas where women often excel (World Economic Forum, 2023). When paired with resilience, EI equips women to lead diverse teams effectively and to navigate the systemic and interpersonal challenges that often come with leadership roles. Balancing work and personal

responsibilities remains one of the biggest challenges women face in the workplace. Many still shoulder the majority of caregiving duties, which can make traditional career paths more difficult to navigate. That's why flexible policies, like remote work, childcare support, and job sharing, are proving so effective. Companies that embrace these practices not only retain more women but also foster a more diverse leadership pipeline. Initiatives like the "Family friendly workplaces" project are helping employers recognize that supporting working mothers isn't just ethical, it's smart business. Some large organizations have made meaningful strides. By the end of 2024, women held 30% of managing director roles at Accenture, reaching the company's diversity goal ahead of schedule (MarketScreener, 2024). However, in early 2025, the company announced it would be discontinuing formal diversity targets in response to legal and political shifts in the U.S. While the long-term impact of this change remains to be seen, Accenture's prior progress illustrates the power of sustained inclusion efforts. Achieving gender equity in leadership is not a question of possibility, but one of sustained commitment, organizational accountability, and the readiness to challenge entrenched norms. Progress depends on leaders who are willing to prioritize inclusion not just in policy, but in everyday decision-making and culture.
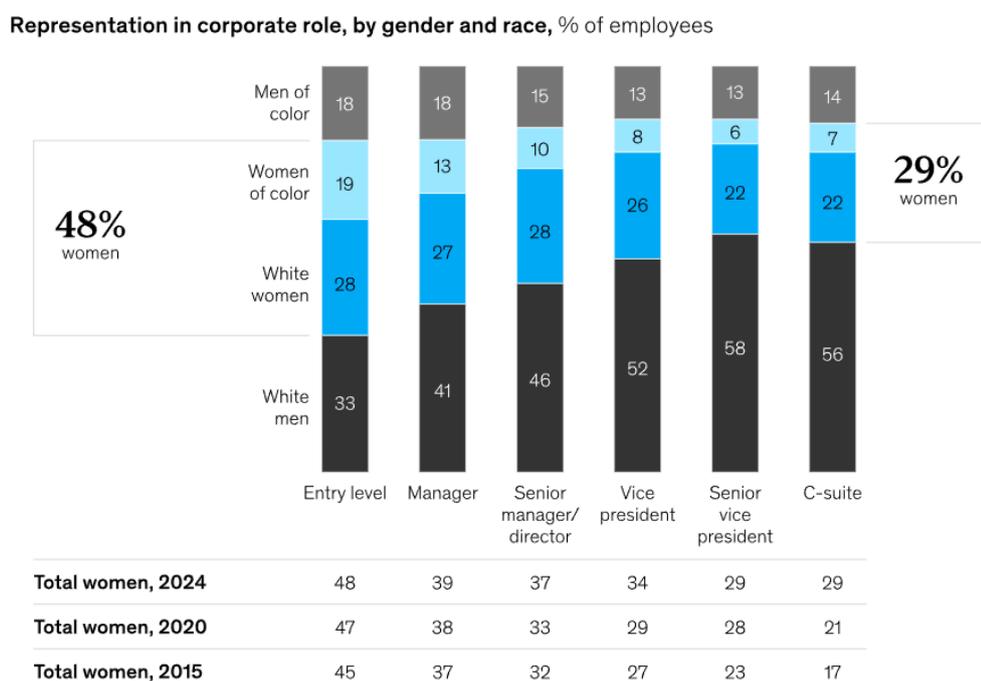
Representation in corporate role, % of employees

	Entry level	Manager	Senior manager/ director	Vice president	Senior vice president	C-suite
Men of color	18	18	15	13	13	14
Women of color	19	13	10	8	6	7
White women	28	27	28	26	22	22
White men	33	41	46	52	58	56

48% women

29% women

	Entry level	Manager	Senior manager/ director	Vice president	Senior vice president	C-suite
Total women, 2024	48	39	37	34	29	29
Total women, 2020	47	38	33	29	28	21
Total women, 2015	45	37	32	27	23	17

Figure 4: Representation in corporate role,by gender and race, Source:McKinsey&Company (https://www.mckinsey.com/featured-insights/diversity-and-inclusion/women-in-the-workplace#/)

CONCLUSION

The aim of this research was to understand the key barriers preventing women from reaching senior leadership roles and how businesses can begin to tear them down. The findings confirm that the glass ceiling is not constructed by a single factor, but a combination of internal ones like self-doubt or fear of inadequacy, and external barriers like gender prejudice, lack of exposure to mentoring or sponsorship, and pay inequity (RQ1). These forces intersect, creating a culture where women have to work twice as hard just to arrive at the same destination. Change is possible and it starts with action at the organizational level (RQ2). Sponsorship efforts, focused leadership development, and workplace policies can create a measurable difference. Supporting flexible work arrangements for women, compensating and advancing employees fairly and openly, and setting measurable diversity targets are just a few of the approaches corporations can leverage to construct improved leadership pipelines. metrics like the Female Achievement Index (FemAI) and the Female Disadvantage Index (FemDI) offer helpful feedback on regional shortfalls and drive decision-making on where help is needed. All that being said, this study is narrow. It's secondary research that doesn't include first-hand experience from women leaders today. Future research needs to investigate lived experience across different cultures, sectors, and identity groups to produce more complete solutions. Breaking the glass ceiling isn't a numbers problem, it's about changing systems, and that involves persistent effort, collaboration, and a desire to get things done differently.

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THE ANALYSIS AND MEASUREMENT OF JOB SATISFACTION AMONG DIGITAL DESIGNERS

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ABSTRACT

This paper presents the results of a study that investigates job satisfaction among digital designers, focusing on the processes they work on, their opportunities for further advancement through knowledge exchange, and good collaboration with colleagues and management. Job satisfaction activities and team collaboration are relationships based on creativity in design. The results suggest that during the design collaboration process, designers focused most of their efforts on job satisfaction. Differences between design environments had only a minor impact on the amount of effort invested in job satisfaction activities and collaboration with employees. Furthermore, it was found that the traditional digital designer environment contributed to their job satisfaction, which is useful for solving mutual collaboration issues through knowledge exchange. A survey was developed that allows for the identification of digital designers' attitudes, and its results provide clear guidelines for change. The entire process was carried out to improve the final result, i.e., the performance of designers and, consequently, the entire organization. The 1989 Work America study by Wyatt identified 12 dimensions of job satisfaction, which were adopted in this research. Based on the presented study, it can be concluded that digital designers are generally satisfied with the organization of work, performance reviews, control, opportunities for professional development, and career training. Designers reported dissatisfaction with working conditions, communication, benefits, and the company's image. Designers had a neutral stance on communication, work atmosphere, and company management.

Keywords: Digital Designer, Knowledge Exchange, Work Organization, Communication, Benefits.

INTRODUCTION

Creativity, the development of new ideas, the ability to respond quickly, and adaptability to changes have become reliable tools for achieving success. Accordingly, significant attention is directed towards the digital designer and their job satisfaction. In order to ensure that it meets the needs of its growing workforce, VSP conducts regular employee satisfaction surveys, as noted by Robbins and Judge (2009). VSP's internal human resources group conducts an annual survey with all employees, questioning a quarter of the staff every four months, according to Robbins and Judge (2009). In addition, VSP uses external services from a consulting firm that surveys all employees every two years. Together, these two surveys provide VSP's management team with information about the "temperature" within the company, offering insights into areas that can be improved. Job satisfaction is the positive feeling about one's work, which arises from the evaluation of the job's characteristics, as defined by Hodson (1991). Jobs require interaction with colleagues and supervisors, adherence to organizational rules and policies, meeting performance standards, and accepting working conditions that are often far from ideal, as indicated in the Work America study by Wyatt (1989). Analyzing the influencing factors has led to the recognition of the importance of values, beliefs, and behavioral norms that dominate within an organization and influence the attitudes of digital designers.

LITERATURE REVIEW

It can be argued that design creates a competitive advantage by improving user satisfaction and the perceived benefits to consumers. As empirical evidence from a recent literature review by Tabeau et al. (2017) shows, this can lead to better sales, greater market share, or higher profit margins, along with the potential to enter new markets. One of the key channels through which this happens is the changing nature of the innovation process. The uniqueness of a product opens access to a wide range of markets, makes it more difficult for competitors to imitate the product, and facilitates its market introduction. Furthermore, it has been shown that design facilitates external collaboration, paving the way for knowledge and technology transfer between companies, according to Valsh (1996). For all these reasons, design has become a strategic resource for a product's market success (Verizer & Borja de Mozota, 2005) and for improving customer satisfaction (Noble & Phillips, 2004). Innovative design goes beyond protecting an existing market from emerging competition and enables companies to penetrate new markets, as stated by Bruce & Dali (2007).

In the entire literature, design is mentioned as an organizational catalyst for change, according to Vriglei (2016). From this perspective, the role of design is to continuously explore, stimulate, challenge, and disrupt internal organizational processes, restructure business activities, and ensure the integration of new and improved competencies and knowledge into organizational strategy. The relevance of design for organizational change can also be viewed through the concept of creative confidence, as noted by Kellei & Kellei (2013). As these authors pointed out, the internal desire to release creative confidence enables organizations and individuals to see new ways to improve the status quo and seize opportunities.

While driven by creative confidence, designers need resources from various departments, along with knowledge of organizational culture and practices, as stated by Czarnitzki & Thorvarth (2012). A significant part of design activities draws resources from research and development departments through design, construction, and prototyping of new ideas, as noted by Valsh (1996). It also opens new paths for contextual and collaborative learning about users, according to Oigur & Thompson (2020). At the same time, design contributes to the production and launch of new products, which require input from production departments. Finally, design activities include tasks such as packaging, advertising, and branding of new and existing products and services, based on inputs from marketing departments. As a result, design becomes a type of coordinator of interdepartmental collaboration, according to Von Stamm (2003), and a bridge between different organizational functions, facilitating the leveraging of synergy between organizational resources.

As a result, it can be argued that design disrupts the existing way of creating value (Kretschmer & Khashabi, 2020) and influences the coordination of work activities across various parts of the organization, its strategy, and culture (Borja de Mozota, 2002; Jevnaker, 2000).

EMPIRICAL PART OF THE RESEARCH: THE IMPACT OF JOB SATISFACTION AMONG DIGITAL DESIGNERS

The research presented in this paper was conducted among digital designers and employees in design agencies during 2023-2024. The study focused on examining and measuring job satisfaction among digital designers and employees, with the aim of obtaining the necessary information to improve operations in design agencies.

The research was conducted through an online questionnaire. Questionnaires were sent to 200 companies, and 90 of them responded to the call to participate in the study, representing 45% of the sample. The gender structure of the respondents consisted of 41 male designers (45.5%) and 49 female designers (54.5%). Regarding the age distribution of the designers, the largest group is in the age range of 31-40 years, with 33 designers (36.7%), followed by 29-year-olds, who account for 32.2%.

Nineteen designers (21%) are aged between 41-50 years, while the smallest group consists of designers aged over 50 years, totaling 9, or 10% of the population.

When it comes to work experience, most designers (48%) have between 5 and 15 years of experience, amounting to 43 designers. A significantly smaller number (28%) have less than 5 years of work experience (24 designers). Fifteen designers (17%) indicated having 15-25 years of work experience. The smallest group, consisting of 7 designers (8%), reported having more than 25 years of work experience.

Descriptive Statistics

The research analyzed the following aspects of designers' job satisfaction:

Table 1: Descriptive Statistics

	N	Min	Max	Mean value	Standard deviation
1.Organization of work	90	1	5	3,45	1,173
2. Working conditions	90	1	5	2,92	1,17
3. Communications	90	1	5	3,48	1,172
4. Work performance	90	1	5	3,32	1,197
5. Performance review	90	1	5	3,43	1,113
6. Control	90	1	5	3,38	1,203
7. Business management	90	1	5	3,37	1,204
8. Salaries	90	1	5	2,59	1,133
9. Benefits	90	1	5	3,08	1,149
10. Career development and training	90	1	5	2,98	1,119
11. Job satisfaction	90	1	5	2,48	1,275
12. Company images and changes	90	1	5	3,39	1,279

Research results

Table 2 presents the responses of designers who express their attitude towards the work organization in which they work. According to the obtained data, the largest number of designers, 26 of them (28.9%) are satisfied with the organization of work, slightly less of them, 22 (24.4%) have a neutral attitude, 20 designers, 20 (22.2%) are satisfied, 18 designers (20%) is dissatisfied, while 4 designers (4.4%) are very dissatisfied.

Table 3 obtained results for working conditions, the largest number of designers is satisfied or not satisfied 34 (37.8%). 18 (20%) designers are not satisfied, slightly less 16 (17.8%) are satisfied, 12 (13.3%) are very dissatisfied, while 10 (11.1%) are very satisfied with the working conditions.

Table 2: Organization of work

	Frequency	Percentage	Valid %	Cumulative %
1	4	4,4	4,4	4,4
2	18	20,0	20,0	24,4
3	22	24,4	24,4	48,9
4	26	28,9	28,9	77,8
5	20	22,2	22,2	100
Total	90	100	100	

The frequency of responses shown in Table 4 shows that designers are mostly satisfied or have a neutral attitude towards communication in the service where they do their work, which indicates that the same number of designers 24 (26.7%) just stated this answer, 22 (24.4%) designers are very satisfied, while 16 (17.8%) are dissatisfied, and only 4 (4.4%) of them are very dissatisfied with

communication in the organization. Tables 2, 3, and 4 indicate that digital designers are mostly satisfied with the organization of work, working conditions and communication in the organization where they work.

Table 3: Working conditions

	Frequency	Percentage	Valid%	Cumulative %
1	12	13,3	13,3	13,3
2	18	20,0	20,0	33,3
3	34	37,8	37,8	71,1
4	16	17,8	17,8	88,9
5	10	11,1	11,1	100
Total	90	100	100	

Table 5 shows how satisfied digital designers are with their work performance. The largest number of them have a neutral attitude 26 (28.9%), 22 (24.4%) are satisfied, while the same percentage of them 18 (20%) stated that satisfied or very satisfied, and the smallest percentage of them, 6 (6.7%), declared that they were very dissatisfied with the work performance in the organization where they work.

The largest number of digital designers 30 (33.3%) indicated that they were satisfied with the performance review with colleagues. A slightly smaller number of them, 24 (26.7%) believe that they are neither satisfied nor dissatisfied. The same number of digital designers, 16 (17.8%) stated that they were dissatisfied, that is, very satisfied, and only 4 (4.4%) of digital designers stated that eoma was dissatisfied with direct cooperation with colleagues. The previous tables 5 and 6 indicate that there is a favorable climate of work performance and review performance in the surveyed companies.

Table 4: Communications

	Frequency	Percentage	Valid %	Cumulative %
1	4	4,4	4,4	4,4
2	16	17,8	17,8	22,2
3	24	26,7	26,7	48,9
4	24	26,7	26,7	75,6
5	22	24,4	24,4	100
Total	90	100	100	

Table 5: Work performance

	Frequency	Percentage	Valid %	Cumulative %
1	6	6,7	6,7	6,7
2	18	20,0	20,0	26,7
3	26	28,9	28,9	55,6
4	22	24,	24,	80
5	18	20,0	20,0	100
Total	90	100	100	

Table 6: Performance review

	Frequency	Percentage	Valid %	Cumulative %
1	4	4,4	4,4	4,4
2	16	17,8	17,8	22m2
3	24	26,7	26,7	48,9
4	30	33,3	33,3	82,2
5	16	17,8	17,8	100
Total	90	100	100	

Table 7 digital designers are satisfied with the control in the organization, which is considered by 30 (33.3%) respondents, slightly less of them 22 (24.4%) have a neutral attitude, 16 (17.8%) are very satisfied, 14 (15, 6%) stated that they were dissatisfied, and 8 of them (8.9%) were very dissatisfied with the control in the organization.

Table 7: Control

	Frequency	Percentage	Valid %	Cumulative %
1	8	8,9	8,9	8,9
2	14	15,6	15,6	24,4
3	22	24,4	24,4	48,9
4	30	33,3	33,3	82,2
5	16	17,8	17,8	100
Total	90	100	100	

Table 8 shows the structure of responses of digital designers about the level of satisfaction with the management of the company where they work. The largest number of them 28 (31.1%) have a neutral attitude, 22 (24.4%) are satisfied, 18 (20%) of them are dissatisfied, while the same percentage of digital designers are very satisfied, a small number of digital designers are very dissatisfied 4 (4.4%).

Table 9 shows the frequency of responses to how satisfied digital designers are with their monthly earnings, i.e. salary. The smallest number of digital designers are very satisfied 6 (6.7%), the largest number of them are dissatisfied 36 (40%), a slightly smaller number of them 20 (22.2%) are neither satisfied nor dissatisfied, and 14 each (15, 6%) of digital designers stated that they were satisfied or very dissatisfied with their salary.

Table 8: Company management

	Frequency	Percentage	Valid %	Cumulative %
1	4	4,4	4,4	4,4
2	18	20,0	20,0	24,4
3	28	31,1	31,1	55,6
4	22	24,4	24,4	80,0
5	18	20,0	20,0	100
Total	90	100	100	

Table 9: Salaries

	Frequency	Percentage	Valid %	Cumulative %
1	14	15,6	15,6	15,6
2	36	40	40	55,6
3	20	22,2	22,2	77,8
4	14	15,6	15,6	93,3
5	6	6,7	6,7	100
Total	90	100	100	

Table 10: Benefits

	Frequency	Percentage	Valid %	Cumulative %
1	6	6,7	6,7	6,7
2	26	28,9	28,9	35,6
3	26	28,9	28,9	64,4
4	20	22,2	22,2	86,7
5	12	13,3	13,3	100
Total	90	100	100	

The extent to which digital designers are satisfied with the possibility of benefits is shown in table 10. An equal number of them, 26 (28.9%) are dissatisfied, i.e. they are neutral, slightly fewer of them, 20 (22.2%) are satisfied, 12 (13.3 %) is very satisfied, while 6 of them (6.7%) are very dissatisfied with the opportunities for benefits.

The largest number of digital designers 28 (31.1%) stated that they were not satisfied with the possibilities of training and career training, slightly less of them 26 (28.9%) had a neutral attitude, 16 (17.8%) of them were satisfied, 12 (13.3%) are very satisfied, while 8 of them (8.9%) are very dissatisfied with the opportunities for improvement and career training.

Table 11: Career development and training

	Frequency	Percentage	Valid %	Cumulative %
1	8	8,9	8,9	8,9
2	28	31,1	31,1	40,0
3	26	28,9	28,9	68,9
4	16	17,8	17,8	86,7
5	12	13,3	13,3	100
Total	90	100	100	

Table 12: Satisfaction with job content

	Frequency	Percentage	Valid %	Cumulative %
1	14	15,6	15,6	15,6
2	40	44,4	44,4	60,0
3	20	22,2	22,2	82,2
4	10	11,1	11,1	93,3
5	6	6,7	6,7	100
Total	90	100	100	

When it comes to the possibility of satisfaction with the job content, the largest number of digital designers, 40 (44.4%) stated that they are dissatisfied, 20 (22.2%) have a neutral attitude, even 14 (15.6%) are very dissatisfied, 10 (11.1%) of digital designers stated that they were satisfied, and only 6 of them (6.7%) were very satisfied with the job content. Tables 10, 11 and 12 show digital designers' dissatisfaction with benefits, training, career training and job satisfaction.

Table 13 shows that digital designers are dissatisfied with the company's image and changes, which is considered by as many as 24 (26.%), 22 (24.4%) of them have a neutral attitude, 20 (22.2%) are satisfied, 18 (20%) are very satisfied, and only 6 of them (6.7%) are very dissatisfied with the image of the company and the changes.

Table 13: Company image and changes

	Frequency	Percentage	Valid %	Cumulative %
1	6	6,7	6,7	6,7
2	24	26,7	26,7	28,9
3	22	24,4	24,4	53,3
4	20	22,2	22,2	73,3
5	18	20,0	20,0	100
Total	90	100	100	

Discussion of results:

−   The research conducted among different design firms aimed to determine how satisfied digital designers are with the environment in which they work, salary, opportunities for further advancement and training, or satisfied with the job content,
−   Based on the research presented, it can be concluded that digital designers are mostly satisfied with: Organization of work 26 of them (28.8%), Review of performance 30 (33.3%), Control 30 (33.3%), Possibility of improvement and training for career 28 (31.1%)
−   Digital designers are dissatisfied with: Working conditions 34 (37.8%), Communication 24 26.7%), Benefits 26 (28.9%), and Company Image 24 of them (26%).
−   Neutral digital designers have: Communications 24 (26.8%), Work atmosphere 28.9%) and Company management 28 (31.1%). Very satisfied digital designers are: control 16 (17.8%).

CONCLUSION

Numerous researches have been conducted in the field of organizational behavior and have shown that the strength of an organization largely depends on the relationship between its employees. Under the

influence of satisfying personal interests but also personal emotional experience of their employer and work, employees will form their own reactions. The job satisfaction of employees is dealt with by a large number of autorajers starting from the assumption that a satisfied employee is a more productive employee. However, empirical research has shown that the relationship between employee satisfaction and productivity is not as clear as it may seem at first glance. Increasing productivity improves performance, which increases employee rewards and satisfaction. A satisfied employee will not only be more productive, but, which is sometimes just as important, will create a better atmosphere at work and positively influence the work of other colleagues.

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Session C: MARKETING MANAGEMENT

MARKETING TRENDS AND DEVELOPING BUSINESS COMPETITIVENESS

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ABSTRACT

Modern marketing trends driven by digital technologies are reshaping business competitiveness through improved consumer engagement and strategic market adaptation. This paper analyzes the integration of advanced digital technologies, customer-centric marketing strategies, and global market adaptation as primary elements that contribute to competitive advantages. Artificial intelligence, big data analytics, and marketing automation improve targeting and personalization, while customer-centric strategies focus on interactive engagement and loyalty programs. Global market adaptation emphasizes localized content, multilingual platforms, and compliance with regional regulations to strengthen market presence. Government support through infrastructure development and data privacy enforcement, along with consumer advocacy for ethical marketing, further supports these initiatives. Strategic recommendations for governments, enterprises, and individuals include investing in technology, promoting sustainability, and embracing cultural sensitivity in global markets. The main goal was to develop a theoretical model for improving business competitiveness through new marketing trends.

Keywords: Modern marketing, Business competitiveness, Trends, New technologies.

INTRODUCTION

The fast evolution of digital technologies has affected marketing strategies, offering businesses innovative tools to connect with consumers and analyze market behaviors more efficiently. Advanced technologies such as artificial intelligence (AI), machine learning, big data analytics, and blockchain have become instrumental in transforming traditional marketing approaches into data-driven, customer-focused strategies. According to Labib (2024), AI has revolutionized marketing by driving digital transformation, enabling real-time data collection and targeted marketing strategies that align more closely with consumer preferences. Predictive analytics and automated decision-making powered by AI allow companies to optimize their marketing efforts, leading to more effective outreach and improved consumer engagement (Krivokuća et al., 2024). Furthermore, blockchain technology is emerging as a solution for improving transparency and trust in digital marketing transactions, addressing concerns around data privacy and security (Chotisarn & Phuthong, 2025). The integration of these technologies not only improves operational efficiency but also provides deeper insights into market trends and consumer behaviors, enabling businesses to maintain a competitive edge in a rapidly evolving digital landscape. Modern consumers increasingly prioritize brands that demonstrate a commitment to sustainable development and responsible sourcing (Pandjaitan, 2024).

This trend is not limited to product offerings but extends to corporate transparency and social responsibility. Brands that align their marketing strategies with sustainable principles often experience greater customer loyalty and stronger brand reputation (Punjabi et al., 2024). Ethical marketing, which emphasizes fair trade, environmental consciousness, and community engagement, has become a important component of brand identity in global markets. As companies strive to meet these expectations, sustainability is increasingly integrated into marketing campaigns, showcasing not only product quality but also corporate commitment to broader societal goals. This shift towards sustainable marketing is not merely a response to consumer demand but a strategic approach to building long-term relationships based on trust and shared values. Customer-centric marketing strategies have become essential in an environment where consumer expectations are continually evolving. Businesses are moving away from traditional, one-size-fits-all marketing approaches and are embracing personalized, data-driven strategies that prioritize consumer experience. According to Bakator et al. (2024), Marketing 5.0 emphasizes personalized customer experiences, supported by AI-driven analytics and real-time data processing. These technologies allow businesses to anticipate consumer needs, tailor communications, and engage with customers through personalized digital channels. Globalization has expanded market opportunities but has also introduced complexities in cross-border marketing (Bashar et al., 2024). The digital age has enabled companies to reach global audiences, yet it requires a nuanced understanding of cultural differences, regulatory requirements, and consumer behaviors across different regions. Businesses must navigate local customs, language differences, and market-specific regulations to avoid legal complications and maintain a positive brand image. Additionally, digital adaptability, including localized content and culturally aware marketing messages, is necessary to engage effectively with international consumers and sustain competitive positioning.

This paper aims to present a theoretical model for improving business competitiveness through modern marketing trends. The paper consists of an Introduction section, then a theoretical literature analysis section that discusses modern marketing trends. Afterwards, the developed model is presented. Next, suggestions how to improve business performance are noted. Finally, conclusions are drawn.

LITERATURE ANALYSIS

The emergence of digital technologies has transformed the landscape of marketing, introducing advanced methods for engaging with consumers and analyzing market behavior. Technologies such as artificial intelligence (AI), big data analytics, machine learning, and blockchain have reshaped traditional marketing practices, providing new opportunities for data-driven decision-making and personalized communication (Al-Ababneh, 2024). According to Labib (2024), AI-driven marketing strategies allow companies to process vast amounts of consumer data in real-time, enabling more accurate predictions of customer behavior and preferences. This capability not only improves the targeting of marketing campaigns but also improves the overall customer experience through more personalized interactions. Predictive analytics, powered by machine learning algorithms, can identify patterns in consumer behavior, allowing marketers to anticipate needs and adjust strategies accordingly. This data-centric approach enables companies to optimize their marketing efforts, reducing costs and improving outreach effectiveness (Krivokuća et al., 2024). The integration of big data analytics into marketing strategies further supports real-time decision-making and customer engagement. With access to extensive datasets, marketers can track consumer interactions across multiple platforms, gaining insights into purchasing habits, content engagement, and brand perception. This analytical capability allows for more precise segmentation and targeted messaging, ensuring that marketing efforts are both relevant and timely. According to Punjabi et al. (2024), companies that leverage big data analytics can identify emerging trends faster and respond to market changes with greater agility. This adaptability is particularly important in highly competitive markets where consumer expectations are constantly evolving. Data analytics also aids in measuring the effectiveness of marketing campaigns, providing insights that can be used to refine strategies and improve future outreach efforts (Pratiwi et al., 2024). Machine learning, as an extension of AI, contributes to marketing innovation through its ability to learn and adapt from consumer interactions. Algorithms

can automatically adjust marketing content and strategies based on real-time feedback, optimizing engagement and conversion rates. Labib (2024) highlights how machine learning improves customer segmentation by analyzing user behavior to create more detailed consumer profiles. These profiles allow for hyper-personalized marketing, where messages are specifically tailored to individual preferences and behaviors. This level of personalization not only improves customer satisfaction but also increases the likelihood of brand loyalty and repeat business. Moreover, machine learning enables more effective recommendation systems, where consumers are presented with products and services that align with their previous behaviors and expressed interests (Bezovski, 2025).

Digital marketing technologies also contribute to sustainability efforts, as more businesses prioritize ethical and environmentally conscious practices. Modern consumers increasingly expect brands to demonstrate corporate responsibility, not only in their operations but also in their marketing strategies. According to Pandjaitan (2024), ethical marketing practices that promote sustainability and transparency are gaining traction among consumers who are conscious of their environmental impact. Companies that adopt sustainable marketing practices are better positioned to build trust and loyalty with socially conscious customers. This shift towards ethical marketing is part of a broader trend where consumers demand greater accountability from brands, particularly regarding environmental preservation and social responsibility (Pratiwi et al., 2024). The rise of ethical consumerism has also influenced digital marketing strategies, prompting businesses to align their branding with values that resonate with socially aware consumers. Marketing campaigns increasingly highlight environmental efforts, community involvement, and responsible sourcing as key elements of brand identity (Aripin et al., 2024). This approach reflects a shift in consumer expectations, where ethical considerations are becoming as important as product quality and price. Companies that fail to align with these expectations risk losing relevance in a market where consumer awareness of ethical issues continues to grow. Sustainable marketing strategies are thus becoming an integral part of business competitiveness, as they address both consumer expectations and broader societal concerns (Ramos et al., 2024). According to Bakator et al. (2024), the concept of Marketing 5.0 emphasizes personalized customer experiences driven by AI technologies. These technologies allow marketers to collect real-time data and analyze it to predict consumer behavior and optimize marketing campaigns. This level of personalization increases the relevance of marketing messages, making them more impactful and engaging for the consumer. Understanding the customer journey has become essential in this context. Businesses are increasingly investing in technologies that allow them to map out every interaction a consumer has with their brand (Kumar, 2025). This includes online searches, social media interactions, website visits, and purchases. The ability to track and analyze these interactions provides marketers with insights into consumer preferences and potential pain points (Wild Ali & Ortega-Guyierrez, 2025).

Furthermore, interactive engagement has become a core aspect of customer-centric marketing. Social media platforms, mobile applications, and personalized email campaigns have opened new avenues for real-time communication between brands and consumers. This continuous dialogue not only keeps consumers informed but also allows brands to respond quickly to customer feedback and address concerns (Bashar et al., 2024; Punjabi et al., 2024). Customer-centric strategies also extend to loyalty programs and customized offers. Brands are increasingly utilizing data analytics to understand consumer purchasing patterns and preferences, enabling them to craft loyalty programs that reward consistent engagement. Personalized offers based on previous purchases and browsing behavior have proven effective in encouraging repeat business. Localized content is crucial in maintaining relevance in diverse markets. Brands that understand the cultural values and consumer expectations of their target regions are better positioned to craft marketing messages that resonate. This may include adjusting visual content, promotional offers, and communication styles to reflect local tastes and cultural sensitivities. Chotisarn and Phuthong (2025) emphasize that effective localization not only helps in building brand awareness but also in establishing trust among local consumers. This trust is essential for long-term engagement, especially in markets where consumer loyalty is influenced by cultural alignment and social responsibility.

The convergence of customer-centric marketing and globalization illustrates the growing complexity of engaging with diverse consumer bases. Advanced technologies have enabled businesses to personalize marketing strategies and expand into new markets more effectively. Based on the analyzed literature a theoretical model for improving digital entrepreneurship in the context of Society 5.0 is developed. The model is presented on Figure 1.
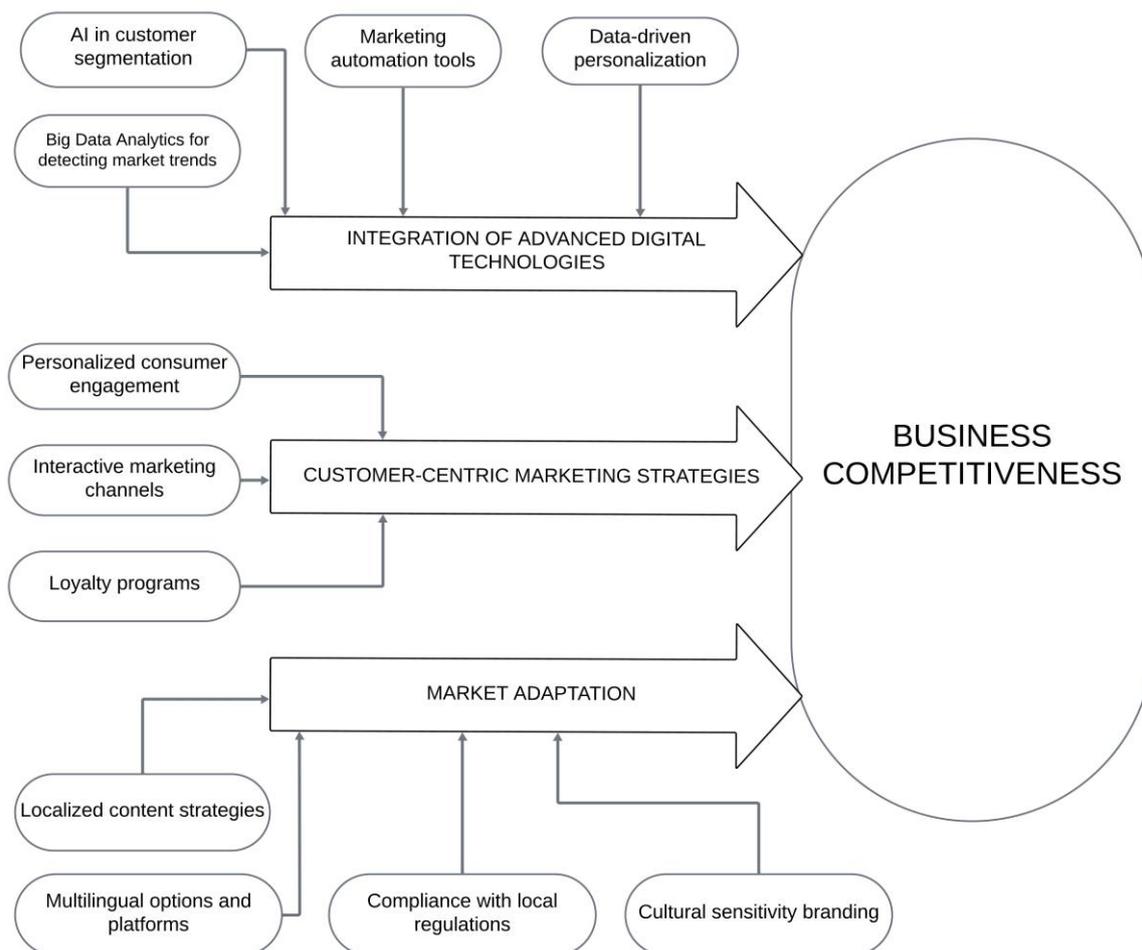

Figure 1: Model for improving digital entrepreneurship

The integration of advanced digital technologies is essential for modern marketing competitiveness. AI-driven customer segmentation allows for targeted marketing, while marketing automation tools streamline routine tasks, ensuring consistent communication. Data-driven personalization tailors marketing messages based on consumer behavior, improving engagement and loyalty. These technologies support real-time adjustments, keeping campaigns relevant and impactful. Customer-centric strategies focus on personalized engagement, interactive marketing channels, and loyalty programs. Technologies enable real-time communication through social media and mobile apps, providing immediate responses and strengthening trust. Personalized offers and loyalty rewards based on consumer behavior data improve retention and encourage repeat purchases. Market adaptation is crucial for global competitiveness. Localized content strategies consider cultural preferences, while multilingual platforms broaden market reach. Compliance with local regulations prevents legal issues, ensuring smooth market entry. Cultural sensitivity in branding avoids misunderstandings and builds local trust. Collaborating with regional influencers and local businesses accelerates brand acceptance and market penetration. These elements, when effectively integrated, allow businesses to meet consumer expectations, adapt to global markets, and maintain competitiveness. The combination of technology-driven personalization, customer-focused marketing, and strategic market adaptation positions companies for sustainable growth in a rapidly evolving digital landscape.

SUGGESTION AND GUIDELINES

Based on the developed model and analyzed literature, the following strategies and actions for improving business competitiveness through modern marketing trends are noted:

- Promote digital infrastructure development to support advanced marketing technologies. This includes expanding high-speed internet access and providing incentives for technological innovation.
- Enforce data privacy regulations that protect consumers while allowing businesses to leverage big data for marketing analytics. Clear guidelines can encourage responsible data use and build consumer trust.
- Invest in AI-driven analytics to optimize marketing segmentation and personalization. These technologies allow for real-time adjustments based on consumer behavior and preferences.
- Develop multilingual and culturally adapted marketing strategies to reach global markets. This includes localized content and compliance with regional regulations.
- Implement marketing automation to streamline repetitive tasks and improve response times. Automation ensures consistency and allows marketing teams to focus on strategic planning.
- Focus on sustainability and ethical marketing to build brand loyalty. Transparent practices and environmentally conscious messaging resonate with socially responsible consumers.
- Collaborate with local influencers and community leaders to increase brand acceptance. Local partnerships improve credibility and facilitate market adaptation.
- Engage with brands that prioritize ethical marketing and transparent practices. Support for responsible companies encourages broader market shifts toward sustainability.

CONCLUSION

Modern marketing trends driven by digital technologies have transformed how businesses engage with consumers and maintain competitiveness. The integration of artificial intelligence, big data analytics, and marketing automation allows companies to target their audience with greater precision and efficiency. These technologies provide deeper insights into consumer behavior, enabling more personalized and responsive marketing strategies. Through advanced data analysis, companies can adjust their campaigns in real time, ensuring that marketing efforts remain effective and aligned with changing consumer expectations. This adaptability is crucial in a fast-evolving digital landscape where consumer preferences are constantly shifting. Customer-centric marketing strategies have become increasingly important as businesses shift their focus towards personalized consumer engagement and interactive communication. Social media platforms, mobile applications, and automated messaging systems allow brands to connect with customers instantly, addressing concerns and providing information as needed. Personalized marketing messages tailored to individual preferences contribute to stronger brand loyalty and increased consumer satisfaction. Loyalty programs and data-driven personalization further reinforce this connection, encouraging repeat business and positive word-of-mouth.

For future studies, empirical research could be conducted in enterprises. A survey could be developed to assess the noted factors of modern marketing trends. This approach would further provide significant insight into the changing landscape of the modern business.

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POSITIONING OF SUSTAINABLE FASHION BRANDS IN SERBIA

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ABSTRACT

This paper explores the current position and promotion strategies of sustainable fashion brands in Serbia, a market still dominated by fast fashion. The research is based on direct communication with local sustainable fashion brands and designers, combined with an analysis of market trends and insights from relevant literature. Although sustainability is gaining attention, the Serbian market for sustainable fashion remains underdeveloped. Brands are still in the early stages of market penetration, often facing challenges related to limited visibility, high production costs, and a lack of institutional support. Moreover, there is no official data on the exact number of companies operating in a sustainable manner, which further complicates the mapping of the sector. A SWOT analysis is used to illustrate the main internal and external factors that impact brand development and at the same time, offer an effective promotion strategy that consist of influencer marketing and collaboration with public figures. The results suggest that despite the structural constraints, open communication, core value commitment, and the application of creative strategies in the digital domain are the factors that allow these brands to connect with consumers beyond the ecological ones.

Keywords: Sustainable fashion, Serbia, Market development, Brand positioning, Influencer marketing.

INTRODUCTION

Sustainable fashion represents a global trend that emerged as a response to climate change, overconsumption, and unethical production practices caused by the fast fashion movement, which has dominated the fashion industry for decades (Eryuruk, 2012). In 2025, it can be said that the sustainable approach in the textile and fashion industry is becoming increasingly prominent. In Serbia, sustainable fashion still holds a modest but important position through several local brands that promote eco-friendly materials, handmade production, or recycling.

However, the development of such brands is accompanied by numerous challenges – from high product costs to insufficient media and institutional support. Despite these obstacles, sustainable fashion brands in Serbia are increasingly finding their way to the public through social media, direct communication, and participation in fashion events. Sustainable brands also face the challenge of sourcing sustainable textile materials, which are largely available only through import.

There are no official statistics on the number of fashion companies in Serbia that work in line with sustainable principles, which, consequently, makes it hard to have a clear understanding of the extent and effect of such a sector. The majority of sustainable brands are small businesses and independent designers who are usually not supported by a structured industry and rely on personal ideas and creativity to a greater extent. Their positioning on the market is still emerging, and their visibility largely depends on direct interaction with consumers and digital presence. As such, sustainable fashion in Serbia is currently more of a growing movement than a clearly defined sector, with

potential for development through increased awareness, targeted promotion, and stronger collaboration within the fashion ecosystem.

The aim of this paper is to explore how sustainable fashion brands in Serbia are positioned on the market, what promotion strategies they use, and to highlight their strengths, weaknesses, opportunities, and threats through a SWOT analysis in the context of today's fashion system

SUSTAINABLE FASHION BRANDS IN SERBIA

In Serbia, there is a small number of brands and leading companies that have fully embraced a sustainable approach to production. These are mostly brands and companies oriented toward foreign markets, where, in recent years, sustainability requirements have become a standard – and often a mandatory condition – for placing garments on the market. For this reason, many of them obtain internationally recognized certifications such as GOTS (Global Organic Textile Standard), Standard 100 by OEKO-TEX®, or FSC (Forest Stewardship Council) to demonstrate that their production meets ecological and ethical criteria that are increasingly important to the modern consumer. These types of certificates do not only satisfy the technical needs of the market, but also they make it easy to gain confidence among the consumers who, more and more, are taking their buying decisions based on the brand's disclosure of the company's operating capabilities and social responsibility. Research shows that third-party certifications can not only alleviate the problems of greenwashing, but they can also foster the perception on the part of the consumers of the companies being more ethical, trustworthy, and loyal.

There is currently no official statistic on the number of sustainable fashion brands in Serbia, but based on personal research, some of the most prominent actors in this field can be identified. These include ARBA (see also on Figure 1), COZY, GIA Design, DAIRE, and AMELIE, as well as designers who apply a sustainable approach, such as Ana Trošić Trajković (Figure 2), Milutin Lađević, Divna Lazić, and Aleksandar Latinović. In addition to smaller brands and individual designers, it is also important to mention larger fashion companies that invest in sustainability, such as IVKO WOMEN and FUSH.

Figure 1: ARBA fashion brand (ARBA, n.d.)

*Figure 2: Ana Trošić Trajković – Fashion designer (*Tošić, Trajković, 2021*)*

The mentioned brands use a variety of sustainable materials in their production. For example, ARBA focuses on using 100% organic cotton, COZY utilizes natural materials such as viscose, organic

cotton, bamboo, and many others. GIA Design is known for employing eco-friendly fabrics and the use of natural dyes, while DAIRE often uses materials obtained by recycling old textiles. AMELIE stands out through handmade production and the use of natural materials like hemp and organic cotton. All these brands are focused on minimizing their ecological footprint through careful selection of raw materials and production processes that respect all principles of sustainability. The aforementioned larger companies, IVKO WOMEN and FUSH, in addition to carefully selecting raw materials for production, also stand out through the implementation of sustainable manufacturing processes and transparency in the supply chain.

SWOT ANALYSIS OF SUSTAINABLE FASHION BRANDS IN SERBIA

To gain a clearer understanding of the current state of sustainable fashion brands in Serbia, a SWOT analysis was conducted. This analysis highlights the internal strengths and weaknesses of the brands, as well as the external opportunities and threats they face in the market. By recognizing these factors, we can better comprehend the challenges and potentials for the development of the sustainable fashion sector in Serbia. The analysis was based on responses from brand owners, combined with data collected from relevant studies. The results of the SWOT analysis are presented in Table 1.

Table 1: SWOT Analysis of Sustainable Fashion Brands in Serbia

Strengths	Weaknesses
− Authenticity − Use of eco-friendly materials − Increasing consumer awareness − Transparent and ethical production − Redesign of stock materials or redesign of existing outlet collections	− Higher price − Lower availability − Limited distribution channels − Textile materials are imported
Opportunities	Threats
− Export opportunities − Increasing interest in sustainability globally and locally − Increased level of sustainability awareness among the younger generation, Gen Z. − Collaboration with influencers and sustainable platforms	− Domination of fast fashion − Economic uncertainty − Import of sustainable materials − Greenwashing

The biggest strengths of sustainable brands are authentic and transparent (Joy et al., 2012). These strengths make consumers trust and be loyal to the brands that are increasingly becoming aware. They also make brand credibility stronger together with ethical production and the use of eco-friendly materials (Niinimäki, 2020). Yet, such brands are sometimes plagued by certain issues, like increased prices and restricted availability, which in turn block their market access (Henninger, Alevizou, & Oates, 2016). Moreover, localized distribution channels pose another challenge to these brands' growth, particularly in markets dominated by fast fashion (Bhardwaj & Fairhurst, 2010). Nonetheless, we can observe that the trend of both the global and local population is the growth of interest in sustainability, eventually leading to the businesses' benefit from exporting and getting into collab. with the influencers & sustainable platforms, thus being in consumers' eye line and boosting their engagement (McNeill & Moore, 2015). But the risks are also at a high level, with the main threats being fast fashion's prevalence, economic instability, the high costs and lack of materials, which are environmental-friendly and greenwashing, which can shake the confidence of the customers (D'Souza et al., 2007). Having the knowledge of these factors is the key to overseeing and promoting the growth of the sustainable fashion sector of Serbia.

PROMOTION AND POSITIONING OF SUSTAINABLE BRANDS

Sustainable fashion brands in Serbia mostly communicate with their customers through various channels such as social media. They use social media like Instagram and TikTok for influencer marketing and storytelling, which they carry out very actively. Online shops are the primary outlet for purchases of the sustainable fashion brands while influencer engagement and sponsored posts are used to reach a wider audience, thus building trust and loyalty, which are key in sustainable fashion (Joy et al., 2012).

Besides digital channels, fairs and fashion shows – particularly Serbia Fashion Week – play an important role in promotion. These events have more and more become sustainable and nature-friendly in recent years and done a good job of sustainability, while branding has become their main tool of marketing and public relations and communication with the public. Consumers who are the potential buyer of these brands are more likely to follow a quality over a quantity approach.

The consumer who has a lot of knowledge about the benefits of sustainable fashion that is also aware of the fact that these products are way better and have a durability factor significantly better than those that are of a conventional market is the one sought by the firms (Niinimäki, 2020). Through transparent communication and effective promotion, sustainable brands succeed in building authentic relationships with consumers and strengthening their market position against fast fashion competitors (Henninger, Alevizou, & Oates, 2016). Additionally, visually appealing and engaging campaigns on Instagram and TikTok attract a significant number of potential consumers. Some examples of such promotional activities are shown in Figures 3 and 4.

Figure 3: COZY fashion brand campaign for collection summer 2025 (COZY, n.d.)

Figure 4: AMELIE fashion campaign (AMELIE, 2024)

One notable example of effective promotion through public figures is the collaboration between the Serbian sustainable fashion brand ARBA and this year's Eurovision representative, Stefan Zdravković like we can see on Figure 5. The public presentations of the artist in ARBA outfits made the brand's popularity go up dramatically and also paved the way for its growth by extending it to an even wider audience.

ARBA through a link with the figure that is both aware of them and supports them, greatly confirmed its identity and won consumer satisfaction that kept their eco-conscious desires and at the same time managed to penetrate beyond the niche market of eco-conscious consumers. This strategy is in line with a study by McCormick (2016), where he argues that celebrity endorsements play a role in the

enhancement of brand credibility and consumer engagement, especially if the values of the public figure and the brand are considered to be congruent.

Figure 5: Stefan Zdravković in ARBA T-shirt
(Zdravković., 2025)

CONCLUSION

Sustainable fashion in Serbia, though still developing, demonstrates clear potential for growth. Author brands with such features as the identity and the responsible environmental production and selling of the product, and the transparency of the supply chain are successfully creating consumer trust and brand loyalty. Apart from the difficulties like restricted distribution and the competitiveness of fast fashion, chances abound in terms of export potential, the growing popularity of global sustainable development, and finally cooperation with influencers. For instance, with the case of ARBA and Stefan Zdravković, it is evident that associating with people from the public who share the brands' beliefs can greatly raise brand credibility and audience reach. For the Serbian sustainable brands to make further progress in this area, they will need to use digital media, develop their supply chains and align with global sustainability trends. They will in this way have the opportunity to move from the niche markets and become one of the key contributors to the global sustainable fashion movement.

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CUSTOMER PERCEPTIONS OF ARTIFICIAL INTELLIGENCE IN SALES AND MARKETING

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ABSTRACT

In an environment where customers are surrounded by diverse offers aimed at efficiently satisfying their needs, technology plays a crucial role. Various technological solutions and innovations have been implemented to enhance value delivery and achieve competitive advantages. Today, artificial intelligence (AI) has become an essential tool for overcoming challenges across nearly all sectors of human activity. Its role is particularly significant in sales and marketing, given the importance of tailoring products and services to customer needs. Thus, analyzing customer perceptions of AI implementation is crucial, as customers represent the ultimate users of AI-driven tools – the intended beneficiaries of such technologies. This paper focuses on the application of artificial intelligence in sales and marketing, emphasizing customer perceptions regarding its usefulness and ease-of-use. Preliminary research was conducted to identify the levels of customer perceptions and explore relation among them.

Key words: Artificial intelligence, Sales, Marketing, Ease-of-use, Usefulness

INTRODUCTION

Artificial intelligence (AI) in the retail sector represents a revolutionary change, especially concerning the interaction between companies and their customers (Pawar, 2024). Similarly, Patil (2024) highlighted that retail transformation driven by AI implementation has significantly altered how companies operate and engage with customers.

According to Pawar (2024, p. 55), AI technology has fostered the evolution of marketing strategies by „gaining a deeper understanding of consumer behavior, allowing the design of highly segmented and personalized campaigns". AI offers opportunities for detailed analysis of current and potential customer profiles, allowing for tailored marketing offerings (Nagy and Hajdú, 2021). Besides predicting customer behavior and market trends, AI algorithms support demand forecasting, optimize inventory management, and minimize stock shortages or excess inventory (Patil, 2024).

For successful AI implementation, it is essential to consider the demand side – the customers themselves. As customers represent the primary beneficiaries of such technologies, their perceptions were central to this research. Specifically, this study emphasizes customers' perceived usefulness and ease-of-use regarding AI applications in sales and marketing.

LITERATURE REVIEW

Customer perceptions toward the use of AI in sales and marketing have become a significant focus in recent research. Bunea et al. (2024) investigated consumer purchase intentions in online shopping environments, specifically examining factors such as exposure to AI, AI usage levels, knowledge about AI, perceived usefulness, and perceived ease-of-use. Their findings indicated that perceived usefulness and perceived ease-of-use of AI positively and significantly influenced customers' purchase intentions in AI-powered online shopping contexts.

Similarly, Nagy and Hajdú (2021) conducted research based on the Technology Acceptance Model (TAM) to assess customer acceptance of AI in online shopping. Among the others, their study revealed that perceived ease-of-use significantly enhanced trust and perceived usefulness, while perceived usefulness had a direct, positive, and significant effect on both behavioral intention and customer attitudes.

The research conducted by Myin and Watchravesringkan (2024), which focused on customer adoption of AI chatbots, included perceived ease-of-use and perceived usefulness as two of the examined variables. Their findings indicated that both factors significantly and positively influenced customer attitudes toward the use of AI chatbots.

RESEARCH METHODOLOGY

This study examines customer perceptions regarding the ease-of-use and usefulness of AI in sales and marketing. The sample consists of 31 respondents, which is considered sufficient given the preliminary nature of this research. More than 70% of the respondents were female, and the average age was 24.

The items proposed by Bunea et al. (2024) were applied: five items to assess the usefulness of AI (UAI1, UAI2, UAI3, UAI4, and UAI5) and five items to assess the ease-of-use of AI (EUAI1, EUAI2, EUAI3, EUAI4, and EUAI5) (Table 1). Each item was evaluated on a 5-point Likert scale, ranging from 1 ("totally disagree") to 5 ("totally agree").

Table 1: Research items (Bunea et al., 2024)

Variables	Items
Usefulness of AI	I see the use of AI in sales and marketing as innovative and beneficial (UAI1)
	I believe AI can bring significant improvements to online shopping strategies (UAI2)
	I see AI as an effective tool for personalizing offers and customer experiences (UAI3)
	I believe that the use of AI can help increase efficiency in online shopping (UAI4)
	In general, I have a positive perception of the use of AI in online shopping (UAI5)
Ease-of-use of AI	AI-powered shopping apps and online stores are easy to use (EUAI1)
	When AI provides alternatives, shopping doesn't require significant mental effort (EUAI2)
	AI simplifies shopping by suggesting products to me (EUAI3)
	I find it simple to understand how to use AI-optimized shopping apps and online stores (EUAI4)
	Developing skills in using AI-powered shopping apps and online stores is simple (EUAI5)

After presenting the descriptive statistics, correlation analysis was performed to examine the relationship between the two variables. The analysis was conducted using SPSS software.

RESULTS

The overall mean values for both variables (UAI and EUAI) were above 4, indicating that respondents had positive perceptions and considered the use of artificial intelligence in sales and marketing both useful and easy to use (Table 2).

Table 2: Mean values – UAI and EUAI items

Variables	Items	N	Mean	Std. Deviation
Usefulness of AI	UAI1	31	4.13	0.885
	UAI2	31	4.16	0.898
	UAI3	31	4.16	0.860
	UAI4	31	4.35	0.608
	UAI5	31	3.68	1.107
	UAI - overall	31	4.09	0.755
Ease-of-use of AI	EUAI1	31	4.26	0.682
	EUAI2	31	4.00	0.816
	EUAI3	31	4.19	0.703
	EUAI4	31	4.19	0.654
	EUAI5	31	4.16	0.688
	EUAI - overall	31	4.16	0.571

Among individual items, the only item with a mean value lower than 4 was UAI5 (3.68), though it was still above 3.5. The highest mean value for usefulness was found in item UAI4 (4.35), whereas for ease-of-use, the highest was item EUAI1 (4.26).

Regarding the relationship between perceived ease-of-use and perceived usefulness of AI, correlation analysis was conducted. As shown in Table 3, the positive ($r = 0.581$) and statistically significant ($p = 0.001$) Pearson correlation coefficient indicates a moderate to strong positive relationship between these two variables. This suggests that higher perceived ease-of-use is associated with greater perceived usefulness of AI.

Table 3: Correlation coefficient

		UAI	EUAI
UAI	Pearson Correlation	1	0.581[**]
	Sig. (2-tailed)		0.001
	N	31	31
EUAI	Pearson Correlation	0.581[**]	1
	Sig. (2-tailed)	0.001	
	N	31	31

Additionally, the positive relationship between EUAI and UAI is visually confirmed by the scatter plot presented in Figure 1.

Although the distribution of data points indicates that usefulness increases along with ease-of-use, the observed variability among the points suggests that other factors might also influence this relationship.

CONCLUSION

Artificial intelligence represents an innovation that has already significantly influenced various sectors, holding the potential to drive revolutionary changes in the future. Its implementation is especially important in the fields of sales and marketing, offering numerous benefits for both companies and their customers.

Building on similar studies, this paper conducted preliminary research focusing on two key variables: perceived ease-of-use and perceived usefulness of AI in sales and marketing contexts. The findings revealed high mean values for both variables, suggesting that customers generally hold positive perceptions toward AI.
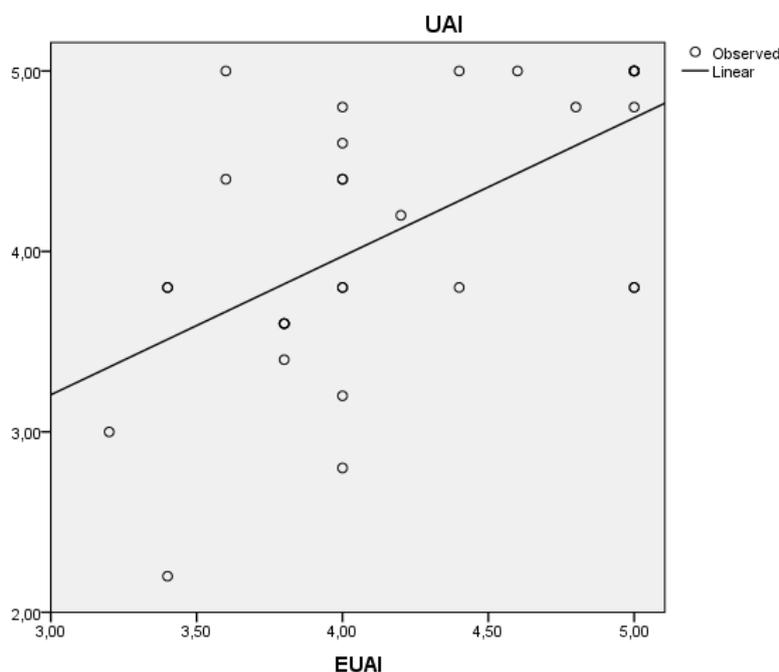
Figure 1: Scatter plot

Additionally, this study explored the relationship between perceived ease-of-use and perceived usefulness. Correlation analysis and the accompanying scatter plot confirmed a positive association, indicating that increased ease-of-use tends to result in higher perceived usefulness. This finding aligns with previous research (Nagy & Hajdú, 2021), which identified a positive and significant influence of perceived ease-of-use on perceived usefulness.

Given these results and the positive consumer perceptions identified, companies, particularly retailers, should consider integrating AI-based tools and solutions into their sales and marketing strategies. Such implementation could enhance not only operational efficiency but also customer relationships. Future research should incorporate additional variables to further clarify the relationship between ease-of-use and usefulness, as well as investigate customers' behavioral intentions towards AI adoption.

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ANALYSIS OF THE USE OF DIGITAL CHANNELS IN CUSTOMER RELATIONSHIP MANAGEMENT - CONSUMER ATTITUDES ON DIGITAL COMMUNICATION AND IT SOLUTIONS

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ABSTRACT

Paper explores role of communication channels in customer relationship management (CRM) with focus on consumers comments and behavior towards information technology solutions that are used in this process. The aim of this investigation was to analyze how consumers observe communication through websites and applications (social networks) and what impact these channels have on their behavior when it comes to shopping and how much they have trust in brand. A quantitative survey was conducted and data that were collected were processed in Microsoft Excel. Results have shown that Facebook and Instagram have most popularity and trust when it comes to products, while other channels are used less frequently. Papers also shortly discuss about challenges of integrating Artificial Intelligence (AI) into CRM systems.

Keywords: CRM, Social network, Digital channel, Consumer behavior, Digital communication.

INTRODUCTION

In today's time of rapid development of technologies, the Internet and great competition of all kinds of products and services, the ability to satisfy all the specific needs and wishes of customers is important. An effective relationship with customers is the basis for a bright future for any business (Fraculj-Matole, 2024). CRM is the process of establishing, maintaining and adjusting business relationships that are built on mutual trust, openness, shared risk and shared reward and plays a key role in the company's business on the market. In order to create the right basis for the application of the concept of customer relationship management and the control of the undertaken activities, it is necessary to establish two-way communication between the company and the target groups, on the basis of which flexible systems are formed for collecting, storing and broadcasting data, necessary to form knowledge about each individual customer. Two-way communication in a turbulent environment, which sometimes requires instant decision-making in interaction with customers, is not only desirable, but over time has been presented as one of the key standards of marketing communication, with the purpose of securing dominance over the competition (Jugović et al.,2015).

CUSTOMER RELATIONSHIP MANAGEMENT (CRM)

With CRM systems, customers are better served in their daily processes, and with more reliable information, their demand for independent services from companies will decrease. Therefore, if there is less needed to contact the company for various problems, the level of customer satisfaction increases. Through the implementation of CRM, companies can remove the confusion that exists in productivity, efficiency and control at every level through the proper use of CRM. These central benefits of CRM will be hypothetically linked to three types of equity, namely: relationship, value and

brand and finally to customer equity. The advantages of CRM implementation can be singled out (Mohammadhossein, N., & Zakaria, 2012):

− Improved ability to target profitable customers
− Integrated help in all channels
− Improved efficiency and effectiveness of the sales force
− Improved prices
− Customized products and services
− Improved efficiency and effectiveness of customer service
− Individualized marketing messages.

For customer relationship management to be profitable and successful, efforts should be concentrated on choosing the right customers, as well as bringing together people, knowledge, technology and processes in the organization to create value for each individual customer, build long-term relationships and achieve competitive advantage. The main obstacle to competition is the knowledge and information about customers that a particular organization has acquired about them. The more an organization invests in data collection and data management, the better positioned it will be compared to its competitors. An organization's competitive position and its profitability are directly related to the volume of customer data that the organization possesses in relation to its competitors (Jugović, et al., 2015) A CRM system helps companies store and record information about customers, such as their goals, needs, and events. Furthermore, the stored knowledge is updated in the CRM system, so that customer information will be up-to-date and not outdated (Mohammadhossein, N., & Zakaria, 2012). Figure 1 shows the process of customer relationship management (Antukić, 2016).
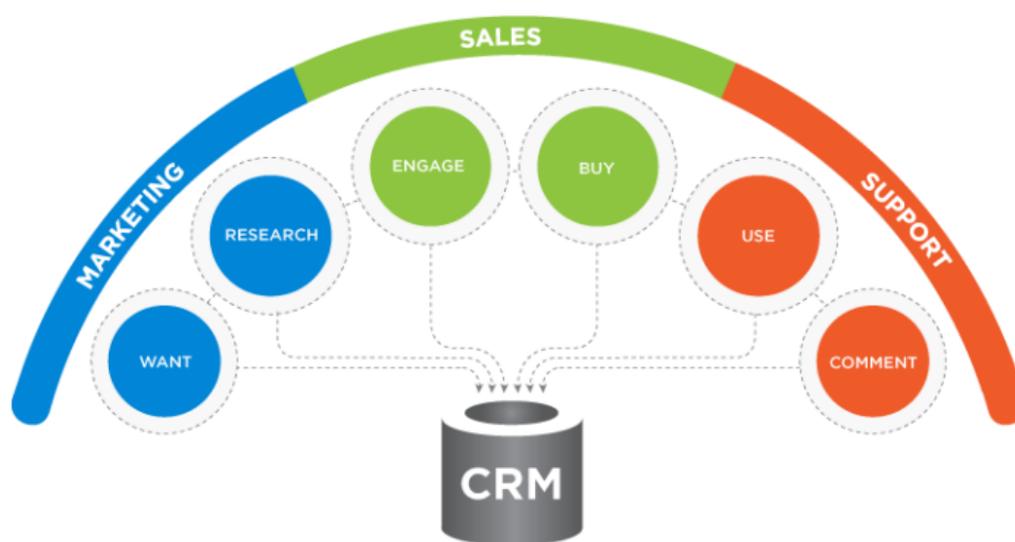
Figure 1. Example of the Facebook Ad

IMPACT OF DIGITALIZATION ON CONSUMER BEHAVIOR

Digitization of business as well as the opportunities provided by the Internet increase the effectiveness of existing marketing functions and represent a very effective communication and distribution channel (Domazet et al., 2019). Digitization has changed the way consumers access products and services. The increasing availability of the Internet and mobile devices has enabled consumers to research, compare and buy products with ease, anytime and anywhere. This change has led to an increased demand for online sales, digital payments and personalized marketing strategies, encouraging the development of digital platforms that can meet these needs (Leljak, 2024). Today, almost everyone who is looking for a certain product, whether for children, for themselves or for their company, starts by searching the Internet. It starts with Google or another search engine, and then seeks help from Internet friends,

family members, and colleagues, usually via email, online chat, Facebook, or Twitter. Thanks to this, companies can attract the attention of customers without large budgets and without resorting to attractive but expensive TV advertisements.

DIGITAL MARKETING

Social networks, or in a broader sense social media, are today among the most accessible opportunities for connecting a brand with potential consumers. Social media is a great way for businesses to "socialize" and gain the trust of consumers, connecting with them on a deeper level (Krajnović et al., 2019). Communication through social networks is relatively fast, cheap and customers can get answers to their questions very quickly. Facebook is suitable for any type of advertising because it has different audiences in its user base. Facebook currently has more than 2.38 billion monthly active users. According to a 2017 survey by HubSpot, 74% of respondents confirmed that they use Facebook for professional purposes. The possibilities that Facebook offers to companies are advertising, organization of events, sweepstakes, user animation and efficient customer support that can quickly respond to user inquiries. Facebook ads are predominantly visual, attract users' attention and can be displayed on the home page or on the side of the home page.

LinkedIn is a serious, professional and business social network intended for business users and companies, and today it has over 500 million active users. Of that number of users, according to a 2019 survey by Omnicore Agency, 40% of them visit this social network every day. The primary idea was to network business users, but it is also used as an advertising platform. On LinkedIn you can ask for recommendations, assess skills and talents, search for jobs and search for employees. There are two types of profiles on this social network: private person and company. This social network prefers longer and more meaningful posts, and the main focus is on quality content (Lukinec, 2019).

Instagram is perfect for promoting any type of product or service that is presented visually rather than textually. This social network has over 500 million daily active users. Instagram is a creative and primarily mobile social network. In promotion, a picture is worth 1000 words and Instagram proves it with successful promotions of products or services. Ads on Instagram are also targeted and visually noticeable. Like on Facebook, they can be targeted by gender, age, location, interests and affinities. Activities that are mainly advertised on Instagram are gastronomy, tourism, fashion, photography and all others that base their marketing on visual information. A fact that speaks to the possibilities of business advertising on Instagram is that according to the company Sprout Social, 7 out of 10 # (hashtags) come from or are directed towards a brand (Lukinec, 2019).

METHODOLOGY

This work is aimed at analyzing the importance of digital channels in modern CRM systems. It therefore aims to investigate the effectiveness of digital communication channels on the management of relationships with customers/consumers in modern business. Quantitative research was conducted from the perspective of consumers. The created online survey contained 20 concise questions that aimed to explore consumer attitudes, habits and experiences when it comes to researching digital communication channels. Also, emphasis was placed on the application of IT solutions in the mentioned channels (CRM tools, etc.). The survey itself was distributed via social networks: Facebook, WhatsApp, Viber and e-mail; so the response of users of social networks to the survey was monitored in this way. The survey was anonymous. Answers were collected during the month of April 2025, and a total of 23 respondents participated in the survey. It consisted of three parts: a) basic data of respondents (age, gender, education, employment status, etc.), b) habits of using social media when shopping and experience when shopping; c) views on the impact of its solutions on social networks from the consumer's point of view. The collected data were statistically processed in MS Excel.

Figure 2 shows the age of respondents who participated in the survey and filled out the survey correctly. The diagram was generated in MS Excel.
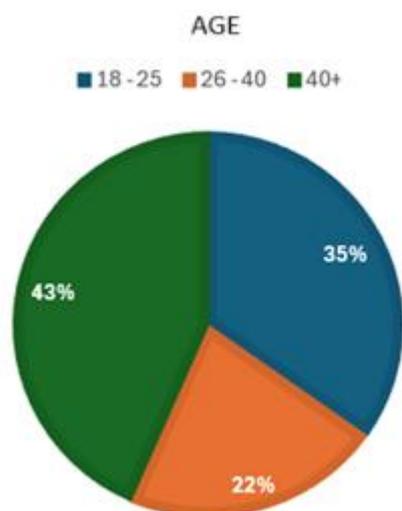

Figure 2: Age of respondents

Figure 3 shows a graph showing which social network the consumers who completed the survey who consider the most reliable for information about products when purchasing.
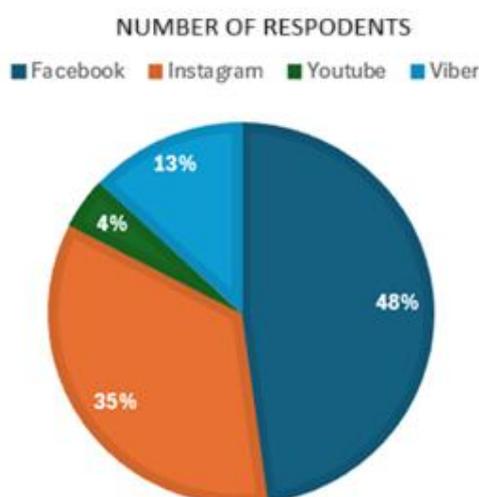

Figure 3. The most trusted social network for shopping

The key question for the third unit was: "When sponsored messages appear on social networks, how do you usually react?" The answers are given in Figure 4.

DISCUSSION

It can be concluded that women are predominantly more active when it comes to shopping through digital channels, which shows that this demographic group is more likely to resort to social networks and shopping. This indicates that companies should adapt marketing campaigns to the target group, which is more likely to purchase through digital communication channels. In this way, unnecessary costs are reduced and the company's profits increase. When it comes to the popularity of social networks (social implications), the survey showed that consumers more often resort to Facebook and Instagram, while the trust directed towards Viber and YouTube is significantly lower. Based on this, it is concluded that consumers still prefer traditional social networks and ways of informing about products through them. In other words, consumers who choose to purchase and obtain product

information through digital communication channels are more resistant to more modern digital formats, as they consider them "untested" and unfamiliar, such as Viber.

NUMBER OF RESPODENTS

■ I look at it, but rarely click on the ad   ■ I click if it looks interesting

■ I often access the product/service   ■ I ignore the ad
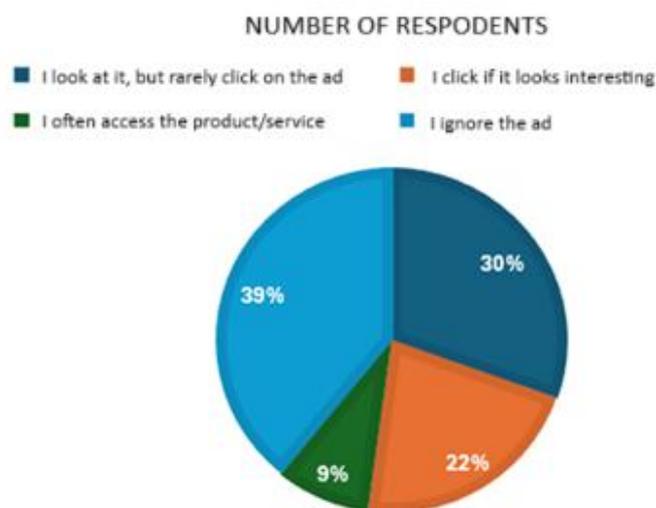
Figure 4. The most trusted social network for shopping

This can be of great importance to companies when creating marketing campaigns. In the third section, which relates to the views on the impact of IT solutions on social networks from the consumer perspective, when asked about sponsored messages, one can notice a pronounced reservation of consumers towards this type of communication. Most respondents react to these types of advertisements by ignoring them. This indicates that the currently used IT solutions for content marketing via digital channels are not the best option from the consumer's point of view. It can be concluded that it is necessary to further improve the optimization of digital channels in CRM, especially in the context of sponsored messages. One way in which companies can effectively reach consumers is to periodically set up surveys to check the level of satisfaction among consumers. In addition, companies will be able to see suggestions and proposals, as well as praise from consumers, and react in a timely manner to contribute to greater interest in the products themselves, as well as interest on social networks.

CHALLENGES IN THE IMPLEMENTATION OF CRM IN A BUSINESS ENVIRONMENT WITH A FOCUS ON THE INTEGRATION OF ARTIFICIAL INTELLIGENCE

Unlike stand-alone AI applications, AI within CRM requires seamless integration with existing CRM platforms and databases and often involves complex data environments and minimal disruption. Moreover, CRM requires strong attention to scalability and customization requirements which can introduce complexity in terms of data mapping, synchronization, real-time updates and configuration and therefore can lead to specific challenges. In the sphere of customer relationship management, close cooperation between marketing and sales teams is essential; artificial intelligence should serve as an intermediary in aligning these two functions, providing insights and recommendations that effectively connect their activities. In addition, CRM places a special emphasis on understanding customer emotions and feelings, which requires AI systems to recognize and respond appropriately to emotional signals during customer interactions. This emotional dimension adds an additional layer of complexity to AI models, which sets CRM apart from simpler applications (Ledro et al., 2023).

CONCLUSION

Based on the conducted research, it is evident that digital channels play a key role when es talks about modern management of relations with customers, but with special reservations of consumers when

talking about contents that are supported through sponsorship. The results of the survey show that users still rely on platforms that have been relevant for a long time, such as Facebook and Instagram, while other channels such as e.g. Viber less preferred for information when making purchase decisions. This may suggest that companies need to carefully adjust their CRM strategies on the preferences of specific and target groups, focusing on personalized and much less imposing forms of communication. Also, the integration of more modern and advanced IT solutions and AI in CRM systems is a recognized step in further development, but it also brings a new type of challenge that should not be ignored.

In future work, it would be useful to expand the sample size and include consumer opinions in different market forms to provide a broader picture of the effectiveness of these and many other digital channels in CRM.

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THE USAGE OF ARTIFICIAL INTELLIGENCE IN DIGITAL ADVERTISING

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ABSTRACT

Artificial intelligence (AI) is becoming an indispensable tool in digital marketing, enabling personalization, automation, and effective consumer targeting. The main goal of our research was to explore and analyse how consumers perceive and understand the use of artificial intelligence in digital advertising. The focus of the research was to examine consumers' attitudes towards the use of personal data, the transparency of algorithmic operations, corporate responsibility, and the impact of AI on their purchasing decisions and behaviour. We also wanted to find out whether the use of AI in digital marketing contributes to greater personalization and improved user experience. Research has shown that most of respondents are familiar with the use of AI in advertising and that such ads affect their purchasing habits.

Key words: Artificial intelligence, Digital advertising, Personalized marketing messages, Shopping behaviour.

INTRODUCTION

The advantage of AI is to gain rapid insight into customer behaviour, as it allows for the capture of huge amounts of data in a very short time. This data can be used to respond and adapt to customer needs based on their actions and preferences. AI also adapts and improves over time using feedback and new data.

Digital online advertising therefore encompasses all marketing activities that are carried out online. The impact of digital marketing on customer acquisition is increasing year by year, as more and more people use the web to browse, connect and make purchases. The Digital 2022: Global Overview Report states that 4.95 billion people use the web, which is almost 63 percent of the world's population (Digital Marketing Institute, 2022). Advanced technologies such as sentiment analysis, personalized recommendations, advanced chatbots, and voice-activated virtual assistants are increasingly used in digital marketing (Magalhães, 2023).

DEVELOPMENT AND USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence does not replace human roles and efforts but is a technology that complements and enhances these roles and requires human skills to be used effectively (Digital Marketing Institute, 2022). Artificial intelligence is a technology that enables computers and machines to simulate human intelligence and problem-solving abilities. Alone or in combination with other technologies, it performs tasks that would otherwise require human intelligence or intervention. It includes machine learning and deep learning, which enable the development of artificial intelligence algorithms capable of "learning" from available data and eventually making more accurate predictions than humans can make (IBM, 2022).

Due to its ability to process large amounts of data, it allows companies to gain insights into their business in ways that they would not otherwise notice. Among other things, generative AI tools are

becoming increasingly important in various fields such as education, marketing, and product design (Laskowski, Tucci and Craig, 2022).

Digital marketing, characterized by its dynamic nature and reliance on real-time data, will greatly benefit from the potential offered by artificial intelligence. From predictive analytics to personalized user experiences, artificial intelligence is revolutionizing the way companies communicate with their audiences in the digital environment (Ziakis & Vlachopoulou, 2023). In the field of AI, ethical aspects are also very important, as they are constantly evolving and changing. Organizations must commit to continuous learning, be aware of current ethical guidelines, and adapt their practices accordingly (Mathieu, 2024).

USING ARTIFICIAL INTELLIGENCE IN DIGITAL ADVERTISING

Artificial intelligence, including generative AI, is used in advertising today to do everything from generate ad creative and copy to optimize ad budgets and predict advertising campaign performance (Kaput, 2024). The most attractive feature of AI is its ability to provide personalized experiences for customers. By analysing vast datasets, AI algorithms can predict customer preferences, tailor recommendations, and anticipate their needs before they are even expressed. This level of personalization was once only available in luxury services, but today AI is bringing it to the mass market, allowing brands to provide each customer with an individualized experience (The Marketing Hustle, 2024).

Digital advertising encompasses all marketing activities on the Internet, such as online advertising, websites, social media, and email, that are used to promote a company and get to know its customers. It is therefore a type of marketing that uses the Internet to connect with current and potential customers to gain insight into marketing efforts and determine how well customer needs are being met. The main characteristic of digital advertising is the use of various digital tactics and channels to establish contact with customers where they spend most of their time, that is, online (Desai, 2019). Digital advertising combines with traditional marketing techniques and allows companies to communicate with their target audience better than ever before. On the one hand, this allows consumers to have a wide range of entertainment, products, services, and prices from different providers, as well as a convenient way to choose and purchase products. On the other hand, digital marketing offers organizations the opportunity to expand into new markets, introduce new services, innovative ways of communicating with target groups, and compete on an equal footing with larger companies (Chaffey & Ellis-Chadwick, 2019).

EMPIRICAL FINDINGS

In empirical research we used a survey questionnaire to research and analyse how consumers perceive and respond to the use of artificial intelligence in digital advertising. A questionnaire was made in 1KA - a one-click survey. We shared the link to the survey via e-mail and distributed it to various groups on Facebook and Instagram. A total of 283 respondents participated in the survey, of which 112 completed the questionnaires, 82 of whom were women and 30 were men.

We first obtained data on the age structure of the respondents. Most respondents are from the 25-34 age group, as 49% of respondents belong to this group. It is followed by the 45 and more age group, represented by 21% of respondents. 20% of respondents are from the age group of 18-24 years. Only a small number (9%) of participants were between 35 and 44 years old and only one respondent was under 18 years old.

The next question was about educational structure of the respondents. One had primary school, 26 secondary school, 36 a higher vocational school, 17 a university degree, 21 a master's degree and one had a doctorate. To gain insight into the level of understanding of the use of AI in digital advertising

among our respondents, we asked them how they would rate their knowledge in this area. Respondents rated their understanding on a five-point scale from 1 to 5, where 1 means very poor understanding and 5 means very good understanding.
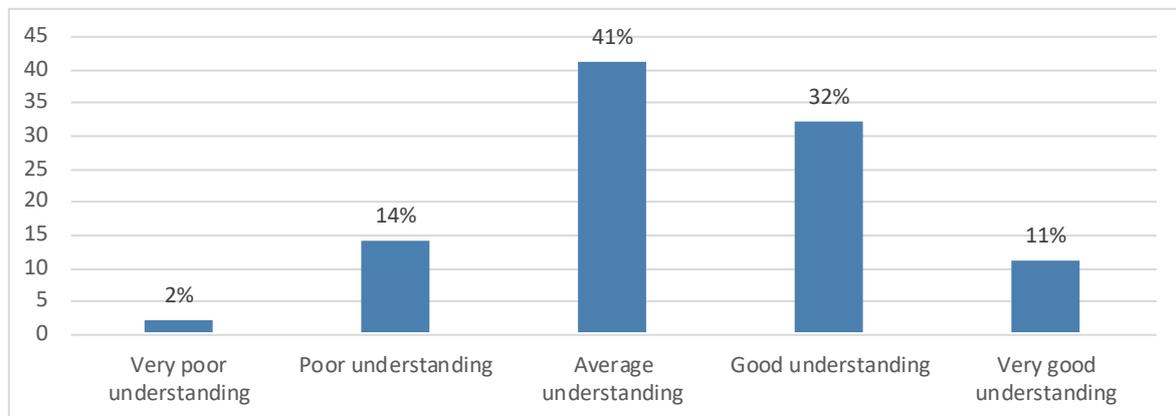

Figure 1: Understanding the use of AI in digital advertising

Most respondents (41 percent) rate their understanding of the use of AI in digital marketing as average. The prevailing rating of 3 indicates that the understanding of this area is mostly at an average level. This may mean that most respondents know the basic concepts but may not have in-depth knowledge. The share of those who rated their understanding as "Good" or "Very good" (43 percent in total) indicates that there is also a part of respondents with a better understanding, but this segment of respondents is still smaller compared to those with an average understanding. The small share (16 percent) indicates that only a few respondents have a poor or very poor understanding. (Figure 1)

In the next question, we wanted to find out how important it is for respondents to be informed when AI is involved in determining the marketing content or recommendations they receive. With the increasing use of AI in digital advertising, it is important to understand whether consumers want to know when and how this technology is being used to personalize their experiences. Respondents gave their opinions on a five-point scale from 1 to 5, where 1 means very unimportant and 5 means very important.
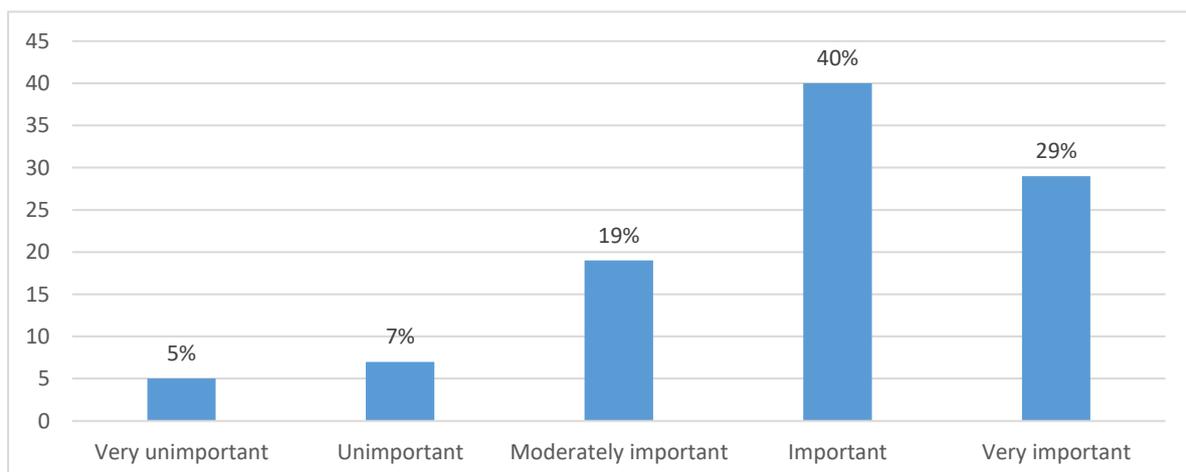
Figure 2: Arithmetic mean of answers to individual statements

A total of 69 percent of respondents (40 percent + 29 percent) consider it "Important" or "Very important" to know when AI is involved in determining marketing content or recommendations. This indicates a strong desire for transparency and information about the use of AI in digital advertising. "Medium important" was selected by 19 percent of respondents. Only 12 percent of respondents

consider it "Unimportant" or "Very unimportant" to know when AI is involved in determining digital marketing content. The results clearly show that most respondents (69 percent) attach great importance to being informed about the use of AI in determining marketing content or recommendations. (Figure 2)

With the next question, we wanted to find out how the purchasing decisions of respondents have changed due to targeted ads and personalized marketing messages enabled by artificial intelligence.
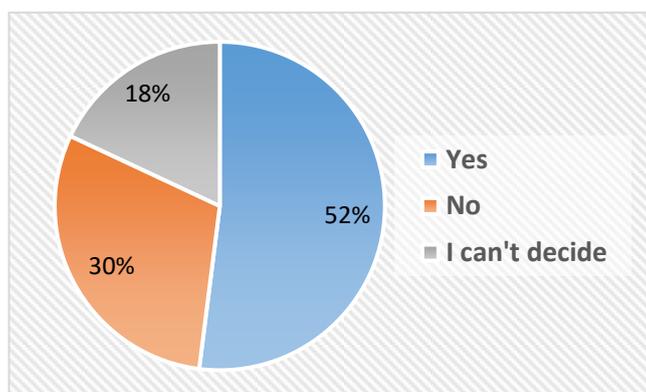
Figure 3: Change in purchasing decisions due to targeted ads and personalized marketing messages

Based on the respondents' responses, it can be concluded that artificial intelligence has noticeable effects on the purchasing decisions of more than half of those surveyed (52 percent), indicating a strong influence of AI on consumer purchasing decisions. (Figure 3). The purpose of the next question was to understand how often consumers make purchasing decisions based on recommendations they receive through digital advertising.
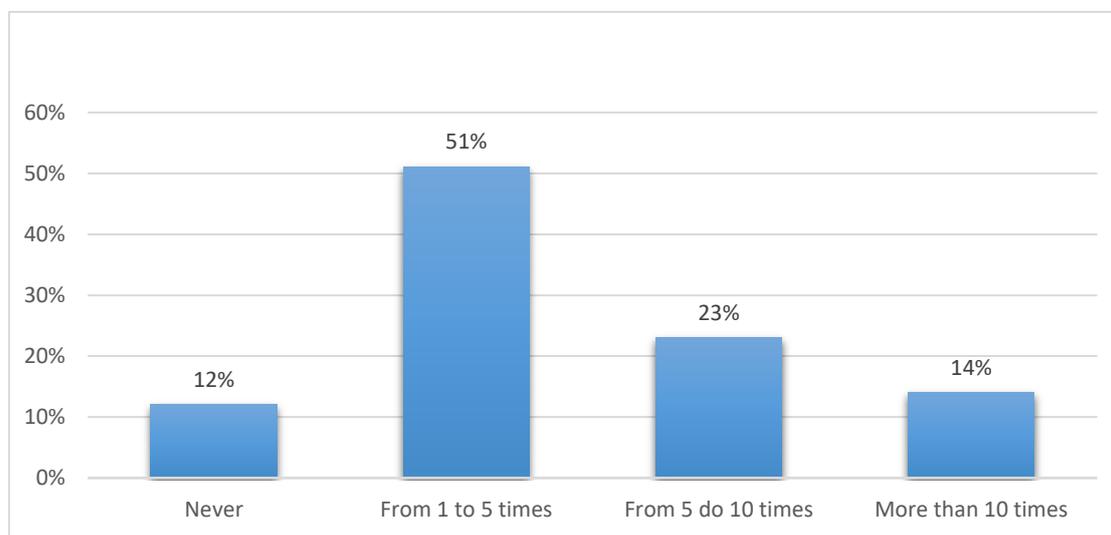
Figure 4: Frequency of purchasing products or services recommended through digital advertising

Analysis of the responses suggests that most respondents (74 percent) respond to digital advertising to some extent by purchasing recommended products and services. (Figure 4) However, this effectiveness varies, with more than half of respondents (51 percent) reporting a relatively low number of purchases (from 1 to 5 times). A relatively small proportion of respondents (14 percent) made more than 10 purchases, suggesting that this is a group of highly responsive consumers who place a high level of trust in digital advertising. The low percentage of respondents (12 percent) who have never made a purchase based on digital advertising is also significant, as this group may represent a segment of consumers who may be resistant to digital advertising. With the following question, we wanted to

find out whether consumers believe that personalized ads and recommendations allow them to make better choices about products and services.
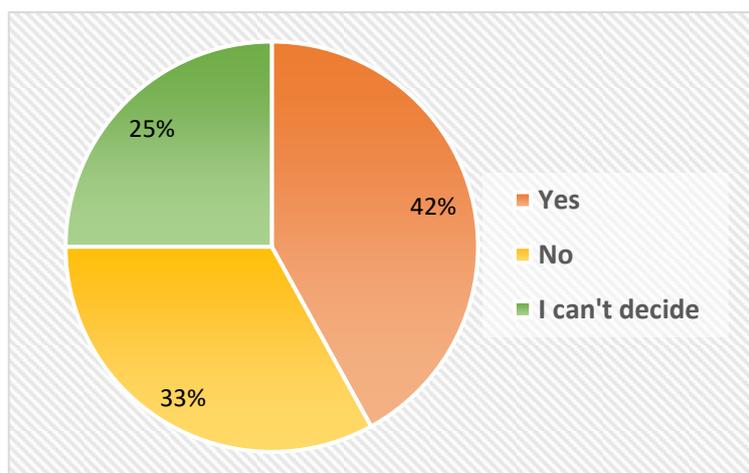
Figure 5: Improved product or service selection due to personalized ads or recommendations

The analysis of the results is as follows: (Figure 5)

− 47 respondents (42 percent) believe that recommendations allow for improved product or service choices, which indicates that these consumers have positive experiences with personalized marketing approaches.

− 37 respondents (33 percent) respondents do not believe that personalized ads or recommendations improve their product or service choices. From this we can conclude that this proportion of consumers may have negative experiences, which could be the result of inadequate personalization or excessive invasiveness of advertisements.

− 28 respondents (25 percent) were undecided about the impact of personalized ads on improving their choices.

We were also interested in whether respondents believed that AI-driven advertising could encourage overspending or excessive shopping behaviour.
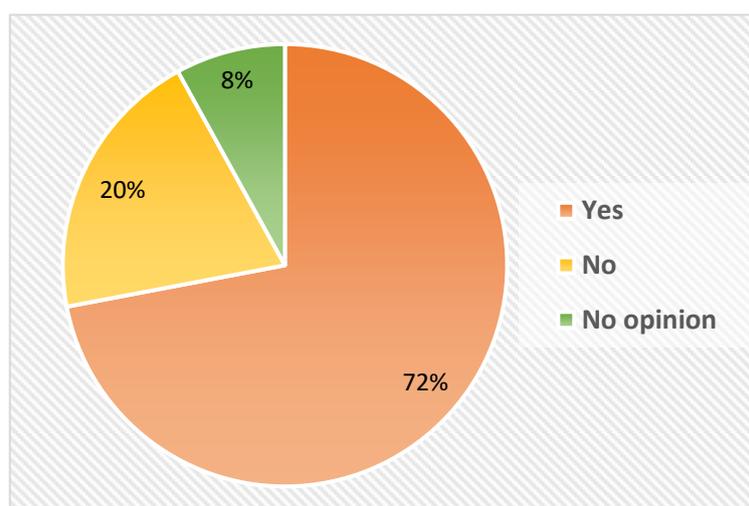
Figure 6: AI-driven advertising overspending and impulse buying behaviour

The results show that most respondents (72 percent) perceive AI as a potential factor that can encourage overspending and excessive shopping behaviour. Only 20 percent of all respondents expressed no concern, which may represent a segment of the population that either trusts regulatory mechanisms or does not see a direct connection between advertising made by AI and shopping habits.

CONCLUSION

Due to the increasing use of the internet, especially via smartphones, consumers are less accessible in the physical environment and increasingly in the online environment, which limits traditional forms of advertising due to the lack of information about our interests and desires. Digital advertising allows companies to reach their target audience at the right time, when they are looking for a specific product or service, and address them with personalized messages based on demographic, geographic, behavioural and other relevant parameters.

Digital advertising is a marketing approach in which products or services are promoted using digital technologies, primarily online, but also via mobile devices, display advertising, and other digital media. Artificial intelligence, which enables advanced data analysis, content personalization, and marketing automation, has the potential to radically change the way companies reach consumers. However, despite the benefits of this technology, important ethical issues arise, such as personal data protection, bias, algorithm transparency, and the impact of AI on consumer choice.

It is important to most respondents to know when AI influences marketing content and recommendations. Based on the results obtained, we found that 69 percent of respondents find it important or very important to know when AI influences the creation of marketing content. The survey results show that consumers are aware of the use of artificial intelligence in digital marketing, but they express concerns about the security and privacy of their data. We found that consumers want greater transparency about how companies collect, process and use their data, and they also want to know when and how AI influences their decisions with personalized ads and recommendations. Based on these results, we can suggest that companies pay more attention to educating consumers about the functioning of AI and ensure greater accountability and transparency in the use of this technology.

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Session D: ECONOMY

IMPLEMENTATION OF CIRCULAR ECONOMY AS A STRATEGY FOR SUSTAINABLE COMPETITIVE ADVANTAGE

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ABSTRACT

The aim of this paper is to explore the current situation and future prospects of circular economy development in Serbia, with a focus on the economic and ecological aspects of implementing this model, as well as the challenges faced by companies and legislative authorities. The methodology is based on the analysis of existing theoretical frameworks of the circular economy, case studies of successful implementations in global industries, and an assessment of the situation in Serbia through an overview of legal regulations, industrial applications, and the level of awareness among citizens and entrepreneurs. By using secondary data from relevant sources, such as reports from international organizations and studies from specialized agencies, the paper provides insights into the advantages and challenges of transitioning from linear business models to circular ones. Special attention is given to aspects such as financial incentives, education, and innovation to support the faster development of circular principles in Serbia. Through this analysis, the paper offers recommendations for improving policy and supporting the implementation of the circular economy in the country.

Key words: Circular economy, Sustainability strategy, Competitive advantage.

INTRODUCTION

In the modern business environment, companies face increasing pressure to adapt their production operations to sustainability principles. The traditional linear economic model, based on the "take, make, dispose" approach, is increasingly revealing its ecological and economic shortcomings. Population growth, depletion of natural resources, and environmental issues such as climate change and pollution necessitate new approaches to business operations.

The circular economy is an innovative model that focuses on waste reduction, material reuse, and the regeneration of natural systems (Smol et al., 2020). Its implementation enables more efficient resource management, reduces negative environmental impacts, and increases the economic value of products and services. By adopting circular principles, companies not only contribute to sustainability but also gain a competitive advantage in the market.

The transition to a circular economy brings numerous benefits, including lower production costs, increased innovation, and stronger customer relationships. Modern consumers increasingly value sustainable products and companies that operate responsibly, making the circular economy a strategic tool for long-term success (Ghisellini, Cialani & Ulgiati, 2016). Additionally, regulatory requirements in many countries are becoming stricter, encouraging companies to adopt sustainable business models.

However, implementing a circular economy is not a simple process. Companies face challenges such as high initial costs, the need for technological innovations, and adapting existing business models. Moreover, the lack of adequate legal frameworks and infrastructure can hinder the practical application of circular principles.

CIRCULAR ECONOMY – ECONOMIC ASPECT

The circular economy is an economic model aimed at minimizing waste and maximizing resource use through recycling, reuse, and material regeneration. Unlike the linear model, which follows the "take, make, dispose" principle, the circular approach extends product life cycles and reduces external costs associated with pollution and the depletion of natural resources (Geissdoerfer et al., 2017).

From a macroeconomic perspective, the implementation of the circular economy can contribute to GDP growth by improving resource efficiency and creating new jobs in sectors such as recycling and sustainable design (Stahel, 2016). At the same time, reducing dependence on raw materials through circular principles enhances economic resilience to market shocks and resource price volatility (Ellen MacArthur Foundation, 2015).

At the business level, circular business models, such as servitization and closed-loop production, enable greater efficiency and competitiveness. Companies shifting from product sales to service provision (e.g., leasing instead of selling) generate long-term revenue and reduce raw material costs (Bocken et al., 2016). This model is particularly suitable for industries where resources have high value, such as the automotive industry.

Additionally, the adoption of circular strategies drives innovation in eco-design and digitalization, enabling more efficient resource management and cost reduction through technologies such as the Internet of Things (IoT) and artificial intelligence (Ranta et al., 2018). On the other hand, high initial costs and the need for infrastructural adjustments can pose challenges for implementation, particularly for small and medium-sized enterprises (Kirchherr et al., 2018).

In the labor market context, the circular economy generates new jobs in sectors such as repair, recycling, and product repurposing, but also requires workforce reskilling (Nademi & Kalmarzi, 2025). Investments in education and training are crucial to ensuring the necessary skills for transitioning to sustainable business models.

At the global level, the circular economy has the potential to reduce economic inequalities by improving resource distribution and creating inclusive markets. However, transitioning to this model requires coordination between governments, industries, and consumers, as well as incentive measures such as tax benefits and regulations that promote sustainable production and consumption (OECD, 2019).

CIRCULAR ECONOMY – ECOLOGICAL ASPECT

The circular economy is a sustainable development model aimed at minimizing the ecological footprint through efficient resource use, waste reduction, and ecosystem regeneration. This approach contrasts with the linear economic model, which leads to excessive exploitation of natural resources and waste accumulation (Geissdoerfer et al., 2017).

One of the key environmental benefits of the circular economy is the reduction of air, water, and soil pollution. Extending product lifespans and recycling reduce the need for primary resource extraction, thereby lowering greenhouse gas emissions associated with mining, transportation, and

production (Ellen MacArthur Foundation, 2015). Research suggests that transitioning to circular business models could reduce global carbon dioxide emissions by 39% by 2050 (Khalifa et al., 2022).

The introduction of strategies such as eco-design and the use of renewable raw materials enables the reduction of a product's environmental footprint throughout its entire life cycle (Bocken et al., 2016). The application of biomaterials and biodegradable packaging further contributes to reducing plastic pollution, one of the most pressing environmental challenges of our time (Geyer, Jambeck, & Law, 2017).

Closed material loops in the circular economy have a positive impact on biodiversity by reducing the need for expanding industrial and mining zones that threaten natural habitats (OECD, 2019). Sustainable waste management through recycling and composting prevents ecosystem degradation and reduces methane emissions from landfills, which is crucial for mitigating climate change (European Environment Agency, 2021).

Water, as one of the most endangered natural resources, also gains importance in circular models. Wastewater reuse and treatment strategies reduce freshwater consumption and pollution of aquatic ecosystems (Mekonnen & Hoekstra, 2016). Industrial symbiosis, where one industry's waste becomes a resource for another, plays a key role in preserving water resources (Bain et al., 2010).

The circular economy promotes regenerative practices in agriculture, such as agroecology and soil carbon sequestration, which enhance soil fertility and reduce the negative impacts of conventional agriculture (Rockström et al., 2017). Implementing zero-waste principles and circular supply chains in the food industry can significantly reduce global food waste and its environmental impact (Ardra & Barua, 2023).

Adopting circular solutions at the urban level contributes to reducing cities' ecological footprints through energy-efficient buildings, smart transportation systems, and green infrastructure projects (Bibri & Krogstie, 2020). The use of renewable energy sources and decentralized energy networks further enhances the sustainability of urban ecosystems (Mathews & Tan, 2016).

Despite numerous environmental advantages, the transition to a circular economy faces challenges, including technological barriers, inadequate regulations, and high initial costs (Kirchherr et al., 2018). However, the long-term benefits of reducing environmental externalities and increasing ecosystem resilience make this model essential for a sustainable future.

CIRCULAR ECONOMY – CHALLENGES FOR THE FUTURE

Circular economic models enable long-term sustainability and profitability through efficient resource use, waste reduction, and innovations in production and distribution. These models incorporate strategies such as recycling, reuse, remanufacturing, and servitization, which minimize externalities and optimize material flows (Geissdoerfer et al., 2017).

One of the key factors for long-term profitability in circular models is reducing dependence on primary raw materials, allowing businesses to protect themselves from market fluctuations and supply chain uncertainties (Ellen MacArthur Foundation, 2015). According to research by Material Economics (2019), implementing circular principles could reduce operational costs in industries such as automotive and electronics by more than 20%.

The adoption of circular strategies drives innovation in product design, where eco-design enhances product durability, facilitates repair, and simplifies recycling (Bocken et al., 2016). This approach helps companies gain a competitive advantage and strengthen consumer loyalty through sustainable business models.

Servitization, in which companies shift from selling products to providing services (e.g., leasing instead of selling), enables them to generate long-term revenue and increase product value through multiple usage cycles (Tukker, 2015). Such models are particularly successful in the IT and automotive industries, where the concept of shared mobility (e.g., Car-as-a-Service models) is increasingly evolving. An example of a successful circular model is Rimac Automobili, which integrates battery remanufacturing and material recovery into its production process. By using advanced technologies for recycling battery cells, the company reduces its environmental footprint and procurement costs for critical materials such as lithium and cobalt (Rimac Group, 2023).

Although circular models offer numerous advantages, they also face significant challenges. One major obstacle is the need for substantial initial investments in recycling technologies and infrastructure for closed material loops (Kirchherr et al., 2018). Many companies hesitate to transition to circular processes due to the high costs of research and development.

Another challenge is regulation, which in many countries is not yet adapted to circular practices. The lack of standardized methods for assessing product circularity makes it difficult for companies to fully implement sustainable business models (OECD, 2019).

Consumer behavior also plays a crucial role in the success of circular models. While environmental awareness is increasing, many consumers still prefer product ownership over shared economy or repurposing models (Schwanholz & Leipold, 2020).

Despite these challenges, the advantages of circular models in terms of long-term resilience and profitability clearly indicate their potential as the dominant economic system of the future. With technological innovations, adequate policies, and shifts in consumer habits, the circular economy could become a key factor in the sustainable development of the global economy.

Table 1: Circular Economy in Serbia – Current Situation and Future Perspectives

Aspect	Current situation	Perspectives for the future
Legal framework	Insufficient regulation and weak implementation of existing laws.	Stronger regulation with greater focus on circular practices, compliance with EU standards is expected.
Industrial application	Circular principles are just beginning to be applied in industry (processing, textile).	Greater integration of circular models in the processing, textile and electrical industries.
Education and awareness	Low awareness among entrepreneurs and citizens about the benefits of the circular economy.	Increasing education and promotion of sustainable business models, development of professional staff.
Financial incentives	Lack of sufficient incentives and subsidies for companies implementing circular practices.	Introduction of financial incentives and subsidies for companies implementing circular strategies.
Investments and innovations	A relatively small number of investments in research and development of circular technologies.	Growing number of investments in circular technologies, development of startups dealing with sustainable innovations.

This overview highlights the current challenges in implementing the circular economy in Serbia, as well as the opportunities for its faster development in the future. We hope that in the coming years, more favorable conditions will be created for its broader development, both in industry and in the everyday life of citizens**.**

CONCLUSION

The transition to a circular economy represents a fundamental shift in modern business practices, addressing both ecological and economic challenges associated with the traditional linear model. By prioritizing resource efficiency, waste minimization, and sustainable innovation, circular strategies contribute to long-term business competitiveness, economic resilience, and environmental preservation.

Despite its numerous advantages, the implementation of circular models faces significant challenges, including high initial costs, regulatory gaps, and consumer behavior inertia. Overcoming these barriers requires coordinated efforts from governments, industries, and consumers, supported by financial incentives, infrastructure development, and educational initiatives.

In Serbia, the adoption of circular economy principles is still in its early stages, with limited regulatory support and investment in circular innovations. However, future perspectives indicate a growing alignment with EU sustainability standards, increased financial incentives, and greater integration of circular business models across industries. Strengthening education and awareness will be crucial in fostering a cultural shift towards circularity among businesses and consumers.

Ultimately, the circular economy represents a viable path toward a more sustainable and resilient global economy. By embracing circular principles, businesses and policymakers can not only mitigate environmental impact but also unlock new economic opportunities, ensuring long-term sustainability and prosperity.

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ENVIRONMENTAL TAXATION AND ECONOMIC DEVELOPMENT NEXUS IN NORDIC COUNTRIES

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ABSTRACT

This study explores the relationship between environmental taxes and economic development in Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden) from 2013 to 2022. Using secondary data from OECD Revenue Statistics, the research employs descriptive statistics, panel unit root tests, and causality analysis to examine the nexus between environmental tax revenues (ETR) and GDP per capita (GDPpc). The findings reveal significant variability in ETR and GDPpc across the Nordic region, with Norway showing the highest fluctuations. Causality tests indicate a unidirectional relationship, where economic development (GDPpc) influences environmental tax revenues, but not vice versa. This suggests that wealthier economies may implement stronger environmental tax policies, highlighting the role of economic growth in shaping environmental taxation. The study underscores the importance of well-designed environmental tax policies to balance economic and environmental objectives, emphasizing the need for further research to explore the complexities of this relationship in different contexts.

Key words: Environmental taxes, Economic development, Causality, Nordic countries

INTRODUCTION

The relationship between environmental taxes and economic development is a critical topic as countries strive to achieve sustainable growth while addressing climate change. Environmental taxes are designed to reduce pollution and encourage the adoption of cleaner technologies, but their implementation can also pose economic challenges, particularly for industries reliant on fossil fuels (Ahmad et al., 2020). While some experts argue that these taxes can drive innovation and energy efficiency, others express concerns about potential job losses and reduced competitiveness. The success of environmental taxes largely depends on factors such as tax design, revenue allocation, and the economic structure of the country (Chen et al., 2022). For instance, if revenues are reinvested into green technologies or used to lower other taxes, both the economy and the environment can benefit (Fan et al., 2019).

Developed countries, such as those in the Nordic region, often find it easier to implement environmental taxes due to their advanced institutional frameworks and higher public acceptance (Stameski et al., 2024). In contrast, developing nations may face significant obstacles due to limited resources and economic constraints (Youssef & Dahmani, 2024). However, studies have shown that well-designed environmental taxes can support sustainable growth by promoting renewable energy and eco-friendly technologies (Rao et al., 2023).

To ensure fairness, governments can redistribute revenues through social programs or infrastructure projects, thereby mitigating potential negative impacts on vulnerable populations (Liu, 2024). International cooperation is also crucial, as uneven tax policies may lead to "carbon leakage," where businesses relocate to countries with weaker environmental regulations (Silajdzic & Mehic, 2018).

Global efforts, such as carbon pricing and trade agreements, can help create a more level playing field for industries worldwide (Fortea et al., 2024). Public acceptance plays a pivotal role in the success of environmental taxes, making clear communication and transparency essential for gaining support (Andrei et al., 2016). Countries that implement well-designed environmental tax policies often experience long-term benefits, including improved public health, increased green investments, and a stronger economy (Chen et al., 2022). However, the outcomes vary depending on how policies are designed and enforced, highlighting the need for context-specific approaches (Rao et al., 2023). Understanding how environmental taxes affect different industries and communities is vital for creating effective policies that balance economic growth with environmental protection (Youssef & Dahmani, 2024).

This paper aims to explore the relation between environmental taxes and economic development in Nordic countries, focusing on the period from 2013 to 2022. By analyzing the potential causality between environmental tax revenues and GDP per capita, the study seeks to provide insights into how taxation can drive sustainable growth without compromising economic stability. A well-designed environmental tax system can protect natural resources while fostering innovation and competitiveness, contributing to a greener and more sustainable future. The structure of the research consists five segmetns. The first and second segment include an introduction and literature review that have estimated the relation among these variables worldwide. The third segment is methodological framework, while the fourth segment represents empirical resuls. Lastly, the last segment manifests conclusions and gives policy implications and recommendations.

LITERATURE REVIEW

The relationship between environmental taxes and economic development has been widely debated in academic research. This section explores key findings from the existing literature, highlighting different perspectives on the influence of environmental taxes on economic development. Several studies have found positive or neutral impacts of environmental taxes on economic development, particularly in certain contexts. A study focusing on Nordic countries—Denmark, Finland, Iceland, Norway, and Sweden—reported that energy and transport tax revenues had significant positive effects on GDP per capita between 2013 and 2022 (Stameski, 2024). This suggests that, in these countries, the revenue generated from these taxes was effectively utilized to support economic activities, potentially through investments in infrastructure, research and development, or other productivity-enhancing initiatives. The study's authors argued that a higher share of revenues in the total tax structure, especially pollution tax revenues, could further enhance economic development in the Nordic region. Similarly, a study comparing China and India found that environmental taxes did not impede economic growth and, in fact, contributed to sustainable development (Ahmad, 2020). This research emphasized the potential for environmental taxes to stimulate innovation and cleaner production methods, leading to long-term economic benefits.

Countries with more consolidated democratic institutions, higher levels of civil society participation, and less corrupt governments experienced greater success in using environmental taxes to achieve environmental goals. Tchapchet-Tchouto et al. (2022) investigated the impact of environmental taxes on economic growth across 31 European countries between 2009 and 2019. Using Pooled OLS, the findings suggested that increases in environmental taxes through tax reforms negatively influence economic growth. Quantile regression further revealed a consistent negative effect of environmental taxes across all quantiles, significant at 1%. However, the impact varies by income level, with low-income countries experiencing more pronounced negative effects compared to medium- and high-income countries. The study of Mirović et al. (2023) employed an econometric analysis to investigate the relationship between environmental taxes, economic growth, and government spending in the Visegrad Group (VG) countries—Czechia, Hungary, Poland, and Slovakia—between 1995 and 2018. The research finds that increases in both total and energy tax revenues positively affect economic growth, while transport tax revenues have a negative impact. This suggests that different types of environmental taxes may have distinct effects on economic performance, underscoring the need for

careful tax policy design. Hassan et al. (2020) found that environmentally related taxes have no significant impact on GDP growth in OECD countries unless initial GDP levels are considered, with positive effects in wealthier nations and negative effects in poorer ones.

Conversely, other studies have reported negative or inconclusive relationships between environmental taxes and economic development. A study examining ten Central and Eastern European countries between 1995 and 2015 found that environmental taxes were ineffective in curbing CO2 emissions (Silajdzic, 2018). This suggests that the effectiveness of these taxes is not universally guaranteed and is dependent on various contextual factors, such as the level of economic development, the presence of other complementary policies, and the specific design of the tax system. The authors noted that the relationship between economic growth and environmental degradation followed an inverted U-shape (EKC), but environmental taxes did not significantly alter this relationship. A study investigating the impact of environmental taxation on economic growth in Romania found mixed results, highlighting the need for further research to establish a conclusive relationship between these variables (Andrei, 2016). The authors emphasized the complexities of evaluating the impact of environmental taxes in a transition economy, where the interplay between economic development, energy reliance, and environmental policy is particularly intricate. Another study examining EU countries found that environmental taxes negatively impacted GDP per capita in the short run (Fortea, 2024), suggesting that the short-term economic costs of implementing such taxes may outweigh the short-term benefits. However, the study also noted a long-run bidirectional causality between economic growth and greenhouse gas emissions in Romania, while in Sweden, the causality ran from economic growth to greenhouse gas emissions. This highlights the considerable variation in the effects of environmental taxes across different countries and economic systems.

The influence of environmental taxes on economic development is demonstrably heterogeneous across countries and contexts. This heterogeneity reflects the interplay of several factors, including institutional quality, economic structure, technological capabilities, and the specific design of environmental tax policies (Youssef, 2024), (Rao, 2023), (Chen, 2022). Studies focusing on diverse regions, such as Africa (Youssef, 2024) and China (Rao, 2023), (Fan, 2019), (Liu, 2024), reveal the significant variation in outcomes. In Africa, the complex relationship between environmental taxes, productive capacities, urbanization, and environmental quality highlights the need for tailored policy strategies that consider the continent's diverse economic and environmental contexts (Youssef, 2024). In China, studies have explored the spatial and temporal heterogeneity of environmental taxes' impact on green economy development, revealing varying effects across different regions and over time (Rao, 2023). The effectiveness of environmental taxes also depends on the type of tax implemented, with energy and transport taxes sometimes showing more positive impacts on economic development than pollution taxes (Stameski, 2024). This variation emphasizes the crucial role of context-specific policy design in maximizing the benefits of environmental taxation while mitigating potential negative consequences.

METHODOLOGY AND DATA

The primary aim of this study is to explore the relationship between environmental taxes and economic development in the Nordic countries over the period 2013–2022. The analysis covers the five Nordic countries—Denmark, Finland, Iceland, Norway, and Sweden—ensuring a comprehensive regional perspective. The study relies on secondary data collected on an annual basis from OECD Revenue Statistics. All statistical tests and estimations are conducted using econometric software to ensure the robustness and reliability of the results. In alignment with the research objective, the following hypothesis were formulated to guide the analysis:

H_1:   There is a causality between environmental taxes and economic development in Nordic countries.

EMPIRICAL RESULTS

The analysis begins with descriptive statistics to provide an overview of the key variables, highlighting differences across countries and trends over the study period. Summary statistics for ETR and GDP per capita (GDPpc) offer insights into the variability and distribution of these indicators. Table 1 includes the mean, standard deviation, minimum, and maximum values for each country and the overall Nordic region.

Table 1: Descriptive statistics

Countries	Denmark	Finland	Iceland	Norway	Sweden	Nordic region
ETR						
Mean	7.59	6.55	5.52	5.31	4.88	5.97
Std. Dev.	1.13	0.46	0.66	1.01	0.30	1.24
Min.	5.8	5.65	4.09	2.97	4.44	2.97
Max.	8.95	7.05	6.27	6.18	5.46	8.95
GDPpc						
Mean	47689	36006	37073	63038	43292	45420
Std. Dev.	2381.99	1205.23	1805.14	19691.05	1707.92	13087.63
Min.	44410	34390	34510	7160	40510	7160
Max.	51660	37560	39170	72640	46170	72640

Table 1 presents data on environmental tax revenues (ETR) as a percentage of GDP and GDP per capita (GDPpc) in USD for Nordic countries from 2013 to 2022. Denmark has the highest average ETR (7.59%), while Sweden has the lowest (4.88%), with the Nordic region averaging 5.97%. Standard deviations indicate variability, with Norway showing the highest fluctuation in both ETR and GDPpc. The minimum and maximum values reflect economic and policy changes over the years, with Norway having the widest range in GDPpc (from \$7,160 to \$72,640). Denmark leads in GDPpc stability, averaging \$47,689, while Finland has the lowest (\$36,006). Iceland and Sweden show moderate GDPpc values, with Iceland averaging \$37,073 and Sweden \$43,292.

Table 2: Panel unit root test

Variable	ETR	GDPpc
Level		
LLC test	-2.204 (0.013)	-2.239 (0.012)
IPS test	-2.538 (0.032)	-2.117 (0.017)
First diff.		
LLC test	-2.785 (0.003)	-7.611 (0.000)
IPS test	-2.861 (0.002)	-2.557 (0.004)

The table shows the results of LLC and IPS panel unit root tests, which check whether ETR and GDPpc are stationary at different significant levels. However, after taking the first difference all p-values drop below 0.05, indicating that both variables become stationary.

Table 3 presents the results of the causality test between ETR and GDPpc with a lag order of 1. The W-bar statistic for ETR → GDPpc is 0.768, while for GDPpc → ETR, it is much higher at 4.619, suggesting a stronger causal relationship in that direction. The Z-bar and Z-bar tilde statistics for ETR → GDPpc have high p-values (0.714 and 0.626), indicating no significant causality. However, the Z-bar (5.722, p = 0.000) and Z-bar tilde (2.079, p = 0.038) for GDPpc → ETR show statistically significant causality. This suggests that GDP per capita causes changes in environmental tax revenues, but not the other way around.

Table 3: Causality test

	ETR → GDPpc	GDPpc → ETR
Lag order	1	1
W-bar	0.768	4.619
Z-bar	-0.367 (0.714)	5.722 (0.000)
Z-bar tilde	-0.488 (0.626)	2.079 (0.038)

CONCLUSION

This study examined the relationship between environmental tax revenues (ETR) and economic development (GDP per capita) in Nordic countries from 2013 to 2022. The findings revealed significant differences in ETR and GDPpc across the region, with Norway exhibiting the highest variability in both indicators. Causality tests indicated a unidirectional relationship, where economic development (GDPpc) influences environmental tax revenues, but not the other way around. This suggests that wealthier economies are more likely to implement stronger environmental tax policies, possibly due to greater public support for environmental protection and more robust institutional frameworks. The results partially confirm the initial hypothesis H_1 and highlight the importance of economic development in shaping environmental taxation. However, the effectiveness of environmental taxes depends on their design and implementation. Policymakers must carefully balance environmental protection with economic objectives, ensuring that tax policies are equitable and do not disproportionately affect vulnerable populations. Revenue recycling, where tax revenues are reinvested into green technologies or used to lower other taxes, can enhance the effectiveness of environmental taxes while mitigating potential negative economic impacts. Future research should employ more robust econometric methods and sophisticated modeling techniques to fully capture the complexities of the relationship between environmental taxes and economic development. Additionally, studies should explore the role of institutional quality, public acceptance, and international cooperation in shaping the outcomes of environmental tax policies. A holistic approach that integrates environmental taxes with broader economic and social policies is essential for fostering a sustainable and equitable future. By addressing these challenges, countries can harness the potential of environmental taxes to drive sustainable growth while protecting the environment for future generations.

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APPLICATION OF LMAW AND RAWEC METHODS IN PERFORMANCE ANALYSIS OF TRADING COMPANIES IN SERBIA

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ABSTRACT

The research in this study aims to look at the performance positioning of the observed trading companies in Serbia to improve it in the future by applying certain measures. Research of the treated problem on original empirical data is based on applying LMAW (Logarithm Methodology of Additive Weights) and RAWEC (Ranking of Alternatives with Weights of Criterion) methods. The results of this study show that the top five trading companies in Serbia include: Doo Vimexim SRB, Mol Serbia, Lidl Serbia, Phoenix Pharma Doo, and Lukoil Serbia Doo. Of the ten largest trading companies analyzed in terms of realized business income in Serbia, the best-positioned trading company Doo Vimeksim SRB, and the worst trading company Mercator-S. Mercator-S trading company is characterized by a high percentage of financial indebtedness. To improve the performance positioning of trading companies in Serbia, it is necessary to manage sales, profit, assets, capital, and human resources as efficiently as possible. In that direction, it is essential to increase efficiency, work productivity, and profitability. Adequate adaptation to dynamic business changes globally and in the environment is certainly important. In this, the digitization of the entire business, as well as the application of the concept of sustainable development, plays an undoubtedly significant role.

Key words: Performance, Trading companies, Serbia, LMAW, RAWEC

INTRODUCTION

Generally speaking, it is very challenging to research the performance of trading companies due to the specific nature of their business. In recent times, various methods of multi-criteria decision-making have been increasingly used to obtain the most accurate results in the function of improvement in the future by applying relevant measures (Ersoy, 2017; Lukić, 2023a-e, 2024; Lukić & Vojteski Kljenak, 2024). This study investigates the performance positioning of the ten largest trading companies in Serbia according to the realized business income based on the LMAW-RAWEC method. This research aims to look at their performance positions as realistically as possible to improve them in the future by taking certain measures.As far as literature is concerned, it is very rich both in the world and in Serbia. All relevant literature in this study serves as a theoretical, methodological, and empirical basis for the most complex research of the treated problem. The study used original empirical data collected from the Agency for Economic Registers of the Republic of Serbia. The given data are of high quality because they were created by the relevant international standards. There are no limitations regarding the international comparability of the results of this study.

METHODOLOGY

In the analysis of the performance of trading companies in Serbia, two methods of multi-criteria decision-making were applied, namely: LMAW and RAWEC. The first is used to determine the value of the criterion. The second is used to rank the alternatives. Their essential characteristics are shown below. The **LMAW** (Logarithm Methodology of Additive Weights) method is the latest method used to calculate criteria weights and rank alternatives (Liao & Wu, 2020; Demir, 2022). It takes place through the following steps: m alternatives $A = \{A_1, A_2, ..., A_m\}$are evaluated in comparison with n criteria $C = \{C_1, C_2, ..., C_n\}$with the participation of k experts $E = \{E_1, E_2, ..., E_k\}$and according to a

predefined linguistic scale (Pamučar et al, 2021). **Step 1:** Determination of weight coefficients of criteria. Experts $E = \{E_1, E_2, …, E_k\}$ set priorities with criteria $C = \{C_1, C_2, …, C_n\}$ in relation to previously defined values of the linguistic scale. At the same time, they assign a higher value to the criterion of greater importance and a lower value to the criterion of less importance on the linguistic scale. By the way, the priority vector is obtained. The label γ_{Cn}^e represents the value of the linguistic scale that the expert $e(1 \le e \le k)$ assigns to the criterion $C_t(1 \le t \le n)$. **Step 1.1:** Defining the absolute anti-ideal point γ_{AIP}. The absolute ideal point should be less than the smallest value in the priority vector. It is calculated according to the equation:

$$\gamma_{AIP} = \frac{\gamma_{min}^e}{S} \qquad (1)$$

Where is γ_{min}^e the minimum value of the priority vector and S should be greater than the base logarithmic function. In the case of using the function Ln, the value of S can be chosen as 3. **Step 1.2**: Determining the relationship between the priority vector and the absolute anti-ideal point. The relationship between the priority vector and the absolute anti-ideal point is calculated using the following equation:

$$n_{Cn}^e = \frac{\gamma_{Cn}^e}{\gamma_{AIP}} \qquad (2)$$

So the relational vector $R^e = (n_{C1}^e, n_{C2}^e, …, n_{Cn}^e)$ is obtained. Where n_{Cn}^e it represents the value of the relation vector derived from the previous equation, and R^e represents the relational vector $e(1 \le e \le k)$. **Step 1.3:** Determination of the vector of weighting coefficients, The vector of weighting coefficients $w = (w_1, w_2, …, w_n)^T$ is calculated by the expert $e(1 \le e \le k)$ using the following equation:

$$w_j^e = \frac{\log_A(n_{Cn}^e)}{\log_A\left(\prod_{J=1}^n n_{Cn}^e\right)}, A > 1 \qquad (3)$$

Where w_j^e it represents the weighting coefficients obtained according to expert evaluations e^{th} and the n_{Cn}^e elements of the realization vector R. The obtained values for the weighting coefficients must meet the condition that $\sum_{j=1}^n w_j^e = 1$. By applying the Bonferroni aggregator shown in the following equation, the aggregated vector of weight coefficients is determined $w = (w_1, w_2, …, w_n)^T$:

$$W_j = \left(\frac{1}{k.(k-1)} \cdot \sum_{x=1}^k \left(w_j^{(x)}\right)^p \cdot \sum_{\substack{y=1 \\ y \ne x}}^k \left(w_{ij}^{(y)}\right)^q \right)^{\frac{1}{p+q}} \qquad (4)$$

The values of p and q are stabilization parameters and $p, q \ge 0$. The resulting weight coefficients should fulfill the condition that $\sum_{j=1}^n w_j = 1$. This study uses the new **RAWEC** (Ranking of Alternatives with Weights of Criterion) method for ranking alternatives. The choice of this method over others is motivated by the goal of simplifying decision-making processes. Emerging methods often complicate decision-making by introducing additional steps that complicate calculations. To solve this problem, the RAWEC method was developed to simplify the process by reducing the number of steps and avoiding complex calculations. It involves only four steps, with the first two being common to all methods. The uniqueness of this method is that it combines two steps typically found in other methods, namely the creation of a weighted normalized decision matrix and the calculation of deviations from ideal and anti-ideal values. This method consists of the following steps (Puška et al., 2024; Trung et al., 2024). **Step 1:** Formation of the decision matrix. This step represents the first step in all other MCDM (Multi-criteria decision-making) methods. In this step, the alternatives are evaluated using the set criteria and an initial decision matrix is formed.

$$\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \ddots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \qquad (5)$$

Step 2: Normalization of the decision matrix. When the initial decision matrix is normalized, double normalization is used, the following expressions:

$$n_{ij} = \frac{x_{ij}}{max(x_{ij})}, and\ n'_{ij} = \frac{min(x_{ij})}{x_{ij}}, if\ j \in B \qquad (6)$$

$$n_{ij} = \frac{min(x_{ij})}{x_{ij}}, and\ n'_{ij} = \frac{x_{ij}}{max(x_{ij})}, if\ j \in C \qquad (7)$$

Where $x_{i\ min}$ represents the minimum value of alternatives according to certain criteria, and $x_{j\ max}$ - is the maximum value of alternatives according to certain criteria. By using double normalization, the initial decision matrix is normalized in two ways. By applying the first normalization, (n_{ij}) all criteria are transformed into benefit criteria, whereby the highest values for individual criteria receive the maximum value, i.e. the value of one (1). By applying the second normalization, (n'_{ij}) all criteria are converted into cost criteria. With this normalization, the lowest values of the alternatives for certain criteria take on the maximum value, i.e. (1). **Step 3:** Calculate the deviation from the criterion weight. The weighting of the normalized decision matrix and the calculation of the deviation from the criterion weights are combined in this step. This is achieved by using the following expressions:

$$v_{ij} = \sum_{j=1}^{n} w_j.\left(1 - n_{ij}\right) \qquad (8)$$

$$v'_{ij} = \sum_{j=1}^{n} w_j.\left(1 - n'_{ij}\right) \qquad (9)$$

Where w_j represents the criterion weight. This step begins by calculating the deviation of the normalized data from the maximum values represented by the number 1. Then the total deviation from the weight of the criterion is calculated by multiplying the deviation with the weight of the criterion. The deviation for the first value (v_{ij}) should preferably be as small as possible, while the deviation for the second value should be (v'_{ij}) as large as possible. Based on these deviations, the final value of the alternatives is calculated. **Step 4:** Calculating the value of the RAWEC method. This is calculated based on the following expression:

$$Q_i = \frac{v'_{ij} - v_{ij}}{v'_{ij} + v_{ij}} \qquad (10)$$

The RAWEC method returns a value that can range between −1 and 1. The superiority of an alternative is determined by how high the method value of that alternative is. The alternative with the highest value is the ideal choice.

RESULTS AND DISCUSSION

Ten criteria and alternatives were used in the study. Criteria are performance indicators. The selected indicators correspond to the nature of the business operations of trading companies. Alternatives are

trading companies with the highest realized business income in Serbia. Criteria and alternatives with original empirical data are shown in Table 2. (In this study, all calculations and results are the authors'.) In Serbia, the largest business income and net result was achieved by the trading company Delhaize Serbia. Trading company Delhaize Serbia has the largest business assets, and capital and employs the largest number of workers. Trading company DOO Vimeksim SRB has the highest coefficient of turnover of business assets. Mercator-S has the highest financial leverage. The business income per employee is the highest at the trading company DOO Vimeksim SRB. The largest business asset per employee is at the trading company DOO Vimeksim SRB. The yield from business assets is the highest at the trading company Lukoil Serbia DOO. All this in its way reflected on the performance positioning of the analyzed trading companies in Serbia in this study, determined based on the application of the LMAW and RAWEC methods. There is a strong correlation between business income and net results, business assets, capital, and the number of employees at the level of statistical significance. Between the turnover ratio of business assets and business income per employee and business assets per employee there is a strong correlation at the level of statistical significance. There is a strong correlation between business income per employee and business assets per employee at the level of statistical significance. The target performance positioning of trading companies in Serbia can be achieved with the most efficient management of sales, profit, assets, and human resources. Adequate financial management (i.e. sources of funding for investments and the entire business) is also important in this direction. It also serves to increase labor productivity and profitability. Using the LMAW method, the criteria were evaluated in this study. Table 2 shows the aggregated vector weight coefficients. (In this study, all calculations and results are the authors'.)

Table 2: Aggregated Weight Coefficient Vectors

	Business income (in millions of dinars)	Net result (in millions of dinars)	Business assets (in millions of dinars)	Capital (in millions of dinars)	Number of employees	Business assets turnover ratio (business income/business assets)	Financial leverage (business assets/capital)	Business income per employee (in thousands of dinars)	Business assets per employee (in thousands of dinars)	Return on business assets (net result/business assets) (%)
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
W1j	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.002	0.002
W2j	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.002	0.001
W3j	0.002	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.002	0.002
W4j	0.002	0.002	0.002	0.002	0.003	0.002	0.003	0.003	0.003	0.002
SUM	0.010	0.011	0.010	0.009	0.011	0.010	0.011	0.011	0.009	0.007
Aggregated Weight Coefficient Vectors	0.1011	0.1039	0.1012	0.0965	0.1061	0.1011	0.1054	0.1055	0.0948	0.0818

In this particular case, the most important criterion is C5 - the number of employees. Then C8 – business income per employee. The target performance of trading companies in Serbia can be achieved with the most efficient management of sales, human resources, and labor productivity. At the same time, the other criteria must not be neglected, i.e. in the function that, they should be effectively managed. Tables 2 - 3 show the initial decision matrix and results of the RAWEC method. Data is shown for 2023.

According to the results of this study, the top five trading companies in Serbia include: Doo Vimexim SRB, Mol Serbia, Lidl Serbia, Phoenix Pharma Doo, and Lukoil Serbia Doo. Of the ten largest trading companies analyzed in terms of realized business income in Serbia, the best-positioned trading company Doo Vimeksim SRB, and the worst trading company Mercator-S. Mercator-S trading company is characterized by a high percentage of financial indebtedness. To improve the performance positioning of trading companies in Serbia, it is necessary to manage sales, profit, assets, capital, and human resources as efficiently as possible. It is also essential to increase labor productivity and profitability. Adequate adaptation to dynamic business changes globally and in the environment is important. Digitization of the entire business plays a significant role in this. The application of the concept of sustainable development in its way affects the positioning of trading companies in Serbia.

Table 2: Initial decision matrix

		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
		max	max	max	max	max	max	min	max	max	max
A1	Nelt CO. DOO Belgrade	95781	60	33354	8241	2384	2.87165	4,047	40176.59	13990.77	0.18
A2	Merkata VT DOO Novi Sad	86256	1345	16138	1701	1039	5.3449	9,487	83018.29	15532.24	8.33
A3	Phoenix Pharma DOO Belgrade	68848	669	35225	8786	585	1.954521	4,009	117688.9	60213.68	1.9
A4	Knez Petrol DOO Zemun	60677	589	11612	3147	1229	5.22537	3.69	49371.03	9448.332	5.07
A5	DOO Vimeksim SRB Novi Sad	59789	245	7016	850	14	8.521807	8,254	4270643	501142.9	3.49
A6	Delhaize Serbia DOO Belgrade	155477	7738	103220	48640	12399	1.506268	2.122	12539.48	8324.865	7.5
A7	Lidl Serbia KD Nova Pazova	103471	1799	76508	36779	3415	1.352421	2.08	30298.98	22403.51	2.35
A8	Mercator-S DOO Belgrade	102038	1658	53425	1282	7372	1.90993	41.67	13841.29	7247.016	3.1
A9	Mol Serbia DOO Belgrade	67837	1496	22751	14560	100	2.981715	1,563	678370	227510	6.58
A10	Lukoil Serbia DOO Belgrade	46514	936	11047	6224	150	4.210555	1,775	310093.3	73646.67	8.47
	min	46514.00	60.00	7016.00	850.00	14.00	1.35	1.56	12539.48	7247.02	0.18
	max	155477.00	7738.00	103220.00	48640.00	12399.00	8.52	41.67	4270643.00	501142.90	8.47

CONCLUSION

The investigation of the problems addressed in this study showed that the top five trading companies in Serbia include: Doo Vimexim SRB, Mol Serbia, Lidl Serbia, Phoenix Pharma Doo, and Lukoil Serbia Doo. The best-positioned trading company is DOO Vimeksim SRB. The worst-positioned trading company is Mercator-S. Mercator-S trading company is characterized by a high percentage of financial indebtedness. Determinants of the positioning of trading companies in Serbia are sales, profit, assets, capital, and human resources. The targeted positioning of trading companies in Serbia can be achieved by their adequate management. For these purposes, it is necessary to increase efficiency, work productivity, and profitability. Adequate adaptation to dynamic business changes globally and in the environment is also important. Digitization of the entire business, as well as the application of the concept of sustainable development, are very important factors in the performance positioning of trading companies in Serbia.

Table 3: Final ranking order using the RAWEC method

ID	Alternatives	v_{ij}	v'_{ij}	Q_i	Rank
A1	Nelt CO. DOO Belgrade	0.6968	0.6788	-0.0131	6
A2	Merkata VT DOO Novi Sad	0.7660	0.6960	-0.0479	8
A3	Phoenix Pharma DOO Belgrade	0.7702	0.7968	0.0170	4
A4	Knez Petrol DOO Zemun	0.7593	0.6869	-0.0500	9
A5	DOO Vimeksim SRB Novi Sad	0.5161	0.6221	0.0931	1
A6	Delhaize Serbia DOO Belgrade	0.5063	0.4840	-0.0225	7
A7	Lidl Serbia KD Nova Pazova	0.6596	0.6959	0.0268	3
A8	Mercator-S DOO Belgrade	0.6541	0.5764	-0.0631	10
A9	Mol Serbia DOO Belgrade	0.6830	0.7492	0.0462	2
A10	Lukoil Serbia DOO Belgrade	0.7220	0.7119	-0.0070	5

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REVENUE TRENDS IN ENERGY TAXATION ACROSS THE BENELUX AND BALTIC REGIONS

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ABSTRACT

This paper presents a comparative analysis of energy tax revenues in two regional groups—Benelux (Belgium, Netherlands, Luxembourg) and the Baltic states (Estonia, Latvia, Lithuania)—over the period 2013–2022, focusing on fiscal outcomes and policy effectiveness. The study examines differences in revenue levels, growth dynamics, and fiscal stability using a combination of descriptive statistics, year-on-year percentage changes, and independent sample t-tests. Results reveal statistically significant disparities between the two regions, with Benelux countries generating substantially higher average revenues and displaying greater fiscal capacity and policy maturity. The Netherlands and Belgium emerged as top performers, while Estonia recorded the lowest averages despite notable growth in selected years. The Baltic countries, although experiencing some positive trends, generally showed lower volumes and higher volatility in revenue performance. A statistically significant difference ($p < 0.001$) confirms the fiscal gap between the regions, reflecting deeper structural, economic, and policy-driven differences. External shocks such as the COVID-19 pandemic and the 2022 energy crisis affected both groups, though with differing impacts. Findings highlight the role of energy taxation not only in revenue generation but also as a strategic instrument for economic resilience, supporting environmental policy, and facilitating energy transition. The analysis offers valuable insights for policymakers aiming to balance fiscal performance, energy security, and climate objectives.

Key words: Energy taxes, Benelux, Baltic, Comparative analysis

INTRODUCTION

Economists and global institutions have long recognized environmental taxation as a powerful policy tool for mitigating the environmental consequences of energy production and consumption, with a particular focus on combatting climate change. This recognition dates back to Pigou's pioneering work (1920), which laid the foundation for modern environmental economics, and continues through contemporary analyses by organizations like the OECD (OECD, 2018). A carefully structured energy taxation framework can serve not only to curb excessive energy use but also to facilitate the transition from fossil fuels to renewable energy sources. The fundamental objective of environmental taxation is to influence consumer and producer behavior by attaching financial disincentives to environmentally harmful activities. These taxes operate by increasing the cost of goods and services that contribute to environmental degradation during their production, distribution, or consumption stages. The effectiveness of this approach is grounded in the economic principle that higher prices on environmentally damaging products lead to reduced demand, thereby minimizing their ecological impact (Freire-González and Puig-Ventosa, 2019).

Since the early 2000s, ecological consciousness has driven the adoption of environmental taxation frameworks, particularly within Nordic countries and the Benelux region, where such mechanisms have gained significant traction as viable policy instruments (Curtin et al., 2019). Environmental taxation has emerged as a commonly implemented policy instrument across European countries,

progressively integrated by member states since the early 1990s to address mounting environmental deterioration. Numerous studies confirm its effectiveness in enhancing environmental quality (European Environment Agency, 2005; Ekins et al., 2011). In addition to environmental advantages, environmental taxation has demonstrated significant effects on economic performance. This dual impact was highlighted through the Environmental Tax Reform (European Commission, 1997), which recommended shifting tax burdens from productive sectors such as labor, capital, and consumption toward environmentally damaging activities and resource overconsumption.

This paper is structured as follows: Section 2 provides an overview of energy taxation in the Benelux and Baltic regions. Section 3 presents the methodology and comparative analysis of energy tax revenues using statistical tools. Section 4 discusses the main findings, while Section 5 concludes the paper by summarizing key insights and offering recommendations for future policy development.

ENERGY TAXES IN BENELUX AND BALTIC COUNTRIES

Environmental taxes are typically classified into four categories: energy, transport, pollution, and resource taxes which serve as essential price control instruments to regulate consumption and emissions, with energy taxes demonstrating the most significant impact in managing energy use and reducing greenhouse gas emissions. These taxation mechanisms effectively curb excessive resource utilization while making natural resource extraction more expensive compared to alternative inputs (Štreimikienė, 2015; Zhang et al., 2019; Babatunde et al., 2017; He et al., 2019; Hickel and Kallis, 2020). Energy taxes specifically represent a core component of both fiscal and environmental policy, designed to regulate how energy is produced, distributed, and consumed. These taxes typically apply to a broad range of energy products, including transport fuels (such as gasoline and diesel) and stationary energy sources (such as electricity, natural gas, and coal). They may also extend to renewable energy products like biofuels, as well as stored energy stocks. A critical dimension of energy taxation is its interaction with carbon pricing mechanisms. While CO_2 taxes are explicitly environmental in nature, they are often integrated into general energy tax regimes, rather than being treated as standalone pollution taxes. This integration promotes consistency in revenue classification and enables harmonized comparisons across countries and tax systems.

The implementation of energy taxes varies across countries, depending on national policy goals, economic structures, and climate commitments. Some countries primarily view energy taxes as tools for revenue generation, while others prioritize their environmental benefits in promoting energy efficiency and reducing greenhouse gas emissions. Within the European Union, energy taxation is a key instrument used to drive climate policy through market-based mechanisms (Liobikienė et al., 2019). These taxes are levied across both energy production and consumption, encompassing not only transport fuels (e.g., petrol, diesel) and stationary energy sources (e.g., fuel oil, gas, coal, electricity), but also renewable sources such as biofuels and stored energy products. Though CO_2 taxes are inherently environmental, they are frequently classified under energy taxes, as they are often embedded within broader tax structures—such as carbon-based mineral oil taxes—and can serve as substitutes for other energy taxes (Famulska et al., 2022). Recent empirical evidence supports the economic benefits of environmental taxation. As demonstrated by Stameski et al. (2024), environmental taxation significantly boosts economic development in Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden), with energy tax revenues showing the greatest positive impact on GDP per capita compared to transport and pollution taxes. This finding aligns with the broader literature on environmental tax reform, confirming that properly designed taxation systems can simultaneously achieve environmental protection and economic growth objectives.

Energy taxation involves financial transfers to governments based on the production or consumption of energy by firms or households. These taxes are applied both upstream (e.g., crude oil or gas production) and downstream (e.g., electricity or fuel consumption). Downstream taxes are often relatively high and can significantly raise end-user prices. Beyond revenue generation, such taxes influence broader economic dynamics and help fund public expenditures (Bacon, 2004). Regional

studies further validate the effectiveness of environmental taxation. Research on the Baltic States has shown that environmental taxation plays a key role in promoting cleaner energy systems by incorporating the environmental costs of pollution into energy prices. Since the energy sector is a leading contributor to both conventional pollutants and greenhouse gas emissions, most EU countries rely on pollution taxes as a core strategy to reduce environmental harm (Streimikiene et al. 2018). A study exploring how such taxes have influenced sustainable energy progress in Lithuania, Latvia, and Estonia between 2005 and 2015, demonstrated their role in encouraging a shift toward low-carbon energy sources. The results showed that increases in the share of environmental taxes relative to GDP had a measurable positive impact on key dimensions of sustainable energy development, including improved energy efficiency, greater use of renewables, and reduced energy dependence, particularly in Latvia and Estonia. Additional research by Leibus and Mazure (2016) analyzes trends in environmental tax revenues and tax burden in the Baltic States, revealing notable differences in growth and fiscal impact across countries. While Estonia and Latvia experienced substantial increases in environmental tax revenues between 2005 and 2014, Lithuania showed minimal growth, and only Estonia exceeded the EU average in terms of environmental tax burden relative to GDP.

COMPARATIVE ANALYSIS OF ENERGY TAXES

This section provides a comparative assessment of energy tax revenues in selected Benelux and Baltic countries, aiming to uncover the structural, fiscal, and policy-driven factors influencing revenue generation from energy taxation. By examining key indicators such as average revenue levels, variability, and growth trends over the period 2014–2022, the analysis seeks to highlight both inter-regional disparities and country-specific dynamics. The six countries included in the study—Belgium, the Netherlands, Luxembourg, Estonia, Latvia, and Lithuania—offer a representative contrast between long-established Western European economies with mature environmental tax systems and newer EU members still consolidating their fiscal and energy policies. Through descriptive statistics, visualized revenue changes, and statistical inference (t-test), this comparison enables a deeper understanding of how energy taxation functions not only as a fiscal tool, but also as a reflection of broader economic and environmental priorities across diverse European contexts.

Table 1: Descriptive statistics

Country	Mean	Std. Dev.	Min.	Max.
Belgium	8060.38	868.05	6543.3	8906.16.
Estonia	600.56	124.76	420.93	817.05
Latvia	751.34	75.68	600.25	849.28
Lithuania	745.65	135.03	537.71	919.38
Luxembourg	906.85	60.81	816.39	1009.55
Netherlands	13608.1	1369.48	11249	15793
Total	4112.145	5099.023	420.93	15793

The data reveals stark differences in energy tax revenues across the six countries studied. Belgium and the Netherlands reported the highest average revenues, at €8060 million and €13608 million, respectively. In contrast, Estonia recorded the lowest average at just €601 million. Revenue stability also varied significantly. The Netherlands saw the most fluctuation, with a standard deviation of €1369 million, while Luxembourg's figures remained relatively steady, deviating by only €61 million. The lowest revenue point was Estonia's €421 million, whereas the Netherlands peaked at €15793 million—the highest in the dataset. Luxembourg's maximum revenue was considerably smaller, reaching just €1,010 million. When combining all countries, the average revenue stood at €4112 million, but the substantial standard deviation (€5099 million) underscores the wide gaps between high- and low-revenue nations. This spread suggests not only disparities in economic scale but also potentially differing levels of energy consumption, taxation structures, and policy priorities across the countries.
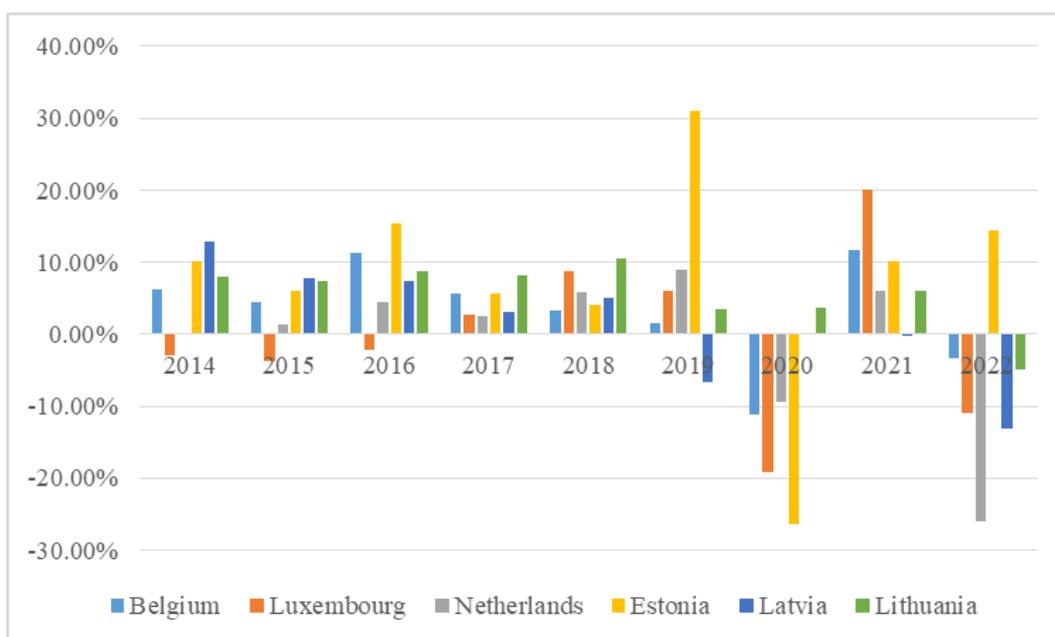
Figure 1: Annual percentage change of energy tax revenues by country

Figure 1 shows the annual percentage change in energy tax revenues for six European countries from 2014 to 2022, along with their average growth rates. Belgium and Lithuania saw mostly positive trends, averaging 3.39% and 5.63% growth, respectively, despite some yearly declines. The Netherlands and Luxembourg had slight negative average growth (-0.54% and -0.25%), with sharp drops in 2020 (COVID-19) and 2022 (energy crisis). Estonia had the highest average growth (7.84%), driven by strong increases in 2016 and 2019, while Latvia's growth was modest (1.78%) but volatile. Most countries experienced significant declines in 2020 and 2022, reflecting pandemic and geopolitical impacts. These variations indicate that external shocks such as the pandemic and energy supply disruptions have had uneven impacts on national tax bases, possibly due to differing dependencies on fossil fuels or energy imports.
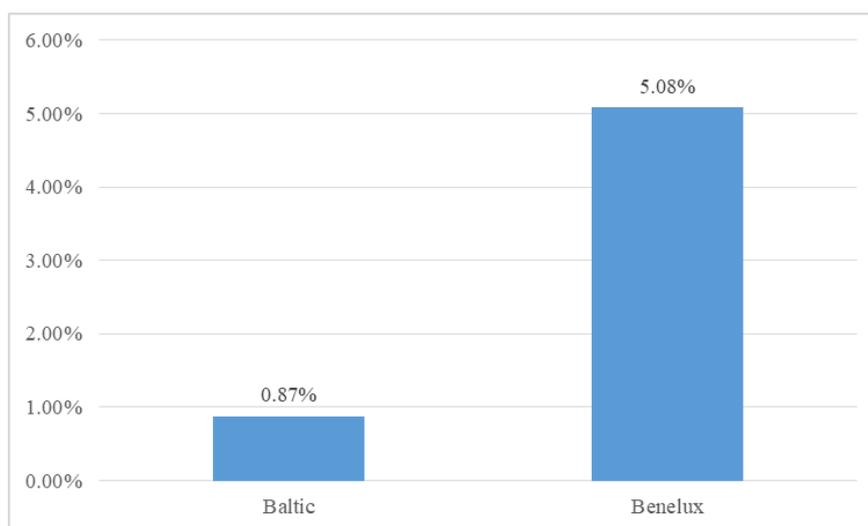
Figure 2: Average percentage change of energy tax revenues by group

Figure 2 shows that energy tax revenues grew at different rates across regional groups, with Benelux (Belgium, Netherlands, Luxembourg) recording a stronger average increase (5.08%) compared to the Baltic states (Estonia, Latvia, Lithuania), which saw modest growth (0.87%). This suggests that economic policies, energy consumption patterns, or tax structures in the Benelux region may have driven higher revenue growth. The Baltic countries' slower growth could reflect smaller economies or

different fiscal approaches to energy taxation. Moreover, it may point to structural differences in energy dependency or efficiency investments, where more developed regions may better leverage tax incentives or penalties to drive fiscal revenue while aligning with environmental goals.

Table 2: T-test results

Group	Mean value	Std. dev.	Mean Diff.	t-value	p-value
Baltic	678.91	199.87	-6531.54	-12.59	0.000
Benelux	7210.45	2832.19			

The t-test results highlight a striking disparity in energy tax revenues between the two regions. On average, Benelux countries (Belgium, Luxembourg, Netherlands) collected €7,210 million (SD = €2,832), vastly outpacing Baltic countries (Estonia, Latvia, Lithuania), which averaged just €679 million (SD = €200). With a mean difference of -€6,532 (t = -12.59), the data shows Benelux revenues were roughly 10 times higher—likely due to stricter tax policies, larger energy markets, or more industrialized economies in the region. The statistical significance ($p < 0.001$) confirms that the observed differences are unlikely to be due to chance, reinforcing the idea that structural and economic fundamentals play a decisive role in energy tax revenue performance.

These findings can inform policy decisions by emphasizing the need for tailored taxation strategies that consider both economic capacity and energy policy objectives.

CONCLUSION

The comparative analysis of energy tax revenues across Benelux and Baltic countries over the period 2013–2022 reveals substantial disparities in fiscal outcomes and policy effectiveness. Using a combination of descriptive statistics, year-on-year growth data, and inferential analysis through a t-test, the study provided a comprehensive overview of how these two regional groups differ in their ability to generate revenue through energy taxation. Benelux countries—most notably the Netherlands and Belgium—demonstrated significantly higher average energy tax revenues, greater absolute revenue values, and larger-scale fiscal capacity, which may be attributed to their more industrialized economies, broader tax bases, and possibly more aggressive taxation models. On the other hand, the Baltic states, while showing certain positive growth patterns (especially in Estonia), operated with much smaller fiscal volumes and exhibited greater volatility in year-to-year performance. The statistically significant differences ($p < 0.001$) underscore that these trends are not coincidental but rather reflect deeper structural and policy-based factors. This implies that while the Benelux countries may focus on stabilizing or fine-tuning their energy tax regimes, the Baltic nations have room for strategic development in order to enhance fiscal returns and align taxation with broader sustainability goals. Additionally, the impact of external shocks—most notably the COVID-19 pandemic and the 2022 energy crisis—was evident across both groups, though with varying intensity. This points to the importance of building fiscal resilience into energy taxation frameworks to mitigate future volatility and maintain consistent revenue flows. Finally, the analysis highlights the critical role of energy taxes not just as a revenue instrument but as a strategic tool for shaping national energy policy, promoting sustainability, and managing macroeconomic stability. Policymakers in both regions can draw on these findings to evaluate and adapt their fiscal approaches in the context of evolving environmental and economic challenges.

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GLOBAL ECONOMIC SHOCKS AND THEIR IMPACT ON FINANCIAL MARKETS VOLATILITY

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ABSTRACT

The volatility of financial markets is a measure of price oscillations, which constantly change under the influence of various factors, showing the extent to which the price of a certain financial instrument, such as shares or bonds, may deviate from the average level in a certain period of time. The causes of these oscillations can be different: economic news, political events, natural disasters, as well as global economic shocks. Analysis of the volatility of financial markets is very important, because with certain instruments, low volatility can indicate stability, while high volatility carries risk and unpredictability. Volatility plays an important role in investor decision-making, as high volatility increases the risk of larger price fluctuations, which can result in losses or larger profits. In some periods, especially when global economic shocks hit the world, volatility can increase dramatically, creating significant uncertainty in financial markets. The aim of this paper is the analysis of global economic shocks and their impact on financial markets. The first part of the paper analyzes the impact of the financial crisis of 2008 as a global economic shock that shook the entire world financial system due to the collapse of the American mortgage loan market. The second part of the paper analyzes the impact of the Covid-19 pandemic, which at the beginning of 2020 brought enormous uncertainty to the global economy.

Key words: Volatility, Financial crisis, Pandemic.

INTRODUCTION

In the financial market, there is a tendency for stock volatility to constantly change over time. Since the 1990s, a lot of research has been conducted on changes in the volatility of stocks and markets, and from those researches it became clear what the connection between volatility, i.e. risks, and future returns. The theory shows that there is a positive correlation between risk and return, this means that if the risk is higher, the expected return will be higher. One of the most important indices that look at volatility is the CBOE index, also known as the VIX, which is the main indicator of stock market volatility. The VIX gives financial professionals insight into short-term market conditions, helping them adjust their portfolios and gain insight into where the market is headed.

The VIX is known as the Chicago Board Options Exchange (CBOE) Volatility Index, which measures how much volatility investors can expect for the S&P 500 index over the next 30 days. Market professionals call this "implied volatility" -- implicit because the VIX tracks the options market, where traders place bets on the future performance of various securities and market indexes, such as the S&P 500. To investors following this index, the S&P 500 is understood to represent the "stock market" or "market" as a whole. When the VIX index rises, it reflects the assumption that investors are responding to higher price volatility in the S&P 500, and thus in the markets in general. In the event that the VIX declines, investors expect price changes in the S&P 500 to be smaller, indicating calmer markets and less uncertainty (American Century Investments, 2023). It is important to point out that, although volatility in most cases has negative associations, such as greater risk, more stress, deeper uncertainty or greater market declines, volatility itself is a neutral concept. It is a statistical measure of price changes for a

security or index. Increased volatility indicates that an index or security is experiencing larger price changes, either positive or negative, over shorter periods of time.

The VIX index measures volatility by tracking options trading on the S&P 500. Large institutional investors hedge their portfolios using options on the S&P 500 to position themselves as winners whether the market rises or falls. The VIX index tracks these transactions to gauge market volatility. The options market can be quite vague, but technically, the VIX measures volatility by analyzing the strike prices of various put and call options based on contracts that expire in one month, as well as those that expire on different Fridays during the next month. Prices are weighted to gauge whether investors expect the S&P 500 to rise or fall in value in the future.If the VIX index is at 12 or below, the market is considered to be in a period of low volatility, while high volatility is often considered a value above 20. When the VIX exceeds 30, it is usually interpreted as a sign that the markets are very volatile (Marquit, 2023).

METHODOLOGY RESEARCH

Secondary research was applied in the work. Analytical-synthetic, inductive-deductive, abstraction and generalization methods were used from the basic methods of knowledge, and for theoretical considerations of the research subject. Of the scientific methods, the method of content analysis was used. Data from available professional literature, scientific and professional works, the Internet and other sources were also used.

THE 2008 FINANCIAL CRISIS AS A GLOBAL ECONOMIC SHOCK

The main cause of the global financial crisis was the collapse of the real estate market in the United States of America in 2008, which led to the destabilization of economies all over the world. Several factors led to the collapse of the real estate market, but we can single out two factors that were the most significant, namely:

– Bursting of the American real estate bubble: A real estate bubble occurs when there is a sudden increase in the market value of real estate, followed by an even faster decline in value, which is a "collapse" or "bubble burst." House prices in America were extremely overvalued, market sentiment was overly optimistic, and a market correction was inevitable.
– Borrowers were unable to repay their loans: This is called the subprime mortgage crisis. A subprime mortgage is a home loan that is given to borrowers with bad credit, that is, borrowers who do not qualify for a prime mortgage, because there is a risk that they will not be able to repay the loans.

The US housing market was flooded with subprime mortgages, and borrowers slowly started defaulting on loans they should never have been approved for. The consequences of these changes in the real estate market spread throughout the world, and it caused the global financial crisis (Stevens, 2024).

At the beginning of the 2000s, the United States and the rest of the world were facing a real estate bubble. Mortgage fraud skyrocketed, and the country entered a period of incipient recession. The rejection rate of mortgage applications decreased drastically between 1997 and 2003. The Federal Reserve took a more lenient approach to supervising banks and lenders during that period, not taking into account credit standards such as assessing borrowers' employment history and income. Borrowing costs rose significantly and the markets were going through a correction, the bubble had officially burst.

In 2007, the real estate market completely collapsed, with hundreds of thousands of homes going into foreclosure, many subprime lenders declaring bankruptcy, and a market clamoring for government bailouts. The slowdown of the market continued, and the most significant trends were the stagnation of prices and the reduction of house sales. The subprime mortgage industry experienced major collapses, including the closure of some of the nation's largest lenders at the time, such as New Century Financial and Lehman Brothers. The real estate industry was not the only one affected, as the credit crisis affected

other areas of the economy, and many experienced bankruptcy. This has resulted in the global stock market experiencing volatility and corrections. This crisis is considered to be one of the biggest economic crises since the Great Crash of 1929, and the collapse of the real estate market in 2008 continues to have effects on the economy that are still felt today (Stevens, 2024).

Analysis of the volatility of stock returns across different time periods, countries and industries indicates a significant spike in volatility in mid-2008, which lasted less than a year. Although the intensity and duration of this increase varied somewhat, the general pattern remained largely similar. Also, financial markets have accurately predicted a rapid reduction in high levels of volatility, even during periods of the most pronounced short-term volatility (Schwert, 2011).

The crisis that arose at the end of 2008 caused serious disruptions in the financial sector. There has been much discussion about the causes and effects that led to the collapse of many large financial institutions, and various proposals have been put forward to ensure that a similar credit crisis does not happen again in the future. The most significant indicator of the crisis was the extremely high level of volatility of stock returns. The uncertainty has led to the creation of many speculations and discussions about the possible real economic consequences of the credit crisis. The jump in stock volatility was present in many countries, and was most pronounced in stocks in the financial sector. Market participants did not expect the high levels of volatility to last long. Those expectations turned out to be correct, as stock volatility returned to significantly more normal levels within a few months (Schwert, 2011).

Figure 1: Volatility S&P 500 index – movement of the VIX index between 2004 and 2014,
Source:(https://www.tradingview.com/chart/?symbol=TVC%3AVIX, 2025)

The chart shows that market volatility has increased significantly, especially in the stock and bond markets. For example, the S&P 500 VIX index, which is used to measure volatility, reached very high peaks during the crisis, and higher swings remained in the following years as investors reassessed risks. In the second half of 2007, the financial crisis began, problems on the credit market already began to appear, and the volatility of the S&P 500 index began to rise, but it had not yet reached its peak. During this period, the VIX was between 20 and 30. In September 2008, the bankruptcy of Lehman Brothers occurred. This was one of the most dramatic points of the crisis. The bankruptcy of Lehman Brothers triggered a massive selloff, and volatility in the S&P 500 index skyrocketed. The VIX rose above 80 during this period, indicating extreme fear in the market. The S&P 500 index showed huge daily price swings. Between October and November 2008 was the peak of the crisis. Daily changes in the S&P 500 index could reach 5-10%. Volatility in this period remained extremely high, and uncertainty in the markets made it difficult to predict the future direction.

Figure 2: The value of the S&P 500 index before, during and after the financial crisis,
Source:(https://www.tradingview.com/chart/?symbol=TVC%3AVIX, 2025)

In early 2009, volatility was still high, but the S&P 500 index gradually began to stabilize and the VIX index slowly returned to values between 40-50. During the crisis of 2008, the volatility of the S&P 500 increased to an extraordinary extent and the market uncertainty lasted for a long time. The rise of the VIX index above the value of 80 maintained the perception of high risk and collapse of the financial system by market participants (Danielsson, Valenzuela, & Zer, 2018).

THE PANDEMIC OF COVID-19 AS A GLOBAL ECONOMIC SHOCK

In 2020, the Covid-19 pandemic caused a significant economic and social shock around the world. The global pandemic has not only burdened health systems, but also seriously affected the world economy. The spread of the pandemic, national shutdowns, production shutdowns and international trade disruptions have created conditions that have caused unprecedented volatility in financial markets.

Stock markets, especially in the early stages of the pandemic, showed a huge decline. Indices such as the S&P 500, Dow Jones and global market indexes began to fall as investor uncertainty and fears about the economic outlook intensified. During this period, volatility became one of the main phenomena of financial markets, as indicated by measuring instruments such as the VIX index.

The following text analyzes how the Covid-19 pandemic affected the volatility of financial markets. The reactions of global markets, the evolution of volatility in different sectors and the effects of actions undertaken by governments and central banks on market movements are examined. The analysis highlights key events and factors that contributed to unprecedented volatility in 2020 (Zhang, Min, & Qiang, 2020).

Looking at the chart of the VIX index in February and March 2020, we can see that the value of the VIX rose sharply, reaching its peak in mid-March, above the 80-point level. This maintains extreme volatility, which is associated with the spread of the coronavirus and the global economic shutdown. Such high values occur very rarely, only during the most severe market disturbances. Also, we can see a sharp decline in the value of this index during April and May. This indicates that markets have started to calm down over time, after central banks and governments introduced economic relief packages, and investors began to adjust to the new situation. While this drop did not return the VIX to pre-pandemic levels, it did

bring significant relief. From the summer of 2020, a gradual decline of the index can be seen. This can be explained by the fact that the markets became more comfortable with the situation, the economy began to recover, and the first vaccines appeared that brought stability. However, even then, the VIX remained higher than pre-pandemic levels, indicating that market participants still felt uncertainty. In the fall of 2020, there were several minor spikes as new waves of coronavirus hit the world. These waves caused further uncertainty in the markets, but the VIX did not reach the high of March 2020. Markets have adapted more quickly to changes, thanks to the predictability of economic policies and the availability of vaccines (Ullah, S., Khan, S, Hashimi, N.I., & Alam, M.S., 2023).

Figure 3: Volatility S&P 500 index – movement of the VIX index between 2017 and 2024, Source:(https://www.tradingview.com/chart/?symbol=TVC%3AVIX, 2025)

Figure 4: S&P 500 index – S&P 500 index decline, Source:(https://www.tradingview.com/chart/?symbol=TVC%3AVIX, 2025)

If we look at the most recent period, we can conclude that the VIX has returned to the normal pre-pandemic range (below 20). This shows that the markets are more stable at the moment, although the impact of the events of 2020 may still be felt. Investors are more risk-averse and markets are more resistant to uncertainty. It can be seen that the pandemic has caused significant volatility in the financial markets, which is reflected in the dramatic increase in the VIX index. Markets have gradually stabilized,

but volatility has only slowly returned to normal levels. With the help of the chart, it is easy to see how the perception of risk by investors has developed during the different stages of the pandemic and how sensitively the VIX has reacted to market conditions.

CONCLUSION

The financial crisis of 2008 posed serious challenges to regulatory authorities, who acted quickly to strengthen the system. In response to the crisis, central banks, especially the Federal Reserve, the European Central Bank (ECB), introduced new monetary tools. Quantitative easing and prolonged low interest rates also played a significant role in reducing volatility. Essentially, after the 2008 crisis, market volatility increased in the long term, and regulatory authorities introduced serious reforms to make the financial system more resilient to future crises. Stricter regulations have contributed to the stabilization of financial markets in the long term, although oscillations remained present in certain sectors.

The Covid-19 pandemic and the 2008 financial crisis have caused economic shocks around the world over the past few decades, which have significantly increased market volatility. These crises have highlighted how vulnerable the world economy can be and how unexpected circumstances can create a general lack of confidence in the market. In these conditions, investors and financial professionals must react quickly to changing circumstances, which often requires making difficult choices and taking great risks.

During the Covid-19 pandemic, the volatility of financial markets has increased significantly, resulting in changes in investor behavior. Many turned to risk aversion and invested in safer assets such as government bonds and gold, while others used strategies such as put options and futures to hedge their portfolios. At the same time, risk-taking investors used volatility for short-term speculation and quick profits, particularly through day trading and leveraged positions. Long-term investors focused on diversification and patiently waited for the market to stabilize.

Measuring instruments such as the VIX index are useful in predicting future market movements. These resources are useful for assessing risk and can help investors make good decisions. However, it should also be remembered that market volatility is a natural phenomenon and can sometimes present favorable opportunities.

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Session E: IT MANAGEMENT

TECHNOLOGIES BEHIND THE WEB PORTALS OF SERBIAN IT COMPANIES: HOSTING AND WEB DEVELOPMENT TRENDS

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ABSTRACT

Modern companies, that focus their business in information technology (IT) area, develop their web portals in aim to enable communication with their clients and represent their potentials and results. Hosting companies provide different services that enable placing web portal solution and data in various forms as well as different communication options (email, web forms etc). Contribution of this paper is twofold. First aim was to explore which technologies are supported at the hosting platforms and the second is to analyze which of these technologies are utilized to support web portals of IT companies in Serbia. Results show that most hosting companies provide CPanel and PHP/MySQL as dominant technologies. Most IT companies in Serbia do not use WordPress to implement their web portals, opting instead for other solutions. Results of this research could be beneficial to direct university teaching towards better alignment to technologies that are commonly used in business practice or to enable evaluation of existing university teaching practice by comparison of current status with the technology trends.

Key words: Web hosting, IT company, Web portal, Web programming, Internet technology

INTRODUCTION

One of key principles in university teaching is that educational content and processes are related to scientific results and professional practice, which enables proper academic background and basis for future requirements at work for students after graduation. To establish a firm basis for evaluation and encouragement of university teaching alignment to the needs of business practice, for the area of web programming, it is beneficial to conduct empirical research on current status and trends in the area of web hosting technologies and web portal development technologies.

This paper contributes with empirical results in analysis of web hosting and development technologies, where sample data were obtained from web hosting companies' websites and IT professional companies' web sites in Serbia. Empirical research has been conducted by Saša Gatarić with menthorship of Ljubica Kazi and published in his Master thesis (Gatarić, 2024).

The rest of the paper is organized as follows: section Background explains basic terms and technologies in web hosting and development, section Related work provides brief literature review of related research, section Research methodology brings details about research questions, hypotheses, sample and methods, Section Results and discussion provides empirical results and final section brings conclusions in the context of educational alignment in web programming with this results and future work directions.

BACKGROUND

According to (Pollock, 2013), hosting could be defined as a service that enables storing and access to data, applications, documents and other electronic content that is stored at remote servers, which is

provided by a hosting provider company. These servers are continually connected to Internet and enable clients to rent 24/7 available server resources. Hosting enables users to utilize servers for their own purpose, without the need to maintain their own hardware. However, some types of hosting service enable users to have more control of the server behavior and content management. There are several types of hosting services, regarding hardware and system organization and appropriate level of user privileges. Some of them are presented at Figure 1: dedicated hosting (one server and all hardware and software resources dedicated for one web site), shared web server hosting (one server with hardware and software resources shared among multiple web sites), VPS hosting (Virtual Private Server) where each web site is assigned to particular virtual server and cloud hosting, where one web application or web portal solution could be placed at multiple physical servers.
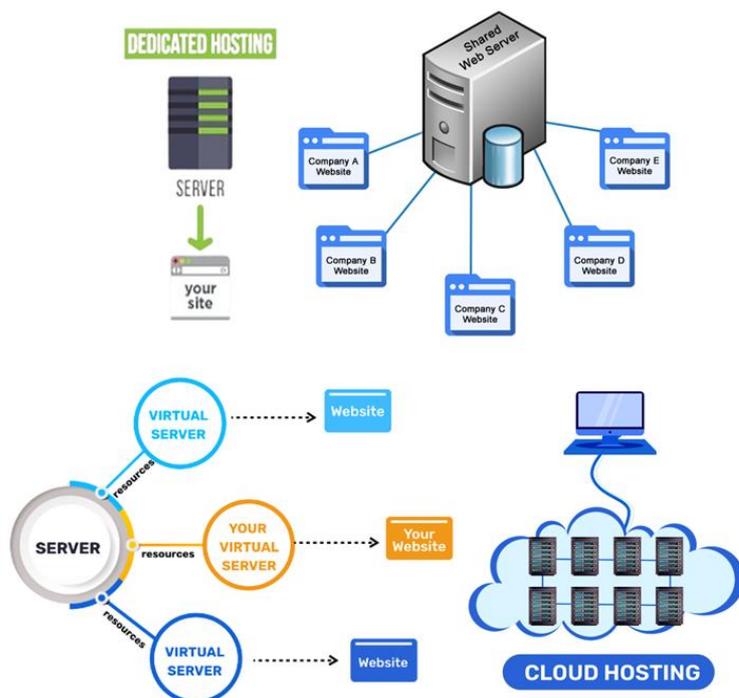
*Figure 1: Dedicated hosting (W1, 2024), shared hosting (*Subramaniam, 2024*), VPS hosting (W2, 2024) and cloud hosting (W3, 2024)*
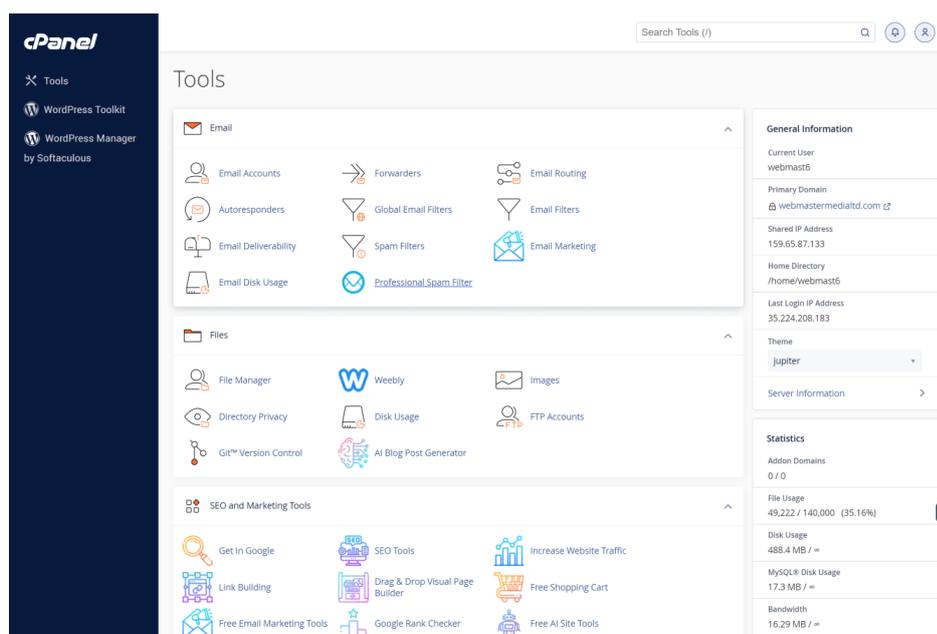
Figure 2: CPanel (W4, 2024)

Web hosting is enabled by a server that includes support to different programming languages included in the implementation of web applications (html, css, Java Script, PHP, ASP.NET, Python, Ruby etc.),

as well as different databases (MySQL, PostreSQL, MongoDB, Microsoft SQL Server etc.). These servers also enable storing textual files, images, video and audio files. Web hosting companies provide also other services, such as server maintenance, backup, technical support, security etc. Different tools that are available for users are often organized in groups that could be accessed via hosting panels, such as Cpanel or Plesk. (Pollock, 2013) Figure 2. presents CPanel that integrates access to multiple tools in web site development and maintenance.

RELATED WORK

Previously published scientific papers related to web hosting emphasize resources optimization and efficiency of servers in various hosting environments (Jain et al, 2020). In research of (Spriestersbach, 2023) processing power, memory and disks capacities are addressed as key elements to support high performances in web hosting environments. These components influence the server response speed and stability, particularly in shared and virtual hosting approaches. According to (Jain et al, 2020), optimization of memory and load balancing could improve loading time for 15-20%, especially in high frequency data transfer environments.

According to (Setiawan & Setiyadi, 2023), in cloud and VPS hosting environments, flexibility and scalability enable hosting systems to respond dynamically to changes in data exchanges, which leads to better performances comparing to traditional hosting solutions. These systems enable better management of simultanious requests, enabling faster loading and low latency. Cloud technology enables scalability that could improve accessiblity and stability of 40%, while VPS hosting improves it up to 25% comparing to shared hosting solutions (Setiawan & Setiyadi, 2023).

Important part of web hosting data management is related to web portal supporting components, such as CMS (Component Management Systems). According to (Tyagi et al, 2012) optimization of CMS platforms (such as WordPress, Joomla and Drupal) enables better stability and web sites response speed, particularly for data exchange high frequency environments. Key factors in CMS optimization include database optimization (query optimization), cache memory management (such as using tools VarnishCache or Memcached) and appropriate server configuration, which could improve web pages loading speed up to 30-40%, efficiency and user experience. According to (Shitote et al, 2018) Joomla and Drupal have shown superiority above WordPress in the aspect of performances, while WordPress has shown dominance in simplicity of use.

RESEARCH METHODOLOGY

This paper empirical research is conducted in aim to answer two research questions, which are formulated also with hypotheses, research samples and methods.

RQ1: Which technologies are mostly used to support web portals by hosting companies in Serbia?
- H1: Hosting companies mostly (more than 50%) utilize CPanel as a hosting platform system.
- Research sample and data extraction method: Data are obtained from texts about web hosting companies' services and technologies that they support and these data are extracted from their official web sites. In this analysis, 20 hosting companies' web sites were analyzed.

RQ2: Which web programming technologies are mostly used to support web portals of IT companies in Serbia?
- H2: Serbian IT companies mostly (more than 50%) do not have their web portals implemented by utilizing WordPress solution.
- H3: Serbian IT companies mostly (more than 50%) have their web portals implemented by utilizing PHP-based and ASP.NET-based technologies.

– Research sample and data extraction method: Data is obtained from analysis of source code of official web portals of 30 IT companies that have their representative offices in Serbia or they are established in Serbia. In web browsers, such as Microsoft Edge, there is an option to use DeveloperTools->Sources, where part of the web portal structure and source code could be displayed and analyzed. For example, if wp-content folder exists, it could be a basis for the conclusion that the analyzed web portal is based on the WordPress utilization.

RESULTS AND DISCUSSION

Results related to web hosting companies services (Figure 3) and Serbian IT companies web portals technologies (Figure 4) and hosting locations (Figure 5) are presented as diagrams and tabular data from the sample analysis.

Figure 3. (a) presents statistics about Control panels available at hosting servers - CPanel had 20 appearances, Plesk 8 and DirectAdmin 1. Figure 3. (b) presents CMS systems available at hosting – Wordpress 20, Joomla 12, Drupal 8 and Magento 6. Figure 3. (c) presents databases support at hosting – MySQL 20, MS SQL 9, PostreSQL 2, MySQLite 1, MariaDB 7 and Redis 1. Figure 3. (d) shows hosting support to programming languages – PHP 20, Python 9, .NET 9, NodeJS 7, Perl 5, C++ 1 and Ruby 2.

(a)

(b)

(c)

(d)
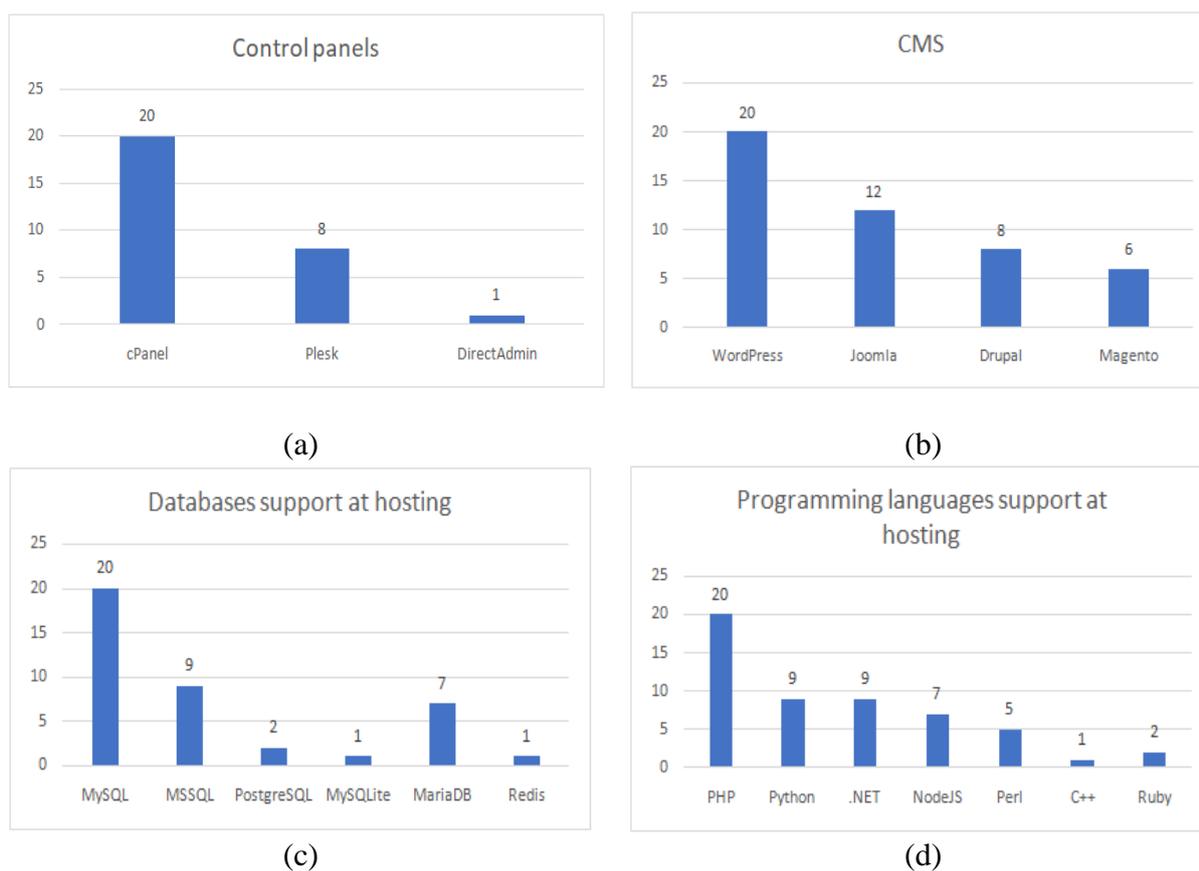
Figure 3: Results for web hosting companies in Serbia

Figure 4. (a) presents percentage of the WordPress use for implementation of web portals of IT companies – 57% do not use WordPress, 43% use WordPress. Figure 4. (b) presents list of data obtained from the analysis of Serbian IT companies web portals. It could be seen that many Serbian It companies host their web portals at Cloudflare, Hetzner, AWS and Google Cloud and large number of Serbian IT companies have implemented Java Script or Java Script frameworks (React, Vue).

Progr. Lang.	Hosting company
PHP	Lanaco NEW Upper Half
JavaScript (React)	Cloudflare
PHP	Cyso Hosting
JavaScript (Vue)	LeaseWeb
PHP	Hetzner
PHP	Hetzner
JavaScript	AWS
PHP	SiteGround
PHP	Hetzner
PHP	Cloudflare
JavaScript (React)	Akamai
PHP	Google Cloud
JavaScript	Akamai
JavaScript	Cloudflare

Progr. Lang.	Hosting company
JavaScript	Cloudflare
JavaScript	AWS
JavaScript	Google Cloud
JavaScript	Incapsula
PHP	Hetzner
PHP	WPEngine
JavaScript	Engineering Ingegneria In
JavaScript	Fastly
PHP	Cloudflare
JavaScript	Cloudflare
JavaScript	Cloudflare
JavaScript (React)	AWS
JavaScript	Fastly
PHP	Hetzner
JavaScript	AWS
PHP	Unlimited.rs

(a)   (b)

Figure 4: Results for implementation of Serbian IT companies' web portals

Figure 5. presents Serbian IT companies web portal hosting server locations - 12 Serbian IT companies host their web portals in USA hosting companies, 6 in Germany, 4 in Canada, 4 in Netherlands, 1 in Serbia, 1 in Italy and 1 in BIH (Bosnia and Herzegovina).
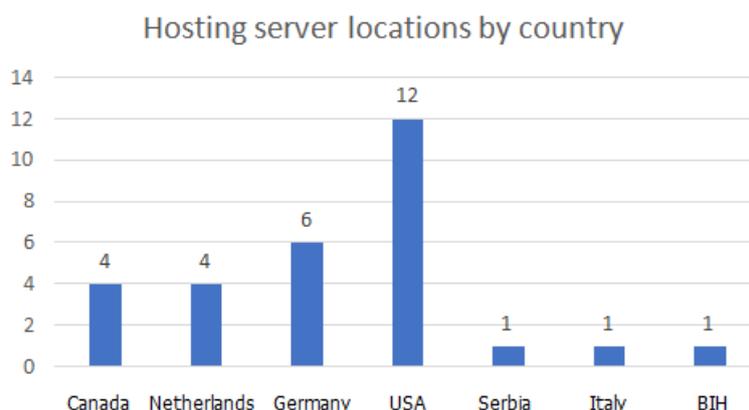
Figure 5: Results for hosting server location of Serbian IT companies' web portals

General conclusion regarding the presented results could be:
1. Serbian hosting companies mostly provide CPanel as a panel for integration of web hosting and development tools; they support PHP/MySQL and provide using WordPress as CMS.
2. Serbian IT companies mostly do not use WordPress for their web portals development, but use Java Script and JavaScript frameworks React and Vue as dominant technology for the implementation of their web portals; they trust USA and Germany's hosting companies the most, for the hosting of their web portals.

CONCLUSION

Aim of this research was to determine which technologies have major utilization in hosting platforms and web portals development, particularly at web portals of IT companies. Two research questions and three hypotheses were set before the start of the empirical research, which was conducted with a research sample from Serbia region. All hypotheses were supported by the results of empirical research.

Considering boundaries with the empirical research sample selection focused on Serbia region, conclusions could be regarded as a firm basis for evaluation of university teaching alignment to real practice needs. Another proof of proper alignment of educational content at University of Novi Sad, Technical faculty "Mihajlo Pupin" Zrenjanin, Serbia to professional needs is provided with results of this research.

Future directions based on results of this paper could be in scientific and educational area. Scientific research could be oriented towards broader scope and sample in aim to analyze impact of professional experiences and demands to education. Regarding educational area improvements, there should be stronger support to teaching latest technologies particularly at practical classes. Although programming-related subjects at University of Novi Sad, Technical faculty "Mihajlo Pupin" Zrenjanin, Serbia adjust frequently (every year) to the technology changes, there is still need to optimize students' workload with the requirements of professional practice knowledge and skills development. Having this research results considered, it could be stated that JavaScript and JavaScript frameworks are included in the teaching content of several subjects at University of Novi Sad, Technical faculty "Mihajlo Pupin" Zrenjanin, Serbia, but there should be even more focus at practical classes and in students' projects to the utilization of these technologies.

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THE EDUCATIONAL PLATFORM ASKING IN THE SERVICE OF DIGITAL TRANSFORMATION OF SOCIETY

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ABSTRACT

This paper will focus on digital technologies in the field of education that have an impact on the development of the entire society in terms of its digital transformation. With the rapid development of artificial intelligence, even traditional tools for graphic design and office productivity have received AI (Artificial Intelligence) functionalities. Knowledge in the field of digital publishing is popular in the labor market and knowledge is competitive. The ASKING platform was jointly developed by the Faculty of Technology "Mihajlo Pupin" in Zrenjanin and the Faculty of Technical Sciences in Novi Sad, University of Novi Sad, and is intended for the target group to master the techniques of applying artificial intelligence in DeskTop Publishing (DTP) tools such as Adobe Photoshop, InDesign, Illustrator, Affinity Photo, Designer, Publisher and Microsoft Office suite.

Key words: digital transformations, educational platform, ai

INTRODUCTION

Digital transformation encompasses the profound changes taking place in society and industries through the use of digital technologies (Agarwal et al. 2010). According to Gobble, digital transformation is defined as a comprehensive transformation of business operations, procedures, knowledge, skills, and designs. This transformation is carried out to maximize technology's impact on society and capitalize on the opportunities event and s in a strategic and prioritized manner. Digital transformation has emerged as an issue that educational institutions must address in the twenty-first century. It is an essential step for organizations that want to maintain high levels of competitiveness and achieve leadership positions in their industries (Mhlanga, D. 2024). Digital transformation has been inevitable in all socio-economic fields, including higher education (Nguyen-Anh, T., Nguyen, A. T., Tran-Phuong, C., & Nguyen-Thi-Phuong, A. (2023). Technologies will both create new jobs and replace existing ones. To cope with increasing labor market dynamics in the digital age, workers will have to become more mobile across jobs, occupations, and industries (Bode, E., & Gold, R. 2018). In recent years, online educational platforms have become an increasingly popular tool for delivering online learning experiences (Adouani, Y., & Khenissi, M. A., 2024). Practicing teachers and managers of educational institutions that organize and coordinate educational activities give special attention to innovations in online learning (Chen, G., Chen, P., Wang, Y., & Zhu, N., 2024).

In line with digital transformations and the needs of modern society, a structured program called ASKING has been created to train future and existing professionals in the graphics industry who will become familiar with the capabilities of AI DTP functions. The platform will contribute to improving the acquisition of users' competencies in the DTP field, making them more competitive in the labor

market, which makes this project socially justified. It is expected that platform participants will develop the skills to more effectively apply AI tools in everyday tasks, thus increasing the productivity and quality of their creative solutions.

THEORETICAL BACKGROUND

In modern conditions, digital technologies are permeating all spheres of life and activities of our society and have become one of the main trends in the development of all economic and social systems (Riazantseva, I., & Parshukova, G., 2022). The labor market in recent decades has been largely affected, worldwide, by the intensive intervention of new technologies in the work process, which has led to the need for transformation and access for professionals to a wider range of skills. The digitalization of society has led to a significant increase in the demand for highly qualified people in certain branches of technical knowledge and there is an evident higher demand for digital skills. One of the fundamental pillars when considering or evaluating the impact of new technologies in any community is human capital, which is why continuous improvement has been positioned as a condition for addressing the needs and conditions for improving employability and increasing differential value in work teams (Fereira, Moro, Moro, Perez, 2020). Previous studies mostly reveal that half of all current jobs are susceptible to automation in the next 10 to 20 years (Dengler, K., & Matthes, B., 2018). To retain workers' employability and strengthen their resilience to it technological change in the digital age, even more workers than in the computerization age need to continuously update and adjust their skills to complement technological progress (Gold, 2017).

Artificial Intelligence (AI) techniques have experienced unprecedented growth and are being applied in various industries (Devagiri, J. S., Paheding, S., Niyaz, Q., Yang, X., & Smith, S., 2022).The AI is a powerful tool that is transforming industries, including digital publishing and has revolutionized the way content is created, distributed, and consumed. The application of AI in e-publishing has also led to the development of innovative solutions such as chatbots, virtual assistants, and recommendation engines. These tools help users to navigate through the vast amount of content available online and find the information they need quickly and easily. They also enable publishers to offer personalized recommendations and suggestions, which enhances the user experience and increases user retention (Vinay, S. B., 2023). In recent years, publishers and bookstores are firmly committed to making a space in the world of desktop publishing, as one more line of their business (Magadán-Díaz, M., & Rivas-García, J. I., 2020). However, the indicators are clear that employees lack the skills to use modern DTP tools that enable improved productivity, faster content processing, and improved design quality. This lack of expertise in the application of these functions poses a challenge for many users.

ANALYSIS OF EXISTING DIGITAL PLATFORMS ON THE MARKET

Broadly speaking, digital educational platforms are online systems that provide access to educational materials, courses, lectures, and interactive content used to enable distance learning and often use various forms of educational resources, such as video lessons, quizzes, discussions, and assignments, to enhance the learning experience. These platforms allow for the acquisition of knowledge at any time and from any place, provided there is access to the internet, which allows for additional adaptation to the specific needs of individuals and makes digital educational platforms provide the possibility of flexible learning. In this way, through the use of computer and communication technologies, access to education is expanded. It should also be noted that platforms are not just repositories of certain content, but also enable interactive and collaborative learning. Thus, platforms provide the possibility of discussion between students and teachers, sharing materials, working in teams, etc. The concept of "platforms" has become ubiquitous in the field of education today and cannot be viewed too narrowly, while on the other hand, it would be a mistake to label all initiatives for the digitalization of education as platforms for digital education (Decuypere et al., 2021).

PLATFORMS AND COURSES FOR APPLYING ARTIFICIAL INTELLIGENCE IN DTP TOOLS

With the rapid development of artificial intelligence, even traditional graphic design and office productivity tools have gained AI (Artificial Intelligence) functionalities. Desktop Publishing (DTP) and graphics tools – such as Adobe Photoshop, Illustrator, InDesign, Affinity Photo, Designer, Publisher as well as office software packages (MS Office: Word, Excel, PowerPoint) – are increasingly integrating AI capabilities (e.g. generative image filling, smart design, automatic word processing, etc.). Consequently, courses and training courses have emerged that convey knowledge on how to use these AI functions in practice. Several online platforms already offer specialized courses on the topic of applying artificial intelligence within the aforementioned tools:

LinkedIn Learning: As a platform geared toward professionals, LinkedIn Learning has several courses dedicated to new AI capabilities in Adobe, Affinity and Microsoft tools. For example, the "Leveraging AI in Adobe Photoshop and Creative Cloud (2023)" course covers Adobe Sensei (built-in AI technology in Adobe apps) to speed up tasks in Photoshop, Illustrator, and InDesign. The course is approximately 4 hours long and is taught by an Adobe expert. Similarly, LinkedIn Learning offers the "Photoshop 2024: New AI Features" course, which focuses on the latest AI features (AI-powered masking, neural filters, etc.). For Microsoft Office, there is a new course "Excel with Copilot: AI-Driven Data Analysis" (2024), which takes approximately 1.5 hours to teach you how to use Microsoft 365 Copilot in Excel for data analysis (e.g., automatic formula generation, AI-powered visualization). The advantage of LinkedIn Learning courses is that they are short and practical, so users (who already pay for a subscription) can quickly master specific skills, and they receive a certificate of completion that they can add to their LinkedIn profile. Comprehensive online training resources for the Affinity creative suite are available through several platforms. LinkedIn Learning offers structured courses such as *Affinity Photo Online Training Courses*, *Affinity Designer Essential Training*, and *Affinity Publisher Essential Training*.

Udemy: As a huge course marketplace, Udemy has dozens of courses created by individual instructors on the topic of AI in Photoshop, Illustrator, and the like. For example, "Photoshop Generative AI Editing MasterClass" (2023) is a popular course (about 4 hours) that goes into detail about using the latest Photoshop features like Generative Fill and Neural Filters for photo editing. Instructors often demonstrate hands-on projects (e.g., how to use AI to remove or add objects in a photo, generate backgrounds, or speed up logo design in Illustrator). There are also courses dedicated to Adobe Firefly (Adobe's new generative AI graphics tool) – e.g., the course "Adobe Firefly: A Guide to AI Art". For Microsoft Office, courses are also starting to appear – e.g., "Unlocking AI in Microsoft Office: Word, Excel, PowerPoint," where instructors walk through using smart features like translators, predictive text, etc. The advantage of Udemy is that users can purchase individual courses that interest them and have lifetime access to the materials, allowing them to stay up to date with new trends. They also receive a certificate of completion. The quality can vary, but the best-rated courses have detailed examples and high user ratings. For those who want comprehensive knowledge, there are also longer courses. Udemy provides a broad selection of instructional content, including titles such as *Affinity Designer: The Complete Guide to Affinity Designer*, *Guide to Make Vector Art in Affinity Designer*, *Affinity Publisher: Beyond the Basics!*, and *Affinity Photo: Essential Training Course*, all of which offer practical and in-depth learning opportunities for users at various skill levels.

Coursera (Adobe Special Programs): An interesting development is that Coursera has also entered this field through a partnership with Adobe. At the end of 2023, professional certificates were launched under the auspices of Adobe, as part of the Coursera platform. As part of the Adobe Graphic Design Professional Certificate program, there is a "Generative AI Content Creation" course that lasts about 3 weeks. This course provides participants with practical exercises with Adobe Firefly and the integration of AI tools in Photoshop/Illustrator, along with a discussion of ethical aspects and best practices (Coursera/Adobe, 2024). Upon completion, participants receive an official certificate from Adobe and Coursera, which can be valuable for their CV. Coursera offers this content with flexibility. It can be listened to for free (without a certificate), or you can pay to get a certificate. These courses

are more deeply structured, with quizzes and projects, so they are suitable for those who want more systematic training in the application of AI in their work. Other platforms and resources: In addition to the ones mentioned, other platforms also contribute to the transfer of knowledge in this area. Skillshare has several short courses in which designers and photographers demonstrate how to use AI tools (e.g. "Using AI in Photoshop for Creative Portraits"). Pluralsight is also starting to include courses on Adobe tools, but not yet so focused on AI innovations. YouTube is also an informal platform where many experts (including the official Adobe channel) publish tutorials on using new AI features; however, this content is not systematized into a certificate course. Adobe also offers free tutorials and guides on its website, and also organizes Adobe MAX conferences, the recordings of which are available and where you can learn directly from the creators of the tools. However, when comparing platforms, you should limit yourself to those with structured courses (LinkedIn, Udemy, Coursera).

Table 1 provides a comparative overview of several specific courses from different platforms that address the application of artificial intelligence in tools such as Adobe Photoshop/Illustrator and Microsoft Excel. Key features are listed: platform, course title and focus, approximate duration, pricing and access model, and whether a certificate is provided.

Table 1. Comparison of AI platforms and courses in DTP/Office tools (Adobe Creative Cloud and MS Office)

Platform	Course (area)	Duration	Price/access	Certificate
LinkedIn Learning	Using Artificial Intelligence in Adobe Photoshop and Creative Cloud (2023) – How to Use Adobe Sensei AI for Photoshop, Illustrator, InDesign.	4 hour	Subscription (included in LinkedIn Premium)	Certificate of Completion
Udemy	Photoshop Generative AI Editing MasterClass – Using generative AI tools in Photoshop for image editing and design	4 hour	One-time course purchase	Certificate of Completion
Coursera	Generative AI Content Creation (Adobe Graphic Designer Professional Certificate) – Integrating AI (Adobe Firefly) into creative design and AI ethics	19 hour	Free to listen; certificate fee (or Coursera Plus subscription)	Verified certificate (Adobe/Coursera)
LinkedIn Learning	Excel with Copilot: AI-Driven Data Analysis – Using Microsoft 365 Copilot (AI assistant) in Excel for data analysis.	1,5 hour	Subscription	Certificate of Completion

Some interesting differences can be seen from the overview above. LinkedIn Learning courses are relatively short and focused on quick use. They are suitable for someone who already has a subscription and wants to learn quickly (e.g. graphic designers who want to immediately apply AI in their daily work). Their certificates are not academic, but they carry weight in the professional community because they can be displayed on a LinkedIn profile. Udemy courses provide detailed practical work and are available to anyone for a one-time small fee. It is good for self-taught professionals or hobbyists, and the certificate confirms completion, although again it is not accredited. The Coursera/Adobe course is the longest and most structured, probably with deeper explanations of concepts and projects, which leads to a more valuable certificate (under the auspices of Adobe, with the possibility of continuing through the entire professional program). The price of the certification is higher, but corresponds to more serious training. Also, the content differs somewhat: e.g. LinkedIn and Udemy focus on how to use the tools (practical skills that can be applied immediately), while Coursera includes the why and the bigger picture (the basics of generative AI, ethics, integration into the workflow). The choice of platform and course depends on the profile of the student. An experienced graphic designer may prefer a short LinkedIn course to stay up to date with innovations,

while someone who wants a comprehensive understanding of AI in design may enroll in Coursera's program.

THE EDUCATIONAL PLATFORM ASKING

Modern DTP tools increasingly integrate AI functions that enable improved productivity, faster content processing and improved design quality. However, the lack of expert knowledge in the application of these functions poses a challenge for many users. The innovativeness of the project is the integration of artificial intelligence into the educational process, i.e. in that the ASKING platform covers a wide range of DTP tools that include AI functions. The application of AI in creative software is still little known in our region, so the platform will improve existing educational services for users and help them improve their graphic design skills in line with the latest technological trends, thereby becoming competitive in the labor market.

The ASKING platform is intended for a target group to master the techniques of applying artificial intelligence in DeskTop Publishing (DTP) tools such as Adobe Photoshop, InDesign, Illustrator and the Microsoft Office suite. The target group consists of students, but also graphic designers, marketing experts, design students and creative professionals who want to improve their skills through the application of modern AI tools in the DTP process.

The main goal of the project is to create a structured training program for future and existing personnel in the graphics industry who will become familiar with the capabilities of AI functions in DTP software, and help them apply them in practical tasks. The training will be organized through modular video tutorials that cover both basic concepts and advanced techniques for applying AI in specific tools. Each module includes video materials and practical tasks, which will allow users to immediately apply the newly acquired knowledge.

The training is delivered through video tutorials and practical assignments, allowing users to master advanced techniques through interactive learning. In this way, the platform will enable the acquisition of relevant skills for working in a modern DTP environment.

The platform includes methodically designed teaching resources, organized in a modular manner, in the form of video tutorials that will contain systematized material, interactive tasks and quizzes. Users will master basic and advanced functions through a series of video materials. AI in DTP tools. Learning will be active and problem-oriented, as each tutorial is followed by a practical task, where what has been learned will be applied, while quizzes will help test knowledge. Technological processes include the use of cloud services for storing materials and automated tools for analyzing progress, ensuring accessibility and monitoring of learning in real time.

The platform ASKING is hosted at: https://www.asking.edu.rs/ and is actually a structured training program for future and existing professionals in the graphics industry who will learn about the capabilities of AI functions in DTP software, and help them apply them in practical tasks. The platform contains courses that are basically modular video tutorials that cover both basic concepts and advanced techniques for applying AI in specific tools. Each module includes a tutorial, practical tasks, and a knowledge test.

CONCLUSION

The platforms that are at the forefront of transferring knowledge about the application of AI in DTP and related tools are mostly the same leading general learning platforms (LinkedIn Learning, Udemy, Coursera), which recognized the need and quickly created specific content. They differ from each other in format, price and scope of content, but together they meet different user requirements, from quick training to full professional development. This comparison also illustrates a broader point: as

new technologies emerge, online educational platforms become the main channel through which knowledge about these technologies is massively distributed to end users.

The ASKING project is of a socially beneficial nature, based on knowledge and aims to develop an educational platform that offers users training in the use of artificial intelligence in DeskTop Publishing (DTP) tools. The project also encourages stronger cooperation between the academic and business sectors by further training future and existing staff in the use of new technologies in the field of graphic design and increasing their competitiveness in the labor market. This will contribute to improving the acquisition of users' competencies in the DTP field, making them more competitive in the labor market, which makes this project socially justified. It is expected that participants of the platform will develop the skills to more effectively apply AI tools in everyday tasks, thus increasing the productivity and quality of their creative solutions.

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GIS-BASED MCDA SUSTABILITY ANALYSIS FOR ECOTOURISM MANAGEMENT IN THE "VRŠAC MOUNTAINS" (SERBIA)

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ABSTRACT

Tourism is one of the fastest-growing and most significant economic sectors worldwide. Ecotourism emerged in the late 20th century and refers to sustainable tourism that promotes the conservation and protection of a location's ecological values. Managing ecotourism requires a thorough understanding of the area and optimal utilization of its resources. This study focuses on assessing the suitability of different parts of the Outstanding Natural Landscape "Vršac Mountains" (Serbia) for the development of ecotourism using a multi-criteria decision analysis conducted in GIS. The criteria used include: slope, visibility from the highest peaks, land use/land cover, distance from rivers, settlements, and roads. All criteria were reclassified into suitability scores from 1 to 5, where 1 represents the lowest and 5 the highest suitability. Equal weight was assigned to all criteria. The resulting map was reclassified into values from 1 to 5. The results show that only 0.23% of the area falls into the moderately suitable class for ecotourism development, while the suitable and highly suitable classes cover 55.94% and 43.83% of the territory, respectively. The development of ecotourism also depends on socioeconomic factors, making it essential to include the perspectives of both the local population and visitors in the planning process.

Keywords: GIS-MCDA, Ecotourism, Management, Sustainability, Serbia.

INTRODUCTION

Since the end of the last century, tourism has become one of the world's most rapidly growing industries, with more than 1.4 billion international tourist arrivals in the recent years (Chaudhary et al., 2021; Gigović et al., 2016). Although tourism represents one of the main economical resources for many countries, the increase in the number of tourists may result in the degradation of the natural environment and disturbance in flora and fauna life cycles, while also affecting the local population (Goodwin, 1996). With the ongoing reduction of preserved and pristine natural areas, their significance is becoming more evident, prompting the need for their protection (Fadafan et al., 2022).

The term 'ecotourism' emerged in the 1990s, as a response to the expansion of mass tourism worldwide. Numerous definitions of this term have been developed, but the essence remained – ecotourism is a sustainable, nature-based tourism that promotes the conservation of ecological values of the natural resource base (Gigović et al., 2016; Islam, Paul & Sarkar, 2025; Whelan, 1991). Ecotourism can be described through five main concepts: nature conservation, low impact, sustainability, meaningful community involvement and environmental education (Ars & Bohanec, 2010).

The development of ecotourism demands strategic planning and the involvement of local communities, experts and stakeholders in the management process (Li et al., 2012; Yasin & Woldemariam, 2023; Zabihi et al., 2020). Due to the uniqueness of each natural landscape, the strategies for ecotourism development should be adapted to the natural values and ecological sensitivity of each specific area (Wishitemi et al., 2015). The key locations with ecotourism potential are protected areas, with their preserved environment and already established management frameworks and legal protection. In addition to that, ecotourism development may contribute to the

local economic development of the region, as well as the quality of life of the local population (Chaudhary et al., 2021).

Numerous spatial factors play a role in the advancement of ecotourism. Geographic information systems (GIS) contribute significantly to analyzing spatial factors through multi-criteria decision analysis (MCDA) (Gigović et al., 2016; Wishitemi et al., 2015). GIS integrate geography, computer sciences, statistics, management, surveying, cartography and mapping into a single, complex analytical system. It is a powerful tool for collecting, managing, analyzing, modeling, and visualizing spatial data (Wei, 2012). With the capabilities of data management and complex spatial analyses, GIS represents an effective decision-making tool, commonly used for land management, urban and rural planning, real estate development, market survey, as well as (eco)tourism planning (Chaudhary et al., 2021; Wei, 2012).

The Outstanding Natural Landscape (ONL) "Vršac Mountains" is located in the South Banat District, Vojvodina - Northern Serbia (Figure 1). Without the protected habitat "Mali vršački rit", it covers an area of around 44 km2, about a third of the Vršac Mountain range (122 km2) (Grad Vršac, 2017). With the Gudurica Peak (641 m), Vršac mountains represent the highest point of Vojvodina. The uniqueness of the "Vršac Mountains" lies in the distinctive relief characteristics and pristine nature diversity. Together with extensive vineyards and anthropogenic heritage, such as Mesić monastery and Vršac tower, the overall experience of the Vršac Mountains is enhanced (Jojić Glavonjić & Doljak, 2023; Trišić et al., 2023). In the area of Vršac Mountains around 130 bird species have been registered. For this reason, this area was included in the world register of internationally important bird habitats (IBA area) in 1989. Besides birds, this area represents important habitat for different species of insects, reptiles, and mammals (Trišić et al., 2023).
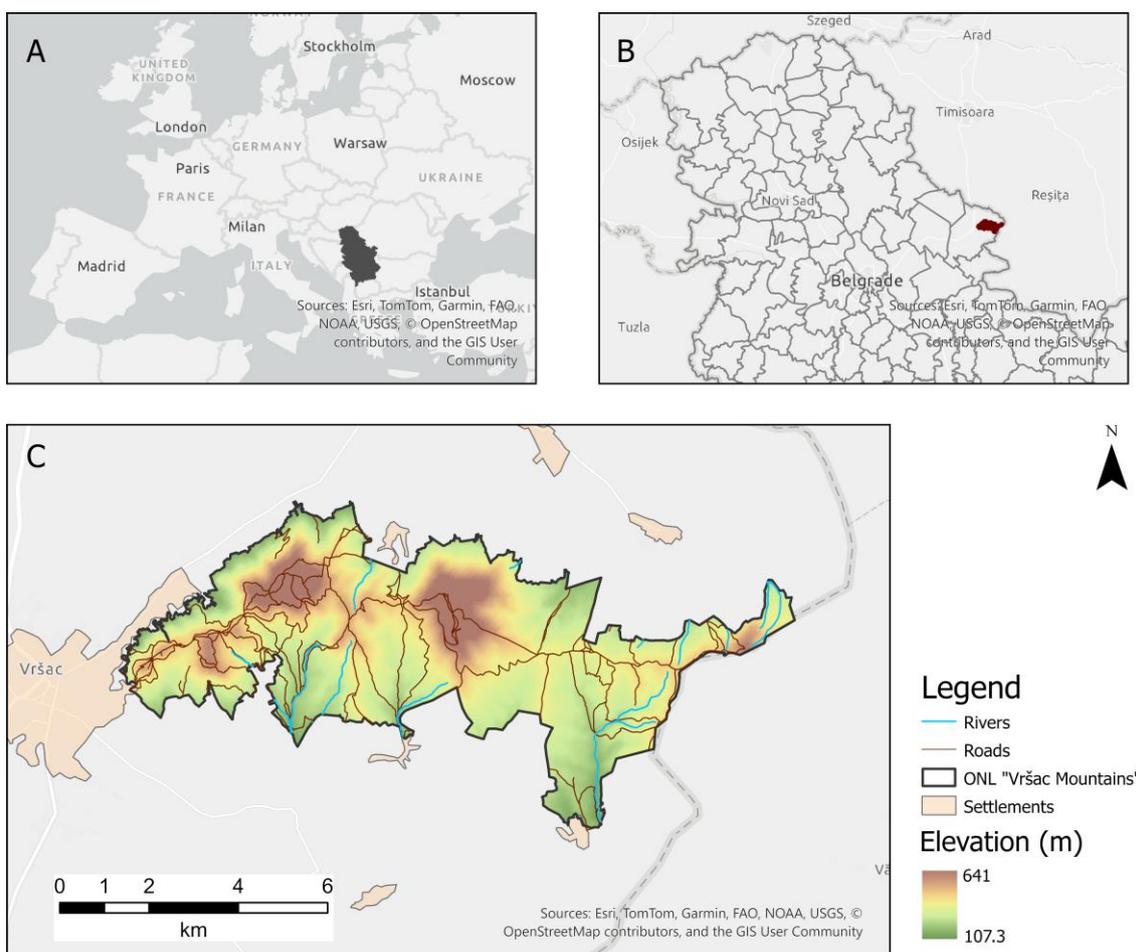
Figure 1: Study area - A: Location of Serbia in Europe; B - ONL "Vršac Mountains" (red) in Northern Serbia; C - ONL "Vršac Mountains"

The aim of this research is to identify suitability zones for the development of ecotourism in the ONL "Vršac Mountains" using GIS-MCDA model. The significance of this study lies in revealing the hidden ecotouristic potential of the highest mountain in the plains of Vojvodina, while also contributing to its scientific recognition.

METHODOLOGY

The analysis of ecotourism suitability involved literature review, data collection and their integration in GIS, standardization and weighting of the data, and, finally, obtaining and visualization of the results. The literature review was conducted by searching for scientific research that apply GIS MCDA methods for ecotourism suitability assessment.

Based on the reviewed studies from various countries, such as Serbia (Gigović et al., 2016; Jovanović et al., 2022), Iran (Fadafan et al., 2022; Omarzadeh at al., 2021; Zabihi et al., 2020), India (Chaudhary et al., 2021), and Ethiopia (Yasin & Woldemariam, 2023), the criteria for this research were selected: slope (S), visibility from highest peaks (V), land use/land cover (LULC), distance from rivers (Dri), settlements (Ds) and roads (Dro). The research show that steeper slopes, better visibility, as well as the presence of forests, positively influence tourist attraction. Moreover, it has been found that water bodies represent significant ecotouristic attraction, because they enhance the visual identity of the landscape. Water bodies and forests also contribute to mental wellbeing of the visitors (Popović et al., 2018). Shorter distance from settlements and roads make attractions more accessible to most tourists. Furthermore, closeness to the settlements may benefit local economy, create jobs, and increase the demand for locally produced goods and services (Yasin & Woldemariam, 2023).

Although the aforementioned studies use several other criteria, such as elevation, temperature, rainfall, and vegetation, these criteria were excluded from this research, since the territory of the ONL is not large enough for them to show meaningful spatial differentiation. Another relevant criterion is area protection. Due to analyzing the protected area, this criterion was not included in the research. The standardization of criteria is given in Table 1.

Table 1: Standardization of criteria

Suitability scores	S (º)	V (viewshed count)	LULC	Dri (km)	Ds (km)	Dro (km)
5	2 - 5	4 - 6	Forests	< 0.2	< 1	< 1
4	5 - 15	3	/	0.2 - 0.5	1 - 3	1 - 3
3	15 - 25	2	Shrub and/or herbaceous vegetation associations	0.5 - 1	3 - 5	3 - 5
2	25 - 35	1	Agricultural areas	1 - 3	5 - 10	5 - 10
1	0 - 2 35 - 90	0	Artificial surfaces	> 3	> 10	> 10

All the data were collected from the open-source and free-of-charge data platforms. The borders of ONL "Vršac Mountains" were downloaded from the Protected Planet website (UNEP-WCMC & IUCN, 2025). Slope and visibility were calculated from the digital elevation model over Europe (EU-DEM) (Eurostat, n.d.). LULC and the distance from settlements analyses were based on CORINE Land Cover 2018 data (Copernicus Land Monitoring Service, 2019). The data on rivers and roads were obtained from Geofabrik GmbH (2025).

In this paper, software QGIS 3.28.12 was used for the analysis, and ArcGIS Pro 3.2.0 was used for visualization of the results. The data were transformed in the coordinate system EPSG: 6316. Vector data were converted into raster datasets, and the calculation of ecosystem suitability was conducted in

Raster calculator. The criteria were assigned equal weights, given that the area is too small for any criterion to significantly outweigh the others. The result from Raster calculator is a raster with pixel values ranging from 1 to 5. This raster was subsequently reclassified so that values between 0 and 1 were assigned a suitability score of 1, between 1 and 2 a score of 2, and so on, up to 5. Lower scores represent the areas less suitable for ecotourism development, while higher scores represent more suitable areas.

RESULTS AND DISCUSSION

The results of ecotourism suitability analysis of ONL "Vršac Mountains" show that almost the entire territory is suitable for ecotourism development. The lowest suitability score is 3 (moderately suitable), occupying around 0.23% of the territory. The scores 4 (suitable) and 5 (highly suitable) cover 55.94% and 43.83%, respectively. Visual representation of the results is given in Figure 2.

The moderately suitable areas are located in the central parts of the ONL, farthest from the rivers and roads. Due to high scores for natural criteria, dense road network and proximity to Vršac, western parts of ONL obtained high scores for ecotourism suitability. Althogh not as close to the settlements, natural attractiveness and relatively dense road network in the easternmost parts of the protected areas enhance its suitability for ecotourism.
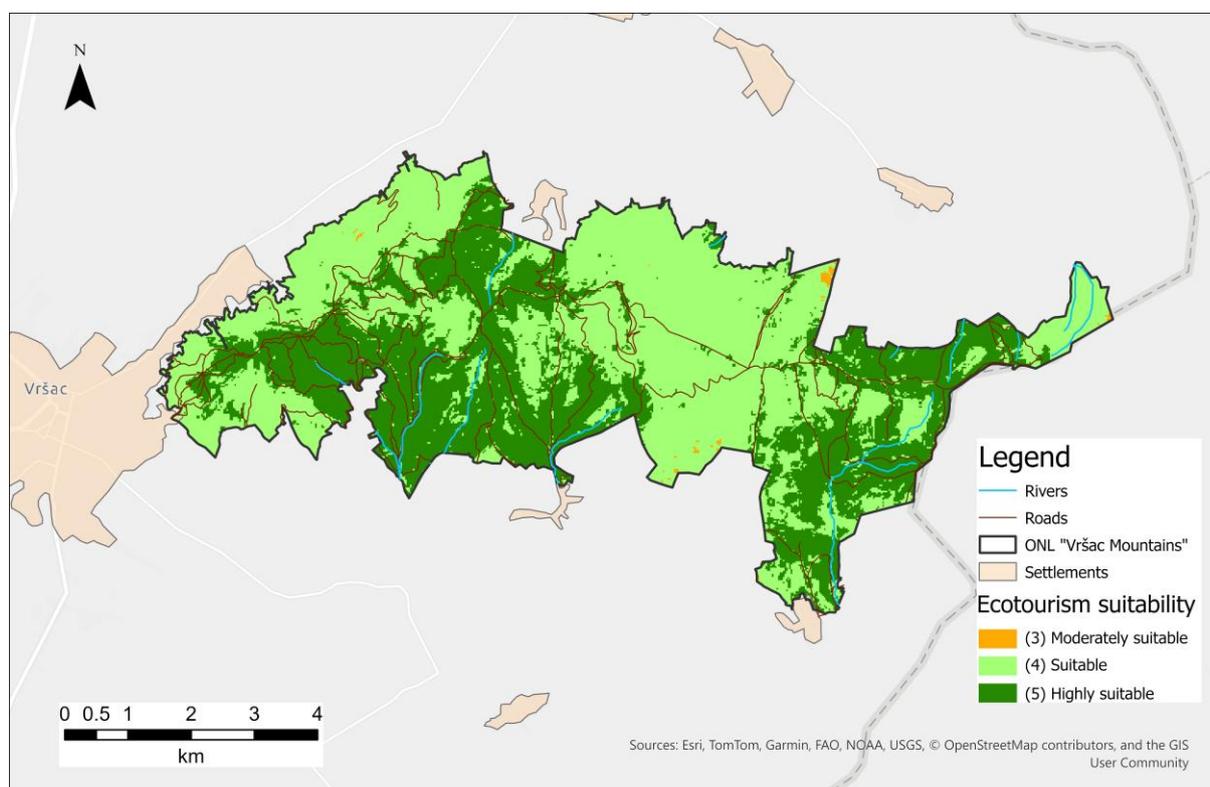
Figure 2: Ecotourism suitability map for "Vršac Mountains"

Beside spatial factors, socioeconomic characteristics also play an important role in assessing ecotourism potential (Yasin & Woldemariam, 2023). The research on sustainable tourism within a protected area by examining the satisfaction levels of both visitors and local residents was conducted in ONL "Vršac Mountains" by Trišić et al. (2023). The main hypothesis suggests that sustainable tourism significantly influences their satisfaction, while the supporting hypotheses explore the impact of the four dimensions of sustainability—ecological, economic, socio-cultural, and institutional—on tourism development. A total of 1,419 respondents (789 residents and 630 visitors) were surveyed using a random sampling method to assess the current state of sustainable tourism in the ONL. The research highlights the importance of ongoing education for visitors, tourism workers, and local communities, as well as dedicated funding for environmental and cultural preservation. Respondents

identified ecological and socio-cultural sustainability as the most important dimensions, indicating strong support for forms of tourism that rely on natural and cultural resources—especially ecotourism. Finally, effective marketing and the promotion of ecologically responsible products are essential to creating a positive image and ensuring the long-term sustainability of tourism in protected areas (Trišić et al., 2023).

CONCLUSION

Ecotourism is one of the newer forms of tourism, emerging from the growing need to reduce the environmental and social pressures caused by mass tourism. Unlike conventional tourism, which often leads to the degradation of natural resources, ecotourism promotes sustainable practices and encourages responsible behavior among tourists. Since one of its core principles is nature conservation, it is not surprising that ecotourism can best develop within already protected areas, where institutional frameworks for environmental management and preservation are already established. Such areas offer a balanced setting where tourism development can be aligned with ecological integrity and community well-being.

The subject of this research is the Outstanding Natural Landscape (ONL) "Vršac Mountains," selected for its exceptional natural characteristics and distinctiveness within the otherwise flat terrain of Vojvodina, in northern Serbia. With its unique geomorphological features, rich biodiversity, and cultural heritage, the area holds considerable potential for ecotourism development. The research shows that the entire territory of this protected area is suitable for ecotourism. Future studies could focus on identifying the most effective strategies for promoting ecotourism, strengthening the role of the local community, and improving the management of natural resources to ensure sustainable development and long-term benefits for both nature and people.

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MANAGING THE TRANSITION TO A HYBRID LEARNING MODEL

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ABSTRACT

This paper examines the transition to a hybrid learning model in schools, a significant shift that combines traditional face-to-face instruction with online learning components. As educational institutions increasingly adopt this technology-integrated approach, it is critical to highlight the challenges and considerations teachers, administrators, and students face during this transformation. The analysis includes a comprehensive SWOT (Strengths, Weaknesses, Opportunities, Threats) framework to provide a structured understanding of the various factors influencing the implementation of hybrid learning. Strengths include increased flexibility and access to resources, while weaknesses include issues related to inequity in access to technology among students. Opportunities for innovation in teaching practices and collaboration are also discussed, along with potential threats such as student disengagement and the need for strong training for teachers in the use of technology. This paper aims to contribute to the ongoing dialogue about effective strategies for managing the transition to a hybrid learning model by analyzing the results of this SWOT analysis in the context of the existing literature. Finally, the aim is to emphasize the importance of identifying specific factors and evaluations to support successful implementation and improve the educational experience for all stakeholders involved.

Keywords: Hybrid learning model, SWOT, Education, Literature Review, Managing transition.

INTRODUCTION

Along with the development of trends and needs of information and communication technologies in the world of education 4.0 today, there have been many innovations and inventions in the form of multimedia devices, as well as ideas and methods in an effort to optimize technological devices in education (Hediansah & Surjono). Changes in the field of education have led to the concept of hybrid learning environments (Hwang, 2018). Hybrid teaching models represent a mixture of teaching in a traditional way (face-to-face) and concepts applied in an e-learning system (Rossouw, Matthee & Weilbach, 2021). It is emphasized that the purpose of teaching reform is to encourage active learning, not passive acquisition of knowledge (Wang et al., 2024).

Managing and understanding change in schools due to technology implementation seems to have all the elements of an ill-structured problem where the solution is not obvious (Rossouw, Matthee & Weilbach, 2021). At the beginning of the hybrid learning period, teachers can use face-to-face interactions to give students an overview of online tools, instruct them on how to get help and how their learning outcomes will be assessed, and thus address some of the barriers to incorporating the hybrid model into teaching (Alshamrani et al., 2023). Ingabire (2024) states that flexibility is one of the most frequently cited advantages of hybrid learning models, which leads to a greater level of personalization of learning and adaptation of teaching to the individual needs of students. The results of Feubli et al. (2023) and Torio et al. (2023) are in agreement with the study of Ingabire

(2024) regarding the importance of flexibility. In addition to the recognized benefits, Wang et al. (2024) state that hybrid learning challenges arise for some students in terms of tasks to be done and time management needs.

METHODOLOGY

In order to thoroughly investigate this topic, a review of the existing literature was conducted along with a SWOT analysis. This analysis identifies the strengths, weaknesses, opportunities and threats of moving to a hybrid learning model. The insights from this research are intended to provide valuable guidance to educational institutions as they navigate the complexities of implementing a hybrid approach. Ultimately, these findings aim to facilitate a smoother transition and improve the effectiveness of learning environments in adapting to new educational norms.

MEASURES FOR MANAGING THE TRANSITION TO A HYBRID LEARNING MODEL

A hybrid way of learning does not mean abandoning the traditional way of learning, but rather opening another possibility to realize and organize both types of learning in the best possible way (Umah et al., 2023). Umah et al. (2023) states that there are numerous pedagogical challenges that lead to the adaptability of teachers to the new learning system, such as the level of IT knowledge among teachers. Hediansah and Surjono (2020) state that there is a need for technical support to implement changes in the teaching process based on digitization. Raes (2021) states that although technology is a prerequisite to introduce a hybrid learning model, it is not sufficient for change to occur.

Gudoniene et al. (2025) point out that factors influencing the adoption of a hybrid learning model in teaching are strong integration of technology, innovative pedagogical strategies, academic development and support, active student participation, effective assessment practices and positive learning outcomes. Eliveria et al. (2019) state that the ease of navigation through materials and parts of lessons is one of the main factors that influence the degree of student engagement in a hybrid learning model.

Changes such as switching to a hybrid learning model can also require a lot of time, which is one of the limitations that must be paid special attention to when planning this process (Dorm et al., 2020). The results of Ottergren and Ampadu (2023) found that hybrid teaching had a negative impact on teaching quality, student achievement, student health, teacher workload, and teacher-student dialogue. That is why it is important to take into account the many negative aspects that come with the introduction of the hybrid model in teaching. In the literature, one finds the point of view that the hybrid learning model does not have to lead to negative consequences in terms of learning results, but that academically weaker students can achieve worse results (Feubli et al., 2023; Cacault et al., 2019).

Students stated in Fabian et al. (2024) that hybrid formats provide fewer opportunities for collaboration and that they were more engaged when attending face-to-face classes, but were able to manage their time better, which stood out as a significant advantage of this model.

Dorm et al. (2020) also states that special focus needs to be placed on students who face special challenges such as living in rural areas, students who grow up in poverty, students who have developmental disabilities, or students who are transitioning from one stage of education to another (e.g. fourth to fifth grade of primary school) (Dorm et al., 2020). Ragni et al. (2024) specifically state that it is important to consider inequalities among students in terms of technological capabilities and access to the Internet that may worsen their situation after the introduction of a hybrid learning model.

Challenges are recognized by lecturers as well, particularly heavy load for lesson preparation and parallel management of face-to-face and online classrooms, lack of knowledge of interactive teaching design suitable for hybrid classes and difficulties in monitoring students' learning process (Li et al., 2023). Fatimawati et al. (2023) state that there is a need for constant improvement of lecturers and their professional development in order to be able to follow the transition to a hybrid learning model.

This way of working gives new possibilities, but also the need to adapt to new ways of working and to investigate how this process can be facilitated

SWOT ANALYSIS OF THE HYBRID LEARNING MODEL

The SWOT analysis provides insight into the key factors that must be considered when managing the transition to a hybrid teaching model in Serbia. Based on analyzes such as SWOT analysis, it is possible to influence the creation of strategies that can contribute to the successful implementation of the hybrid teaching model.

SWOT analysis was done on a sample of primary schools in Serbia. The focus was on grades 1-4, but the results can also be applied to the period 5-8. The sample is wide enough for the results to be generalizable, but at the same time it is important to keep in mind that each educational institution has a set of problems that it faces on an individual level and that need to be further considered as part of the weaknesses presented in this SWOT analysis in order to respond in the best possible way to the challenges that arise during the transition to a hybrid learning model.

Table 1: SWOT analysis of the hybrid learning model

Strengths	Weaknesses
− Monitoring the development of technology - a response to modern challenges − Customizing learning options − Support for implementing hybrid mode of operation − Resistance to external factors such as pandemics	− Lack of formal training − Staff mismatch − Resistance to change − Insufficiently developed monitoring systems − Deficiencies in rural infrastructure
Opportunities	**Threats**
− Professional development − Technology partners − Data analysis − Involvement of parents − Introduction of a centralized system	− Overworked staff − Lack of discipline on the part of students − Inconsistencies in development − Mistrust of the parties involved − Budget constraints

When analyzing the advantages within the scope of the SWOT analysis offered by the hybrid model of work, which affect the way in which the transition from the traditional learning model to the hybrid one should be managed, one can first talk about personalizing the learning process to the individual needs of students and responding to changes that occur due to the development of technology, increasing digitization and globalization, as well as in the field of education. We can further talk about the recognized importance of the hybrid learning model and the advantages it leads to, and there is support for implementing this way of working in schools, which facilitates the management of this model. Through the development of a hybrid learning model, resilience is created in the event of an event such as a pandemic, thus strengthening the education system.

On the other hand, the weaknesses of this learning model are the lack of training and training regarding the management and introduction of the hybrid model. This often leads to large differences in implementation, which further affects the effectiveness of the model and the possibility of its evaluation. Staff in schools are inconsistent in terms of implementation. This can

be influenced by a number of factors, from the personal level of digital literacy to the communication between employees who organize distance learning and those who teach in the classroom. There are insufficiently developed control mechanisms that can provide insight into the effectiveness of the programs introduced as part of the transition to a hybrid mode of operation. This makes it difficult to indicate which aspects need to be improved in order to make the hybrid model more efficient. The complexities brought about by the hybrid model of education can lead to resistance to changes among some actors due to the demands of adapting to the hybrid way of working, new methodologies and ways of working. Within this, it is important to point out that it is not only the teachers who have to adapt, but also the administrative staff who participate in the organization of classes. There are inequalities in the ability to introduce the hybrid model in all schools in the same way and to the same extent, which further leads to differences in the digital infrastructure and the possibilities to transfer part of the teaching remotely.

In addition to internal factors, it is important to look at external factors that affect the management of the hybrid work model. Part of the internal weaknesses can be overcome through the possibility of professional development of employees in schools. One of the opportunities is cooperation with technology partners that could implement a more efficient introduction of hybrid models.

Rely on data processing to establish progress, anticipate challenges and adapt strategies effectively. Another opportunity is to focus on the role of parents, which could lead to a greater degree of cooperation between stakeholders in education and a more realistic distribution of responsibility regarding the outcome of the implementation of this system.

The creation of a centralized system is also of great importance, because it allows to standardize the management and thus to standardize the introduction of hybrid models.

The threats are primarily overworked staff who, due to the numerous obligations that the transition process brings, may make mistakes or experience the effect of burnout. Lack of discipline and commitment among students is also one of the threats that must be looked at. This creates difficulties for students for whom the digital environment creates distractions instead of increasing their motivation. At the same time, the challenge of distance learning is that students have a greater responsibility to organize their time, which is of great importance for the success of the hybrid work model. Given that they were not prepared for these tasks before the introduction of this change, the new expectations may be challenging for them. At the same time, the outcome of the introduction of the hybrid model can be influenced by the different development of digital infrastructure and the Internet, which can lead to inequality in the field of education. A threat that is also significant is the possibility of distrust in new ways of working with which some individuals are not sufficiently familiar. There are also significant threats regarding the budget allocated for these issues.

CONCLUSION

It can be concluded that the transition to hybrid education brings with it great challenges and numerous opportunities. By analyzing the advantages, that is, the strengths that this model has, and focusing on their development, we are working on easier adoption of this model. It is not enough to rely only on the strengths that arise, but it is also important to respond to the weaknesses that have been found. The opportunities that are presented must be used in the management process, because only their recognition has a limited effect, while for the threats, we must work on developing strategies that could avoid a setback in the transition process and the progress of this model in education. This holistic approach, if implemented effectively, offers long-term benefits for both students and teachers.

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