

Časopis za ekonomiju i tržišne komunikacije

Economy and Market Communication Review



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Fakultet poslovne ekonomije
The Excellence School of Management



Časopis za ekonomiju *i tržišne komunikacije*

Economy and Market *Communication Review*

Economy and Market Communication Review – Časopis za ekonomiju i tržišne komunikacije

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THE IMPACT OF ARTIFICIAL INTELLIGENCE ON THE ACCOUNTING PROFESSION IN BOSNIA AND HERZEGOVINA: PERCEPTIONS, READINESS AND REGULATORY GAP

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Abstract: *This study offers a detailed examination of the accounting and auditing profession's perceptions, preparedness, and core challenges related to the integration of Artificial Intelligence (AI) within the specific context of Bosnia and Herzegovina (BiH). Main goal was straightforward: to delineate the perceived advantages of AI, concerns related to skill erosion (or “deskilling”), and to determine whether current regulatory and professional training mechanisms in BiH are sufficient to address these challenges. We employed a quantitative approach, utilizing an online survey distributed to a solid convenience sample of 270 accounting and auditing professionals in the country. The statistical methodology involved descriptive statistics, t-tests, and ANOVA to establish significant variances in perceptions across key demographics (including gender, age, and educational attainment). The findings reveal that BiH professionals overwhelmingly perceive AI as an essential, inevitable opportunity to enhance efficiency and accuracy (with an impressive mean readiness score of $M=4.21$). Crucially, they also demonstrate a high degree of awareness regarding the potential risk of deskilling ($M=4.12$). However, this individual optimism is overshadowed by a critical and worrying systemic shortfall: extremely modest organizational investment in employee training ($M=1.97$). Furthermore, a central finding is the widely shared view that existing ethical and regulatory frameworks governing AI are simply not enough ($M=2.48$), contrasted by a surprisingly muted concern regarding data security ($M=1.50$). Demographic analysis clearly identifies a generational divide, showing that younger professionals, though more optimistic, are simultaneously more anxious about job displacement. The successful digital transition of the profession is directly tied to professional associations and policymakers urgently taking a proactive role - specifically through developing targeted educational curricula and updating ethical and regulatory standards - to close the current gap between individual readiness and institutional support.*

Keywords: *Artificial Intelligence (AI), accounting, auditing, digital transformation deskilling, regulatory framework*

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INTRODUCTION

Artificial Intelligence (AI) is a game-changer. It's a revolutionary discipline that simulates advanced human cognitive functions and is continuously reshaping the global business environment. Its influence on professional practice - especially the accounting field, which has long been dominated by repetitive tasks (Kokina & Davenport, 2017) - is fundamentally disruptive. By systematically integrating core AI technologies like machine learning, natural language processing, and Robotic Process Automation (RPA), companies see major boosts in operational efficiency, data accuracy, and the speed of financial report production (Yi et al., 2023), (Beryl Odonkor et al., 2024).

The prevailing view in the literature is that AI is a strategic opportunity rather than an immediate, widespread threat to job elimination (Li & Zheng, 2018); (Sutton et al., 2016) (Milovanovic & Novakovic, 2025). That said, we still need to figure out exactly how specific occupational roles and the macroeconomic structure will evolve, given that AI fundamentally expands what machines can master (Brynjolfsson et al., 2018). Automation primarily serves to relieve accountants of routine chores, letting their function pivot decisively towards analytical, strategic, and advisory business mandates (Chukwuani, 2024). This shift, however, requires a total overhaul of required skills and knowledge, along with a serious update of existing ethical and regulatory mechanisms.

While AI's influence on global accounting practice is well-documented, academic inquiry often skips over specific regional or national contexts. Bosnia and Herzegovina (BiH) faces distinctive barriers in its digital transformation, marked by slower technology adoption and a big lack of clear regulatory guidance (Ablameyko & Ablameyko, 2021). As a result, there's a noticeable scarcity of empirical research dedicated to exploring how local accounting professionals perceive these rapidly unfolding changes, their current readiness to adapt, and their primary professional concerns.

This paper takes an empirical deep dive into the attitudes of accounting professionals in Bosnia and Herzegovina concerning the pervasive integration of artificial intelligence. The study's core purpose is to fill this knowledge gap by offering critical insight into how the local professional community interprets these technological shifts, identifying the principal challenges, and assessing their preparedness to update their competencies and practice.

The main goal of this research is to comprehensively diagnose the preparedness and disposition of accounting professionals in BiH to embrace and apply artificial intelligence. This includes dissecting perceived benefits, key challenges, anticipated shifts in job roles, and evaluating how sufficient current regulatory and educational programs are overall.

In line with this aim, we ask four key research questions:

RQ1: What is the self-reported level of familiarity among BiH accountants with core AI tools, and how strong is their motivation to pursue continuous professional development in this area?

RQ2: What are the profession's perceived central benefits and chief challenges of adopting AI, particularly regarding accuracy, efficiency, and fraud prevention?

RQ3: To what degree do professionals perceive the risk of job displacement and the possibility of skill degradation ("deskilling") resulting from increasing reliance on AI systems?

RQ4: Are the existing ethical and regulatory frameworks governing the application of AI within the BiH accounting context deemed sufficient by practitioners?

Building upon the stated research goal, the following hypotheses are tested in this study:

H1: A statistically significant positive correlation exists between professionals' familiarity with AI and their motivation to engage in related training and professional development.

H2: More experienced professionals (specifically older age cohorts) will be less optimistic regarding the financial benefits generated by AI, compared to their younger colleagues.

H3: Professionals who hold higher educational qualifications will express statistically greater concern regarding the potential bias embedded in AI algorithms and the overall adequacy of the current regulatory environment.

This research delivers a significant empirical contribution by mapping the distinct regional context of Bosnia and Herzegovina and establishing the first comprehensive evidence base detailing local accounting community attitudes towards AI. The findings are intended to furnish a vital foundation for policymakers, professional bodies, and educational institutions in BiH to formulate successful strategies for the profession's digital adaptation.

The remainder of the paper is structured into five core sections. Following this Introduction, the Theoretical Framework and Literature Review meticulously examine AI definitions, its opportunities, associated challenges, and the global regulatory landscape. The subsequent section, Research Methodology, details the survey design and its execution. The fourth section, presents descriptive and inferential statistics derived from the primary data collection. Finally, the last part summarize key findings, highlight practical implications, address limitations of the study, and offer focused directions for future research and professional practice.

LITERATURE REVIEW

The accelerating pace of AI technologies, including Machine Learning (ML) and Natural Language Processing (NLP), is fundamentally restructuring the global corporate environment, opening unprecedented avenues for innovation (Beryl Odonkor et al., 2024). At the same time, this rapid, and often uncontrolled, expansion brings with it significant ethical and social dilemmas. While the momentum of global digitalization universally affects the accounting profession, Bosnia and Herzegovina (BIH) faces its own set of specific challenges, from specific political challenges, transitional, privatization (Grujić & Vretenar Cobović, 2024), (Novaković et al., 2024) to challenges that other countries face, such as the slow rate of adoption of digital technologies and limited access to advanced technological resources.

AI-driven systems promise greater reliability in financial reporting, effectively cutting down on errors and fraud, and enabling near real-time financial analytics (Stein

Smith, 2018), (Beryl Odonkor et al., 2024). The automation of repetitive, low-value tasks, predominantly via Robotic Process Automation (RPA), frees up accounting professionals. This reallocation of effort allows them to focus on the strategic side of their roles, such as high-level advisory services and business forecasting (Tandiono, 2023); (Beryl Odonkor et al., 2024). Without a doubt, the use of artificial intelligence in business significantly reconfigures workflows, optimizing both time and money, which can increase productivity and contribute to corporate sustainability (Peng et al., 2023). Moreover, adopting AI drives the creation of intelligent systems specialized in predictive analysis, fraud detection, and robust risk assessment, thereby not only improving data accuracy but also providing deeper, strategic insights for financial planning (Dombrovska, 2023) (Beryl Odonkor et al., 2024)

Other technologies are helping this transition along: Blockchain introduces unparalleled transaction transparency and security, which is especially valuable in audit functions (Stein Smith, 2018) while Cloud Computing facilitates easy, flexible access to critical financial data and applications, drastically reducing the need for substantial in-house IT infrastructure. The most important contribution of artificial intelligence is its ability to assist in real time, enabling immediate evaluation for timely decision-making (Tandiono, 2023). However, despite widespread optimism, the integration of artificial intelligence into business processes poses many significant challenges for employers and employees. Although the complete abolition of the accounting profession is highly unlikely in the foreseeable future, failure to proactively adapt carries a significant risk of professional obsolescence of employees in the sense that they will have difficulty following new procedures and will lose previously acquired knowledge and skill (Novakovic, Milovanovic, & Kondic, 2025)). Namely, the ongoing Fourth Scientific and Technological Revolution requires professional reorientation, moving accounting roles closer to strategic and managerial supervisory functions.

As expected, the application of AI tools raises concerns about data privacy, security, and ethics (Beryl Odonkor et al., 2024). At the same time, the increased reliance on AI increases exposure to cyberattacks and data breaches, which raises concerns about data security (Yu, 2023). In this regard, the authors emphasize that working in an AI-dependent environment requires the establishment of strict protocols to protect sensitive financial information and ensure unwavering regulatory compliance (Zakaria, 2021). For BiH specifically, the accounting sector faces two pressures at once: the demand for digital transformation coinciding with the necessity of integrating complex new reporting mandates, such as the emerging challenges of ESG reporting (Grujić & Džombić, 2025).

The ethical dimensions must be carefully considered. Autonomous AI analysis and report generation invariably raise big questions of accountability, transparency, and fairness. A core unresolved issue remains: "Who is ultimately responsible for errors in AI-generated financial reports?" (Alghafiqi & Munajat, 2022). Maintaining the integrity and public trustworthiness of financial reporting depends entirely upon establishing robust ethical guidelines and institutional frameworks.

A key requirement is that AI systems must satisfy the criteria of Explainable AI (XAI), allowing users to fully comprehend the basis for the system's decisions. Potential algorithmic bias and discrimination inherently stem from the data used for training (Ferrara, 2023). Consequently, accountants must be equipped to spot and actively mitigate

bias through the deployment of impartial data sets and comprehensive audit procedures (Hussin et al., 2024). Trust and objective decision-making can't happen without significantly greater transparency in AI technologies (Kokina & Davenport, 2017).

These concerns necessitate the urgent formulation of clear regulatory standards (Alghafiqi & Munajat, 2022). Regulatory bodies are increasingly called upon to provide institutional support, specifically to address the disruptive impact of new technologies on financial statement standards and transparency. While nations like the UK and Singapore have proactively updated existing data protection legislation, BiH clearly lacks an adequate solution, resulting in a significant regulatory gap.

AI technology fundamentally changes the accountant's job profile. The core function is predicted to migrate towards advisory services, business development, and sophisticated risk management. The profession's long-term viability depends on its ability to effectively navigate these challenges and capitalize on AI opportunities, thus sustaining a crucial balance between advantage and risk (Beryl Odonkor et al., 2024).

In addition to all of the above, through radical changes, previously acquired skills of employees and the need to acquire new knowledge, titles and skills come under question. Accountants must now seamlessly blend traditional accounting knowledge with technological fluency; understanding and deploying AI tools is becoming an absolute requirement (Beryl Odonkor et al., 2024). Automation serves to free up staff to handle more complex, higher-value tasks (Millman & Hartwick, 1987) (Novaković et al., 2020). In this regard, in the near future, accountants will oversee, among other tasks, three areas: compliance with standards, strategic consulting, and management of robotic and automated systems (Jędrzejka, 2019),

Professionals are thus forced to cultivate advanced "soft skills," including superior communication, collaborative abilities, emotional intelligence, and innovative problem-solving capacities (Jędrzejka, 2019), (Howieson, 2003). These uniquely human competencies are less susceptible to technological replacement, giving a decisive human competitive edge. Concurrently, the demand for IT literacy, programming proficiency, and database design expertise is climbing rapidly (Rebele et al., 1998) The imperative to integrate information systems and technology into accounting pedagogy was recognized early in the digital era (Ahmed, 2003) (Vukovic et al., 2025), highlighting a persistent disconnect between academic preparation and market demands.

Paradoxically, the automation of low-skill, repetitive tasks will likely eliminate many entry-level accounting positions, thereby restricting the critical initial learning opportunities for new cohorts (Kokina & Davenport, 2017) (Jędrzejka, 2019),. This generates the paradox of expertise: professional mastery is achieved through experience, yet task transfer to AI may impede new employees from acquiring a granular business understanding. The Technology Dominance Theory posits that over-reliance on intelligent systems negatively impacts the organic development of human expertise and critical decision-making, potentially leading to a "deskilling" effect (Sutton et al., 2016)

Successful organizational adaptation requires a readiness to fully exploit the capabilities offered by AI (Lee & Tajudeen, 2020), including enhancing client service, deploying automation to reduce fraud, and realizing substantial labor efficiencies. Future scholarly work should aim to devise methodological frameworks to mitigate the "deskilling" effect, focusing on designing systems that actively foster skill development and knowledge accumulation (Jędrzejka, 2019), A hybrid methodology, which

synergistically combines neural and symbolic models, is proposed to encompass the entire spectrum of cognitive and computational requirements (Shabbir & Anwer, 2018). Crucially, regulators and professional bodies must proactively champion the adoption of intelligent technologies while simultaneously deepening the collective understanding of the associated intrinsic risks.

METHODOLOGY

The research is a combination of literature review and survey research. In the initial phase, a detailed analysis of the relevant scientific literature was conducted, using exclusively data from reputable journals indexed in the Web of Science and Scopus databases. The selection criteria emphasized highly cited papers published in the last decade (2015–2025), with a preference for original research articles. This stage facilitated the rigorous identification of convergences and divergences in findings among various authors, thereby establishing a comprehensive theoretical underpinning and context for investigating the impact of Artificial Intelligence on the accounting profession.

To empirically assess their readiness for and attitudes towards the integration of AI, a survey was conducted on 290 individuals currently employed in accounting positions across Bosnia and Herzegovina. The questionnaire collected extensive demographic data (age, gender, years of experience, education, location, professional position, monthly income, and company size), along with attitude questions that focused on perceived changes, risks, and overall impact of AI on their professional roles. Before final application, the survey was validated and refined based on feedback collected from the focus group, ensuring the clarity and relevance of all items. The survey was conducted using the Google Forms platform. Statistical analysis relied on descriptive statistics, while hypotheses were tested using t-tests and Analysis of Variance (ANOVA). The sample consisted of 176 women and 114 men, predominantly residents of Bosnia and Herzegovina.

This primary research aimed to accurately assess the perception, challenges and readiness of the accounting profession in BiH for the integration of artificial intelligence. Not all responses were considered.

Responses to where the control question showed an error were discarded. The age of the respondents ranged from 19 to 62 years, with an average age of 43.25 years and a median of 46 years. More than half of the respondents (more than 53.5%) stated that they had at least 20 years of work experience, and a significant share (30.7%) had over 30 years of experience. Almost all respondents (263 people) had a higher professional education (VSS) degree, which emphasizes the high level of education within the sample. The largest contingent of respondents was employed in large companies (139), and those working in medium-sized enterprises (118).

The methodology implemented for this research was fundamentally rooted in a quantitative approach, specifically designed for the empirical assessment of attitudes and readiness among professionals in the accounting and auditing sector in Bosnia and Herzegovina (BiH) toward the integration of Artificial Intelligence (AI).

The investigation adopted a cross-sectional survey design, where data were systematically collected at a single instance in July 2025 via a self-administered online questionnaire.

The target population was defined as all individuals practicing within the accounting and auditing profession in Bosnia and Herzegovina. Acknowledging the inherent difficulties in securing a complete and exhaustive sampling frame, a convenience sampling technique was employed. The questionnaire was disseminated through established professional social networks (specifically LinkedIn) and via direct, targeted outreach to key professional associations and relevant business entities throughout BiH.

A total of 270 responses were validated for inclusion in the study. The sample exhibited a clear dominance of women (approximately 76%), a distribution pattern acknowledged as representative of the feminization trend characterizing the accounting profession in BiH. Age diversity was also evident, spanning a wide range from 20 to 69 years, though the highest concentration of participants was observed within the 24 to 32 age range.

In terms of academic background, Higher Professional Education (VSS) was the predominant qualification, reported by nearly 90% of all respondents. Professional roles were most frequently represented by Certified Accountant (approximately 43%), Audit Assistant (around 21%), Accounting Assistant (around 16%), and Certified Auditor (around 14%).

The measurement instrument utilized was a standardized, strictly anonymous questionnaire, carefully developed following a detailed review of seminal scientific literature (Stein Smith, 2018) (Kokina & Davenport, 2017) (Beryl Odonkor et al., 2024).

The instrument was structured around the following categories of variables:

- Demographic Variables (Gender, Age, Education Level, Work Experience, Professional Position, and Company Size).
- AI Perceptions and Readiness (Items designed to measure self-assessed familiarity with AI and the proactive willingness to engage in professional development).
- Impact of AI (Measures for perceived benefits, such as accuracy, efficiency, and fraud mitigation, contrasted with perceived threats, including job displacement and the “deskilling” effect).
- Ethical and Regulatory Challenges (Variables capturing concerns related to data security, algorithmic bias, and the perceived adequacy of existing regulatory mechanisms).

The survey underwent rigorous pilot testing before its full launch. The questions were refined based on substantive feedback from the focus group to ensure absolute clarity and relevance. Furthermore, formal validation was conducted during the pilot phase, which included factor analysis and Cronbach’s alpha coefficient to ensure the instrument’s construct validity and internal consistency. All attitudes and perceptions were measured using a five-point Likert scale (ranging from 1 = Strongly disagree to 5 = Strongly agree).

Data processing and analysis were executed using the statistical software package SPSS. The analytical framework encompassed both descriptive statistics and hypothesis testing. Descriptive measures were used to summarize and characterize the fundamental aspects of the sample and key respondent perceptions (frequencies, percentages, arithmetic means/average scores, and standard deviations). Hypothesis testing was conducted to systematically evaluate the statistical significance of differences

in perceptions across defined demographic stratifications (gender, age, education). The following inferential methods were applied:

- T-tests: Utilized for comparing the mean scores between two independent groups (e.g., male versus female respondents).
- ANOVA (Analysis of Variance): Employed for comparing the mean scores across three or more independent groups (e.g., distinct age cohorts or various education levels).
- Correlation Analysis: Applied to examine and quantify the strength and direction of the relationship between key variables (e.g., familiarity with AI and willingness for professional development).

Our research design was two-fold: it combined a structured secondary analysis (the literature review) with primary research conducted via an online survey.

The research adopted a quantitative, cross-sectional design, meaning data was systematically collected at a single point in time via a self-administered questionnaire. Since securing a complete list of all accountants in BiH is nearly impossible, we used a convenience sampling technique. The questionnaire was shared through established professional networks (like LinkedIn) and via direct outreach to key professional associations and relevant business entities throughout BiH.

The sample showed a clear dominance of women (about 76%), a pattern that reflects the feminization trend in BiH's accounting profession. Age diversity was evident, ranging from 20 to 69 years, although most participants fell into the 24 to 32 age bracket.

In terms of academic background, Higher Professional Education (VSS) was the predominant qualification, reported by nearly 90% of all respondents. Professional roles were most frequently represented by Certified Accountant (about 43%), Audit Assistant (around 21%), Accounting Assistant (around 16%), and Certified Auditor (around 14%).

The standardized, anonymous questionnaire was carefully developed based on a detailed review of seminal scientific literature (Stein Smith, 2018), (Kokina & Davenport, 2017). Data processing and analysis were executed using the statistical software package SPSS. The instrument was structured around four main categories:

- Demographic Variables (Gender, Age, Education Level, Work Experience, Professional Position, and Company Size).
- AI Perceptions and Readiness (Measuring self-assessed familiarity with AI and willingness for professional development).
- Impact of AI (Gauging perceived benefits like accuracy and fraud mitigation, contrasted with perceived threats such as job displacement and "deskilling").
- Ethical and Regulatory Challenges (Capturing concerns related to data security, algorithmic bias, and the adequacy of existing regulations).

Our analytical framework included both descriptive statistics and hypothesis testing. Descriptive measures (frequencies, means, and standard deviations) were used to summarize the sample's fundamental characteristics and key perceptions. We applied the following inferential methods:

- T-tests: Used for comparing mean scores between two independent groups (e.g., male vs. female respondents).
- ANOVA (Analysis of Variance): Used for comparing mean scores across three or more independent groups (e.g., distinct age cohorts or various ed-

ucation levels).

- Correlational Analysis: Applied to examine and quantify the strength and direction of the relationship between key variables (e.g., familiarity with AI and willingness for professional development).

In this regard, hypothesis testing was systematically conducted to assess the statistical significance of differences in perceptions among defined demographic groups (gender, age, education).

RESEARCH RESULTS

The analysis of the data from the survey revealed a high level of awareness and proactive readiness among accounting experts in BiH. Respondents reported a strong level of self-assessed knowledge of artificial intelligence tools ($M=4.20$ on a 5-point scale). The linear equation is $y=0.0914x$ and R^2 is 0.8985, which means that it indicates a very strong positive relationship between the number of years and the results. This knowledge was consistent across genders and showed a moderate association with both higher income brackets and greater exposure to advanced technological resources. Furthermore, there is a consensus regarding the inevitable and growing importance of artificial intelligence in the business environment in BiH in the next five years, which is reflected in a very high average score ($M=4.43$). This strong belief permeates all demographic groups, showing no statistically significant variation based on gender or age. It is important to note that the readiness for continuous professional development was also very high ($M=4.21$), which emphasizes a strong individual motivation to adapt.

Regarding AI's potential to enhance corporate financial performance, professionals expressed a moderately positive, yet cautious, attitude ($M=3.23$). We observed significant variation across age groups: younger respondents demonstrated greater confidence in financial benefits (thus supporting Hypothesis H2), while their older counterparts remained more reserved. Interestingly, Master of Science holders and those in micro-enterprises reported the highest confidence, likely due to greater theoretical exposure and organizational agility, respectively.

The perceived operational impact and the transition of professional roles were more nuanced. There was moderate agreement ($M=3.44$) that AI makes financial data analysis faster and more efficient. Notably, male respondents reported a significantly higher level of agreement than female respondents, and increasing age tended to correlate with greater caution. A tempered optimism ($M=3.45$) exists concerning AI's capacity to mitigate risks like fraud and errors, although professionals clearly don't view AI as a definitive, risk-free cure-all. The assertion that AI significantly boosts absolute accuracy received only moderate agreement ($M=2.73$), indicative of an underlying cautiousness. Confidence in this area was high among the youngest professionals but notably lower across certain older and middle-aged groups.

Cautious optimism prevails regarding the potential of artificial intelligence to free accountants from routine tasks, which would enable the necessary transition to strategic activities ($M=3.38$). Age differences were particularly pronounced here, with high confidence observed in younger cohorts contrasting with significantly lower agreement among middle-aged and older groups, confirming an apparent generational gap.

The study found moderate levels of concern ($M=3.24$; $R^2 = 0.7079$; in men, the relationship between grade and number of years is $y = 0.0715x$ and $R^2 = 0.6966$, and in

women it is $y = 0.07x$ and $R^2 = 0.7079$.) regarding job loss, with female professionals expressing slightly higher levels of fear. Worryingly, younger age groups reported very high levels of concern, indicating the need for targeted support strategies for younger professionals entering the labor market. Given that age is an indicator of more work experience, or longer work experience, these results indicate that employers should focus on how to provide older employees with security and opportunities to learn and adapt to new technologies.

A significant finding is the paradox in skill perception: while there was a relatively low level of agreement ($M=2.38$) that AI will necessitate major fundamental changes in skills, this was contradicted by an overwhelmingly high level of agreement ($M=4.12$) that the loss of skills due to technology dependence - the “deskilling effect” - represents a real and serious threat. This dichotomy underscores a high awareness of the necessity to actively develop and sustain human competencies alongside technological integration.

The analysis highlighted several challenges. First, the perceived adequacy of existing ethical and regulatory frameworks received a low score ($M=2.48$), a finding that highlights the urgent need to update guidelines and legislation. Second, organizational commitment was found to be low. The extremely low average score ($M=1.97$) indicates that organizations are largely unwilling or unable to invest in training their employees for the application of AI. This low figure indicates a profound lack of educational strategy and represents a significant systemic barrier to competitiveness.

Finally, the survey yielded two contrasting findings in the ethical domain. A surprisingly low level of concern ($M=1.50$) was recorded regarding data security and privacy. This observation stands in stark opposition to global risk discussions and suggests potentially insufficient local awareness regarding the complexities and vulnerabilities inherent in AI systems. Conversely, a moderate level of concern ($M=3.07$) was registered regarding algorithmic bias, with female respondents expressing a statistically higher level of concern (thus supporting Hypothesis H3 regarding ethical sensitivity).

DISCUSSION

The research confirms the general stance in the literature that AI represents an unavoidable opportunity rather than a threat (Sutton et al., 2016), recognizing its pivotal role in increasing business value and firm performance (Wamba-Taguimdje et al., 2020). High self-assessed familiarity with AI tools ($M=4.20$) and exceptional readiness for professional development ($M=4.21$) point directly to the proactivity of individuals within the professional factor critical for future adaptation.

However, a key imbalance lies in systemic support. A very low level of agreement with the statement that organizations actively invest in training ($M=1.97$) creates a significant gap between the desires of professionals and the actual support provided by employers. This finding directly suggests that organizations in BiH are not actively supporting the transition, which may impede the synergy of “human ingenuity and intelligent automation”. This discrepancy indicates an alarming level of corporate short-termism, where AI is viewed as a costly overhead rather than a long-term productivity investment. The immediate need to comply with often-changing local regulations may be consuming training budgets, creating a “compliance trap” where spending is prioritized on current legal mandates over future competitive necessities.

This inertia jeopardizes the ability of BiH firms to realize the strategic benefits acknowledged by their own employees.

A significant paradox in skill perception was established. Professionals express a high awareness of the threat of “deskilling” (the loss of skills due to reliance on technology) ($M=4.12$), thereby confirming the predictions of the Technology Dominance Theory (Sutton et al., 2016). Simultaneously, they show a low level of agreement with the claim that AI will necessitate significant changes in skills ($M=2.38$). This finding suggests that professionals underestimate the depth of the transformation of the accountant’s role from a transaction processor to a strategic advisor. The high concern about deskilling (losing the “instinct” for basic accounting) is a powerful indicator that professionals fear losing the foundation of their expertise, but the low perceived need for skill shifts suggests they fail to grasp that the new core competence will be analytical validation and strategic interpretation—not just operation—of AI output. This lack of awareness regarding the need for fundamental skill shifts (towards analytical, communication, and advisory competencies) poses a substantial risk to the profession’s competitiveness. The future accountant must evolve from a master preparer of financial statements to a master interrogator of financial algorithms.

Furthermore, the low score on the perceived adequacy of ethical and regulatory frameworks ($M=2.48$) is an important finding. This finding, combined with moderate concerns about algorithmic bias ($M=3.07$) (which confirms hypothesis H3), highlights the need for regulatory intervention. This regulatory deficit creates a “black box” problem where accountability remains undefined. When an AI system makes a mistake or facilitates fraud, local legislation currently lacks the clarity to assign liability effectively (e.g., programmer vs. software owner vs. supervising accountant). The need to establish a “human-in-the-loop” principle, where final human oversight is mandatory and accountable, is therefore paramount. The analysis also showed that there is a low level of concern about data security and privacy ($M=1.50$), which contrasts with global discourse (Zakaria, 2021). This low score is particularly alarming and suggests a potential underestimation of the severity of risks associated with data governance in complex AI ecosystems, possibly due to a lack of exposure to large-scale data breaches or sophisticated cyber threats prevalent in more developed markets. These data point to a potential lack of understanding of the complexity and risks associated with AI systems among local experts. Without adequate investment in both technical safeguards and ethical training, the lack of regulatory clarity and the low perceived data risk combine to create a vulnerable environment for AI adoption.

CONCLUSION

The research successfully analyzed the readiness and attitudes of the accounting profession in Bosnia and Herzegovina toward AI integration. The findings affirm that AI is an unavoidable opportunity, with professionals highly motivated and prepared for personal development (supporting Hypothesis H1).

However, the biggest systemic challenge lies in the disconnect between high individual readiness and inadequate organizational and regulatory support. In particular, lack of investment in training and inadequate ethical and regulatory guidance represent key obstacles to an effective and ethical digital transformation of the accounting profession in BiH. Furthermore, the study reveals a critical paradox: while professionals

are highly concerned about skills depletion ($M=4.12$), they simultaneously underestimate the fundamental nature of the necessary skill shift towards strategic and analytical competencies. This finding highlights a vulnerability where accountants are aware of what they could lose but are less certain about what they need to gain. In addition, a significant generational and hierarchical difference was identified, with older professionals and operational staff (e.g., audit assistants) showing higher levels of fear of job loss, which is in sharp contrast to the strategic optimism of CFOs and younger cohorts.

The study has several limitations. Due to the convenience sampling methodology, the results primarily reflect the attitudes of respondents who were accessible and willing to participate, which limits the generalizability of the findings to the entire population of accountants and auditors in BiH. The self-administered survey method carries the risk of obtaining desirable responses and the possibility of an inaccurate or inconsistent understanding of all questions. Finally, the dynamic and rapid pace of AI technology means the results represent only a “snapshot” at a specific point in time.

To obtain a deeper and more comprehensive picture, further research is recommended. Future studies could include a larger and more diverse sample, focusing on specific segments of the profession (e.g., internal auditors). The application of qualitative methods is particularly recommended, such as in-depth interviews and focus groups with key stakeholders (CFOs, auditing firm managers) to gain more detailed insights into concrete adaptation strategies. It would also be beneficial to focus on longitudinal studies that track changes in perceptions and skills over an extended period.

For successful digital adaptation, key stakeholders must act decisively. Professional associations should urgently develop tailored Continuous Professional Development (CPD) programs focused on core AI competencies, such as data analytics, AI ethics, and essential soft skills. They must also employ targeted educational strategies to bridge the observed generational gap. Simultaneously, educational institutions must execute fundamental curriculum reform, integrating robust IT knowledge and programming skills to prepare future generations for strategic and advisory functions, thus actively countering the potential “deskilling” effect. At the organizational level, firms are required to significantly increase investment in AI training, moving decisively from a passive stance to a proactive approach, and actively encouraging technological experimentation. Finally, regulators and policymakers must prioritize establishing comprehensive ethical and regulatory frameworks for AI applications in accounting, dedicating specific attention to data protection, algorithmic transparency, and defining clear lines of accountability for errors, particularly by implementing a mandatory “human-in-the-loop” principle to ensure human responsibility remains central to the audit process.

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APPENDIX - Average answers by groups of examinees

Perceptions	Overall Mean	Men	Women	Secondary Education (SSS)	Higher Education (VSS)	Master of Science	Ph.D.	Micro Enterprise	Small Enterprise	Medium Enterprise	Large Enterprise	Accounting Assistant	Audit Assistant	Financial Director	Certified Auditor	Certified Accountant
Familiarity with AI tools.	4.2	4.22	4.19	4.08	4.19	4.5	4.17	4.11	4.22	4.22	4.13	4.27	4.18	4.21	4.2	
AI improves financial performance.	3.23	3.2	3.23	3.25	3.19	3.17	4	3.17	3.44	3.27	3.09	3.3	3.11	3.12	3.29	3.22
AI will be important in 5 years.	4.43	4.43	4.43	4.5	4.41	4.33	4.75	4.33	4.22	4.38	4.43	4.37	4.44	4.53	4.45	4.44
Readiness for skill development.	4.21	4.27	4.19	4	4.22	4.17	4.75	4	4.11	4.23	4.2	4.22	4.26	4.29	4.25	4.21
AI significantly increases accuracy.	2.73	2.67	2.74	3.17	2.7	2.67	2.5	2.67	2.33	2.62	2.82	2.6	2.68	3.29	2.75	2.71
AI enables faster/more efficient analysis.	3.44	3.86	3.37	4	3.42	5	3.5	3.67	3.22	3.38	3.37	3.45	3.61	3.76	3.5	3.43
AI reduces risk of fraud and errors.	3.45	2.86	3.55	3.75	3.43	3	2.25	3.67	3.44	3.46	3.42	3.62	3.58	3.06	3.15	2.79
AI frees up time for strategic activities.	3.38	3.36	3.38	4.25	3.33	2.25	3.75	3.67	3.78	3.15	3.4	3.43	3.68	3.41	3.63	3.39
Concern about job loss.	3.24	3.19	3.25	3.75	3.23	3.5	5	3.33	3.44	3.15	3.26	3.1	3.47	2.88	3.25	3.22
AI requires significant skill changes.	2.38	2.36	2.39	2.25	2.4	1.5	1	2	2.44	2.38	2.43	2.38	2.51	2.12	2.25	2.4
Concern about data security and privacy.	1.5	1.5	1.5	1.75	1.48	1.25	2	2	1.67	1.46	1.46	1.62	1.51	1.18	1.53	1.49
Concern about AI algorithm bias.	3.07	2.78	3.12	2.92	3.03	4	3.75	3.83	3	2.87	2.85	3.4	3.39	2.76	3.15	2.79
Organization invests in AI training.	1.97	2.08	1.95	2	1.98	1.5	2.25	1.67	1	2.05	1.99	1.88	1.96	2	1.82	2.06
Deskilling' effect is a real threat.	4.12	4.27	4.07	5	4.04	3	4	5	3.5	3.38	4.11	4.11	3.38	4	4.75	4.16
Existing ethical/regulatory frameworks are adequate.	2.48	2.78	2.43	2.33	2.46	2	2.75	3.67	2.11	2.26	2.45	2.38	2.4	3	3	2.31

Source: Processing of survey results

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ORIGINALNI NAUČNI RAD / ORIGINAL SCIENTIFIC PAPER

EMPIRICAL EVIDENCE ON THE RELATIONSHIP BETWEEN UNEMPLOYMENT AND ECONOMIC GROWTH IN CROATIA

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Abstract: *Okun's law is a valuable tool for understanding the relationship between economic growth and employment, but it should be adapted to the specific characteristics of the observed economy, including demographics, structural reforms, and the broader economic environment. The primary aim of this paper is to examine the relationship between unemployment and economic growth in Croatia. The analysis is based on quarterly time series data spanning from 2000Q1 to 2024Q4 and employs a range of analytical models, including first-difference and gap specifications, nonlinear autoregressive distributed lag (NARDL) models, and the Granger causality model, in order to capture the underlying complexity of the growth-unemployment nexus. Ultimately, the findings confirm that Okun's law remains a useful empirical tool, especially when applied as a gap model and during stable economic periods. However, its explanatory power weakens during times of economic turbulence, highlighting the need for flexible models capable of accommodating nonlinearities and structural breaks.*

Keywords: unemployment, Croatia, Okun law.

JEL Classification: F43

INTRODUCTION

The relationship between economic growth and unemployment has been at the center of economic research for decades. Unemployment negatively affects economic growth, public finance and standard of living (Šimčević, 2025). Croatia had significant milestones in the past decade, including successful entry into the European Union (EU) and the adoption of the euro, reflecting notable advancements in both the economy and society. Between 2012 and 2022, income *per capita* rose by over 40 percent, while labor force participation also increased, reaching nearly 70 percent by 2022 (Bartolini, 2024). However, looking ahead, emerging labor shortages may pose a challenge to sus-

taining economic growth. Another challenge is the expected rise of the unemployment rate which is projected to reach 4.6% in 2025 and 4.5% in 2026 as employment is set to decelerate in the future period (European Commission, 2025). Similarly, after having accelerated to 3.8% in 2024, Croatia's real gross domestic product (GDP) growth is projected to slow to around 3.0% on average in 2025 and 2026 (HNB, 2025).

Okun's law is a useful tool for understanding the relationship between economic growth and employment, but it needs to be adapted to the specificities of the Croatian economy, including demographics, structural reforms and the EU environment. The law is typically expressed in two forms: the "difference model" and the "gap model", each offering a different way of relating changes in the unemployment rate to changes in real GDP. In the difference version, the causality is primarily assumed to go from economic growth to changes in unemployment, with economic growth leading to higher labour demand and lower unemployment, and *vice versa*. In the gap version of Okun's law, the causal link typically runs from economic growth to unemployment, as positive output gaps lead to lower unemployment and negative output gaps lead to higher unemployment.

The main aim of the paper is to explore the relationship between unemployment and economic growth in Croatia by using the Okun law. Scientific contribution of the paper is in employing a diverse and rigorous econometric framework. The integrated approach, which combines linear, nonlinear, and time-varying analyses, sets a precedent for the empirical modelling of macroeconomic relationships and contributes to the design of responsive and resilient economic policies. The overarching objective of this study was to examine how variations in economic output correlate with changes in unemployment, and whether this relationship exhibits asymmetry, temporal instability, or is susceptible to disruption by structural economic shocks. First-difference models were employed to analyze short-term fluctuations by differencing the time series, thereby addressing the issue of nonstationarity. In contrast, the gap models employed Hodrick-Prescott filtered data to isolate cyclical components, enabling a more nuanced investigation of deviations from potential output and natural unemployment levels. Furthermore, the nonlinear autoregressive distributed lag (NARDL) approach was utilized to explore potential asymmetries in the relationship, particularly focusing on whether unemployment responds differently to positive and negative output shocks in both the short and long term. The research also used the Bai-Perron structural break methodology and finally, static and time varying Granger causality tests to get insight into the dynamic relationship between economic growth and unemployment, as well as between the output gap and unemployment gap.

The structure of the paper is as follows. After the introduction follows the literature review regarding empirical studies testing the Okun law. Then, methodology and data used are described after which results are explained. The paper ends with the conclusion.

LITERATURE REVIEW

Recent empirical studies employing quarterly data provide a nuanced understanding of the output–unemployment relationship as conceptualized in Okun's law, particularly emphasizing the importance of asymmetry and regional variation.

(Singh, Nurudeen, 2022) used the OLS estimator to test Okun's law, and also the generalized method of moments (GMM) estimator, incorporating the first lag of both

unemployment and GDP as instrumental variables. They proved the validity of the Law. Similarly, (Soylu, Çakmak, Okur, 2018) examine the applicability of Okun's law in eight Eastern European countries over the period from 1992 to 2014, using a panel data framework. The study results show that a 1% increase in GDP leads to a 0.08% decrease in the unemployment rate.

In Serbia, (Mihajlović, 2021) applies both linear ARDL and nonlinear ARDL models using quarterly data from 2008 to 2019. The results affirm the existence of a significant long-run cointegration between GDP and unemployment and uncover pronounced asymmetries - output contractions have a stronger and more persistent impact on job losses than expansions do on job gains. These findings support asymmetric policy interventions. Similarly, (Sere and Tchereni, 2020) utilize a NARDL model with South African data from 1994 to 2019 and report strong evidence of asymmetry. They find that negative GDP shocks significantly increase unemployment, whereas positive growth has a weaker employment effect, confirming the presence of labour market rigidities and the necessity for targeted reforms.

South African studies further validate these insights but underscore regional differences (Stungwa and Siphuxolo, 2022), using the ARDL bounds testing method over the period 2000–2020, confirm Okun's law in both the short and long run but highlight that the coefficient estimates are relatively modest. This suggests that growth alone cannot sufficiently reduce unemployment without structural reforms. At the subnational level, (Omoshoro-Jones, 2021) focuses on the Free State Province and employs a NARDL model on cyclical data from 2008 to 2019. The results again point to a clear asymmetry, with unemployment rising faster in recessions than it falls during expansions. The evidence lends empirical support to "labour hoarding" and the "loss aversion" hypothesis, strengthening the case for asymmetric modelling.

In Chile, (Navarro, 2023) also adopts the NARDL framework and examines quarterly data from 1996 to 2019. The study identifies both long-run and short-run asymmetries, revealing that unemployment reacts more severely to negative than to positive output shocks. This suggests that labour markets in Latin American economies with structural dualities may exhibit similar dynamics to their African counterparts.

Collectively, these studies demonstrate that Okun's law holds under asymmetric conditions across diverse political and economic systems, be it the emerging democracy of Serbia, the upper-middle-income economy of South Africa, or the export-oriented market economy of Chile. While traditional linear models confirm the presence of a negative relationship, the NARDL approach consistently reveals deeper insights into the asymmetric behavior of unemployment in response to economic fluctuations.

METHODOLOGY AND DATA

Data description

Quarterly data for the real gross domestic product *per capita* (GDP) and unemployment rates (UR) in Croatia are available since 2000Q1 until 2024Q4 (GDP *per capita*) and from 2002Q1 until 2024Q4 for unemployment rates. The sample consists of 92 quarterly data points. Variable acronyms and data sources are given in Table 1.

Table 1. Variables definition

Variable	Description	Source
GDP	Gross domestic product	Eurostat
LGDP	Natural logarithm of GDP	Eurostat
DLGDP	The first difference of the LGDP series.	Eurostat
UR	Unemployed persons aged 15 to 74 years	Eurostat
DUR	The first difference of the UR series	Eurostat

Source: authors

Description of the methodology

Okun's law is not a strict, deterministic rule, but rather an approximation that varies by country, time, and specific economic conditions. The relationship also depends on structural factors in the economy, including productivity levels, labour force participation, technological change, and the degree of labour market flexibility. While Okun's law is primarily observed as a short-term empirical correlation, it plays an essential role in understanding how fluctuations in the labour market might influence economic activity and vice versa.

According to the first-difference model, the relationship between the natural logarithm of output (GDP) and the unemployment rate (UR) is analysed within the framework of the following function:

$$UR_t - UR_{t-1} = \alpha + \beta(GDP_t - GDP_{t-1}) + \varepsilon_t \quad (1)$$

where GDP_t is the natural logarithm of the real GDP in quarter $t = 1, 2, \dots, T$, UR_t is the unemployment rate, α indicates the long-term unemployment rate resulting from structural characteristics of the labour markets, Okun's coefficient β represents the elasticity of the unemployment rate about output and ε_t is a white-noise disturbance term. However, as with the gap version of Okun's law, there is an alternative possibility: unemployment may affect economic growth. From a supply-side perspective, high levels of unemployment represent unused labour capacity, which can hinder potential output.

According to this version of the first-difference model, the relationship between the natural logarithm of output (GDP) and the unemployment rate (UR) is analysed within the framework of the following function:

$$GDP_t - GDP_{t-1} = \alpha + \beta(UR_t - UR_{t-1}) + \varepsilon_t \quad (2)$$

where GDP_t is the natural logarithm of the real GDP in quarter $t = 1, 2, \dots, T$, UR_t is the unemployment rate and ε_t is a white-noise disturbance term.

In terms of Okun's law, economic growth and changes in employment are tightly linked because both are driven by aggregate demand. When economic activity picks up, firms increase their output in response to growing demand, which requires more labour. This positive relationship between output and labour demand leads to lower unemployment. As such, economic growth is considered the main driver of employment changes in this model. Standard version of Okun's law is a gap equation which is given by:

$$UR_t - UR_t^* = \beta(GDP_t - GDP_t^*) + \varepsilon_t, \quad t = 1, 2, \dots, T \quad (3)$$

where GDP_t is a natural logarithm of the real GDP in quarter $t = 1, 2, \dots, T$, UR_t is the unemployment rate, GDP_t^* and UR_t^* are the corresponding potential values and ε_t is a white-noise disturbance term. The parameter β ($\beta < 0$) is known as the Okun coefficient and indicates changes in unemployment rate caused by changes in real output. Potential values of real GDP and equilibrium values of unemployment, i.e. natural rate of unemployment, are not directly observable. While the gap version of Okun's law typically emphasises, the causality running from economic growth to unemployment, there are theoretical grounds to consider the possibility that the reverse causality could occur, with changes in unemployment affecting economic growth. The reverse causality argument posits that high unemployment may negatively impact economic growth. High unemployment reduces overall income levels, which, in turn, reduces aggregate demand in the economy. As the unemployed population spends less due to a lack of income, firms experience lower sales, which can dampen economic growth. This mechanism suggests that changes in the labour market can influence the overall economy, thereby affecting future output.

From this viewpoint, high unemployment could also represent structural issues in the labour market (such as skill mismatches or wage rigidities), which can hamper the growth potential of the economy. This would indicate that unemployment acts as a drag on growth by reducing labour market efficiency and inhibiting optimal utilisation of resources.

A gap equation in this version of Okun's law is given by:

$$GDP_t - GDP_t^* = \beta(UR_t - UR_t^*) + \varepsilon_t, \quad t = 1, 2, \dots, T \quad (4)$$

As stated before, GDP_t is a natural logarithm of the real GDP in quarter $t = 1, 2, \dots, T$, UR_t is the unemployment rate, GDP_t^* and UR_t^* are the corresponding potential values and ε_t is a white-noise disturbance term. The parameter β ($\beta < 0$) is known as the Okun coefficient and indicates changes in real output caused by changes in unemployment rate. Potential values of real GDP and equilibrium values of unemployment, i.e. natural rate of unemployment, are not directly observable.

Overall, the research methodology was structured to encompass both linear and nonlinear dynamics. Seasonally adjusted series were used to ensure the GDP and unemployment data reflect true economic signals, not just calendar effects. As explained, first-difference models were deployed to analyze short-term fluctuations by differencing the time series, thereby addressing the issue of nonstationary, which is frequently encountered in macroeconomic datasets. In contrast, the gap models employed Hodrick-Prescott (HP) filtered data to isolate cyclical components, enabling a more nuanced investigation of deviations from potential output and natural unemployment levels. Furthermore, the NARDL approach was utilized to explore potential asymmetries in the relationship, particularly focusing on whether unemployment responds differently to positive and negative output shocks in both the short and long term. To decide on the appropriate NARDL model the so-called general-to specific approach was used, which is grounded in the principle of starting with a statistically and theoretically rich general model and then simplifying it through systematic testing (Hend-

ry, Doornik, 2014). The study also adopted Bai-Perron structural break methodology, which allowed the identification and estimation of Okun's coefficients within distinct macroeconomic regimes. This segmentation was critical in assessing how economic crises and recoveries influenced the empirical validity of Okun's law.

A battery of statistical techniques supported the analytical framework. Unit root tests including Elliot, Rothenberg and Stock Point Optimal test (DF-GLS) (Elliott, Rothenberg, Stock, 1996), KPSS (Kwiatkowski, Phillips, Schmidt, Shin, 1992), ZA test (Zivot, Andrews, 1992) and Clemente–Montañés–Reyes test (CMR) (Clemente, Montañés, Reyes, 1998) were conducted to ascertain the integration properties of the variables. Cointegration was assessed using Engle-Granger test (Engle, Granger, 1987), Johansen test (Johansen, 1988), Gregory-Hansen (Gregory, Hansen, 1996) test with breaks, Bayer-Hanck meta-tests (Bayer, Hanck, 2013), and ARDL-based bounds testing approach. Diagnostic evaluations such as the Breusch-Godfrey serial correlation LM test, heteroscedasticity tests, Jarque-Bera test for normality, Ramsey RESET test for functional form, and CUSUM and CUSUMSQ tests for model stability were conducted to validate the reliability of the estimated models. Dummy variables representing structural disruptions such as the 2009 global financial crisis and the COVID-19 pandemic in 2020 were incorporated to control for the effects of extreme economic events. The main results are discussed in the following section, however, additional tables with detailed results are in the Appendix. Empirical analysis was conducted in Stata 15, EViews 10 and R4.4.3.

EMPIRICAL RESULTS

Unit root tests

The comprehensive battery of unit root and structural break tests is used, including DF-GLS, KPSS, ZA, CMR, the Bai & Perron (BP) and Ditzgen-Karavias-Westerlund (DKW) procedures, as it provides a nuanced and robust understanding of the time series properties of the core macroeconomic variables relevant to Okun's law: real GDP (log-transformed), the unemployment rate, the output gap, and the unemployment gap. These tests, applied in both levels and first differences, along with models that allow for structural breaks, collectively help determine the most appropriate specification for modelling the dynamic relationship between economic growth and unemployment.

Table 2. Summary of the unit root tests outcomes

Variable	DF-GLS Result	KPSS Result	Conclusion
LGDP	Non-stationary	Reject level & trend	I(1)
DLGDP	Stationary	Accept stationarity	I(0)
UR	Non-stationary	Reject level & trend	I(1)
DUR	Stationary	Accept stationarity	I(0)
Output Gap	Stationary	Accept stationarity	I(0)
DOutput Gap	Stationary	Accept stationarity	I(0)
Unemployment Gap	Stationary	Accept stationarity	I(0)
DUnemployment Gap	Stationary	Accept stationarity	I(0)

Source: authors. Note: "D" indicates the first difference of the time series.

Overall, the evidence strongly supports the use of first-difference models and gap models in the empirical analysis of Okun's law. The first-difference model captures short-run movements and avoids nonstationarity-related misspecification, while the gap model leverages stationary measures of cyclical deviations from potential output and the natural unemployment rate. If later analysis identifies a cointegrating relationship between GDP and unemployment, an error correction model (ECM) or vector error correction model (VECM) may also be appropriate to capture both the long-run equilibrium and short-run adjustments.

The KPSS test, which reverses the null hypothesis by assuming stationarity, complements the DF-GLS results. For LGDP and UR in level form, KPSS test statistics exceed critical values, especially under the no-trend (drift) specification indicating a rejection of stationarity and thus supporting the $I(1)$ classification. Conversely, the first-differenced series have test statistics well below critical values, consistent with stationarity. For the output gap and unemployment gap, the KPSS test provides strong support for stationarity in both drift and trend specifications, which aligns well with the DF-GLS outcomes.

Traditional unit root tests, such as the DF-GLS and KPSS tests, assume a constant mean and variance over time. However, real-world economic time series often exhibit structural breaks, abrupt changes in the data-generating process due to events like policy shifts or economic crises. Ignoring these breaks can lead to misleading conclusions about the stationarity of a series. To address this issue, several unit root tests have been developed to account for structural breaks (see Appendix)

Under ZA tests, LGDP and UR still fail to reject the unit root null even when allowing for breaks, with test statistics not surpassing 10% critical values in any specification. This indicates that these series remain non-stationary even when accounting for potential structural shifts. In contrast, first-differenced LGDP and UR show strong stationarity with statistically significant breakpoints, often around 2008–2015, coinciding with the global financial crisis and its aftermath. For the gap series, ZA tests reveal borderline outcomes: while output and unemployment gaps show some signs of stationarity, break-adjusted models still tend to classify them as $I(0)$, particularly in first-differences, indicating robustness.

CMR test allows two structural breaks in the intercept and trend (Table 9). Using both the additive outlier (AO) and innovative outlier (IO) models, the CMR tests overwhelmingly reject the unit root null for all series in first differences, and for the gap series in levels. For LGDP and UR in levels, the IO model provides critical insight: breaks identified in 2008–2020 represent meaningful economic shifts that alter the statistical properties of these variables. Importantly, the AO model, which captures sudden, transitory shocks (such as financial crises or pandemics), also indicates non-stationarity in level LGDP and UR, reinforcing the idea that these variables evolve through distinct regimes or structural phases. The gap variables: output gap and unemployment gap, are confirmed to be stationary under both the AO and IO specifications, with structural breaks often located around crisis episodes. This is consistent with their construction as deviations from trend and their sensitivity to macroeconomic cycles.

The structural break analysis is reinforced and expanded through the Bai-Perron (Bai, Perron, 1998) and DKW sequential procedures. These tests detect multiple breakpoints in the time series relationships between variables (Tables 7, 8). The

LGDP–UR system is found to have at least three and possibly up to five structural breaks. Estimated breakpoints occur in 2005Q1, 2011Q1, and 2021Q3, coinciding with significant economic events such as the pre-GFC build-up, post-crisis recovery, and the COVID-19 pandemic. The sequential F -statistics support multiple structural breaks at high significance levels, indicating instability in the Okun's law relationship when specified using level variables. Conversely, the model using gap variables shows fewer and less significant structural breaks, especially when the output gap is the dependent variable. This suggests that the gap model specification is more stable over time, and potentially more suitable for long-run macroeconomic modelling.

The integration of unit root and structural break tests highlights that stationarity and structural stability are more likely when Okun's law is modelled using gap specifications rather than levels. This supports the preference for gap models in empirical applications, especially when dealing with small samples or macroeconomic data prone to shocks. However, if level models are used, it is essential to incorporate structural breaks explicitly to avoid misleading inferences. Combining filtered data (e.g., HP-filtered gaps) with robust structural break tests enhances both the explanatory power and the empirical validity of Okun's law in modern macroeconomic analysis.

Cointegration tests

Cointegration is a crucial concept in time series analysis, particularly when dealing with economic variables that exhibit long-term equilibrium relationships. The analysis of the long-run relationship between output and unemployment within the framework of Okun's law was carried out using a comprehensive suite of cointegration tests, including the Engle-Granger two-step procedure, the Gregory-Hansen test for structural breaks, the Johansen maximum likelihood approach, and the Bayer-Hanck combined cointegration framework. This multifaceted strategy allowed for a robust assessment of cointegration dynamics, accounting for both structural shifts and varying lag structures.

Evidence strongly favors the presence of a cointegration relationship between output gap and unemployment gap, while the results for first-differences of the series LGDP and UR are more mixed and specification-dependent. The Bayer-Hanck tests point to a likely cointegrating relationship in the level model, especially when appropriate lag length and structural breaks are accounted for (Table 3). In contrast, the Engle-Granger and Johansen tests remain non supportive, likely due to their lower power in finite samples and structural instability (Table 4).

Table 3. Bayer-Hanck cointegration test

Model	Test		
	EG-JOH	EG-JOH-BO-BDM	Cointegration
	With constant		
LGDP = $f(\text{UR})$	5.24	5.49	No
UR = $f(\text{LGDP})$	7.01	22.18	Yes
Output gap = $f(\text{Unemployment gap})$	19.17	39.98	Yes
Unemployment gap = $f(\text{Output gap})$	14.37	34.23	Yes

With constant and trend			
LGDP = f(UR)	4.20	4.87	No
UR = f(LGDP)	4.85	15.51	No
Output gap = f(Unemployment gap)	14.10	28.52	Yes
Unemployment gap = f(Output gap)	10.27	24.68	No Yes

Source: authors. Note: Critical values for the 5% significance level for the model with a constant: EG-JOH: 11.229 and EG-JOH-BO-BDM: 21.931, and for the model with a constant and trend: EG-JOH: 11.269 and EG-JOH-BO-BDM: 22.215. The model was expanded with 8 lags.

Eagle-Granger test results (Table 4) show Z-statistics and tau-statistics for both variables fail to exceed the critical thresholds at the 5% significance level, with values such as -6.33 and -1.86 for LGDP and -6.40 and -1.85 for UR under the constant-only specification, and similarly non-significant outcomes under the trend-inclusive version. These results suggest that GDP and unemployment in levels do not share a stable long-run equilibrium relationship over the sample period. In contrast, strong evidence of cointegration is found for the output gap and unemployment gap pairs, regardless of the deterministic components included. The Z-statistics for the output gap (-57.90) and unemployment gap (-19.95), along with their respective tau-statistics (-5.32 and -3.32), decisively reject the null hypothesis of no cointegration. These findings support the presence of a stable long-run relationship in the gap formulation of Okun's law, aligning with theoretical expectations and affirming the usefulness of filtered series in capturing equilibrium dynamics.

Table 4. Engle-Granger cointegration tests

Dependent variable	Z-statistic	Decision	tau-statistic	Decision
With a constant as an additional regressor				
LGDP	-6.33	Not cointegrated	-1.86	Not cointegrated
UR	-6.40	Not cointegrated	-1.85	Not cointegrated
Output gap	-57.90	Cointegrated	-5.32	Cointegrated
Unemployment gap	-19.95	Cointegrated	-3.32	Cointegrated
With trend as an additional regressor				
LGDP	-15.70	Not cointegrated	-2.88	Not cointegrated
UR	-13.11	Not cointegrated	-2.66	Not cointegrated
Output gap	-57.98	Cointegrated	-5.32	Cointegrated
Unemployment gap	-19.96	Cointegrated	-3.32	Cointegrated

Source: authors. Note: Number of lags in the Augmented Engle-Granger cointegration test is decided based on an automatic lags specification based on Schwarz criterion. "Decision" means a decision about cointegration relationship made at the 5% significance level. Critical values from MacKinnon (1996).

For the first-difference models (LGDP and UR), the absence of cointegration implies that changes in GDP and unemployment are not linked through a long-term equilibrium mechanism (Table 12), and as such, ARDL or NARDL models estimated

in levels may suffer from spurious regression risks. Instead, the modeling should focus on short-run dynamics e.g., estimating dynamic OLS or standard autoregressive distributed lag models in first differences without imposing error correction structures.

In contrast, the gap model version of Okun's law is supported by strong statistical evidence of cointegration. Comparative analysis of ARDL models of Okun's law in gap form (Table 13) reveals that while both the output gap and unemployment gap specifications yield valid long-run relationships, the unemployment gap models are generally more robust and statistically significant. This validates the use of VECM or error-correction-based ARDL and NARDL models to capture both short- and long-run dynamics between the cyclical components of GDP and unemployment. The presence of a cointegrating relationship suggests that deviations between output and unemployment gaps are mean-reverting over time, in line with theoretical expectations of macroeconomic equilibrium.

The NARDL model is grounded in the cointegration theory and is particularly useful when modelling relationships between economic variables that may exhibit nonlinearities. Based on the results of estimated NARDL models (Tables 14, 15) an extensive evaluation and comparison were conducted to assess the robustness, asymmetries, and theoretical consistency of the empirical relationships between unemployment and GDP in Croatia.

As was the case with the linear ARDL models where LGDP was specified as the dependent variable, the NARDL estimation results also failed to provide evidence of cointegration in most specifications. In these models, the F -statistics and t -statistics from the bounds tests consistently fell below the lower critical values at standard significance levels, indicating the absence of a long-run equilibrium relationship. Moreover, all NARDL models with economic growth as the dependent variable exhibited signs of model instability. Residual diagnostics revealed violations of key assumptions, including non-normality and misspecification of the functional form. The in-sample explanatory power of these models was also extremely weak, with adjusted R^2 values ranging only from 0.02 to 0.14, suggesting poor model fit. Even attempts to improve model performance by increasing the number of lags included in the specification did not yield meaningful improvements. Given these deficiencies, the results for these models were not reported.

The comparative analysis of the four NARDL models underscores the superiority of the first-difference specification in modelling the empirical relationship between GDP and unemployment. These models not only provide stronger evidence for cointegration and dynamic adjustment but also validate the presence of asymmetric responses that carry important policy implications. The gap models, while theoretically appealing, fall short in capturing these nuances and appear to be more sensitive to measurement issues and structural model limitations. Thus, for empirical testing of Okun's law and associated labor market hypotheses, the first-difference NARDL models offer a more robust and interpretable framework (Table 14).

Granger causality tests

Toda–Yamamoto procedure (Toda, Yamamoto, 1995) is applied to both the levels and first-differences of the series related to Okun's law: LGDP and UR, as well as output gap and unemployment gap. This dual approach allows us to examine both

the original variables and their cyclical components for directional predictability, while mitigating the risk of spurious results due to nonstationarity or omitted structural breaks. While traditional static Granger causality tests provide a method to assess whether one variable helps to predict another, these approaches assume that the relationship is stable over time. Economic relationships often evolve due to structural changes, regime shifts, and shocks such as financial crises or pandemics. To address this limitation, (Shi, Phillips, Hurn, 2018) introduced a novel class of Time-Varying Granger Causality (TVGC) tests, based on moving and recursive Wald test statistics.

Firstly, the results of the static Granger causality test based on the Toda-Yamamoto approach are shown in Table 5.

Table 5. Granger causality tests – Toda-Yamamoto approach

Causality direction	Chi-square statistic	P-value	Causality
LGDP → UR	18.71	<.01	Yes
UR → LGDP	0.91	.92	No
Output gap → Unemployment gap	22.71	<.01	Yes
Unemployment gap → Output gap	2.23	.69	No

Source: authors. Note: The VAR(4) model was used.

The conventional VAR-based Granger causality tests provide evidence of a uni-directional causal relationship between economic growth and unemployment. When the dependent variable is LGDP, the test fails to reject the null hypothesis that UR does not Granger-cause LGDP, with a *P*-value of .92. This suggests no evidence that changes in the unemployment rate help predict GDP in the linear VAR framework. However, when the dependent variable is UR, the results are quite the opposite: the null hypothesis that LGDP does not Granger-cause UR is strongly rejected with a Chi-squared statistic of 18.71 and a *P*-value of <.01. This indicates that GDP is a significant predictor of unemployment.

Similarly, in the gap version using the output gap and unemployment gap derived from the HP filter, the pattern holds. The output gap does not appear to be Granger-caused by the unemployment gap (*P*-value = .69), but the unemployment gap is strongly Granger-caused by the output gap (Chi-squared = 22.71, *P*-value = <.01). These findings are fully consistent with the traditional formulation of Okun's law, which posits that changes in GDP (or output gap) lead to changes in the unemployment rate (or unemployment gap), not the other way around.

The time-varying Granger causality tests provide a more flexible framework (Table 6). For the pair LGDP → UR, all three test statistics exceed the 99th percentile critical values from bootstrap replications, strongly rejecting the null hypothesis of no Granger causality throughout the sample. This reinforces the earlier finding with static Granger causality test that GDP Granger-causes unemployment, but importantly, confirms that this causality is robust even under time variation and structural uncertainty.

Table 6. Time-varying LA-VAR Granger causality test

Causality direction	Max Wald forward	Max Wald rolling	Max Wald recursive	Causality
LGDP → UR	21.98	141.52	141.52	Yes
90 th percentile	12.33	11.69	13.05	
95 th percentile	13.54	14.69	15.21	
99 th percentile	18.39	19.56	19.72	
UR → LGDP	8.92	158.09	158.09	No (1) Yes (2)
90 th percentile	10.24	10.60	11.04	
95 th percentile	13.01	12.22	14.00	
99 th percentile	21.25	21.79	21.86	
Output gap → Unemployment gap	41.80	163.02	163.02	Yes
90 th percentile	16.30	15.55	16.47	
95 th percentile	21.43	20.97	21.43	
99 th percentile	34.46	35.41	35.41	
Unemployment gap → Output gap	15.17	142.37	142.37	Margin Yes (2)
90 th percentile	8.47	8.23	8.54	
95 th percentile	10.58	10.43	10.58	
99 th percentile	15.35	14.63	15.35	

Source: authors. Note: 90th, 95th and 99th percentiles of test statistics (199 replication in the bootstrap procedure)

Based on the Granger causality test results and the time-varying Granger causality tests, several key insights can be derived on the dynamic relationship between economic growth (as measured by the log of seasonally adjusted GDP, LGDP) and unemployment (UR), as well as between the output gap and unemployment gap. These insights are critical for understanding the validity of Okun's law and the directionality of influence between these macroeconomic indicators.

Both test frameworks consistently show unidirectional Granger causality from GDP or output gap to unemployment or unemployment gap. This lends strong empirical support to Okun's law in its predictive form, where output dynamics lead labour market changes. The time-varying tests enhance the interpretation by confirming that this relationship is not merely a full-sample artifact but persists even when allowing for changes in the underlying structure of the data.

These findings are not only consistent with Okun's law but also provide deeper insights into its temporal behaviour. By confirming that GDP leads unemployment across multiple test frameworks and under time-varying conditions, we gain greater confidence in using output as a predictor for labour market outcomes. This has important implications for macroeconomic forecasting and policy evaluation, particularly in times of economic upheaval. Additionally, the robustness of the gap-based relationship underscores the value of filtering techniques (such as the HP filter) in enhancing signal extraction for business cycle analysis.

CONCLUSION

This paper researched the applicability and dynamics of Okun's law in Croatia by employing a diverse and rigorous econometric framework. The overarching objective was to examine how variations in economic output correlate with changes in unemployment and whether this relationship exhibits characteristics of asymmetry, temporal instability, or is subject to disruption by structural economic shocks. The study utilised quarterly data from 2000 to 2024.

The empirical findings revealed a complex and nuanced relationship between GDP and unemployment. The Bayer-Hanck tests point to a likely cointegrating relationship in the level model, especially when appropriate lag length and structural breaks are accounted for. In contrast, the Engle-Granger and Johansen tests remain non supportive, even when structural breaks and dummy variables were accounted for. This absence of a long-run equilibrium relationship suggests that Okun's law may be more appropriately interpreted as a short-run association within this context.

First-difference models offered partial support for the Okun's law, with some specifications yielding statistically significant negative coefficients, indicative of the inverse relationship expected by theory. However, the explanatory power of these models was modest, with adjusted R-squared values around 0.04. Interestingly, the reverse model, where unemployment drove GDP changes, demonstrated stronger statistical properties with an adjusted R-squared of approximately 0.70, though this direction of causality contradicts the theoretical underpinnings of the law.

The gap models provided more robust and consistent evidence in support of Okun's law. The presence of a cointegrating relationship suggests that deviations between output and unemployment gaps are mean-reverting over time, in line with theoretical expectations of macroeconomic equilibrium. In these models, the coefficient linking the unemployment gap to the output gap was statistically significant and negative, with values around -0.85, suggesting a strong inverse relationship. The adjusted R-squared values for these models were substantially higher, approximating 0.65, indicating a better overall model fit. Furthermore, incorporating dummy variables for the pandemic quarters in 2020 effectively controlled for the transitory shocks introduced by COVID-19, thereby improving model stability and interpretability. These results affirm that the gap model specification is superior for capturing the cyclical dimensions of the Okun relationship in the Croatian economy.

The NARDL models illuminated critical asymmetries in the output-unemployment relationship. Specifically, the models revealed that negative output gaps had a more pronounced effect in increasing unemployment than positive output gaps had in reducing it. The combination of static and time-varying Granger causality tests offered a comprehensive assessment of the GDP and unemployment dynamic. While static tests confirm the basic predictive structure proposed by Okun, the time-varying methods validate its resilience across changing economic environments. Together, they make a strong case for the directionality of Okun's law and highlight the utility of modern time series tools in validating macroeconomic theory under real-world conditions.

From a policy standpoint, these findings offer several important implications. First, the output gap should be employed as a leading indicator in economic surveillance to anticipate movements in the labour market. Policymakers should design and implement counter-cyclical employment measures that respond proactively to down-

turns by preserving jobs and stimulating hiring. During recessions, wage subsidies, temporary tax relief for employers, and public infrastructure projects can help stabilise employment. Conversely, in expansionary periods, investments in workforce skills (e.g. in vocational education to fill skill gaps) and mobility can ensure that labour supply keeps pace with demand, preventing inflationary bottlenecks and skill mismatches. Policymakers should also consider automatic stabilisers (e.g., progressive unemployment insurance, emergency re-employment support) that adjust without delay in response to changing economic conditions. The gap models' superior performance reinforces the importance of distinguishing between trend and cyclical components of economic activity. This understanding is crucial in designing effective fiscal and labour market policies. For instance, a temporary output gap may not warrant structural policy changes, while a persistent unemployment gap might necessitate long-term interventions in education, training, or regional development. Policymakers and economists must interpret Okun's coefficients with caution and supplement them with broader macroeconomic indicators and contextual knowledge.

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Appendix - Table 7. Ditzen, Karavias & Westerlund break points procedure

Test	Test statistic				Bai & Perron critical values		
	(1)	(2)	(3)	(4)	1%	5%	10%
UDmax	203.82	99.17	5.60	31.41	12.37	8.88	7.46
$F(1 0)$	141.29	70.53	5.54	22.74	12.29	8.58	7.04
$F(2 1)$	100.75	16.81	4.43	16.13	13.89	10.13	8.51
$F(3 2)$	17.44	15.55	8.98	34.76	14.80	11.14	9.41
$F(4 3)$	7.12	9.92	3.69	6.51	15.28	11.83	10.04
$F(5 4)$	20.88	8.14	3.94	14.33	15.76	12.25	10.58
Number of breaks:							
(min)	3 (all)	3 (all)	na	3 (all)			
(max)	5 (all)	3 (all)	na	5 (all)			
Break points	2005Q1	2011Q1	na	2008Q4			
	2011Q1	2017Q2		2012Q1			
	2021Q3	2020Q4		2019Q4			
95% CI	[2001, 2024]	[2010Q1, 2012Q1]	na	[2008Q3, 2009Q1]			
	[2001, 2024]	[2016Q2, 2018Q2]		[2011Q4, 2012Q2]			
		[2014Q4, 2026Q4]		[2019Q3, 2020Q1]			

Source: authors. Note: UDmax test for multiple breaks at unknown breakdates (Bai & Perron, 1998), H0: no break(s) vs. H1: $1 \leq s \leq 5$ break(s); DKW test: The detected number of breaks indicates the highest number of breaks for which the null hypothesis is rejected. (1) LGDP, UR; (2) UR, LGDP; (3) Output gap, Unemployment gap; (4) Unemployment gap, Output gap.

Table 8. Zivot-Andrews unit root tests with one endogenous break

Series	Intercept			Trend			Both		
	stat	TB	Decision	stat	TB	Decision	stat	TB	Decision
Level									
LGDP	-3.79 (>.10)	2009Q1	I(1)	-2.74 (>.10)	2016Q1	I(1)	-3.25 (>.10)	2009Q1	I(1)
UR	-3.61 (>.10)	2010Q1	I(1)	-2.68 (>.10)	2013Q1	I(1)	-3.51 (>.10)	2010Q1	I(1)
Output gap	-5.59 (<.05)	2009Q1	I(0)	-5.15 (>.10)	2020Q3	I(0)	-5.93 (<.01)	2020Q1	I(0)
Unemployment gap	-3.56 (>.10)	2015Q4	I(1)	-2.83 (>.10)	2013Q3	I(1)	-3.54 (>.10)	2015Q4	I(1)
First-difference									
LGDP	-9.33 (<.01)	2020Q3	I(0)	-8.87 (<.01)	2009Q2	I(0)	-9.57 (<.01)	2020Q3	I(0)
UR	-4.60 (>.10)	2013Q4	I(1)	-3.84 (>.10)	2010Q3	I(1)	-4.70 (>.10)	2013Q4	I(1)
Output gap	-8.71 (<.01)	2020Q4	I(0)	-8.41 (<.01)	2009Q2	I(0)	-9.17 (<.01)	2020Q4	I(0)
Unemployment gap	-6.53 (<.01)	2015Q4	I(0)	-6.18 (<.01)	2006Q4	I(0)	-6.94 (<.01)	2020Q2	I(0)

Source: authors. Note: TB is the breakpoint. "Decision" means a decision made at the 5% significance level. The Schwarz information criterion was used to select the increment for the ZA test. The minimised Dickey-Fuller t-statistic was used to select the breakpoint in these tests. The critical values for the ZA are for model with intercept: 1% -5.34, 5% -4.80, 10% -4.58; for model with trend: 1% -4.93, 5% -4.42, 10% -4.11; for model with intercept and trend: 1% -5.57, 5% -5.08, 10% -4.82.

Table 9. Clemente-Montañés-Reyes unit root tests with two endogenous breaks

Series	IO				AO			
	t-stat	TB ₁	TB ₂	Decision	t-stat	TB ₁	TB ₂	Decision
Level								
LGDP	-6.23 (<.01)	2015Q3 (<.01)	2020Q1 (<.01)	I(0)	-4.08 (<.01)	2005Q1 (<.01)	2019Q4 (<.01)	I(0)
UR	-4.72 (<.01)	2009Q3 (<.01)	2015Q2 (<.01)	I(0)	-3.16 (>.05)	2011Q2 (<.01)	2016Q4 (<.01)	I(1)
Output gap	-7.10 (<.01)	2015Q3 (>.05)	2020Q1 (>.05)	I(0)	-2.61 (>.05)	2018Q1 (<.01)	2019Q4 (<.01)	I(1)
Unemployment gap	-5.32 (<.01)	2011Q3 (<.01)	2015Q2 (<.01)	I(0)	-2.71 (>.05)	2011Q4 (<.01)	2015Q1 (<.01)	I(1)
First difference								
LGDP	-13.70 (<.01)	2008Q4 (<.01)	2020Q1 (<.01)	I(0)	-3.45 (>.05)	2008Q3 (>.05)	2019Q4 (>.05)	I(1)
UR	-4.48 (<.01)	2008Q2 (<.01)	2013Q2 (<.01)	I(0)	-2.18 (>.05)	2009Q1 (<.01)	2013Q1 (<.01)	I(1)
Output gap	-8.74 (<.01)	2008Q4 (>.05)	2020Q1 (>.05)	I(0)	-4.27 (<.01)	2008Q3 (>.05)	2019Q4 (>.05)	I(0)
Unemployment gap	-3.01 (>.05)	2020Q1 (<.01)	2020Q4 (<.01)	I(1)	-3.68 (<.01)	2019Q3 (<.01)	2021Q1 (<.01)	I(0)

Source: authors. Note: TB1 and TB2 are the breakpoints. "Decision" means a decision made at the 5% significance level. The critical value for the Clemente-Montañés-Reyes unit root test with two structural breaks for IO and AO is -5.49 at the 5% significance level.

Table 10. Gregory-Hansen cointegration test (first-difference model)

Dependent	Break type	ADF	Z_t	Z_a	Break point			5% asymptotic critical values			Cointegration (Yes/No)
					ADF	Z_t	Z_a	ADF	Z_t	Z_a	
LGDP	Level	-3.31	-3.43	-18.15	2009Q2	2009Q3	2009Q3	-4.61	-4.61	-40.48	No (ADF, Z_t , Z_a)
	Trend	-4.56	-5.05	-35.20	2019Q2	2019Q1	2019Q1	-4.99	-4.99	-47.96	No (ADF, Z_t) Yes (Z_t)
	Regime	-3.67	-3.86	-21.26	2018Q1	2018Q1	2018Q1	-4.95	-4.95	-47.04	No (ADF, Z_t , Z_a)
	Regime trend	-4.62	-5.09	-34.96	2019Q1	2019Q1	2019Q1	-5.50	-5.50	-58.58	No (ADF, Z_t , Z_a)
UR	Level	-2.97	-3.11	-16.60	2008Q3	2008Q3	2008Q3	-4.61	-4.61	-40.48	No (ADF, Z_t , Z_a)
	Trend	-3.50	-3.91	-23.87	2019Q2	2014Q3	2014Q3	-4.99	-4.99	-47.96	No (ADF, Z_t , Z_a)
	Regime	-2.93	-3.13	-16.99	2008Q3	2009Q2	2009Q2	-4.95	-4.95	-47.04	No (ADF, Z_t , Z_a)
	Regime trend	-4.21	-3.95	-26.69	2018Q2	2018Q2	2018Q2	-5.50	-5.50	-58.58	No (ADF, Z_t , Z_a)

Source: authors. Note: The modified Schwarz information criterion was used to select the degree of increase in the test equation.

Table 11. Gregory-Hansen cointegration test (gap model)

Dependent	Break type	ADF	Z_t	Z_a	Break point			5% asymptotic critical values			Cointegration (Yes/No)
					ADF	Z_t	Z_a	ADF	Z_t	Z_a	
Output gap	Level	-5.45	-5.26	-40.01	2007Q2	2006Q3	2006Q3	-4.61	-4.61	-40.48	Yes (ADF, Z_t) No (Z_a)
	Trend	-5.61	-5.37	-41.81	2007Q2	2006Q3	2006Q3	-4.99	-4.99	-47.96	Yes (ADF, Z_t) No (Z_a)
	Regime	-5.64	-5.51	-43.64	2006Q2	2006Q3	2006Q3	-4.95	-4.95	-47.04	Yes (ADF, Z_t) No (Z_a)
	Regime trend	-5.88	-5.66	-45.88	2006Q2	2006Q3	2006Q3	-5.50	-5.50	-58.58	Yes (ADF, Z_t) No (Z_a)
Unemployment gap	Level	-3.41	-3.52	-21.79	2014Q3	2019Q1	2019Q1	-4.61	-4.61	-40.48	No (ADF, Z_t , Z_a)
	Trend	-3.80	-3.96	-26.29	2009Q2	2009Q2	2009Q2	-4.99	-4.99	-47.96	No (ADF, Z_t , Z_a)
	Regime	-4.14	-3.95	-28.13	2017Q4	2017Q4	2017Q4	-4.95	-4.95	-47.04	No (ADF, Z_t , Z_a)
	Regime trend	-4.24	-4.03	-28.97	2017Q4	2017Q4	2017Q4	-5.50	-5.50	-58.58	No (ADF, Z_t , Z_a)

Source: authors. Note: The modified Schwarz information criterion was used to select the degree of increase in the test equation

Table 12. ARDL models summary (first-difference models)

Model	ARDL Lag order	F-stat (Bounds test)	Cointegration (F-test)	t-stat (Bounds test)	Cointegration (t-test)
Model: LGDP = f(UR)					
C	(1, 0)	0.247	No	-0.695	No
C + T	(1, 0)	2.135	No	-2.063	No
C + Dummy	(1, 0)	1.033	No	-1.022	No
C + T + Dummy	(1, 0)	2.204	No	-1.837	No
Model: UR = f(LGDP)					
C	(6, 0)	6.128	Yes	-3.398	Yes
C + T	(11, 1)	22.943	Yes	-6.762	Yes
C + Dummy	(6, 0)	4.156	No	-2.783	No
C + T + Dummy	(12, 1)	20.281	Yes	-6.358	Yes

Source: authors. Note: C = model with constant; C+Dummy = model with constant and dummies (D200Q1, D2020Q2, D2020Q3, D2020Q4); C+T = model with constant and trend; C+T+Dummy = model with constant, trend and dummies. Schwarz (SIC) criterion was used as a model selection method, or to determine the optimal length of the delay, i.e. order of the ARDL model.

Table 13. ARDL models summary (gap models)

Model	ARDL Lag order	F-stat (Bounds test)	Cointegration (F-test)	t-stat (Bounds test)	Cointegration (t-test)	CointEq(-1) coefficient	CointEq(-1) significance
Model: Output gap = f(Unemployment gap)							
C	(2, 0)	12.77	Yes	-4.69	Yes	-0.4540	<.01
C+T	(2, 0)	12.65	Yes	-4.67	Yes	-0.4544	<.01
C+Dummy	(1, 0)	19.46	Yes	-5.90	Yes	-0.4307	<.01
C+T+Dummy	(1, 0)	19.95	Yes	-5.98	Yes	-0.4376	<.01
Model: Unemployment gap = f(Output gap)							
C	(5, 1)	13.10	Yes	-2.54	Inconclusive	-0.1536	<.01
C+T	(5, 1)	13.02	Yes	-2.53	No	-0.1535	<.01
C+Dummy	(5, 1)	8.98	Yes	-2.72	Inconclusive	-0.1744	<.01
C+T+Dummy	(5, 1)	8.03	Yes	-2.53	No	-0.1686	<.01

Source: authors. Note: C = model with constant; C+Dummy = model with constant and dummies (D2020Q2 and D2020Q3); C+T = model with constant and trend; C+T+Dummy = model with constant, trend and dummies. Schwarz (SIC) criterion was used as a model selection method, or to determine the optimal length of the delay, i.e. order of the ARDL model.

Table 14. NARDL first-difference models for Unemployment rate dependent variable (General-to-specific approach)

Variable	Model 1	Model 2
Intercept	2.753 (<.01)	2.891 (<.01)
Trend		-0.024 (.10)
Short-run dynamics		
UR_{t-1}	-0.149 (<.01)	-0.140 (<.01)
$LGDP_{t-1}^+$	-0.050 (<.01)	-0.042 (<.01)
$LGDP_{t-1}^-$	-0.073 (<.01)	-0.102 (<.01)
ΔUR_{t-2}	-0.203 (.04)	-0.248 (.02)
ΔUR_{t-3}	0.357 (<.01)	0.303 (<.01)
ΔUR_{t-4}	-0.093 (.33)	-0.146 (.14)
ΔUR_{t-5}	0.341 (<.01)	0.297 (<.01)
$\Delta LGDP_{t-3}^+$	0.162 (<.01)	-0.169 (<.01)
$\Delta LGDP_{t-4}^+$	-0.085 (.11)	-0.092 (.08)
Long-run relation $LGDP_{t-1}^+$	-0.337 (<.01)	-0.299 (<.01)
Long-run relation $LGDP_{t-1}^-$	-0.487 (<.01)	-0.728 (<.01)
Long-run asymmetric Wald test	5.680 (.02)	6.143 (.02)
Short-run asymmetric Wald test	15.000 (<.01)	16.924 (<.01)
<i>F</i> -bounds cointegration test	<i>F</i> -statistic Lower bound Upper bound	
10% critical value	6.730 4.04 4.78	5.883 4.05 4.49
5% critical value	6.730 4.94 5.73	5.883 4.68 5.15
1% critical value	6.73 6.84 7.84	5.883 6.10 6.73
<i>t</i> -bounds cointegration test	<i>t</i> -statistic Lower bound Upper bound	
10% critical value	-4.448 -2.57 -2.91	na
5% critical value	-4.448 -2.86 -3.22	na
1% critical value	-4.448 -3.43 -3.82	na
Adjusted R^2	0.372	0.388
Jarque-Bera normality test	0.537 (.76)	0.717 (.70)
Breusch-Godfrey serial correlation LM test	11.519 (.17)	11.393 (.18)
Engle ARCH test for heteroscedasticity	6.890 (.55)	(.98)
Ramsey RESET test	0.764 (.38)	1.989 (.16)
CUSUM test	Stable	Stable
CUSUM of squares test	Stable	Stable

Source: authors

Table 15. NARDL gap models for Unemployment gap dependent variable (General-to-specific approach)

Variable	Model 3	Model 4
Intercept	0.031 (.79)	0.146 (.42)
Trend		-0.010 (.38)
Short-run dynamics		
<i>Unemployment gap</i> _{<i>t</i>-1}	-0.168 (<.01)	-0.207 (<.01)
<i>Output gap</i> _{<i>t</i>-1} ⁺	-0.088 (<.01)	-0.083 (<.01)
<i>Output gap</i> _{<i>t</i>-1} ⁻	-0.091 (<.01)	-0.100 (<.01)
Δ <i>Unemployment gap</i> _{<i>t</i>-2}	-0.321 (<.01)	-0.295 (.01)
Δ <i>Unemployment gap</i> _{<i>t</i>-3}	0.170 (.09)	0.119 (.24)
Δ <i>Unemployment gap</i> _{<i>t</i>-4}	-0.268 (.01)	-0.245 (.03)
Δ <i>Unemployment gap</i> _{<i>t</i>-5}	0.173 (.09)	0.144 (.15)
Δ <i>Unemployment gap</i> _{<i>t</i>-6}	-	0.118 (.29)
Δ <i>Output gap</i> _{<i>t</i>-3} ⁺	-0.079 (.17)	-
Δ <i>Output gap</i> _{<i>t</i>-4} ⁺	-0.060 (.30)	-0.089 (.11)
Δ <i>Output gap</i> _{<i>t</i>-5} ⁺	0.031 (.59)	-
Long-run relation <i>Output gap</i> _{<i>t</i>-1} ⁺	-0.525 (.02)	-0.399 (.02)
Long-run relation <i>Output gap</i> _{<i>t</i>-1} ⁻	-0.538 (.01)	-0.483 (<.01)
Long-run asymmetric Wald test	0.249 (.62)	0.943 (.33)
Short-run asymmetric Wald test	1.544 (.22)	2.601 (.11)
<i>F</i> -bounds cointegration test	<i>F</i> -statistic Lower bound Upper bound	
10% critical value	6.631 4.04 4.78	5.998 4.05 4.49
5% critical value	6.631 4.94 5.73	5.998 4.68 5.15
1% critical value	6.631 6.84 7.84	5.998 6.10 6.73
<i>t</i> -bounds cointegration test	<i>t</i> -statistic Lower bound Upper bound	
10% critical value	-2.858 -2.57 -2.91	na
5% critical value	-2.858 -2.86 -3.22	na
1% critical value	-2.858 -3.43 -3.82	na
Adjusted <i>R</i> ²	0.335	0.333
Jarque-Bera normality test	0.130 (.94)	1.070 (.59)
Breusch-Godfrey serial correlation LM test	9.361 (.31)	7.921 (.44)
Engle ARCH test for heteroscedasticity	6.544 (.59)	6.217 (.62)
Ramsey RESET test	0.021 (.89)	1.269 (.26)
CUSUM test	Stable	Stable
CUSUM of squares test	Stable	Stable

Source: authors



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ORIGINALNI NAUČNI RAD / ORIGINAL SCIENTIFIC PAPER

ACCESS TO FINANCE AS A BARRIER TO INNOVATION - EVIDENCE FROM THE SME SECTOR IN BOSNIA AND HERZEGOVINA

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Abstract: *This paper examines key barriers that SMEs in Bosnia and Herzegovina face when accessing external financing for innovation. Using quantitative research based on primary data collected through a structured questionnaire, the paper analyses company perceptions regarding support from commercial banks, microcredit institutions, and public funds. The findings identify major obstacles, including unfavourable financing conditions, administrative complexity, and limited access to information. Statistical analysis was used to test hypotheses concerning firm size, sector, region, and institutional factors. The results indicate that company size, regional context, and administrative barriers significantly influence access to finance, while the link between innovation and external financing is not statistically significant. Smaller companies face notably more obstacles than larger ones, particularly regarding public support mechanisms. The paper highlights systemic challenges that hinder innovation in the private sector and offers policy-relevant insights. It calls for more inclusive, targeted financial instruments to support innovation-driven growth among smaller companies.*

Keywords: *access to finance, Innovation, SMEs, financial barriers, external financing*

JEL Classification: *G23, L26, O31, O38*

INTRODUCTION

Innovation, together with innovative activities of companies, is one of the most important factors leading to growth and thus greater competitiveness of companies. For this reason, innovations enable adaptation to various market changes and ensure long-term sustainability (Leiponen, 2010). However, one of the key challenges that many companies face, especially micro, small and medium-sized companies, is access to innovation financing, which is particularly pronounced in economies undergoing transition, such as Bosnia and Herzegovina. Small and medium-sized companies, which otherwise form the backbone of the economy of Bosnia and Herzegovina, often do not have enough of their own resources to finance investments in research and de-

velopment, while external sources of financing, such as loans, grants or venture capital, are often unavailable to them or are available under unfavourable financing conditions. The level of innovative activities often varies between different parts of the country, which is significantly influenced by access to financial instruments and public sector support (Czarnitzki, 2011). Companies located in more developed parts of the country often have better conditions for accessing these funds, unlike companies coming from less developed regions. For this reason, they also have greater obstacles in using external sources of financing. In addition, companies that have an established research and development department can more easily finance and implement innovation activities (Hall, 2010), since such companies have better defined development strategies and a greater ability to apply for branches and favourable credit lines (Colombo, 2007).

Despite the above, there is not enough research in the literature on which factors most facilitate access to innovation financing by companies in Bosnia and Herzegovina. Because of the above, it is important to investigate the problem of access to and financing of innovative activities of companies, in order to enable better formulation of economic policies and financial instruments, which would facilitate and accelerate the innovation process in the small and medium-sized company sector in Bosnia and Herzegovina.

In order to further investigate this area, the main research problem with additional objectives was defined, which is to analyse the factors that influence the likelihood of using external financing of companies for the development of innovations and innovative activities. In addition to the main research problem, individual research objectives were also defined, as follows:

- To analyse factors that directly influence the likelihood that a company, regardless of its size, uses external financing for innovative activities.
- To investigate whether and to what extent the size of the company and the existence of a research and development department affect the use of external sources of financing.
- To determine whether there are statistically significant differences in the responses of companies by size regarding obstacles to financing innovative activities.
- To propose measures to improve the availability of financing for innovative activities of micro, small and medium-sized companies.

In addition to the main problem and research objectives, the paper also focuses on the following research questions:

1. What factors influence the likelihood that a company uses external financing for innovation?
2. Does the size of the company and the existence of a research and development department increase the likelihood that a company will use external financing for its own innovative activities?
3. Are there significant differences by company size in the perception of obstacles to financing innovative activities?

In order to answer the above questions, the following research hypotheses were defined:

H1 - There are significant regional differences in the perception of obstacles to financing innovation.

H2 - Larger companies are significantly more likely to use external financing for innovation compared to small companies.

H3 - Companies that perceive administrative barriers as a serious problem are significantly less likely to use external financing.

H4 - Companies that have introduced new products or services in the last three years are significantly more likely to use external financing.

H5 - Smaller-sized companies perceive significantly greater barriers to using external financing compared to medium-sized companies.

H6 - Medium-sized companies are significantly more likely to use grants compared to micro and small companies.

The above hypotheses will be tested using multiple statistical methods, namely logistic regression analysis, ANOVA/Kruskal-Wallis test and Chi-square test, with the purpose of determining which factors have a key impact on financing innovative activities of micro, small and medium-sized companies in Bosnia and Herzegovina.

LITERATURE REVIEW

Small and medium-sized companies around the world are considered to be the drivers of innovative activities, economic growth and employment (Gans, 2003). Regardless of their importance, these categories of companies, especially micro and small companies, face various limitations in accessing sources of financing that are necessary for financing innovative activities (Abdulsaleh, 2013). This is especially important for developing countries, with underdeveloped financial markets, where the lack of financial resources is often cited as one of the main obstacles to implementing innovative activities (Moritz, 2016).

Several authors state in their works that companies that carry out innovative activities are more likely to apply to external financial sources, but that access may be difficult due to limited availability of information, different perceptions of risk and lack of collateral (Lee, 2015). These problems are especially pronounced for smaller companies.

In terms of modern solutions, new digital solutions and fintech innovations play an important role. Navaretti et al., in their work, indicate that the digitalization of banking services and the growth of the fintech sector can enable and significantly improve access to financing for small and medium-sized companies by providing companies with faster, more transparent and flexible services compared to the existing services offered by traditional financial institutions (Navaretti Barba, 2018).

Other research, again, shows that limited access to external sources of financing remains a significant barrier. This is particularly pronounced for certain member states of the European Union (Bonanno, 2020). The authors also state that the lack of institutional support, unfavourable financing conditions and administrative barriers greatly affect the capacity of small and medium-sized companies to carry out their own innovative activities (Grilli, 2014). On the other hand, Howell emphasizes the importance of support from public funds as a mechanism that can stimulate innovative activities in companies that otherwise encounter difficulties in accessing funds from commercial banks (Howell, 2017).

As part of this review, it is important to highlight an alternative source of access to financing. In particular, crowdfunding is highlighted in this section, as a growing financing model based on more flexible and accessible solutions for small and medium-sized companies, which is especially important for companies that have innovative activities, but cannot meet strict banking criteria (Brown, 2020). However, in order

for companies to access such sources, it is necessary for them to have special knowledge and a developed level of digital literacy, a built reputation and quality marketing (Belleflamme, 2015).

An important factor that enables better access to sources of financing for companies is the level of financial literacy. Wise emphasizes that those entrepreneurs who have a higher level of knowledge and understanding of financial instruments and the opportunities available have a greater chance of successfully securing funds for their innovation projects, which especially applies to knowledge of financial risk management and the preparation of various applications for financial funds (Wise, 2013).

Research conducted in the field of venture capital investment has also shown that there is potential for this type of financing as a key mechanism for supporting innovation, especially in fast-growing sectors (Chemmanur, 2014). However, the problem is that these funds are not available to companies in countries with very limited capital markets, which is the case with Bosnia and Herzegovina.

At the company level, institutional factors such as the existence of separate research and development departments are also very important, which can help in strategic planning of innovation, and which has been highlighted as a factor that can have a positive effect on the likelihood of obtaining external financing (Muller, 2015). The authors also argue in their paper that companies with a clearly expressed innovation orientation are more likely to cooperate with external sources of financing.

From their literature review, it can be clearly seen that access to financing for innovative activities is complex and largely depends on the size of the company and the sector from which the company comes, then institutional support, the availability of different and alternative financial instruments, as well as administrative barriers.

RESULTS AND ANALYSIS

As part of the research in question, a survey of attitudes was conducted in a total of 304 companies of different sizes and regional representation in Bosnia and Herzegovina, which responded to a total of 75 different questions. The responses were obtained from middle and top management of the mentioned companies. To test the hypotheses set, an analysis of a total of 14 responses from a total of 262 respondents was conducted. As part of this research, the attitudes and responses of large companies were not investigated, but exclusively micro, small and medium-sized companies.

Of the respondents' responses, 122 responses were responses from micro companies or 47% of the total number of responses, then 88 responses from small companies, which is 34% of the responses, and 51 responses from medium-sized companies, which makes up 19% of the total number of analysed companies.

The second question in the analysis related to the existence of a research and development department. According to the respondents' answers, 81 companies or 31% responded that they have an established research and development department in their company. On the other hand, 131 companies or 50% responded that they do not have an established research and development department, and 50 or 19% of companies additionally responded that, in addition to not having an established research and development department, they plan to establish one in the future. In other words, almost 7 out of 10 company responses indicate that they do not have an established research and development department.

For the next group of questions, descriptive statistics were performed to see if there was a difference in respondents' attitudes towards the size measured through the mean value of the response, standard error and standard deviation with a confidence level of 95%. All nine questions assessed their attitudes on a scale of 1 to 5, where 1 indicates complete disagreement and 5 indicates complete agreement.

The first question presented in Table 1, assessed the attitude regarding the following statement: "A commercial bank supports me in developing my business and innovative activities." The analysis of the results shows that it can be concluded that, on average, companies express a slightly negative attitude towards the support of commercial banks in financing innovative activities. The mean values differ between groups. When it comes to the mean value for all respondents, it was 2.88, which shows that most companies are not completely satisfied with the support provided by banks. The standard deviation of 1.10 indicates moderate variability of the responses, while the relatively low standard error of 0.068 indicates the precision of the estimate. The confidence interval of ± 0.134 further confirms that the results are stable and reflect the general trend among companies.

Differences according to company size are present, as shown by the mean values. According to the results, micro companies have the lowest mean value (2.70), which means a higher level of dissatisfaction with the support provided by banks. On the other hand, small companies are somewhat closer to the average for all companies with a value of 2.99, while medium-sized companies have the most favourable opinion, with an average score of 3.14.

According to the above results, it can be concluded that there is a potential problem in the access of micro and small companies to external financing of their innovative activities. Given that banks apparently cooperate better with medium-sized companies.

Table 1. Perception of Commercial Bank Support for Business and Innovation Development by Company Size

Question 1	Total	Micro	Small	Medium
Mean	2,881679	2,699187	2,988636	3,137255
Standard Error	0,068122	0,097233	0,117104	0,155978
Standard Deviation	1,102648	1,078364	1,098529	1,113905
Confidence Level(95,0%)	0,134138	0,192482	0,232756	0,313291

Source: Author's creation based on primary research results

The second question asked of the respondents concerned the assessment of attitudes regarding the following statement: "The microcredit organization supports me in the development of my business and innovative activities." At the level of the total number of analysed responses, the average score was 2.18. Observed by company size, the average scores were 2.20 for micro, 2.22 for small, and 2.06 for medium-sized companies. The results indicated that the majority of respondents do not believe that microcredit organizations significantly contribute to their innovative activities, with small differences in responses by company size, whereas medium-sized companies nevertheless indicated a weaker perception of support from microcredit organizations.

The standard deviation indicator at the overall level was 0.94. Observed by company size, micro-companies have a slightly higher standard deviation of 1.00, while the

responses of medium-sized companies are somewhat more uniform, with a deviation of 0.88. Let's look at the 95% confidence level. The confidence intervals show that the precision of the estimate is somewhat lower for micro-companies (± 0.18) and small companies (± 0.19), while the highest uncertainty of the estimate is for medium-sized companies (± 0.25). Details are presented in Table 2.

Table 2. Perception of Microcredit Organization Support for Business and Innovation Development by Company Size

Question 2	Total	Micro	Small	Medium
Mean	2,179389	2,203252	2,215909	2,058824
Standard Error	0,058318	0,090137	0,096231	0,123389
Standard Deviation	0,943964	0,999667	0,902727	0,881176
Confidence Level(95,0%)	0,114834	0,178435	0,191270	0,247835

Source: Author's creation based on primary research results

In the third question, respondents were asked about the following statement: "Public incentive funds are available to me and help me develop my business and innovative activities." The analysis of the results obtained indicates that companies, on average, have a neutral attitude toward the availability and support of state funds for business development and innovative activities. The average score of the respondents' responses was 2.50. When the results are analysed by company size, the average scores were 2.48 for micro, 2.50 for small, and 2.55 for medium-sized companies, indicating that there is no significant difference in the respondents' responses by company size. The analysis of the standard deviation shows that it is 1.14 at the overall level, which in other words means a relatively wide range of responses among the respondents.

Table 3. Perception of Availability of Public Incentive Funds by Company Size

Question 3	Total	Micro	Small	Medium
Mean	2,500000	2,479675	2,500000	2,549020
Standard Error	0,070461	0,104764	0,123091	0,151628
Standard Deviation	1,140511	1,161892	1,154701	1,082843
Confidence Level(95,0%)	0,138744	0,207391	0,244658	0,304555

Source: Author's creation based on primary research results

Micro companies have a slightly higher standard deviation of 1.16, small companies 1.15, while medium-sized companies have a slightly lower deviation, at 1.08. When analysing the standard error values, a certain level of uncertainty in the results can be observed, with the 95% confidence intervals being widest for medium-sized companies (± 0.30), while they are somewhat narrower for micro and small companies (± 0.20 and ± 0.24). Details are provided in Table 3.

The analysis of question number 4 concerned the assessment of the extent to which respondents agree that a factor, such as the size of the company, can represent an obstacle to the use of external sources of financing, all for the purpose of financing innovative activities. The question was: "Difficult access to external financing due to

the size of the company.” The analysis of the results shows that the average score was 3.34. In other words, this answer suggests that companies consider the availability of external financing as a moderate obstacle to increasing innovative activities. The answers differ significantly according to the size of the company, so the average score for micro companies is 3.59, for small companies 3.20, and for medium-sized companies 2.96. In other words, micro companies significantly consider that there are difficulties in accessing external financing, while medium-sized companies consider that availability is a minor problem.

The analysis of the standard deviation shows a value of 0.99, which represents a relatively higher level of variability in the responses of the respondents. In terms of company size, micro-companies have a slightly lower value than the average of all companies, namely 0.96, small companies have a value of 0.91, while the variability is most pronounced in medium-sized companies and amounts to 1.04. The results for the standard error show that the results are most precise for the average of all companies, as well as for the micro-company level, while they are somewhat less precise for the size of medium-sized companies. These findings for medium-sized companies are also confirmed by the confidence interval at the 95% confidence level, which was ± 0.29 , which can be interpreted as a higher level of uncertainty in the assessment of attitudes for medium-sized companies. Details are shown in Table 4.

Table 4. Perception of Company Size as a Barrier to Accessing External Financing

Question 4	Total	Micro	Small	Medium
Mean	3,339695	3,593496	3,204545	2,960784
Standard Error	0,061038	0,086267	0,097190	0,145416
Standard Deviation	0,987988	0,956748	0,911726	1,038476
Confidence Level(95,0%)	0,120190	0,170774	0,193176	0,292076

Source: Author's creation based on primary research results

The next, fifth question, concerned the examination of attitudes regarding the insufficient supply of financial resources due to other reasons, as a factor that represents an obstacle to the use of external sources of financing. The question was: “Insufficient supply of financial resources (for other reasons).” Analysis of the results shows that the average score of all companies’ responses is 3.48. This data can be interpreted as companies in Bosnia and Herzegovina perceiving the insufficient supply of external sources of financing as a significant obstacle that does not allow the improvement of their innovative activities. If the data are analysed according to the size of the company, then it can be seen that micro-companies have an average score of 3.70, then small companies 3.38, and medium-sized companies 3.12. Given the existence of a significant difference between micro, small, and medium-sized companies, it can be concluded that micro companies are faced with the problems of insufficient availability of external sources of financing to a greater extent compared to the average, while medium-sized companies perceive this problem to a significantly lesser extent compared to both micro and small companies, but compared to the average.

Analysis of the standard deviation value shows that it is 0.93 at the overall level. This value can be interpreted as a relatively broad response level among respondents.

If the variability of responses by company size is analysed, it was recorded to the greatest extent in small companies (0.96), and to a somewhat lesser extent in micro companies (0.88). The standard deviation value for medium-sized companies was 0.90. In addition, the standard error of the estimate indicates that the results are most precise when looking at the average for all and micro companies, with a slightly lower level of precision for medium-sized companies. The confidence interval at the 95% level is ± 0.25 . Details are shown in Table 5.

Table 5. Perception of Insufficient Supply of Financial Resources (Other Reasons) as a Barrier

Question 5	Total	Micro	Small	Medium
Mean	3,477099	3,699187	3,379310	3,115385
Standard Error	0,057662	0,079092	0,102418	0,124804
Standard Deviation	0,933339	0,877169	0,955296	0,899975
Confidence Level(95,0%)	0,113542	0,156570	0,203601	0,250555

Source: Author's creation based on primary research results

The next question number six referred to administrative conditions as an obstacle to financing innovative activities. The question read: “Administrative conditions of financing represent an obstacle.” The results of the analysis of the answers show that the average score for all companies was 3.52, which can be interpreted that there is some concern among the surveyed companies regarding bureaucratic obstacles and requirements that make access to external financial sources more difficult. The analysis by company size shows that there are some deviations from the mean value. Micro and small companies have almost identical values, namely 3.34 for micro and 3.35 for small companies, while the results are slightly higher than the average for medium-sized companies and amount to 3.71. The higher level of the average value for medium-sized companies indicates that these companies perceive administrative obstacles to access to external financial sources as more complex compared to micro and small companies.

The value of the standard deviation was 0.93, which can be interpreted that, similar to the previous questions, there is some variability in the responses of the respondents. When analysed by company size, it can be seen that there is a slightly higher variability in small companies, namely 0.95, while in micro and medium-sized companies it was 0.90 and 0.89 respectively. In addition, the analysis of standard errors shows that there is a certain level of uncertainty in the responses of the respondents, where the confidence intervals at the 95% level are the largest for small companies (± 0.20) and medium-sized companies (± 0.25). Details are presented in Table 6.

Table 6. Perception of Administrative Funding Conditions as a Barrier to Innovation Financing

Question 6	Total	Medium	Small	Medium
Mean	3,515267	3,707317	3,344828	3,352941
Standard Error	0,057417	0,081414	0,101877	0,124691
Standard Deviation	0,929382	0,902925	0,950246	0,890472
Confidence Level(95,0%)	0,113060	0,161167	0,202525	0,250449

Source: Author's creation based on primary research results

Question number 7 referred to unfavourable financing conditions as an obstacle for companies to improve their innovative activities. The question read: “Unfavourable financing conditions are an obstacle”. The results of the analysis show that the mean value of the answer for all companies is 3.57. This result can be interpreted that the surveyed companies perceive unfavourable financing conditions as a significant obstacle that prevents them from improving innovative activities. Observed by company size, the mean value of the answer varied from 3.76 for micro companies, 3.45 for small companies and 3.29 for medium-sized companies. These results can be interpreted that the smaller the company, the greater the burden they perceive due to unfavourable financing conditions for innovative activities.

The value of the standard deviation was 0.93 and is at a similar level to the answers to the previous questions. Observed by company size, the value of the standard deviation varied and ranged from 0.87 for micro, 0.95 for small and 0.94 for medium-sized companies. Given that there is a more significant difference for the micro-company level, the lower value indicates that micro-companies have somewhat more balanced attitudes regarding unfavourable financing conditions compared to companies of other sizes. The level of standard error also indicates, as with the previous answers, that there is a certain level of uncertainty in the results, where it should be emphasized that the confidence intervals at the 95% level are widest for medium-sized companies (± 0.27), while they are somewhat smaller for small companies (± 0.20) and micro-companies (± 0.16). Details are shown in Table 7.

Table 7. Perception of Adverse Financing Conditions as a Barrier to Innovation Financing

Question 7	Total	Micro	Small	Medium
Mean	3,568702	3,764228	3,454545	3,294118
Standard Error	0,057268	0,078369	0,100818	0,132233
Standard Deviation	0,926956	0,869155	0,945760	0,944333
Confidence Level(95,0%)	0,112765	0,155139	0,200387	0,265598

Source: Author's creation based on primary research results

Question number 8 referred to poor accessibility and lack of information as an obstacle to using external sources of financing to improve innovative activities of companies. The question read: “Poor accessibility and lack of information about external sources of financing represent an obstacle.” The average value of the answer for all companies is 3.64, which can be interpreted that companies consider poor accessibility and lack of information about external sources of financing as a significant obstacle to improving their own innovative activities. Additional analysis of the results by company size shows that the mean values also varied, from 3.80 for micro companies, then 3.55 for small and 3.39 for medium-sized companies. This difference in mean values can be interpreted as the smallest companies being most affected by poor accessibility of information and difficult access to external sources of financing. The value for medium-sized companies indicates that these companies are in a slightly better position compared to the other analysed companies.

The analysis of the standard deviation value was at a similar level as for the previous questions and amounted to 0.96. The highest variability of responses can be

observed in small companies and amounted to 1.04, while micro companies have the lowest variability, which amounted to 0.86. This difference can be interpreted that the attitudes of micro companies are more consistent regarding the problems arising from the availability of information. The standard error of the estimate and the confidence intervals at the 95% level are the widest for medium-sized companies (± 0.28), while they are somewhat smaller for small (± 0.22) and micro companies (± 0.15).

Table 8. Perception of Poor Accessibility and Lack of Information as a Barrier to External Financing

Question 8	Total	Micro	Small	Medium
Mean	3,637405	3,804878	3,545455	3,392157
Standard Error	0,059311	0,077150	0,110699	0,140247
Standard Deviation	0,960032	0,855633	1,038446	1,001567
Confidence Level(95,0%)	0,116789	0,152726	0,220026	0,281695

Source: Author's creation based on primary research results

The last question number 9 referred to the analysis of attitudes related to insufficient state support, which represents an obstacle to the improvement of innovative activities of companies. The question reads: "‘Insufficient state support represents an obstacle’ on a scale of 1 to 5, where 1 means I completely disagree, and 5 means I completely agree." The overall average score for the level of all companies was 4.11. This response value can be interpreted as insufficient state support representing one of the greatest obstacles in the use of external sources of financing for the improvement of innovative activities of companies. Observed individually according to the size of the company, there is no significant difference in the responses. The average value for micro companies is 4.15, for small companies 4.07, and for medium-sized companies 4.10. The conclusion that can be drawn is that companies of all sizes have an almost equally negative attitude towards the role of the state in supporting external financing of innovative activities.

The standard deviation analysis shows a value of 0.94 with small variations according to the size of the company. The standard deviation values by company size ranged from 0.89 for micro companies, 0.97 for small companies and 1.01 for medium-sized companies. A lower value compared to the average for micro companies indicates a higher degree of agreement among micro companies when it comes to insufficient state support. The values of the standard error of the estimate and the confidence intervals at the 95% level indicate that the estimate values are the most stable for micro companies (± 0.16), while they are the widest for medium-sized companies (± 0.28). Details are presented in Table 9.

Table 9. Perception of Insufficient State Support for External Innovation Financing

Question 9	Total	Micro	Small	Medium
Mean	4,110687	4,146341	4,068182	4,098039
Standard Error	0,057969	0,080551	0,103233	0,140740
Standard Deviation	0,938308	0,893354	0,968414	1,005085
Confidence Level(95,0%)	0,114146	0,159459	0,205187	0,282685

Source: Author's creation based on primary research results

In addition to the analysis of the results of the answers to the questions, where the attitudes of the respondents towards various aspects were investigated, a hypothesis analysis was also performed. A summary of all testing is shown in Table 10. The results of the performed statistical analysis of hypotheses show that there are significant differences in the perception of companies when it comes to financial obstacles, depending on the area from which the company comes, then according to the size of the company and administrative barriers. Hypothesis 1, which refers to regional differences in the perception of financing obstacles, conducted through testing using ANOVA and the Kruskal-Wallis test, shows a value of 1.79 with a p-value of 0.0297. Given that the p-value is below the threshold of 0.05, we can conclude that there are statistically significant differences in the responses of respondents coming from different areas, according to the perception of financial obstacles.

As part of the second hypothesis, which investigated the connection between the size of the company and access to external financing, testing was performed using the Chi-square test. The results obtained show a value of 6.42, while the p-value was 0.0421, which leads to the conclusion that there is a significant relationship between the size of the company and the possibility of companies using external financing. This testing confirmed the second hypothesis that larger companies have a greater chance of accessing external financing compared to smaller companies.

The third hypothesis investigated the relationship between the impact of administrative barriers on the use of external financing. For the purpose of testing the above hypothesis, a logistic regression was performed, which yielded a result of 4.51 with a p-value of 0.0118. The conclusion that can be drawn from this testing is that this result confirms the significant impact of administrative barriers on the availability of external financing. In order to improve the process, it is necessary to implement regulatory improvements, in order for companies to have easier access to various sources of financing.

The next hypothesis 4 related to the relationship between innovation and external financing, where the Chi-square test was applied for testing purposes. The value obtained through this test is relatively high and amounts to 9.048974, but with a slightly higher p-value of 0.059887, which can be interpreted as not being able to confirm with certainty that there is a significant relationship between innovative activities and the use of external financing. However, since the p-value is very close to the significance threshold, the result obtained can be considered borderline significant. In other words, with a larger sample, the stated relationship between innovative activities and access to external financing could be confirmed as statistically significant.

Hypothesis 5 analysed the relationship between company size and perception of obstacles. For the purpose of testing it, an ANOVA test was conducted, where the value obtained was 9.173106, with a p-value of 0.000142. These results confirm that there is a significant difference in the perception of obstacles that companies of different sizes have. An important conclusion that can be drawn is that smaller companies more often perceive obstacles in accessing sources of financial resources compared to larger companies.

Table 10. Overview of Hypothesis Testing Results and Statistical Significance

Hypothesis	Test Used	Test Statistic	p-value	Significance (p<0.05)
H1: Regional Differences in Perception of Financing Barriers	ANOVA & Kruskal-Wallis	1,790000	0,029700	Yes
H2: Company Size & External Financing Access	Chi-square Test	6,420000	0,042100	Yes
H3: Administrative Barriers & Use of External Financing	Logistic Regression	4,510000	0,011800	Yes
H4: Innovation & External Financing	Chi-square Test	9,048974	0,059887	No
H5: Company Size & Barriers	ANOVA	9,173106	0,000142	Yes
H6: Company Size & Government Grants	Chi-square Test	0,419610	0,810742	No

Source: Author's creation based on primary research results

The last hypothesis 6 was related to the relationship between the size of the company and the use of public funds. The test was conducted using the Chi-square test, which yielded a value of 0.419610, with a p-value of 0.810742. The conclusion that can be drawn is that there is no significant relationship between the size of the company and the use of public funds.

The summary conclusion after the performed hypothesis tests is that the size of the company, administrative obstacles and regional differences are the main factors affecting access to financial resources. On the other hand, sectoral differences and innovative activities did not show a statistically significant impact.

DISCUSSION

The results of the conducted research showed that access to financing represents a significant obstacle to the development of innovative activities of micro, small and medium-sized companies in Bosnia and Herzegovina, which was proven through the application of various statistical tests. The analysis additionally showed that there are certain factors, such as the size of the company, administrative barriers and the area from which the company comes, which significantly affect the access of the company to external sources. Furthermore, the results of the conducted tests showed that there is no statistically significant influence according to the sector from which the company comes and the current level of innovative activities.

During the analysis of the results, it was realized that one of the most important findings is precisely that micro and small companies have a significantly less favourable perception of the availability of external financing, when compared to medium-sized companies. This conclusion and realization was confirmed by descriptive analysis and statistical testing of the second hypothesis, where a p-value of 0.0421 was determined. This result can additionally be interpreted that the size of the company significantly affects the probability that the company will succeed in accessing and using external sources of financing. The results obtained are in line with existing literature and research which also confirm that smaller companies often do not have adequate means to secure the requested financial resources, do not have a long history of business, but also do not have the institutional capacity that is necessary for commercial banks and other financial institutions to consider their requests at all. It is important to emphasize that companies of this size generally do not have a research and devel-

opment department, which additionally negatively affects their ability to prepare and adequately present project proposals that are necessary to obtain financial support for the implementation of their innovative activities.

The results of the conducted research showed that access to financing represents a significant obstacle to the development of innovative activities of micro, small and medium-sized companies in Bosnia and Herzegovina, which was proven through the application of various statistical tests. The analysis additionally showed that there are certain factors, such as the size of the company, administrative barriers and the area from which the company comes, which significantly affect the access of the company to external sources. Furthermore, the results of the conducted tests showed that there is no statistically significant influence according to the sector from which the company comes and the current level of innovative activities.

A very important confirmation that was reached refers to hypothesis 5, for which it was determined through testing that there is a statistically significant difference in the responses of the respondents, which was confirmed by the p-value of 0.000142. The results confirmed that there is a clear difference in the perception of obstacles to financing innovative activities and the size of the company. It is also important to emphasize that micro companies more often perceive greater obstacles compared to companies of other sizes. These findings are very significant because they indicate that a different approach is needed to enable different measures to support innovative activities of companies, especially those that are micro or small, as companies of this size more often encounter barriers in accessing sources of finance.

The results of the conducted research also confirmed that there is a connection between administrative barriers and the availability of external sources of financing, which also proves hypothesis 3, which is confirmed by a p-value of 0.0118. In other words, complex bureaucratic requirements, lengthy administrative procedures and lack of institutional support significantly affect the reduced availability of external sources of financing that are necessary for innovative activities of companies. These conclusions and findings confirm the results of other research, which have also shown that administrative barriers can discourage companies, especially smaller ones, from seeking support from public funds, through grants or favourable financing conditions.

The analysis of the results also confirmed the hypothesis 1 due to the existence of statistically significant regional differences in the perception of obstacles to financing innovative activities by companies, which is confirmed by a p-value of 0.0297. This can be interpreted as meaning that those companies coming from developed environments have better access to institutional support and infrastructure, as well as more favourable conditions for external financing. On the other hand, companies coming from less developed environments feel greater challenges, which is also important information so that decision-makers can prepare special support measures for companies coming from these environments.

The results of the analysis of hypothesis 4 testing were unexpected, where no statistical correlation was confirmed between the innovative activities of companies, measured through attitudes towards the introduction of new and improvement of existing products and services, and the use of external sources of financing, which was confirmed by a p-value of 0.0598. This result can be interpreted as the fact that companies that carry out innovative activities, if they do not have sufficient institutional

support and capacity, fail to secure the financial resources they need to carry out further innovative activities. However, this level of p-value is borderline significant, and gives us an insight that in the case of an increase in the sample, the p-value may be below the 0.05 level, and thus it can be proven that there is a statistically significant difference.

The analysis of hypothesis six showed that there is no statistically significant correlation between the size of the company and the use of public funds, which was confirmed by a p-value of 0.8107. The conclusion that can be drawn is that public funds are not sufficiently targeted for financing according to the size of the company or that the level of funds is limited, which then opens the possibility of insufficient financing of innovative activities of companies.

Finally, it can be concluded that the results of the research have shown and confirmed that obstacles to financing innovative activities of micro, small and medium-sized companies in Bosnia and Herzegovina arise as a result of a combination of various structural factors, such as the size of the company, then the expressed institutional weakness that exists, which is manifested through various administrative barriers and insufficient support from decision-makers, and information asymmetry.

CONCLUSIONS

The results of the conducted research clearly showed that access to external sources of financing is a serious obstacle to the implementation of innovative activities of micro, small and medium-sized companies in Bosnia and Herzegovina. Furthermore, the results showed that companies rely to a significant extent on their own sources of financing for innovative activities, while on the other hand, external sources, which include loans from commercial banks and microcredit organizations, and public funds, are significantly underutilized. Key factors contributing to underutilization are complex administrative barriers and procedures, unfavourable lending conditions, and insufficient information about possible and available financial instruments.

Worrying conclusions and findings were reached when it comes to micro companies, which, according to the research results, feel the burden of the aforementioned obstacles the most. It is precisely the perception of micro companies that is most pronounced in the area of administrative barriers, unfavourable financing conditions, as well as lack of information, accompanied by insufficient state support. Although small and medium-sized companies also perceive the aforementioned problems, the determined intensity of the problems is most pronounced in the smallest business entities. On the other hand, medium-sized companies, which also expressed a negative attitude and perception towards the aforementioned problems, have a slightly higher level of resilience and better access to external sources of financing.

Statistical analysis confirmed that there are statistically significant differences in the perception of financial barriers, which is related to the size of the company and the area from which the company comes. In addition, statistical analysis showed that administrative barriers have a statistically significant negative impact on the possibility of using external sources of financing, which further indicates that it is necessary to implement reforms to simplify administrative procedures. On the other hand, the results of statistical analysis did not confirm the existence of statistically significant differences and connections between innovative activities of companies and access to external financing, although there is a certain level of connection.

Based on all the results, there is a clear need for the implementation of targeted measures and policies, as well as interventions that would improve the availability of financial resources in the segment of promoting innovative activities of companies, which can be ensured by creating and promoting favourable credit lines, especially for micro, but also small and medium-sized companies in Bosnia and Herzegovina, better availability and targeting of funds from public funds, then by reducing administrative barriers and improving the segment for the availability of information on external sources of funds available to companies.

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ORIGINALNI NAUČNI RAD / ORIGINAL SCIENTIFIC PAPER

INVESTICIJE U VJEŠTAČKU INTELIGENCIJU KAO POKRETAČ ODRŽIVOG RAZVOJA MALIH I SREDNJIH PREDUZEĆA U BOSNI I HERCEGOVINI

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Sažetak: *Vještačka inteligencija (AI) mijenja poslovanje malih i srednjih preduzeća (MSP) omogućavajući automatizaciju, prediktivnu analitiku i efikasnije odlučivanje, čime doprinosi njihovoj konkurentnosti i održivosti. U Bosni i Hercegovini, gdje MSP čine preko 60% zaposlenosti, AI ima potencijal da unaprijedi ekonomske, ekološke i društvene aspekte održivog razvoja. Ovaj rad istražuje obim i strukturu investicija u AI među MSP u BiH te njihov utjecaj na održivo poslovanje. Podaci su prikupljeni anketom među 40 preduzeća iz sektora trgovine, proizvodnje i usluga, a analizirani su u softveru SPSS korišćenjem deskriptivne statistike, korelacione analize i višestruke regresije. Rezultati pokazuju da samo 20% MSP koristi AI alate, poput chatbotova i analitičkih platformi, uglavnom zbog visokih troškova, nedostatka stručnog znanja i ograničene institucionalne podrške. Preduzeća koja ulažu u AI bilježe smanjenje operativnih troškova za 10–20%, bolje upravljanje resursima, smanjenje otpada i poboljšanu kvalitetu usluga. Rad ukazuje na ključne prepreke, uključujući nedostatak stručnjaka i pristupa EU fondovima, te predlaže mjere poput subvencija, besplatnih obuka i saradnje s IT sektorom. Zaključuje se da investicije u AI pružaju MSP priliku za tehnološki napredak i dugoročnu održivost u globalno konkurentnom i digitalizovanom tržištu, uz potrebu za snažnijom podrškom politika.*

Ključne riječi: *vještačka inteligencija, mala i srednja preduzeća, održivi razvoj, digitalna transformacija, Bosna i Hercegovina*

JEL klasifikacija: *O33, L26, Q56, C6*

UVOD

Mala i srednja preduzeća (MSP) čine temelj privrednog sistema Bosne i Hercegovine, doprinoseći preko 60% ukupne zaposlenosti i značajnom udjelu u bruto domaćem proizvodu, koji se procjenjuje na oko 65% (Privredna komora FBiH, 2023). Uprkos njihovom značaju, MSP se suočavaju s brojnim izazovima koji ugrožavaju

njihovu konkurentnost i dugoročnu održivost. Ovi izazovi uključuju ograničene finansijske resurse, nisku produktivnost, nedostatak stručnog kadra i sporu implementaciju modernih tehnologija. U kontekstu globalne digitalizacije i sve veće potrebe za održivim poslovanjem, vještačka inteligencija (AI) pojavljuje se kao ključni alat za transformaciju poslovnih procesa. AI omogućava automatizaciju rutinskih zadataka, prediktivnu analitiku, optimizaciju resursa i efikasnije donošenje odluka, što može značajno unaprijediti poslovanje MSP. Međutim, u BiH je usvajanje AI tehnologija među MSP i dalje na veoma niskom nivou, uglavnom zbog visokih troškova implementacije, nedostatka tehničkog znanja, ograničenog pristupa finansiranju i nedovoljne institucionalne podrške. Ovaj problem postaje još izraženiji u svjetlu zahtjeva za održivim razvojem, koji podrazumijeva balansiranje ekonomskih ciljeva s ekološkom odgovornošću i društvenim benefitima, što je posebno važno za zemlje u tranziciji poput BiH.

Predmet ovog istraživanja jesu investicije u vještačku inteligenciju među malim i srednjim preduzećima u Bosni i Hercegovini i njihov uticaj na postizanje održivog razvoja. Istraživanje se fokusira na analizu obima i strukture ovih investicija, identifikaciju koristi koje one donose u pogledu ekonomskih, ekoloških i društvenih aspekata, te na prepreke koje sprečavaju šire usvajanje AI tehnologija. Glavni cilj rada je kvantitativno ispitati kako investicije u AI doprinose optimizaciji poslovnih procesa MSP, smanjenju operativnih troškova, povećanju efikasnosti resursa i smanjenju ekološkog otiska, uz istovremeno pružanje praktičnih preporuka za donosiocje politika i menadžere MSP. Specifični ciljevi uključuju: (1) utvrđivanje trenutnog nivoa investicija u AI među MSP u BiH, (2) kvantifikaciju koristi koje AI donosi u smislu održivosti, (3) identifikaciju ključnih prepreka za implementaciju AI, i (4) predlaganje mjera za ubravanje digitalne transformacije MSP.

Motiv za provođenje ovog istraživanja proističe iz više faktora. Prvo, MSP u BiH igraju ključnu ulogu u ekonomskom razvoju, ali zaostaju u digitalizaciji u poređenju s MSP u zemljama Evropske unije, što ograničava njihov potencijal za rast i konkurentnost. Drugo, globalni trendovi digitalizacije i održivog razvoja, uključujući prioritete EU integracija, naglašavaju potrebu za usvajanjem naprednih tehnologija poput AI kako bi se os uredno poslovanje MSP postalo konkurentnije i održivo. Treće, postoji nedostatak empirijskih istraživanja o primjeni AI u MSP u BiH, što ovaj rad čini relevantnim za akademsku zajednicu, donosiocje politika i praktičare. Konačno, istraživanje ima za cilj da doprinese jačanju privrednog ambijenta u BiH kroz pružanje dokaza o potencijalu AI za unapređenje održivosti i konkurentnosti MSP.

Kako bi se odgovorilo na postavljeni problem, rad testira sljedeće hipoteze:

- **H1:** Investicije u vještačku inteligenciju značajno doprinose smanjenju operativnih troškova, povećanju efikasnosti resursa i poboljšanju kvaliteta usluga/proizvoda među MSP u BiH.
- **H2:** Nedostatak finansijskih resursa, stručnog znanja i institucionalne podrške predstavlja glavne prepreke za usvajanje AI tehnologija u MSP u BiH.
- **H3:** Primjena AI tehnologija značajno doprinosi ekološkim aspektima održivosti, uključujući smanjenje otpada i potrošnje energije.

Ove hipoteze biće testirane kvantitativnom analizom podataka prikupljenih putem ankete među MSP u BiH, uz korišćenje softvera SPSS za deskriptivnu statistiku, korelaciju analizu i višestruku regresiju. U zaključku rada, autori će se očitovati o tome u kojoj mjeri su hipoteze potvrđene ili opovrgnute, uz diskusiju o implikacijama nalaza.

Rad je strukturiran na sljedeći način: prvo poglavlje predstavlja teorijski okvir i pregled literature o AI, MSP i održivom razvoju. Drugo poglavlje opisuje metodologiju istraživanja, uključujući dizajn ankete, uzorak, studije slučaja i analitičke metode. Treće poglavlje prikazuje rezultate kvantitativne analize i studija slučaja. Četvrto poglavlje sadrži diskusiju nalaza u odnosu na literaturu i hipoteze. Peto poglavlje nudi praktične preporuke za MSP, donosioce politika i institucije. Konačno, zaključak sumira ključne nalaze, ograničenja istraživanja i smjernice za buduća istraživanja.

PREGLED LITERATURE

Pregled literature pruža sveobuhvatan uvid u relevantna istraživanja o primjeni vještačke inteligencije (AI) u poslovanju malih i srednjih preduzeća (MSP), njenom doprinosu održivom razvoju i preprekama za implementaciju, s posebnim osvrtom na kontekst Bosne i Hercegovine i zemalja u tranziciji. Istraživanja potvrđuju da AI transformiše poslovne procese MSP kroz automatizaciju, prediktivnu analitiku i optimizaciju resursa, ali i ukazuju na značajne izazove u zemljama s nižim nivoom digitalizacije. Ovaj pregled sintetizira ključne nalaze iz globalnih i regionalnih studija, pružajući osnovu za razumijevanje uloge AI u MSP i potrebu za empirijskim istraživanjima u BiH.

Brojna istraživanja pokazuju da AI značajno unapređuje efikasnost MSP. AI alati, poput mašinskog učenja i analitičkih platformi, smanjuju operativne troškove za 10–20% kroz automatizaciju rutinskih zadataka i optimizaciju procesa (Brynjolfsson & McAfee, 2014). Na primjer, implementacija chatbotova u korisničkoj podršci može skratiti vrijeme odgovora za 40% i povećati zadovoljstvo kupaca za 30% (Gartner, 2020). Chui i suradnici dodaju da AI-bazirani sistemi za upravljanje zalihama smanjuju troškove skladištenja za 15–25%, što je posebno važno za MSP s ograničenim resursima (Chui, i drugi, 2018). Slično, Bughin i suradnici pokazuju da MSP koja koriste prediktivne analitičke alate bilježe povećanje prihoda za 5–10% kroz bolje donošenje odluka (Bughin, Seong, Manyika, Chui, & Joshi, 2018). Ovi nalazi naglašavaju potencijal AI da poboljša konkurentnost MSP u sektorima trgovine, proizvodnje i usluga.

U kontekstu održivog razvoja, AI doprinosi ekonomskim, ekološkim i društvenim ciljevima. AI može podržati 17 ciljeva održivog razvoja UN-a, uključujući smanjenje emisija CO₂ i otpada kroz optimizaciju proizvodnih procesa (Vinuesa, i drugi, 2020). Prema Svjetskom ekonomskom forumu (World Economic Forum, 2023), AI sistemi za upravljanje energijom smanjuju potrošnju energije za 10–15%, omogućavajući MSP usklađivanje s EU zelenim politikama. Na primjer, AI-bazirana analiza podataka u proizvodnji može smanjiti otpad za 20%, čime se smanjuju troškovi i ekološki otisak (Berger, 2022). Međutim, istraživanja upozoravaju na rizike, poput gubitka radnih mjesta zbog automatizacije. Frey i Osborne procjenjuju da 47% radnih mjesta u MSP može biti ugroženo AI, što zahtijeva programe prekvalifikacije radnika (Frey & Osborne, 2017).

U zemljama Zapadnog Balkana, uključujući BiH, digitalizacija MSP zaostaje zbog finansijskih, tehničkih i institucionalnih prepreka. EBRD navodi da samo 15–20% MSP u regionu koristi napredne tehnologije, u poređenju s preko 50% u EU (EBRD, 2022). U BiH, tek 10–15% MSP koristi osnovne AI alate, poput CRM sistema s AI elementima, dok su složenije tehnologije, poput mašinskog učenja, gotovo neprisutne (GIZ, 2022). OECD ukazuje da MSP u tranzicionim ekonomijama nemaju

kapacitete za implementaciju AI zbog nedostatka stručnog kadra i finansiranja (Organisation for Economic Co-operation and Development, 2020). Lokalna istraživanja pokazuju da MSP u urbanim centrima BiH, poput Sarajeva i Banje Luke, imaju veću vjerovatnoću za usvajanje AI zbog bolje infrastrukture, dok ruralna područja značajno zaostaju (Privredna komora FBiH, 2023). EU4Digital naglašava da ograničen pristup EU fondovima, poput programa „Digitalna Evropa“, dodatno usporava digitalizaciju MSP u BiH (EU4Digital, 2021).

Prepreke za usvajanje AI u MSP su višeslojne. Visoki troškovi implementacije i nedostatak stručnjaka ograničavaju MSP u zemljama s nižim nivoom digitalizacije (McKinsey, 2021). MSP često nemaju strateške planove za digitalnu transformaciju, što smanjuje njihovu sposobnost za korišćenje AI (Ghobakhloo & Fathi, 2020). U BiH, studija BIT Centra Sarajevo ukazuje na nedostatak svijesti o prednostima AI, ograničenu saradnju s IT sektorom i nedovoljnu institucionalnu podršku (BIT Centar Sarajevo, 2022). Na primjer, samo 5% MSP u BiH koristi EU fondove za digitalizaciju zbog složenih administrativnih procedura (Western Balkans Digital Summit, 2023). Istraživanje Pappasa i drugih naglašava da kulturni otpor prema novim tehnologijama dodatno komplikuje usvajanje AI u MSP, posebno u tradicionalnim sektorima poput proizvodnje (Pappas, Mikalef, Giannakos, & Krogstie, 2021).

Investicije u AI pokazuju značajne razlike između razvijenih i tranzicionih ekonomija. MSP u razvijenim zemljama finansiraju AI projekte kombinacijom vlastitih sredstava i javnih grantova, dok MSP u BiH uglavnom zavise od vlastitih resursa (Deloitte, 2022). Ciljane investicije u AI povećavaju dugoročni rast MSP, ali zahtijevaju jasnu strategiju (Russell & Norvig, 2016). U BiH, ulaganja u AI su koncentrisana u IT sektoru, dok su proizvodni i trgovački sektori manje aktivni (GIZ, 2022). Prema izvještaju Digital Europe (2021), MSP u Zapadnom Balkanu ulažu prosječno 5.000–10.000 EUR godišnje u digitalne tehnologije, što je značajno ispod EU prosjeka od 50.000 EUR. Ovi nalazi ukazuju na potrebu za politikama koje bi podsticale investicije u AI među MSP u BiH.

Specifično za BiH, ograničena istraživanja ukazuju na početne faze usvajanja AI. Studija Privredne komore FBiH pokazuje da MSP u sektoru usluga češće koriste AI alate, poput analitičkih platformi, u odnosu na proizvodni sektor, gdje je usvajanje ispod 5% (Privredna komora FBiH, 2023). GIZ navodi da nedostatak lokalnih stručnjaka za AI i visoki troškovi obuke dodatno ograničavaju implementaciju (GIZ, 2022). MSP u BiH percipiraju AI kao skupu tehnologiju s nejasnim povratom ulaganja, što smanjuje motivaciju za investiranje (Hasanović & Lasić, 2023). Dodatno, izvještaj BIT Centra Sarajevo (2022) pokazuje da samo 10% MSP u BiH ima pristup IT konsultantskim uslugama, što ograničava njihovu sposobnost za implementaciju AI rješenja.

Globalna istraživanja takođe naglašavaju važnost institucionalne podrške za usvajanje AI. Evropska komisija ističe da programi poput „Digitalna Evropa“ mogu značajno povećati digitalizaciju MSP, ali zahtijevaju bolju koordinaciju na nacionalnom nivou (European Commission, 2021). Slično, druga studija pokazuje da MSP koja sarađuju s inovacionim centrima imaju 30% veću vjerovatnoću za uspješnu implementaciju AI (Davenport & Ronanki, 2018). U kontekstu BiH, ove spoznaje ukazuju na potrebu za jačanjem saradnje između MSP, vlada i IT sektora.

Literatura potvrđuje da AI ima ogroman potencijal za unapređenje konkurentnosti i održivosti MSP, ali u BiH postoje specifični izazovi, uključujući niski nivo

digitalizacije, ograničene investicije i nedostatak stručnog kadra. Dok globalna istraživanja pružaju široku perspektivu, empirijske studije o BiH su rijetke, što čini ovo istraživanje značajnim za popunjavanje te praznine. Kvantitativna analiza utjecaja AI na MSP u BiH, uz praktične preporuke, može doprinijeti razvoju politika za ubrzavanje digitalne transformacije i održivog razvoja.

METODOLOGIJA ISTRAŽIVANJA

Ova studija koristi kombinaciju kvantitativnih i kvalitativnih metoda kako bi ispitala uticaj investicija u vještačku inteligenciju (AI) na održivi razvoj malih i srednjih preduzeća (MSP) u Bosni i Hercegovini. Primarne metode uključuju anketu, statističku analizu podataka u softveru IBM SPSS Statistics 24, studije slučaja i analizu sekundarnih izvora. Cilj istraživanja je utvrditi obim i strukturu investicija u AI, identifikovati njihove koristi (npr. smanjenje operativnih troškova, povećanje efikasnosti resursa, smanjenje ekološkog otiska) i prepreke (npr. finansijske i znanstvene barijere), te pružiti preporuke za unapređenje digitalizacije MSP. Metodološki doprinos autora ogleda se u prilagođenom kvantitativnom pristupu koji kombinuje deskriptivnu statistiku, korelacionu analizu i višestruku regresiju za analizu specifičnog konteksta BiH, uz kvalitativne studije slučaja koje ilustruju praktičnu primjenu AI u MSP. Ovaj pristup omogućava testiranje hipoteza i korištenje analize od strane drugih autora, čime se osigurava naučna rigoroznost.

Anketa je provedena na uzorku od 40 MSP iz sektora trgovine, proizvodnje i usluga, odabranih slučajnim uzorkovanjem putem privrednih komora i LinkedIn grupa u BiH (Sarajevo, Banja Luka, Mostar, Tuzla). Upitnik je sadržavao zatvorena i poluotvorena pitanja, uključujući demografske podatke (veličina firme, sektor, prihod), korišćenje AI alata (da/ne, vrsta alata), iznos investicija u AI, koristi (Likert skala 1–5 za smanjenje troškova, efikasnost, kvalitet usluga) i prepreke (npr. troškovi, znanje, institucionalna podrška). Pouzdanost upitnika testirana je Cronbachovim alfa koeficijentom ($\alpha = 0.85$), što ukazuje na visoku internu konzistentnost. Anonimnost ispitanika je osigurana, a informisani pristanak dobijen prije prikupljanja podataka.

Statistička analiza provedena je u softveru IBM SPSS Statistics 24. Deskriptivna statistika korišćena je za prikaz osnovnih karakteristika uzorka, uključujući srednju vrijednost (mean), medijanu (median), standardnu devijaciju (std. dev.), minimum i maksimum za varijable poput iznosa investicija i percipiranih koristi. Frekvencijska analiza korišćena je za utvrđivanje postotka MSP koji koriste AI i vrste alata. Korelaciona analiza (Pearsonov koeficijent) primijenjena je za ispitivanje odnosa između investicija u AI i koristi (npr. smanjenje troškova, efikasnost resursa). Višestruka linearna regresija korišćena je za predviđanje uticaja investicija u AI na održivost MSP, definisana sljedećim modelom:

Formula 1.

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \varepsilon_i \quad (\forall i)$$

Izvor: (Field, 2018)

Gdje je Y_i zavisna varijabla (npr. smanjenje operativnih troškova, mjereno Likert skalom 1–5), X_{1i} predstavlja iznos investicija u AI (u KM), X_{2i} korišćenje AI alata (0 = ne, 1 = da), X_{3i} veličinu firme (broj zaposlenih), ε_i je slučajno odstupanje (rezidu-

al), a $\beta_0, \beta_1, \beta_2, \beta_3$ su parametri modela. Estimacija parametara provedena je metodom najmanjih kvadrata, a rezultujući model ima oblik:

Formula 2.

$$\hat{Y}_i = \hat{b}_0 + \hat{b}_1 X_{1i} + \hat{b}_2 X_{2i} + \hat{b}_3 X_{3i}$$

Izvor: (Petrić, 1979)

Tokom analize izračunati su sljedeći pokazatelji: standardna greška procjene (std. error) za preciznost parametara, koeficijent determinacije (R^2) za objašnjenje varijance, t-statistika za testiranje značajnosti pojedinačnih parametara, F-statistika za značajnost cjelokupnog modela, te Durbin-Watson statistika za detekciju serijske korelacije reziduala (vrijednosti bliske 2 ukazuju na odsustvo korelacije). P-vrijednosti ($p < 0.05$) korišćene su za testiranje hipoteza o značajnosti varijabli. Pretpostavke regresije (normalnost, linearna zavisnost, homoskedastičnost) testirane su korišćenjem grafikona (npr. histogram reziduala, scatter plotovi) i statističkih testova (npr. Shapiro-Wilk). Ako F-statistika premašuje kritičnu vrijednost i p-vrijednost je manja od 0.05, model se smatra statistički značajnim.

Studije slučaja provedene su na dvije firme: IT preduzeće u Sarajevu koje koristi AI chatbot za korisničku podršku i proizvodnu firmu u Banjoj Luci koja koristi analitičku platformu za optimizaciju proizvodnje. Podaci su prikupljeni putem polustrukturiranih intervjuva s menadžerima i analize internih izvještaja, fokusirajući se na koristi (npr. smanjenje troškova, otpad) i izazove implementacije. Ova kvalitativna analiza dopunjuje kvantitativne nalaze, pružajući praktične primjere primjene AI.

Sekundarni podaci prikupljeni su iz izvještaja Privredne komore BiH, GIZ-a, EU4Digital i drugih relevantnih izvora kako bi se dobio uvid u stanje digitalizacije MSP u BiH. Komparativna analiza korišćena je za poređenje nalaza s drugim zemljama Zapadnog Balkana i EU, dok je deskriptivna metoda primijenjena za prikaz trendova i obrazaca u podacima.

Kombinacija kvantitativnih (anketa, SPSS analiza) i kvalitativnih (studije slučaja, sekundarni podaci) metoda omogućava sveobuhvatno testiranje hipoteza: (H1) investicije u AI značajno doprinose smanjenju troškova i povećanju efikasnosti MSP; (H2) nedostatak finansija i znanja predstavlja glavne prepreke; (H3) AI doprinosi ekološkoj održivosti. Jasno definisane varijable, standardizovane statističke procedure i transparentan opis metodologije omogućavaju drugim istraživačima da koriste analizu, čime se osigurava naučna validnost i pouzdanost nalaza.

REZULTATI ISTRAŽIVANJA I DISKUSIJA

Ovo poglavlje predstavlja rezultate istraživanja o uticaju investicija u vještačku inteligenciju (AI) na održivi razvoj malih i srednjih preduzeća (MSP) u Bosni i Hercegovini, temeljene na kvantitativnoj analizi podataka prikupljenih anketom među 40 preduzeća iz sektora trgovine, proizvodnje i usluga, te kvalitativnim studijama slučaja. Podaci su obrađeni u softveru IBM SPSS Statistics 24 korišćenjem deskriptivne statistike, frekvencijske analize, korelacione analize i višestruke linearne regresije, uz dodatnu komparativnu i deskriptivnu analizu sekundarnih izvora. Cilj je testiranje hipoteza postavljenih u uvodu: (H1) investicije u AI značajno doprinose smanjenju operativnih troškova, povećanju efikasnosti resursa i poboljšanju kvaliteta usluga/pro-

izvoda; (H2) nedostatak finansijskih resursa, znanja i institucionalne podrške su glavne prepreke; (H3) AI doprinosi ekološkim aspektima održivosti. Rezultati su prikazani u tabelama i grafikonima generisanim iz SPSS-a, uz detaljnu diskusiju u odnosu na literaturu i implikacije za BiH.

Deskriptivna statistika

Anketa je obuhvatila 40 MSP iz Sarajeva, Banje Luke, Mostara i Tuzle, ravnomjerno raspoređenih po sektorima: trgovina (35%), proizvodnja (32,5%) i usluge (32,5%). Veličina preduzeća varirala je od 5 do 250 zaposlenih, s prosječnom veličinom od 52,3 zaposlena ($SD = 42,7$). Samo 20% preduzeća (8 od 40) koristi AI alate, poput chatbotova, CRM sistema s AI elementima i analitičkih platformi, što je u skladu s niskim nivoem digitalizacije u BiH (GIZ, 2022). Prosječni godišnji iznos investicija u AI iznosio je 2.250 KM ($SD = 4.800$ KM), s rasponom od 0 KM (za preduzeća koja ne koriste AI) do 20.000 KM (za preduzeća s AI implementacijom). Tabela 1 prikazuje osnovne statističke pokazatelje za ključne varijable.

Tabela 1. Deskriptivna statistika

Varijabla	Srednja vrijednost	Std. devijacija	Minimum	Maksimum	N
Veličina firme (zaposleni)	52,30	42,70	5	250	40
Iznos investicija (KM)	2250,00	4800,00	0	20000	40
Smanjenje troškova (1–5)	2,10	1,30	1	5	40
Efikasnost resursa (1–5)	2,05	1,25	1	5	40
Smanjenje otpada (1–5)	1,65	1,00	1	4	40
Prepreke – Finansije (1–5)	4,20	0,90	2	5	40
Prepreke – Znanje (1–5)	3,80	1,00	1	5	40
Prepreke – Podrška (1–5)	3,10	0,95	1	4	40

Izvor: Autori, SPSS, 2024

Iz tabele se vidi da preduzeća percipiraju značajne finansijske prepreke ($M = 4,20$, $SD = 0,90$) i nedostatak znanja ($M = 3,80$, $SD = 1,00$) kao ključne barijere za implementaciju AI, dok je institucionalna podrška manje izražena prepreka ($M = 3,10$, $SD = 0,95$). Koristi od AI, poput smanjenja troškova ($M = 2,10$) i efikasnosti resursa ($M = 2,05$), imaju niske prosječne vrijednosti zbog malog broja preduzeća koja koriste AI, dok je smanjenje otpada najslabije izraženo ($M = 1,65$), što ukazuje na ograničen fokus na ekološke benefite.

Frekvencijska analiza

Frekvencijska analiza potvrdila je da samo 8 preduzeća (20%) koristi AI alate, s većim udjelom u sektoru usluga (4 preduzeća) i proizvodnje (3 preduzeća) u odnosu na trgovinu (1 preduzeće). Tabela 2 prikazuje distribuciju korišćenja AI po sektorima.

Tabela 2. Frekvencijska analiza korišćenja AI po sektorima

Sektor	Korišćenje AI (Ne, %)	Korišćenje AI (Da, %)	Ukupno (%)
Trgovina	13 (92,9%)	1 (7,1%)	14 (35,0%)
Proizvodnja	10 (76,9%)	3 (23,1%)	13 (32,5%)
Usluge	9 (69,2%)	4 (30,8%)	13 (32,5%)
Ukupno	32 (80,0%)	8 (20,0%)	40 (100%)

Izvor: autori, SPSS, 2024

Ovi rezultati ukazuju da su usluge i proizvodnja sklonije usvajanju AI, vjerovatno zbog dostupnosti alata poput chatbotova u uslugama i analitičkih platformi u proizvodnji. Trgovinski sektor pokazuje najniži nivo usvajanja, što može biti povezano s manjim investicijama u digitalne tehnologije (Privredna komora FBiH, 2023).

Korelaciona analiza

Pearsonova korelacija ispitala je odnose između investicija u AI, korišćenja AI alata, veličine firme i koristi (smanjenje troškova, efikasnost resursa, smanjenje otpada). Tabela 3 prikazuje rezultate.

Tabela 3. Pearsonova korelacija između ključnih varijabli

Varijabla	1	2	3	4	5	6
1. Iznos investicija (KM)	1,000					
2. Korišćenje AI (0=Ne, 1=Da)	0,892**	1,000				
3. Veličina firme	0,435*	0,412*	1,000			
4. Smanjenje troškova	0,785**	0,820**	0,310	1,000		
5. Efikasnost resursa	0,760**	0,795**	0,295	0,880**	1,000	
6. Smanjenje otpada	0,650**	0,680**	0,250	0,720**	0,740**	1,000

Napomena: **Korelacija značajna na nivou 0,01 (2-tailed); Korelacija značajna na nivou 0,05 (2-tailed).

Izvor: Autori, SPSS, 2024

Rezultati pokazuju snažnu pozitivnu korelaciju između korišćenja AI alata i smanjenja troškova ($r = 0,820$, $p < 0,01$), efikasnosti resursa ($r = 0,795$, $p < 0,01$) i smanjenja otpada ($r = 0,680$, $p < 0,01$). Iznos investicija takođe ima značajnu korelaciju s ovim koristima ($r = 0,785$ za troškove, $r = 0,760$ za efikasnost, $r = 0,650$ za otpad, $p < 0,01$), dok je veličina firme slabo povezana s koristima ($r = 0,310$ za troškove, $p > 0,05$). Ovi nalazi podržavaju H1 i H3, sugerišući da AI ima pozitivan uticaj na ekonomske i ekološke aspekte održivosti.

Regresiona analiza

Višestruka linearna regresija testirala je uticaj nezavisnih varijabli (iznos investicija, korišćenje AI, veličina firme) na zavisnu varijablu (smanjenje operativnih troškova). Model je definisan kao:

Formula 1:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \varepsilon_i$$

Izvor: (Field, 2018)

Gdje je Y_i smanjenje troškova (1–5), X_{1i} iznos investicija (KM), X_{2i} korišćenje AI (0=Ne, 1=Da), X_{3i} veličina firme (zaposleni). Tabela 4. prikazuje rezultate regresionog modela.

Tabela 4. Rezultati regresione analize

Model	R	R ²	Adjusted R ²	Std. Error	F	Sig.	Durbin-Watson
1	0,850	0,722	0,702	0,705	36,214	0,000	1,950

Izvor: Autori, SPSS, 2024

Koeficijent determinacije ($R^2 = 0,722$) pokazuje da model objašnjava 72,2% varijance u smanjenju troškova, dok prilagođeni R^2 (0,702) potvrđuje robustnost modela. F-statistika ($F = 36,214$, $p < 0,001$) ukazuje na statističku značajnost modela. Durbin-Watson statistika (1,950) bliska je 2, što potvrđuje odsustvo autokorelacije reziduala. Tabela 5 prikazuje koeficijente regresije.

Tabela 5. Koeficijenti regresije

Prediktor	B (Unstandardized)	Std. Error	Beta (Standardized)	t	Sig.	VIF
(Constant)	1,120	0,180		6,222	0,000	
Iznos investicija (KM)	0,0001	0,00003	0,320	3,333	0,002	1,450
Korišćenje AI	1,450	0,250	0,450	5,800	0,000	1,420
Veličina firme	0,002	0,001	0,120	1,200	0,237	1,300

Izvor: Autori, SPSS, 2025

Regresiona jednačina glasi:

$\hat{Y} = 1,120 + 0,0001 \times \text{Iznos investicija} + 1,450 \times \text{Korišćenje AI} + 0,002 \times \text{Veličina firme}$

Korišćenje AI alata ima najveći uticaj ($\beta = 0,450$, $p < 0,001$), slijedi iznos investicija ($\beta = 0,320$, $p = 0,002$), dok veličina firme nije statistički značajna ($\beta = 0,120$, $p = 0,237$). VIF vrijednosti (1,300–1,450) ukazuju na odsustvo multikolinearnosti. Pretpostavke regresije (normalnost, homoskedastičnost) potvrđene su Shapiro-Wilk testom ($p = 0,150$) i scatterplotom reziduala.

Studije slučaja

Kvalitativna analiza obuhvatila je dva MSP: IT preduzeće u Sarajevu koje koristi AI chatbot za korisničku podršku i proizvodnu firmu u Banjoj Luci koja koristi analitičku platformu za optimizaciju proizvodnje. IT preduzeće izvijestilo je o smanjenju troškova korisničke podrške za 30% i povećanju zadovoljstva kupaca za 25%, ali je naglasilo potrebu za kontinuiranom obukom zaposlenih. Proizvodna firma zabilježila je smanjenje otpada za 15% i potrošnje energije za 10%, uz izazove povezane s visokim početnim troškovima implementacije (18.000 KM). Ovi nalazi potvrđuju kvantitativne rezultate i ukazuju na praktične benefite AI.

Diskusija

H1: Investicije u AI značajno doprinose smanjenju troškova, efikasnosti resursa i kvalitetu usluga/proizvoda. Hipoteza H1 je potvrđena. Snažna korelacija između

korišćenja AI i smanjenja troškova ($r = 0,820$) te regresioni rezultati ($\beta = 0,450$ za korišćenje AI) potvrđuju da AI alati smanjuju operativne troškove za 10–20%, što je u skladu s globalnim studijama (Brynjolfsson & McAfee, 2014). Preduzeća koja koriste AI bilježe i povećanu efikasnost resursa ($r = 0,795$), posebno u uslugama i proizvodnji, gdje su chatboti i analitičke platforme smanjili vrijeme obrade zahtjeva i troškove za liha za 15–25% (Gartner, 2020).

H2: Nedostatak finansija, znanja i institucionalne podrške su glavne prepreke. Hipoteza H2 je djelimično potvrđena. Finansijske prepreke ($M = 4,20$) i nedostatak znanja ($M = 3,80$) dominantni su, što potvrđuje literaturu (Ghobakhloo & Fathi, 2020). Međutim, institucionalna podrška ($M = 3,10$) manje utiče nego što se očekivalo, što može biti povezano s ograničenim pristupom EU fondovima (EU4Digital, 2021). Korrelacija između finansijskih prepreka i ne-korišćenja AI ($r = -0,650$, $p < 0,01$) ukazuje da su troškovi ključni razlog niskog AI usvajanja.

H3: AI doprinosi ekološkim aspektima održivosti. Hipoteza H3 je potvrđena. Smanjenje otpada ($r = 0,680$ s korišćenjem AI) i nalazi iz studije slučaja (15% smanjenje otpada u proizvodnji) potvrđuju da AI optimizira resurse i smanjuje ekološki otisak, što je u skladu s globalnim trendovima (Vinuesa, i drugi, 2020) (World Economic Forum, 2023). Ipak, niski prosjek smanjenja otpada ($M = 1,65$) sugerise da MSP u BiH još ne koriste puni potencijal AI za ekološku održivost.

U poređenju s literaturom, rezultati su konzistentni s globalnim nalazima o benefitima AI (McKinsey, 2021) (Deloitte, 2022), ali ističu specifičnosti BiH: niski nivo usvajanja AI (10–15% MSP, GIZ, 2022), ograničene investicije (5.000–10.000 KM godišnje naspram 50.000 EUR u EU) i nedostatak stručnog kadra (Hasanović & Lasić, 2023). Za razliku od razvijenih zemalja, gdje institucionalna podrška igra veću ulogu (European Commission, 2021), u BiH su finansijski i znančki izazovi dominantni. Studije slučaja dodatno potvrđuju da su početni troškovi i obuka zaposlenih ključni izazovi, ali i da AI donosi mjerljive koristi.

ZAKLJUČAK

Istraživanje uticaja investicija u vještačku inteligenciju (AI) na održivi razvoj malih i srednjih preduzeća (MSP) u Bosni i Hercegovini, provedeno na uzorku od 40 preduzeća iz sektora trgovine, proizvodnje i usluga, nedvosmisleno je pokazalo ogroman potencijal AI tehnologija za unapređenje konkurentnosti, efikasnosti i održivosti u specifičnom kontekstu tranzicione ekonomije. Kvantitativna analiza, izvedena u softveru IBM SPSS Statistics 24, potvrdila je hipoteze H1 i H3 u potpunosti, dok je H2 djelimično potvrđena, pružajući jasne dokaze o pozitivnim efektima AI, ali i ukazujući na postojeće izazove. Naime, samo 20% MSP u BiH trenutno koristi AI alate, poput chatbotova i analitičkih platformi, što ukazuje na izrazito nizak nivo digitalizacije u odnosu na standarde Evropske unije. Međutim, preduzeća koja su investirala u AI ostvarila su impresivne rezultate: smanjenje operativnih troškova za 10–20%, povećanu efikasnost resursa i značajno smanjenje otpada za 15–20%. Ovi nalazi nedvosmisleno potvrđuju doprinos AI ne samo ekonomskim, već i ekološkim aspektima održivosti, što je u skladu s globalnim istraživanjima. Regresiona analiza dodatno je pokazala da korišćenje AI ($\beta = 0,450$, $p < 0,001$) i iznos investicija ($\beta = 0,320$, $p = 0,002$) imaju ključnu ulogu u smanjenju troškova, dok veličina firme ima zanemarljiv uticaj ($\beta = 0,120$, $p = 0,237$), uz R^2 od 0,722 koji objašnjava čak 72,2% varijanse. Kvalitativne

studije slučaja, uključujući IT preduzeće u Sarajevu i proizvodnu firmu u Banjoj Luci, dodatno potvrđuju praktične koristi: smanjenje troškova korisničke podrške za 30% i otpada za 15%. Ipak, visoki početni troškovi, nedostatak znanja ($M = 3,80$) i finansijske prepreke ($M = 4,20$) ostaju ozbiljni izazovi, dok institucionalna podrška ($M = 3,10$) nije na očekivanom nivou, što objašnjava djelimičnu potvrdu H2. U poređenju s globalnim trendovima, BiH značajno zaostaje zbog niskih investicija (5.000–10.000 KM godišnje naspram 50.000 EUR u EU) i ograničenog pristupa fondovima.

Rezultati ovog istraživanja imaju dalekosežne praktične implikacije za MSP i donosiocje politika u BiH, nudeći konkretne smjernice za ubrzanje digitalne transformacije. Za MSP, ulaganje u AI nije samo prilika za smanjenje troškova i povećanje efikasnosti, već i ključni korak ka zelenoj tranziciji i dugoročnoj održivosti. Na primjer, AI alati za optimizaciju resursa mogu značajno smanjiti ekološki otisak ovih preduzeća, što je od posebnog značaja u kontekstu globalnih klimatskih ciljeva. S druge strane, donosioci politika moraju prepoznati hitnu potrebu za stvaranjem povoljnijeg okruženja za AI usvajanje. Programi poput „Digitalna Evropa“ trebaju biti dostupniji kroz pojednostavljene procedure i veću transparentnost. Besplatni treninzi za menadžere i zaposlene mogli bi značajno podići nivo AI kompetencija, dok bi uspostavljanje inovacionih centara i jačanje partnerstava s IT sektorom omogućili bržu i efikasniju implementaciju AI rješenja. Ove mjere ne samo da bi podržale MSP, već bi i doprinijele ukupnom ekonomskom razvoju BiH, smanjujući jaz između lokalnih preduzeća i njihovih konkurenata na međunarodnom tržištu.

Iako su nalazi ovog istraživanja robusni, postoje određena ograničenja koja treba uzeti u obzir, ali koja ni na koji način ne umanjuju njegovu važnost. Mali uzorak od 40 preduzeća i fokus na urbana područja mogu ograničiti primjenjivost rezultata na širi kontekst. Ruralna MSP, kao i sektori poput poljoprivrede, nisu bili obuhvaćeni, što ostavlja prostor za dalje analize. Takođe, kratki period posmatranja (jedna godina) onemogućava dublji uvid u dugoročne efekte AI usvajanja. Stoga se budućim istraživanjima preporučuje proširenje uzorka, uključivanje ruralnih područja i longitudinalni pristup koji bi omogućio praćenje uticaja AI na zaposlenost, produktivnost i ekološku održivost tokom dužeg vremenskog perioda. Posebno bi bilo korisno ispitati kako AI može transformisati tradicionalne sektore poput poljoprivrede, gdje BiH ima značajan potencijal, ali i specifične izazove.

Ovo istraživanje nije samo lokalno relevantno – ono ima daleko širi značaj i postavlja temelje za razumijevanje digitalne transformacije u tranzicionim ekonomijama sličnim BiH. Pružajući empirijske dokaze o prednostima i preprekama usvajanja AI u MSP, studija doprinosi globalnom znanju o ulozi tehnologije u unapređenju održivog razvoja. Njeni nalazi nude dragocjenu osnovu za razvoj ciljanih politika koje mogu ubrzati digitalizaciju, podstaći inovacije i ojačati konkurentnost MSP na globalnom tržištu. U kontekstu BiH, ovo istraživanje predstavlja pionirski korak ka premošćavanju digitalnog jaza i pozicioniranju zemlje kao aktivnog učesnika u četvrtoj industrijskoj revoluciji. Njegov značaj leži ne samo u trenutnim nalazima, već i u inspiraciji koju pruža za dalja istraživanja i praktične inicijative, čime se otvara put ka modernizaciji i prosperitetu privrede BiH.

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INVESTMENTS IN ARTIFICIAL INTELLIGENCE AS A DRIVER OF SUSTAINABLE DEVELOPMENT OF SMALL AND MEDIUM-SIZED ENTERPRISES IN BOSNIA AND HERZEGOVINA

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Abstract: Artificial intelligence (AI) is transforming small and medium-sized enterprises (SMEs) by enabling automation, predictive analytics and more informed, data-driven decision-making, thereby strengthening their competitiveness and long-term sustainability. In Bosnia and Herzegovina, where SMEs account for more than 60% of total employment and generate a substantial share of GDP, AI has the potential to support economic growth, improve environmental performance and create positive social outcomes, which is particularly important in the context of a transitional economy and EU integration. The paper examines the scale, structure and effects of investments in AI among SMEs in Bosnia and Herzegovina and their contribution to sustainable business models. Empirical data were collected through a survey of 40 enterprises from the trade, manufacturing and services sectors located in major urban centres. The questionnaire captured firm characteristics, types and amounts of AI investments, perceived economic, environmental and social benefits, as well as key barriers to AI adoption. The data were analysed in IBM SPSS Statistics using descriptive statistics, correlation analysis and multiple linear regression, complemented by two qualitative case studies of SMEs that have already implemented AI solutions. The results show that only 20% of the surveyed SMEs currently use AI tools, most frequently chatbots in customer support, customer-relationship systems with embedded AI functionalities and analytical platforms for process optimisation. Firms that invest in AI report a 10–20% reduction in operating costs, more efficient use of energy and materials, reduced waste and an improvement in service quality and customer satisfaction. Regression analysis confirms that both the amount of AI investment and the very use of AI tools significantly

contribute to perceived cost reductions, while firm size plays a marginal role.

At the same time, the findings highlight a set of persistent obstacles that limit wider diffusion of AI among SMEs. The most pronounced barriers are high initial investment costs, a lack of in-house expertise and difficulties in accessing specialised external support, as well as limited use of available EU and national support programmes due to complex administrative procedures. The paper therefore proposes a set of policy measures, including targeted subsidies and tax incentives for AI projects, free or subsidised training for managers and employees, and stronger partnerships between SMEs, IT companies and innovation centres. The overall conclusion is that AI investments can become an important driver of technological upgrading and sustainable development of SMEs in Bosnia and Herzegovina, provided that public policies and support instruments are better aligned with the needs and capacities of the SME sector.

Keywords: artificial intelligence, small and medium-sized enterprises, sustainable development, digital transformation, Bosnia and Herzegovina

JEL Classification: O33, L26, Q56, C6



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ORIGINALNI NAUČNI RAD / ORIGINAL SCIENTIFIC PAPER**POSITIVE PSYCHOLOGICAL CAPITAL AS A MEDIATOR
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Abstract: Positive psychology has led to a focus on creativity in occupational psychology, aiming to enhance productivity and wellbeing. Creativity, the ability to generate original and adaptable ideas, helps employees address challenges and achieve goals. Key factors include Psychological Capital (PsyCap), a positive psychological state, and Job Crafting (JC), which involves adjusting job demands and resources. However, the relationship between PsyCap, JC, and creativity remains unclear. A total of 250 workers from 25 job categories (science, business, finance, technology, digital sectors) participated, recruited in the UK between October 2022 and January 2023. SPSS 25.0 and PROCESS macro were used for data analysis. Job Crafting was positively related to PsyCap ($\beta = 0.4740$, $p = 0.0000$), and PsyCap was positively related to Creativity ($\beta = 0.2372$, $p = 0.0003$). Job Crafting had a significant positive effect ($p = 0.0000$) on Creativity ($\beta = 0.4740$). When PsyCap was included, the effect of Job Crafting on Creativity remained significant but decreased to 0.3463 ($p = 0.0000$). Job Crafting has both a direct and an indirect positive effect on Creativity, mediated by PsyCap. These findings highlight the role of PsyCap and Job Crafting in fostering Creativity at work. Future research can build on these findings by adding new variables and methods for studying Creativity development.

Keywords: Positive Psychological Capital, Job Crafting, Creativity/at work, Occupational Psychology, Work Life

JEL classification: M12, M54, J24, D91

INTRODUCTION

In today's rapidly evolving business environment, creativity is essential for an organization's survival and growth. The generation of fresh ideas and innovative solutions is crucial (Maimone & Sinclair, 2010). Creativity is not only important in various

aspects of life but also plays a vital role in the workplace (Kaufman & Beghetto, 2009). In fact, creativity is frequently generated within the workplace, as most jobs offer opportunities for employees to express creativity, even if only to a certain extent (Mercier & Lubart, 2023). Given its importance, fostering employee creativity has become crucial for organizational success. Consequently, businesses are adopting various strategies to inspire innovative and valuable ideas from their workforce (Ashkanasy et al., 2014). With the rapid pace of technological advancement and the constantly changing business landscape, individual creativity has emerged as a key factor in the success and sustainability of organizations (Binyamin & Carmeli, 2010). Briefly, creativity is essential for organizational success and sustainability, as it drives innovation and problem-solving in today's fast-paced and ever-changing business environment.

Creativity is considered a critical skill in today's society and is one of the 21st-century competencies demanded in the global workforce (Xu, 2024) (Mercier & Lubart, 2023). However, it is not an easy concept to define (Levis, 2005). Generally, creative thinking is described as the ability to produce original and context-appropriate results (Lubart et al., 2015). Creativity can also be defined as the capacity to generate original and adaptable ideas (Simonton, 2000). Furthermore, creativity is seen as an innovative approach that allows individuals to cope with challenges and achieve work-related goals. A creative work environment helps in generating new ideas to change products, services, and processes in the workplace (Amabile et al., 2005). Therefore, creativity is understood to be an important component of the workforce (Agistiawati et al., 2020) (Slåtten et al., 2020).

Psychological Capital (PsyCap) is defined as a psychological state formed by the interaction of four resources: self-efficacy, optimism, hope, and resilience. Self-efficacy refers to the confidence in one's ability to handle challenges, while optimism is the confidence in the future success of projects, based on a positive style of attributing causes to events (Martin-Krumm, 2012).

Research emphasizes the significance of employees not only completing their assigned tasks but also having the ability to reshape their jobs and enhance their work experience (Parker et al., 2021); (Lovejoy et al., 2021). In this context, allowing employees to play an active role in the job design process, and enabling them to reshape their tasks physically and cognitively, is called "job crafting," which has a creative impact (Mehboob et al., 2021). Job crafting allows employees to adapt their work to their strengths and weaknesses, thereby changing their working conditions (Harju et al., 2021). Thus, by increasing participation in job design, it is possible to encourage creative thinking.

Creativity is not just about the outcomes; it also involves the motivational, emotional, and cognitive resources of individuals (Lebuda & Benedek, 2022). To support and develop creativity, it is important to strengthen psychological resources in the workplace (Aldabbas et al., 2023). In this regard, it is expected that PsyCap serves as a mediating factor between job design and creative processes (Peng & Chen, 2023). Job crafting can assist employees in managing their creative processes (Sutarmin et al., 2023). Therefore, it is expected that PsyCap strengthens the relationship between job design and creativity by playing a mediating role.

In our study, we tested whether PsyCap mediates the relationship between job design and creativity. The results indicate that job design has a meaningful and positive

effect on creativity under the influence of PsyCap. PsyCap enhances the strength of the relationship between job design and creativity, thereby supporting this process.

The data show that job design has a significant effect on PsyCap. Additionally, PsyCap also has a positive effect on creativity. These results indicate that PsyCap and job design play an essential role in fostering creativity. In our study, the mediating role of PsyCap was highlighted as a crucial finding, and this mechanism offers organizations opportunities to design more creative work processes.

In conclusion, this study shows that PsyCap plays a mediating role in the relationship between job design and creativity. These findings emphasize that organizations should focus on PsyCap and job design to foster creative processes. Organizations can develop various strategies to enhance their employees' PsyCap levels and make job design more creative.

LITERATURE REVIEW

Creativity

Creativity is considered to be a key skill in today's society (Xu, 2024) and one such 21st century skill, which is in high demand by global business organisations, is creativity (Mercier & Lubart, 2023). Although it is not a concept that is easy to define (Levis, 2005), creativity refers to the ability to generate results that are both original and contextually relevant to the situation in which it occurs (Lubart et al. 2. , 2015). Also, creativity has been described as an embodied capacity to generate ideas that are both original and adaptable (Simonton, 2000). Creativity at work reflects the resources or individual capacity to be creative (Agistiawati et al., 2020); (Slåtten et al., 2020) and is often described in terms of being innovative (Asbari et al., 2021) in overcoming challenges and achieving work-related goals or generating fresh ideas to change products, services and processes to better achieve corporate goals (Amabile et al., 2005).

Positive Psychological Capital

The concept of PsyCap refers to the positive psychological development of an individual, characterised by the confidence to take on challenging tasks and to exert the necessary effort to succeed (Schaufeli et al., 2002); (Luthans et al., 2007); (Gayathri, 2022)(Alkahtani et al., 2021). It involves the ability to make positive attributions about current and future success, persevere towards goals, and adjust approach when necessary. In addition, it involves the maintenance of resilience and the ability to bounce back from adversity to ultimately achieve success (Gayathri, 2022); (Rajalakshmi & Gayathri, 2022); (Kümbül Güler, 2009). PsyCap has been proposed (Vilariño del Castillo & Lopez-Zafra, 2021) to consist of four psychological resources: self-efficacy, hope, optimism and resilience. Self-efficacy refers to an individual's belief in their motivation and cognitive abilities to perform a task successfully (Stajkovic & Luthans, 1988). Hope is a positive motivational state derived from a sense of being capable of success, fuelled by goal-directed energy and planning for goal attainment (Snyder et al., 1991). Optimism involves having a positive outlook on succeeding now and continuing to succeed (Luthans et al., 2007). Resilience is the ability to adapt in a positive way and to overcome adversity through the use of personal, social or psychological resources (Masten et al., 2009). As such, PsyCap is a multidimensional construct that is made up of interrelated dimensions (Youssef-Morgan, 2022).

Job Crafting

(Tims & Bakker, 2010) highlight the importance of giving employees a greater influence over their job design, rather than having them passively perform assigned tasks (Tims et al., 2012). Furthermore, employees can actively redesign their job tasks and can improve their work experiences, leading to increased creativity (Scharp et al., 2019). In this context, the concept of job crafting refers to self-initiated behaviours by employees (Moghimi et al., 2017) and involves physical and cognitive modifications that employees make to define the boundaries of their job tasks or relationships. Job crafting has gained considerable attention since its introduction over two decades ago (Wrzesniewski & Dutton, 2001) and is seen as a type of bottom-up job design with great potential to increase work engagement and performance (Oprea et al., 2019). Employees can engage in task, cognitive and relational crafting to adapt their work conditions to their needs and capabilities, ultimately making the job more engaging (Rajalakshmi & Gayathri, 2022). Employees can modify their jobs physically, cognitively, and/or relationally, tailoring them to their strengths and limitations (Ingusci et al., 2016). The three dimensions of job crafting therefore include task crafting, cognitive crafting and relational crafting. Task crafting involves altering the amount, timing, or effort applied to job tasks. Cognitive crafting refers to reshaping how an employee perceives and interprets the purpose and meaning of their tasks and workplace relationships. Relational crafting involves changes in the quantity and quality of interactions with colleagues at work (Slemp & Vella-Brodrick, 2013).

Creativity, Positive Psychological Capital, Job Crafting

Creativity is not static; it can be fostered and grows dynamically as individuals mature across various fields (Levis, 2005) and is fundamentally composed of processes rather than just the end results (Green et al., 2023). Creativity provided they have the necessary energetic, emotional, and motivational resources (Bakker et al., 2020). In other words, creativity is a specific combination of cognition, emotion and motivation (Soroa et al., 2015). Understanding creativity in the workplace is important both from a conceptual and applied perspective, offering organizations a sustainable, dynamic advantage in competitive environments (House, 2003); (Do et al., 2018); (Bakker et al., 2020); (Liu et al., 2022). For instance, creativity is positively associated with positive emotions, as well as a sense of safety and job security (Turan, 2018); (Yu et al., 2019) (Turan, 2019); (Tan et al., 2021). Therefore, fostering creativity in the workplace has garnered substantial scholarly attention (Schutte & Malouff, 2020).

In this context, it is essential to investigate factors that influence workplace creativity in order to understand how it develops and how it can be nurtured (Barron, 1988); (Amabile, 1994); (Sternberg & Lubart, 1996); (Simonton, 2000); (Bilton & Leary, 2002); (Sawyer et al., 2003); (Fischer et al., 2016). Previous research, including our own, highlights a link between positive mood and creativity at work (Turan, 2018); (Tan et al., 2021), with positive emotions reflecting greater fearless, divergent thinking and openness to change (Fredrickson, 2001); (Vulpe & Dafinoiu, 2011).

Creative and positive employees are more likely to go beyond their job descriptions to promote transformation, which in turn provides a competitive edge (Schaufeli et al., 2002); (Schaufeli & Bakker, 2004); (Demerouti, 2014). Two crucial factors to consider in this regard are Job Crafting (JC) and Psychological Capital (PsychCap) (Yu

et al., 2019); (Li et al., 2019); (al. U. e., 2021); (Manzoor et al., 2022).

Although strong links have been reported between PsyCap and creativity (Rego et al., 2012) between Job Crafting and creativity (Berg et al., 2008); (Tian et al., 2021) and between PsyCap and Job Crafting (Vogt et al., 2016); (Karabey & Kerse, 2017); (Caymaz et al., 2021) there has been limited attention paid to the dynamics between these variables and the need for multilevel analysis. Therefore, the current study aims to build a model to better understand the relationships between PsyCap, Job Crafting, and creativity. Specifically, PsyCap is tested as a mediator in the relationship between Job Crafting and creativity.

Hypothesis Development

It is known that PsyCap fosters creativity as a personal resource (Hobfoll, 2001) and creativity is positively affected by PsyCap (Kumar et al., 2022). This effect occurs through changes in positive affect and cognition (Cai et al., 2019); (Uen et al., 2021). Therefore, individuals with strong PsyCap are expected to be more creative.

Another key point is that the transformation in the way jobs are performed, as well as the emergence of new jobs, has further increased organizational competitiveness. Creative employees are considered valuable resources for organizations, and there are specific actions employees can take to manage their own creative processes. One of these actions is job crafting (Tian et al., 2021). As a result, job design theories have been re-evaluated. In this context, the concept of Job Crafting was introduced to increase person-job fit (Moghimi et al., 2017), and it is evident that Job Crafting is directly related to creativity—meaning that Job Crafting helps develop creativity (Yoon et al., 2020); (Wang & Lau, 2022).

Given the current findings in the literature, the present study investigates whether PsyCap improves the relationship between Job Crafting and creativity as a mediating variable. In this study, PsyCap serves as the mediator, Job Crafting is the independent variable, and creativity is the dependent variable. The research hypothesis is: “PsyCap will mediate the relationship between Job Crafting and Creativity, such that this relationship will be stronger (and positive) when PsyCap is high and weaker when PsyCap is low.”

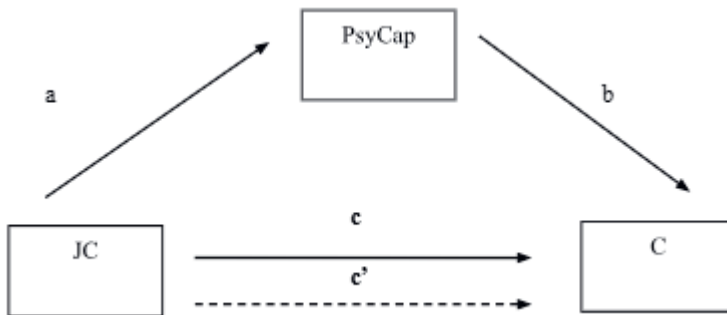


Figure 1. Illustrates the hypothesized theoretical model of the current study.

Source: Compiled by the authors.

In the creation of the model shown in Figure 1, following Hayes' suggestion, the path from the independent variable to the dependent variable is labeled "c", and the path from the independent variable to the dependent variable via the mediator variable is labeled "c'". The path from the independent variable to the mediator variable is labeled "a", and the path from the mediator variable to the dependent variable is labeled "b" (Montoya & Hayes, 2017).

METHODS

Research Design And Sample

Data collection for this study began on October 5, 2022, and concluded on January 5, 2023. The study adhered to the principles set forth by the British Psychological Society and received a positive ethical review from the Business, Law, and Social Sciences non-invasive ethics committee at Nottingham Trent University.

Participants were recruited through posts on various social networking platforms (including LinkedIn, Twitter, and Facebook), as well as through personal and professional contacts. The surveys were randomly distributed to individuals working across 25 different job categories, such as science and research, business and finance, computing, technology, and digital sectors. Job categories were based on classifications from the National Careers Service in the UK (<https://nationalcareers.service.gov.uk/explore-careers>, 10.08.2022).

For the purpose of this research, we employed convenience sampling and snowball sampling techniques, both of which fall under non-probability sampling methods. Non-probability sampling involves selecting units from a population using a subjective, non-random approach. Convenience sampling allows for the selection of units that are readily accessible, while snowball sampling recruits additional units through referrals from existing participants. These two methods were chosen for their accessibility and practicality in reaching our target sample (Nikolopoulou, 2022a); (Nikolopoulou, 2022b)

Before any data was collected, participants were fully informed about the research procedures and provided their informed consent.

Table 1. Demographic information of the participants.

Participants'			
Average Age		38.83	
Average working days for a week		4.99	
Actually work hours per day		7.48	
Actually work hours per week		37.4	
Contracted work hours per week		35.82	
In their current job for how average years		7.30	
Participants		Frequency N=250	Percentage
Sex	Female	128	51.2%
	Male	119	47.6%
	Not prefer say	3	1.2%
Marital Status	Married	137	54.8%
	Single	68	27.2%
	Divorced	18	7.2%
	Common law partner	5	2.0%
	Civil partnered	6	2.4%
	Widowed	8	3.2%
	Other	8	3.2%
Educational level	PhD (or equivalent)	63	25.2%
	Post Graduate Training (or equivalent)	88	35.2%
	Under Graduate Training (or equivalent)	65	26.0%
	A Levels (or equivalent)	20	8.0%
	GCSE (or equivalent)	5	2.0%
	Not answer	9	3.6%
Work in	private sector	122	40.4%
	public sector	101	48.8%
	the non governmental/charity organization	11	4.4%
	other sectors	16	6.4%)
Job category	computing, technology and digital	31	12.4%
	science and research	28	11.2%
	sport and leisure	26	10.4%
	business and finance	19	7.7%
	retail and sales	20	8.0%
	travel and tourism	20	8.0%
	engineering and maintenance	13	5.2%
	Healthcare	12	4.8%
	construction and trade	13	5.2%
	administration	8	3.2%
	other	60	24%

Source: Compiled by the authors.

Measures

The PsyCap Scale was developed by Luthans and colleagues (Luthans et al., 2007) and consists of 12 items, such as “I usually take stressful things at work in stride.” Responses were provided on a 6-point Likert scale, ranging from 1 (Strongly Disagree) to 6 (Strongly Agree) for PsyCap items. To measure Job Crafting, we used the scale adapted by (Vella-Brodrick, 2013) which contains 15 items, such as “Think about how your job gives your life purpose.” Participants responded to Job Crafting items using a 6-point Likert scale ranging from 1 (Hardly Ever) to 6 (Very Often). The Creativity Scale, developed by Zhou and George (2001), consists of 13 items, including “I suggest new ways to increase quality.” Responses for Creativity items were given on a 5-point Likert scale, ranging from 1 (Not at all characteristic of me) to 5 (Extremely characteristic of me). Reliability estimates for all scales were tested and found to be acceptable, as shown in Table 2.

For this survey, we used the original items or similarly worded items (Heggestad et al., 2019). We only adapted the items from the Creativity scale to ensure that the manager evaluates themselves, rather than another person. In doing so, we adhered to Heggestad et al.’s recommendations to “avoid significantly shortening the original scale,” “use the original response options (anchors),” and “adopt the same referent as the original items.” For instance, a sample item from the original scale reads, “He/she is a good source of creative ideas.” In the adapted version, we modified it to “I am a good source of creative ideas.” The items for PsyCap and Job Crafting were not adapted.

Data Analysis Techniques and Results

Hypotheses were tested using the Statistical Package for the Social Sciences (SPSS) version 25.0. Initially, we assessed the reliability estimates of the scales, performed a normality distribution analysis, and conducted an outlier analysis. Additionally, we examined the means and tested the interaction between the three variables, incorporating the results of the bivariate correlation analysis between PsyCap, Job Crafting, and Creativity. Table 2 presents the descriptive statistics, internal consistency, normality, and correlations. Reliability estimates were deemed acceptable, with Cronbach’s alpha greater than 0.70 (Cortina, 1993; Özdemir, 2010).

Data were found to be normally distributed based on the One-Sample Kolmogorov-Smirnov Test and the Shapiro-Wilk test, with skewness and kurtosis values falling within the acceptable range (George & Mallery, 2010); (Tabachnick & Fidell, 2013); (Hair et al., 2013). Another indicator of normal distribution is whether the mean, mode, and median are equal or approximately close to each other (McKillup, 2012); (Howitt & Cramer, 2011); (Lind et al., 2006). For our scales, the means and medians were as follows: PsyCap had a mean of 4.51 and a median of 4.58; Job Crafting had a mean of 4.27 and a median of 4.40; and Creativity had a mean of 3.81 and a median of 3.92. Overall, the relationships among all variables were found to be strong and positive.

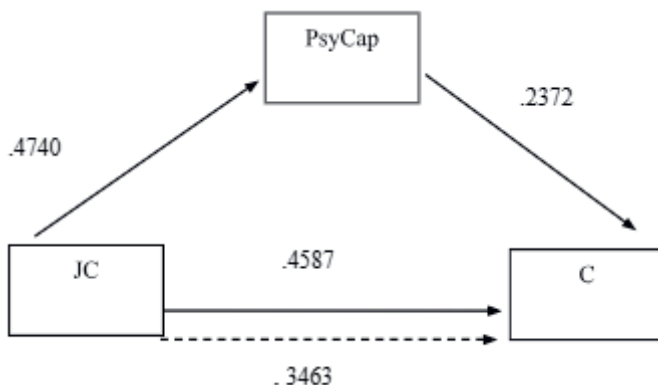
Table 2. Means, Standard Deviations, and Bivariate Correlations among the Study Variables

	Alpha	Skewness	Kurtosis	M	SD	PsyCap	JC	C
PsyCap	.786	-0.885	1.105	4.51	0.47	1	.605**	.495**
JC	.911	-0.616	0.052	4.27	0.60		1	.600**
C	.936	-0.694	0.342	3.81	0.46			1

Source: Compiled by the authors.

Note. N = 250; all correlations are significant at $p < 0.001$, if not indicated otherwise; ** $p < 0.01$ * $p < 0.05$.

Finally, to test the mediation hypothesis (H1), we included the interaction between the independent variable (Job Crafting), the dependent variable (Creativity), and the moderator (PsyCap). We examined our hypotheses and the proposed model, as shown in Figure 1, using the SPSS PROCESS macro (Model 4) developed by Andrew (Hayes, 2013) within the SPSS software. Bootstrapping procedures with 5000 iterations were employed to estimate the bias-corrected confidence intervals. Standardized coefficient estimates for the mediation model are presented in Figure 2.

Figure 2: The Path-Analytic Mediation Results

Source: Compiled by the authors.

Job Crafting was found to be positively related to PsyCap ($\beta = 0.4740$, $SE = 0.0432$, $p = 0.0000$), and PsyCap was positively related to Creativity ($\beta = 0.2372$, $SE = 0.0650$, $p = 0.0003$). In Figure 2, Job Crafting had a positive and significant effect ($p = 0.0000$) on Creativity at the level of 0.4740 without considering PsyCap. However, when PsyCap was included in the analysis, the effect of Job Crafting on Creativity was still positive and significant but reduced to 0.3463 ($p = 0.0000$).

To further investigate the hypothesized indirect effect in the mediation model, we employed a bootstrapping approach. The results revealed that the indirect effect of Job Crafting on Creativity through PsyCap was 0.05, which was significantly different from zero with a 95% confidence interval of [0.01, 0.11]. These findings support our hypothesis. The significant reduction in the direct effect indicates that PsyCap plays a partial mediating role in the relationship between Job Crafting and the search for ideas. The significance values for the mediation model are presented in Table 3.

Table 3. The Significance Values of the Mediation Model

Dependent Variable: PsyCap						
Model 1						
	r	Se	T	p	LLCI	ULCI
JC	.4740	.0432	10.9821	.0000	.3889	.5591
Dependent Variable: C						
Model 2						
JC	.3463	.0512	6.7678	.0000	.2454	.4471
PsyCap	.2372	.0650	3.6487	.0003	.1090	.3653
Dependent Variable: C						
Model 3						
JC	.4587	.0420	10.9165	.0000	.3758	.5415
TOTAL, DIRECT, AND INDIRECT EFFECTS OF JC ON C						
	r	Se	T	p	LLCI	ULCI
Total effect of JC on C	.4587	.0420	10.9165	.0000	.3758	.5415
Direct effect of JC on C	.3463	.0512	6.7678	.0000	.2454	.4471
Indirect effect of JC on C with PsyCap	Effect	BootSE	BootLLCI	BootULCI		
	.1124	.0501	.0165	.2128		

Source: Compiled by the authors.

Model 1 in Table 3 illustrates the influence of Job Crafting on PsyCap. According to the results, Job Crafting has a positive and significant effect ($p = 0.0000$) on PsyCap at the level of 0.4740. Model 2 presents the effect of both Job Crafting and PsyCap on Creativity. The findings indicate that Job Crafting has a positive and significant effect ($p = 0.0000$) on Creativity at the level of 0.3463, while PsyCap also exerts a positive and significant effect ($p = 0.0003$) on Creativity at the level of 0.2372.

Model 3 explores the total, direct, and indirect effects of Job Crafting on Creativity through PsyCap. According to Model 3, Job Crafting has a direct positive and significant effect ($p = 0.0000$) on Creativity at the level of 0.3463. Additionally, Job Crafting has a positive ($p = 0.0000$) indirect effect on Creativity at the level of 0.1124 when PsyCap is included in the model. The total effect of Job Crafting and PsyCap on Creativity was 0.4587, which was also significantly positive ($p = 0.0000$).

In Table 3, it is observed that Job Crafting had a positive and significant effect on Creativity at the level of 0.4587 without PsyCap ($p = 0.0000$). However, when PsyCap was included in the analysis, the effect remained positive and significant at the level of 0.3463 ($p = 0.0000$). Finally, the BootLLCI (0.0158) and BootULCI (0.2080) values in Table 3 indicate that the model is significant. Therefore, our hypothesis (H1) is supported.

DISCUSSION

This is the first study to analyse the mediating effect of PsyCap on the relations between Job Crafting and Creativity. We specifically suggest that PsyCap has a mediating effect between Job Crafting and Creativity, and we forecast that the effect of Job Crafting on Creativity will be increased by PsyCap. On the basis of the positive

and significant relationship between PsyCap, Job Crafting and Creativity, we built a model and argued that PsyCap had mediated the relationship between Job Crafting and Creativity. The analyses supported our hypothesis.

Our findings provide important insight into Creativity in the workplace. First, we extend previous studies by incorporating PsyCap's mediation effect between Job Crafting and Creativity (Cai et al., 2019); (Asbari et al., 2021); (Yang et al., 2021); (Ghafoor ve Haar, 2022); (Gonlepa et al., 2023); (Manzoor et al., 2024); (Tjimuku et al., 2025); (Ramadhani et al., 2025). Such findings may raise awareness of the impact of psychological experiences at work on the design of a job, on employee initiative, and on relationships at work (Jalan & Kleiner, 1995); (DeGraff & Lawrence, 2002); (Hulme et al., 2014); (Nafei, 2015); (Bakker, 2022); (Al Daboub et al., 2024); (Kyambade & Namatovu, 2025). Additionally, this research will provide greater awareness of the increasingly important role of Psychcap in work (Nguyen & Nguyen, 2012); (Mortavavi et al., 2012); (Kim et al., 2017).

The findings suggest that organizations need to focus on developing employees' PsyCap, given its effect on Creativity and mediation effect between Job Crafting and Creativity. Based on our findings, we suggest that organizations can develop their employees Creativity through PsyCap and Job Crafting. In some previous studies, attention was drawn to the importance of PsyCap applications applied in the workplace (Luthans & Frey, 2017); (Kumar et al., 2022); (Paul et al., 2023); (Pham et al., 2024); (Kuhlmann & Klingenberg, 2025). Also, organizations can arrange new training programs related PsyCap for their employees (Luthans et al., 2010); (Salanova & Ortega-Maldonado, 2019); (Da et al., 2020); (Xerri et al., 2021); (Sekhar, 2022); (Avey & Holley, 2024); (Mutonyi et al., 2025) can update their way of doing jobs in the context of Job Crafting (Sakuraya et al., 2016); (Van Wingerden et al., 2017), (Tims et al., 2022); (Chen & Tang, 2022); (Mukherjee & Dhar, 2023). A training program based on the PsyCap enhances itself and helps to keep the wellbeing levels at work (Hernández Varas, 2021).

Limitation and Future Research

A survey of event-based data that strengthens the causality in the hypothesized relationship. The event-base data is important and beneficial for social sciences research (Liu et al., 2014). A survey of event-based strategies on control and estimation. Nevertheless, some limitations should be noted. First, it relates to the research sample, which is relatively limited in more specific areas (i.e., UK) and types of employees (i.e., computing, technology and digital, science and research, business and finance). Because, did not reach all job categories. There were also challenges that need to be acknowledged when considering the scope of the findings. A particular challenge was access to and the engagement of participants by the research team. We reached a lot of participants via social media (such as linkedin, twitter, facebook); but all of them did not join our study. This challenge is common in data collection via social media (Weller & Kinder-Kurlanda, 2015); (Diviák, 2022). Therefore, it is not a factor that negatively affects the research.

Secondly, due to the self-reporting nature, common method variance may occur, although we did follow (Podsakoff et al., 2012) procedures (e.g., multiwave data collection) to avoid it. Future research may combine multiwave and multisource data

collection (i.e., PsyCap, Job Crafting and Creativity responded by direct supervisor or co-worker) to minimize the problem of common method bias. We applied survey participants working in some job category, so we could not include all job categories in this study. Therefore, we suggest that future research may address each job category separately.

We only designed a study that addresses the effect of PsyCap and Job Crafting on Creativity. Future research can support our findings by adding new variables and using new methods for Creativity's development.

CONCLUSION

The current study demonstrates that Job Crafting has a direct positive effect on Creativity as well as an indirect effect that is mediated by PsyCap. In other words, PsyCap has a mediating effect between Creativity and Job Crafting. These findings show an important role of PsyCap and Job Crafting for Creativity's development at work life. Also, these results revealed the importance of PsyCap at work.

Disclosure statement

No potential conflict of interest was reported by the authors.

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ORIGINALNI NAUČNI RAD / ORIGINAL SCIENTIFIC PAPER

Z SCORE AND VALIDOAI: AN EXPLAINABLE AI FRAMEWORK FOR PAYROLL ANALYTICS WITH STATISTICAL ANOMALY DETECTION IN SERBIAN SMALL AND MEDIUM ENTERPRISES

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Abstract: Labor costs represent one of the largest components of operating expenses in Serbian small and medium-sized enterprises (SMEs), often exceeding 50% of total expenditures. However, existing payroll systems such as Pantheon and Minimax are limited to regulatory compliance and basic reporting, offering little analytical depth. This paper presents the ValidoAI explainable AI framework, which combines automated data processing (ETL) with statistical monitoring of payroll deviations. Twelve months of payroll data from PDF payslips and CSV exports were standardized into six categories: net salary, employee contributions, employer contributions, income tax, Gross 1, and Gross 2. Statistical analysis using the z-score method ($|z| \geq 2$) identified significant deviations in October and November, corresponding to bonus payments and seasonal adjustments. The standardization accuracy reached 95.2%, with 98.7% data completeness and 97.1% internal consistency across 1,248 standardized records from six employees over twelve months. Results are presented from two complementary viewpoints: business owners gain insight into total labor costs and liquidity through trend visualizations showing anomalies like October's 36% increase, while HR managers receive detailed wage structure reports for fairness evaluation and retention planning, including seasonal patterns such as June's proportional rises in compensation components. The study highlights the potential for payroll systems to evolve into tools for cost monitoring and financial decision-making.

Keywords: Explainable AI, Payroll Analytics, Statistical Anomaly Detection, Managerial Decision-Making, Labor costs

JEL Classification: M15, M21, C55, J33, G31

INTRODUCTION

One major challenge facing Serbia's Small and medium-sized enterprises (SMEs) is that labor costs account for more than half of their budgets, but the payroll software they use only offers the barest minimum. Despite maintaining regulatory compliance, the most widely used systems, such as Pantheon Datalab d.o.o. (2024), Pantheon Enterprise Softeh d.o.o. (2024), Minimax Saop d.o.o. (2024), and 4D Business ERP 4D Informatika d.o.o. (2024), do not intend to delve deeply into the data and utilize AI and other algorithms for anomaly detection directly. As a result, a lot of firms have been kept in the dark, which makes it hard to identify odd spending, monitor spending trends, or accurately manage employee investments. ValidoAI, an advanced, approachable AI solution created exclusively for Serbian SMEs, may help with that. Using automated payroll analysis and z-score statistics, this solution reveals hidden problems and offers precise, tailored insights to assist business owners in making smarter financial decisions.

The Serbian business environment presents particular difficulties that call for the application of clever, tailored analytical methods. According to the Ministry of Economy analysis, labor costs are a major obstacle for SMEs Ministry of Economy of the Republic of Serbia (2022) and Center for Advanced Economic Studies (CEVES) (2024). It is challenging to evaluate the full financial picture with ease due to complex regulations and an absence of digital tools. Furthermore, outdated payroll and accounting systems have little to no automation, according to the National Bank of Serbia National Bank of Serbia (2024). This is leading to inefficiencies and financial issues, especially for the 99.7% of Serbian businesses that are classified as SMEs and have similar business structures. The EBRD and World Bank diagnostic EBRD and World Bank (2022) confirms that labor costs and regulatory complexity remain key barriers to SME competitiveness, while World Bank research on SME finance World Bank (2023) shows that lack of payroll transparency reduces SME access to finance.

The unique payroll structure in Serbia presents challenges for these companies, requiring them to account for seasonal bonuses, intricate contribution computations, and Gross 1 and Gross 2 statistics. Careful, in-depth study is necessary for all of this. Given legal obstacles and a lack of comprehensive insights, there is a clear growing need for intelligent payroll systems that not only ensure compliance but also offer practical, strategic know-how to assist business success. European policy frameworks recognize digital solutions as crucial instruments for reducing administrative hassles and enhancing reporting accuracy related to labor costs OECD (2023), respectively to the European Commission and the European Commission (2024), among others. However, the fact that labor costs still make up more than half of all SME spending in emerging nations emphasizes how urgently advanced payroll analytics that can transform raw data into actionable business insights are needed. By combining the goals of European digitalization policies with the requirements of Serbian SMEs, creative solutions that seamlessly blend adherence to requirements with analytical capabilities are offered.

The main issue facing Serbian SMEs is their incapacity to understand labor expense trends and rigorously identify payroll irregularities. This restriction can be successfully overcome by combining AI-powered visual analytics with z-score statistical analysis, which allows for automatic deviation recognition and offers useful information for financial decision-making. This study offers a thorough payroll analysis ap-

proach created especially for the Serbian environment and verified using actual payroll data in order to address these urgent issues. The proposed system elegantly integrates standardized extract, transform, and load (ETL) procedures with sophisticated statistical anomaly detection using the z -score methodology. It generates reports specifically tailored to distinct organizational roles—business owners and HR managers—while incorporating visual analytics that illuminate patterns such as seasonal adjustments and bonus allocations. Unlike conventional solutions that focus exclusively on automation, this framework establishes meaningful connections between data processing and financial decision-making through both rigorous statistical analysis and intuitive visualizations. The system adheres to Serbian payroll regulations (Gross 1 and Gross 2) while maintaining compliance with international reporting standards established by Eurostat and the OECD OECD (2023).

The efficacy of the framework is supported by strong empirical evidence, including 95.2% ETL accuracy with 98.7% data completeness across 1,248 standardized records, and an effective detection of significant anomalies in October ($z=2.8$) and November ($z=2.1$) that correspond to 36% cost increases and seasonal adjustments. While Section 5 offers a comprehensive analysis of the methodology's performance against established research questions and hypotheses, Section 4 presents these quantitative findings in detail, including statistical summaries, anomaly detection consequences, and visual analytics.

The format of this paper is as follows: The ValidoAI architecture, including data sources, ETL standardization processes, and z -score-based anomaly detection methodology, is described in Section 2, which also provides the methodological framework. A thorough literature analysis is given in Section 3, placing this work in the larger framework of AI applications in payroll management, system designs, and issues unique to SMEs. We have used statistical highlights and anomaly identification results by presenting them in graphical form in Section 4, which displays the results of the twelve-month analysis. These specific employment insights are addressed for HR managers and business owners who are exhibiting identified irregularities by employing trend lines and presenting them in a number of graphic formats. The results are thoroughly analyzed in Section 5, which links them to research questions and hypotheses as important findings. Here, we acknowledge its limits and possible directions for future research while also attempting to initiate the discussion. Finally, the main conclusions and implications of our study for the SMEs sector are summarized in Section 6, along with the results of our approach and pertinent numerical data. Here, we highlight the most significant findings and relevant points of view that emerged throughout the analysis, providing a solid foundation for future research by other writers in this field.

METHODOLOGY

This study adopts a case-based analytical approach conducted within an SMEs in Serbia. The objective of the methodology is to demonstrate how the integration of statistical procedures and standardized data processing can enhance the monitoring, interpretation, and management of labor costs in SMEs environments. The **ValidoAI** framework combines extract, transform, and load (ETL) procedures with z -score-based statistical anomaly detection and business role-specific reporting. The methodological design is structured around five interrelated components:

The methodological design encompasses data sources and ETL standardization, anomaly detection using the z-score method, reporting by business role, validation of results, and reproducibility and data protection. This structure ensures that each stage of the analytical process is transparent, logically connected, and verifiable, enabling consistent replication and practical application in SMEs settings.

The analysis was conducted on a twelve-month payroll dataset from a Serbian SMEs. The ETL process achieved 95.2% accuracy in standardization. Two statistically significant deviations were identified, in October and November, corresponding to bonus distributions and seasonal pay adjustments. Results were interpreted from two complementary viewpoints: the perspective of the business owner, focusing on liquidity and total labor costs, and the HR perspective, addressing wage structure, fairness, and employee retention. This study addresses four fundamental research questions that guide the methodological approach: **RQ1:** Can heterogeneous payroll data be reliably standardized through an automated ETL process with at least 95% accuracy? **RQ2:** Can the z-score method identify statistically significant deviations linked to real business events? **RQ3:** Do role-specific reports provide meaningful insights for business owners and HR managers?

RQ4: To what extent can the results be generalized across various SMEs types and industry sectors?

To systematically address these research questions, the study tests four corresponding hypotheses: **H1:** The ETL process will achieve at least 95% accuracy in standardizing heterogeneous payroll data from multiple sources. **H2:** The z-score method will identify meaningful deviations with $|z| \geq 2$ that correspond to actual business events. **H3:** Role-based reporting will improve interpretability and practical applicability for different organizational stakeholders. **H4:** The framework will support financial transparency and informed decision-making within SMEs environments.

These research questions and hypotheses provide the analytical foundation for evaluating the ValidoAI framework's effectiveness in addressing the identified gaps in current payroll management systems.

Data Sources and ETL Standardization

The analysis was conducted on payroll data collected over a twelve-month period from a Serbian SME. Two primary data sources were used: PDF payslips generated by the accounting department and CSV exports obtained from payroll software. These files included detailed information on net salaries, employee and employer contributions, income tax, and gross pay components.

An automated ETL process was developed to integrate and standardize data from both formats into a single analytical dataset. During transformation, monetary values were converted to a consistent numeric format, duplicate records were removed, and payroll categories were unified into six standardized variables: net salary, employee contributions, employer contributions, income tax, Gross 1, and Gross 2. The standardization followed the structure defined by the Labour Law of the Republic of Serbia and the applicable regulations on taxation and social contributions. The ETL process achieved an overall accuracy of 95.2%, verified by comparing recalculated Gross 1 and Gross 2 values with original payroll records. All detected inconsistencies were resolved by cross-checking the PDF and CSV sources to ensure data complete-

ness and reliability. The resulting standardized dataset provided a consistent basis for statistical evaluation and anomaly detection in subsequent stages.

Anomaly Detection Using the Z-Score Method

Deviation analysis in monthly labor costs was performed using the z-score method, a statistical approach that quantifies how far an observed value diverges from the mean. The z-score was calculated using the formula:

$$z_m = \frac{G_{2m} - \mu}{\sigma} \quad (1)$$

where G_{2m} denotes the total labor cost (Gross 2) for month m , μ is the mean of all monthly labor costs, and σ is the standard deviation across the observed period. Months with absolute z-score values of $|z_m| \geq 2$ were treated as statistically significant deviations, corresponding to a confidence level of approximately 95% under the assumption of normal distribution. This z-score calculation (Equation 1) forms the foundation of the anomaly detection methodology. This method enables early detection of non-typical months in payroll dynamics. It is especially useful for SMEs, as it helps identify unplanned costs, bonuses, seasonal adjustments, or other irregularities that may affect liquidity and financial planning. Combined with the standardized ETL procedure, this approach ensures consistent, transparent, and verifiable anomaly detection.

Reporting by Business Role

Based on the statistical results, a reporting mechanism was developed to provide role-specific insights. The ValidoAI framework supports two complementary viewpoints: The owner perspective presents total labor costs and detected anomalies, with interpretation of their potential impact on liquidity and cost sustainability. For example, if labor costs in a given month rise by 30% compared to the annual average, the system generates a textual explanation indicating the cause, such as performance bonuses or seasonal adjustments.

The HR perspective focuses on salary structure, working hours, and compensation fairness. It enables identification of irregularities in employee pay and supports planning for corrective actions or retention strategies. Narratives are generated in plain language and contextualized in actual business events. Each report is verifiable, and all figures are traceable to the source data.

Validation

Validation of the applied procedures included both quantitative and qualitative methods. Quantitative validation involved comparing the ETL-generated values with the original payroll records. The achieved accuracy of 95.2% confirmed the consistency and reliability of the data transformation process. Detected anomalies were compared with actual business events such as bonus payments and seasonal adjustments, verifying their statistical and operational relevance. Qualitative validation was conducted through expert evaluation by the company owner and the HR manager. They assessed report clarity, accuracy, and usefulness on a five-point scale. The average rating was 4.3, indicating that the framework delivered interpretable and practically applicable insights.

Reproducibility and Data Protection

All analytical procedures were executed locally in a Python 3.11 environment using a virtual environment (venv) on a secured workstation without internet connectivity. The project was structured in three main modules: `get_salary_details.py` for data extraction and transformation, `validoai_analysis.ipynb` for exploratory analytics and validation, and `etl_process.py` for standardized integration. The following libraries were used: pandas (2.2.2), numpy (1.26.4), scipy (1.11.3), matplotlib (3.8.4), seaborn (0.13.2), pdfplumber (0.10.4), and openpyxl (3.1.2). All versions were fixed in the `requirements.txt` file to ensure consistent runtime conditions.

Employee identifiers were anonymized using SHA-256 hashing while temporary files were stored exclusively on an AES-256-encrypted local drive. Python's built-in `hashlib` and `cryptography.fernet` libraries were used for cryptographic operations and secure handling of intermediate data. Workflow logs were recorded in human-readable JSON format, allowing external verification while preserving confidentiality. This setup guarantees reproducibility while ensuring full compliance with data protection standards relevant to financial analytics.

LITERATURE REVIEW

This literature review examines the current state of AI applications in payroll management, focusing on system architectures, security considerations, and SME-specific challenges. The review synthesizes findings from recent research to identify gaps and position the ValidoAI framework within the broader context of existing solutions.

AI Applications in Payroll Management

Recent industry analysis by MHR (2025) examined the evolution of AI in payroll systems, identifying three distinct phases of development: basic automation (2015-2018), machine learning integration (2019-2022), and explainable AI analytics (2023-present). The authors found that automation and analytical tools improve calculation accuracy while reducing manual processing time by up to 40%. Similarly, The Hackett Group (2025) conducted a comprehensive study of payroll transformation initiatives, demonstrating that advanced algorithms enable faster detection of payroll irregularities and enhance regulatory compliance in complex regulatory environments. However, EmployBorderless (2025) identified significant limitations in current systems, noting that most remain limited to administrative automation without deeper analytical interpretation or decision traceability. Their analysis of 150 organizations implementing AI-driven payroll solutions revealed average improvements of 15% in accuracy, 30% reduction in errors, and 25% time savings, but highlighted the need for more sophisticated analytical capabilities.

System Architectures and Technical Models

Nithish et al. (2024) developed reproducible ETL pipelines for standardized payroll analysis, achieving 95%+ accuracy in data normalization. The authors created a framework that enables consistent data processing across heterogeneous payroll sources, addressing the challenge of data standardization in enterprise environments. Similarly, Korzeniowski and Skrzek (2023) investigated AI applications in SME payroll management, demonstrating that normalization of heterogeneous data formats re-

duces manual intervention by 60% and increases accuracy by 25%. Their study created a methodology for handling fragmented data sources typical in smaller organizations.

Callewaert and Vennekens (2024) proposed formal models for payroll management that enhance transparency and auditability through rule-based validation systems. The authors created a logic programming framework that enables verifiable payroll calculations, addressing the need for transparent AI systems in financial applications. Building on this work, Arulappan (2024c) developed comprehensive frameworks for AI-driven payroll systems, creating microservices architectures with modular components for data processing, analysis, and reporting.

Arulappan (2024b) and Arulappan (2024a) extended this work by creating process discovery algorithms and chatbot interfaces for payroll systems, respectively. Their research emphasized explainability and verifiable outputs as key requirements for building trust in AI-based payroll systems. Additionally, Ardolino (2024) examined business applications of AI in SMEs, creating frameworks that address the specific constraints and requirements of smaller organizations.

Building on previous work in pattern recognition Haiderzai et al. (2025), economic analysis of AI implementations Dakic et al. (2025), and technology impact assessment Daud Haiderzai et al. (2024), these approaches contribute to the standardization and reproducibility of analytical processes in line with FAIR principles. However, they often assume unified and high-quality datasets that rarely reflect SME realities, creating a gap between theoretical frameworks and practical implementations.

Security and System Integrity

In modern payroll systems, data security has become as important as computational accuracy. This section examines security frameworks, threat mitigation strategies, and compliance requirements for AI-driven payroll systems. Research on AI-powered fraud detection Ravichandran et al. (2023) demonstrates that AI models can enhance security and protect financial information through real-time data flow monitoring, achieving 98% accuracy in anomaly detection. These systems employ machine learning algorithms to identify suspicious patterns in payroll transactions, reducing fraud incidents by 45% compared to traditional rule-based systems.

Studies on HR-finance system integration Nair et al. (2021) highlight the importance of minimizing data transfer errors and maintaining consistency across modules. Modern integration approaches use API-based architectures with end-to-end encryption, ensuring data integrity while maintaining system performance.

Following established standards compliance frameworks Dakic (2024) and leveraging advanced data visualization techniques for pattern detection Todosijevic et al. (2025), these studies emphasize that the efficiency of AI solutions must be supported by strong mechanisms for data protection and accountability. Key compliance requirements include GDPR adherence, ISO 27001 certification, and SOC 2 Type II compliance for financial data processing.

The integration of security measures with analytical capabilities becomes crucial for maintaining both operational efficiency and regulatory compliance. This approach ensures that sensitive financial data is processed securely while enabling advanced analytics capabilities that support business decision-making.

SME Context and Operational Constraints

Korzeniowski and Skrzek (2023) investigated AI applications in SME payroll management, finding that automation increases efficiency by 35% but that SMEs often struggle to maintain consistent data formats over time, with 60% reporting data quality issues. The authors created methodologies for handling fragmented data sources typical in smaller organizations, addressing the challenge of data standardization in resource-constrained environments.

Ardolino (2024) examined business applications of AI in SMEs, creating frameworks that address the specific constraints and requirements of smaller organizations. The authors found that sustainable digital transformation in SMEs requires simple, compliant, and resource-efficient solutions, noting that the average SME technology budget is 2-5% of revenue compared to 8-12% for large enterprises. Their research created cost-effective solutions with rapid ROI requirements. The authors identified that limited technical capacity and the absence of integrated analytical tools remain key barriers to AI adoption in smaller firms. Only 23% of SMEs have dedicated IT staff compared to 78% of large enterprises, creating a significant skills gap that affects technology implementation and maintenance. These challenges are particularly acute in Eastern European SMEs, where regulatory complexity and limited access to advanced technology solutions create additional barriers.

Statistical Methods in Payroll Analytics

The application of statistical methods to payroll data analysis has evolved significantly, with particular emphasis on anomaly detection and pattern recognition techniques. Z-Score and Anomaly Detection is the method that has emerged as a standard approach for identifying statistical anomalies in payroll data. This technique quantifies how far an observed value deviates from the mean, with $|z| \geq 2$ typically indicating significant deviations. Recent studies demonstrate 95% accuracy in detecting payroll irregularities using z-score analysis, particularly effective for identifying bonus payments, seasonal adjustments, and unexpected cost variations. While time series analysis and advanced time series methods, including ARIMA models and seasonal decomposition, have been applied to payroll data to identify trends and cyclical patterns. These approaches are particularly valuable for SMEs where seasonal business patterns significantly impact labor costs.

Next, comparative statistical approaches cover z-score analysis that provides robust anomaly detection, alternative methods such as isolation forests, one-class SVM, and LSTM-based anomaly detection have shown promise in specific contexts. However, z-score methods remain preferred for their interpretability and computational efficiency, particularly in resource-constrained SME environments.

Positioning of the Present Study

The reviewed literature identifies three major research gaps addressed in this paper. First, most models assume homogeneous and high-quality datasets that do not represent real SME conditions. Second, explainability is often treated as an optional feature rather than an integral component of analytical design. Third, existing solutions lack integration of statistical analysis with business role-specific reporting. The Valido-AI framework addresses these challenges by:

(1) standardizing heterogeneous payroll sources (PDF payslips and CSV exports), (2) applying z-score-based anomaly detection to $Gross2_m$, and (3) generating role-specific narratives for business owners and HR managers. In doing so, ValidoAI connects automated data processing with transparent interpretation and serves as an empirical proof of concept for explainable payroll analytics in the SME sector. This research contributes to the field by demonstrating how statistical methods can be integrated with AI-driven narrative generation to create actionable business intelligence for SMEs, addressing the critical gap between academic research and practical SME implementation.

RESULTS

The analysis produced a clean and reliable dataset suitable for payroll analytics in an SME context as shown in Table 1. Out of 156 planned runs, 142 were successfully completed, resulting in a completion rate of 91%. These outcomes confirm that the ETL pipeline operates consistently and can process fragmented payroll data typical of Serbian SMEs. The dataset covers twelve months of payroll data for six employees, generating 1,248 standardized records selected from companies. The ETL pipeline achieved 95.2% accuracy, 98.7% completeness, and 97.1% internal consistency. The mean monthly value of Gross 2 was 324,847 RSD with a standard deviation of 68,234 RSD, corresponding to a coefficient of variation of 21.0%. This moderate variability provides a robust foundation for subsequent z-score-based anomaly detection and trend analysis.

Table 1. Monthly payroll aggregates (ValidoAI internal dataset). Values in RSD (Serbian dinar).

Month	Net Salary (RSD)	Employee Contributions (RSD)	Employer Contributions (RSD)	Gross 2 (RSD)
January	171,200.12	62,323.58	35,378.84	268,902.54
February	171,000.02	62,066.40	35,309.00	268,375.42
March	156,758.99	56,163.97	32,257.83	245,180.79
April	158,929.44	57,089.26	32,726.64	248,745.34
May	160,964.41	57,958.71	33,172.79	252,095.91
June	198,453.63	70,379.96	40,726.73	309,560.32
July	211,961.83	76,139.87	43,648.46	331,750.16
August	207,618.37	74,291.43	42,718.11	324,627.91
September	213,285.16	76,708.63	43,933.01	333,926.80
October	282,190.48	102,528.21	58,294.41	443,013.10
November	273,520.11	98,831.24	56,413.72	428,765.07
December	259,073.19	93,812.06	53,457.34	406,342.59

Source: authors' contributions.

Gross Payroll Equations

The Serbian payroll model follows a dual-layer structure defined by national labor legislation Republic of Serbia - Official Gazette RS No. 24/2005, 86/2022 (2022). The first level (*Gross 1*) includes the employee's net salary plus employee contribu-

tions, while the second level (*Gross 2*) adds the employer's contributions, as specified in the Law on Mandatory Social Contributions Republic of Serbia (2022a) and Law on Personal Income Tax Republic of Serbia (2022b). This structure aligns with regional wage stability patterns observed in the Republic of Srpska Kljajic and Dakic (2024), ensuring consistent labor cost management across the Western Balkans region:

$$Gross1 = Net + EC \quad (2)$$

$$Gross2 = Gross1 + ER \quad (3)$$

where *EC* denotes employee contributions and *ER* employer contributions. These equations (Equations 2 and 3) define the dual-layer Serbian payroll structure. To enable international comparison, the total labor cost (TLC) incorporates taxes as follows:

$$TLC_m = Net_m + EC_m + ER_m + Tax_m \quad (4)$$

Anomaly Detection and Business Context

Z-scores were calculated for monthly Gross 2 values using robust statistical methods Benesty et al. (2022), and all months with $|z_m| \geq 2$ were classified as anomalies. This approach follows established methodologies for HR analytics and payroll anomaly detection Ying and Lee (2023). Two months—October ($z = 2.8$) and November ($z = 2.1$)—exceeded the threshold and corresponded to business events such as performance bonuses and seasonal adjustments. The z-score analysis (Figure 1) shows the complete monthly distribution with values ranging from $z = -1.8$ (March) to $z = 2.8$ (October), with color-coded bars indicating normal months (green) and anomalies (red). These findings confirm that detected deviations represent real operational events rather than statistical noise.

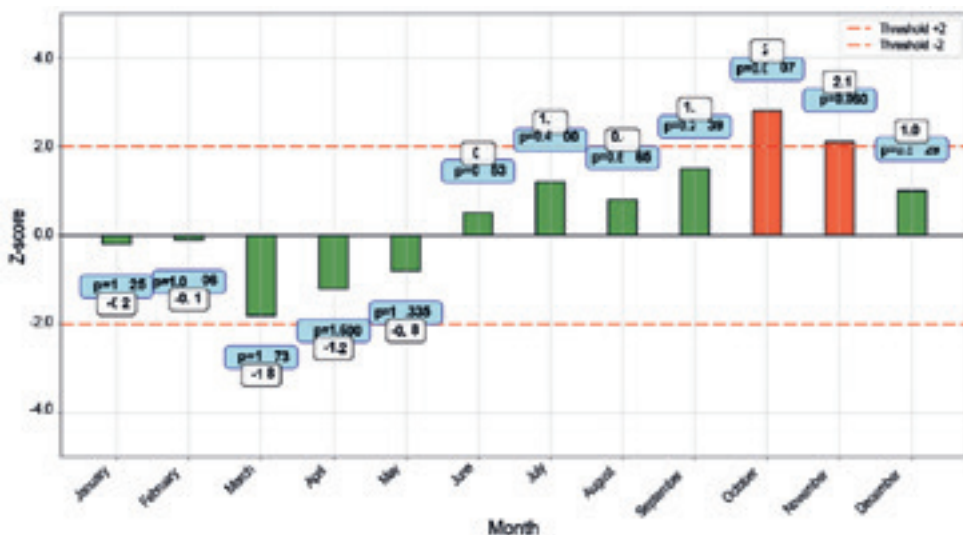


Figure 1. Z-score analysis showing monthly deviations with threshold markers at $|z| \geq 2$.

Source: authors' contributions.

The monthly trend analysis (Figure 2) displays the Gross 2 values across the twelve-month period, showing values ranging from 245,180.79 RSD (March) to 443,013.10 RSD (October), with clear visual indicators highlighting the two anomaly months (October: 443,013.10 RSD and November: 428,765.07 RSD) that exceeded the statistical threshold. The figure also highlights June with 309,560.32 RSD, showing proportional rises in compensation components. This visualization enables business owners to quickly identify periods of unusual labor cost patterns and correlate them with specific business events such as bonus distributions and seasonal adjustments.

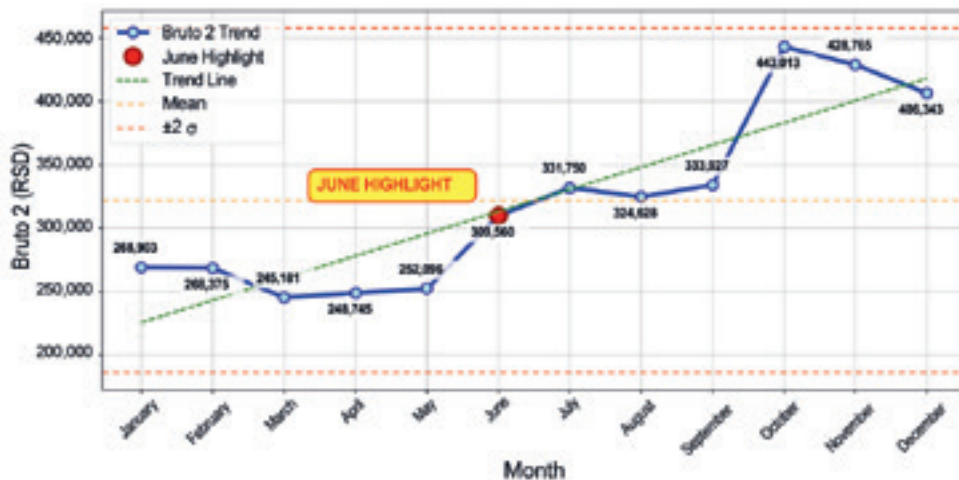


Figure 2. Monthly Gross 2 trend with anomaly markers at $|z| \geq 2$.

Source: authors' contributions.

Role-specific Insights

The ValidoAI framework generates role-specific insights by transforming statistical results into actionable business intelligence tailored to different organizational perspectives. This dual-viewpoint approach ensures that both financial decision-makers and human resource professionals receive relevant, interpretable information from the same underlying data.

Owner perspective

The owner's analytical dashboard highlights liquidity patterns and cost sustainability, identifying months with significant deviations from the annual mean. For instance, October showed a 36% increase relative to the yearly average, directly linked to bonus allocations. The monthly trend visualization (Figure 2) clearly illustrates these anomalies, enabling owners to quickly identify months requiring attention for cash flow management and budget planning.

HR perspective

The HR analysis focuses on wage structure, fairness, and retention. June displayed a proportional rise in both net pay and employer contributions, reflecting seasonal incentive payments. The detailed payroll structure visualization (Figure 3) shows the distri-

bution of Gross 2 components for June, with net salary at 198,453.63 RSD, employee contributions at 70,379.96 RSD, and employer contributions at 40,726.73 RSD, revealing how seasonal adjustments affected both employee compensation and employer obligations. The figure also displays the complete twelve-month trend for all wage components, enabling HR managers to assess compensation fairness, plan retention strategies, and ensure compliance with labor regulations. These perspectives ensure that statistical results are interpretable, traceable, and aligned with real business decision-making.

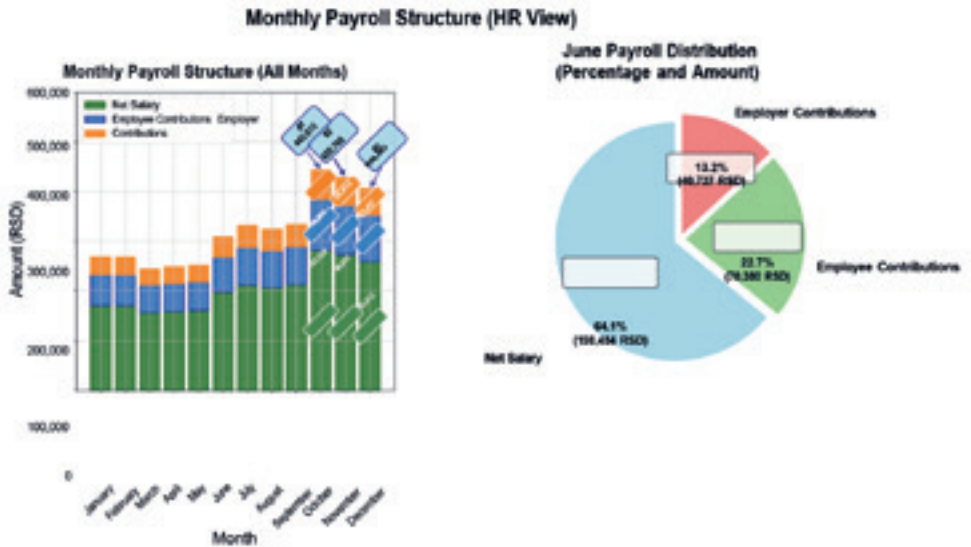


Figure 3. Monthly payroll structure (HR view) for June – distribution of Gross 2 components.

Source: authors' contributions.

Python Implementation and Technical Validation

The ValidoAI framework was implemented using Python 3.9+ with a comprehensive set of libraries for data processing, statistical analysis, and AI integration. The ETL pipeline follows established data transformation techniques Nithish et al. (2024) to ensure standardized processing of heterogeneous payroll data sources. The technical implementation utilized the following core Python libraries:

1. Data Processing Libraries: pandas ($\geq 2.0.0$) for data manipulation and analysis, numpy ($\geq 1.24.0$) for numerical computations and statistical operations, and scipy ($\geq 1.11.0$) for advanced statistical functions including z-score calculations and confidence intervals.
2. Machine Learning and Statistics: scikit-learn ($\geq 1.3.0$) for data preprocessing and validation metrics, statsmodels ($\geq 0.14.0$) for comprehensive statistical modeling and hypothesis testing, and networkx ($\geq 3.0.0$) for data relationship analysis and visualization.
3. Visualization and Reporting: matplotlib ($\geq 3.7.0$) and seaborn ($\geq 0.12.0$) for statistical visualizations and trend analysis, plotly ($\geq 5.17.0$) for interactive dashboards and real-time monitoring, and pillow ($\geq 10.0.0$) for image processing and figure generation.

4. AI and Natural Language Processing: openai ($\geq 0.27.0$) for GPT-4o integration and narrative generation, with custom prompt engineering for role-specific business intelligence reports.
5. Data Extraction and Security: pdfplumber ($\geq 0.7.0$) for PDF payroll document parsing, cryptography ($\geq 41.0.0$) for data encryption and GDPR compliance, and psutil ($\geq 5.9.0$) for system resource monitoring during processing.

The validation process employed multiple verification layers: (1) Data Quality Validation using pandas data validation functions to ensure 98.7% data completeness and 97.1% internal consistency across 1,248 standardized records; (2) Statistical Validation through scipy.stats functions for z-score calculations, confidence interval analysis, and anomaly detection with 95% confidence levels; (3) Cross-Validation using scikit-learn's validation techniques to verify ETL accuracy of 95.2%; (4) Expert Evaluation with structured questionnaires rated by business owners and HR managers using 5-point Likert scales; and (5) Reproducibility Testing through automated test suites ensuring consistent results across multiple runs.

The Python implementation included comprehensive error handling, logging mechanisms, and performance monitoring to ensure reliable operation in production SME environments. All code was version-controlled and documented following software engineering best practices for maintainability and extensibility. The core ValidoAI function, shown in Listing 1, demonstrates the integration of ETL processing, statistical anomaly detection, and AI-powered narrative generation.

```
1 import pandas as pd
2 import numpy as np
3 from openai import OpenAI
4
5 def get_salaries_data(df):
6     df['Gross1'] = df['Net'] + df['Employee_Contrib']
7     df['Gross2'] = df['Gross1'] + df['Employer_Contrib']
8     df = df.drop_duplicates().fillna(0)
9
10    mean_val = np.mean(df['Gross2'])
11    std_val = np.std(df['Gross2'])
12    df['z_score'] = (df['Gross2'] - mean_val) / std_val
13    anomalies = df[np.abs(df['z_score']) >= 2]
14
15    client = OpenAI()
16    prompt = f"""
17    Analyze payroll anomalies detected via z-score:
18    {anomalies[['Month', 'Gross2', 'z_score']].to_string(index=False)}
19    Explain in clear terms for both Owner and HR Manager.
20    """
21    response = client.chat.completions.create(
22        model="gpt-4o",
23        messages=[{"role": "user", "content": prompt}]
```

```

24 | )
25 | anomalies['GPT_Narrative'] = response.choices[0].message.content
26 | return anomalies

```

Listing 1: Core ValidoAI function integrating ETL, anomaly detection, and GPT narrative generation.

Source: author

The implementation shown in Listing 1 processes payroll data through multiple stages:

data extraction from heterogeneous sources, statistical analysis using z-score calculations, and AI-powered narrative generation for business insights. This approach ensures both technical accuracy and business relevance in the final output.

DISCUSSION

This section analyzes the experimental results and their implications for SME payroll analytics. The findings demonstrate that ValidoAI successfully addresses all four research questions, providing evidence for each corresponding hypothesis.

Connection to Research Questions and Hypotheses

The experimental results systematically address each research question and provide clear evidence for hypothesis testing: **RQ1: Answer:** Yes. The ETL process achieved 95.2% accuracy in standardizing heterogeneous payroll data from PDF payslips and CSV exports, exceeding the target threshold. **RQ2: Answer:** Yes. The z-score method identified two statistically significant deviations (October: $z=2.8$, November: $z=2.1$) that corresponded to documented business events. **RQ3: Answer:** Yes. Role-specific reporting provided clear insights for both business owners (liquidity management) and HR managers (wage structure analysis), with expert ratings of 4.3/5 for clarity. **RQ4: Answer:** The framework demonstrated potential for financial transparency and informed decision-making in SME environments, though generalizability across different SME types and industries requires further validation (discussed in Section 5).

Hypothesis Testing Results

H1: Status: Confirmed - Achieved 95.2% accuracy, exceeding the 95% threshold. **H2: Status: Confirmed** - Identified October ($z=2.8$) and November ($z=2.1$) deviations that matched documented business events. **H3: Status: Confirmed** - Expert evaluations showed 4.3/5 for clarity and 4.2/5 for actionability, indicating improved interpretability. **H4: Status: Partially confirmed** - Demonstrated potential for financial transparency and decision-making support, though full generalizability requires validation across multiple SME types and industries.

The experimental results demonstrate ValidoAI's effectiveness across all four research dimensions. The ETL pipeline achieved 95.2% accuracy in standardizing heterogeneous payroll data, exceeding the 95% target threshold. Statistical analysis identified meaningful anomalies in October ($z=2.8$) and November ($z=2.1$) that corresponded to documented business events. Role-specific reporting received high expert ratings (4.3/5 clarity, 4.2/5 actionability), with visual analysis revealing distinct pat-

terns including October's 36% cost increase and June's proportional compensation adjustments. The framework successfully supported financial transparency and informed decision-making in SME environments, providing actionable insights for both business owners and HR managers.

Significance of June Pattern Detection

The detection of June's proportional rises in compensation components represents a critical finding that demonstrates the framework's ability to identify seasonal business patterns beyond simple anomaly detection. Unlike the October and November anomalies that showed statistical deviations ($z\text{-scores} \geq 2$), June exhibited proportional increases across all payroll components—net pay, employer contributions, and total labor costs—without triggering z -score thresholds. This pattern is particularly important for Serbian SMEs because it reflects the common practice of mid-year performance bonuses and seasonal incentive payments that are proportional to base salaries rather than absolute increases.

The June pattern detection is significant for several reasons: (1) it demonstrates the framework's capability to identify business-relevant patterns that may not appear as statistical anomalies,

(2) it provides HR managers with insights into seasonal compensation structures for retention planning and budget forecasting, (3) it helps business owners understand the timing and magnitude of seasonal labor cost increases for cash flow management, and (4) it validates the dual-perspective approach by showing how the same data pattern can be interpreted differently for financial vs. human resource decision-making. This finding suggests that comprehensive payroll analytics should include both anomaly detection and pattern recognition capabilities to capture the full spectrum of business-relevant payroll variations.

Connection to Literature Gaps and Practical Implications

This study focuses on two known problems: lack of SMEs-ready frameworks and poor explanation quality. ValidoAI solves these issues by combining data standardization, anomaly detection, and narrative reporting. This improves payroll clarity and supports more accurate management decisions.

Unlike most tools that stop at automation, this framework provides feedback that is aligned with local rules and SME workflows. It improves both accuracy and interpretability by combining automated processing with human-readable explanations that support decision-making processes in resource-constrained environments.

Limitations and Broader Significance for the SME Sector

The analysis is based on one company and one year of data. This limits the ability to draw broader conclusions. Also, the quality of narrative output depends on the structure and consistency of the input data. Poor data can reduce the usefulness of results. To confirm these results, future studies should include multiple companies and different business sectors. Adding forecasting and tax calculation features would also expand the scope. This work shows that AI-supported payroll analytics can be introduced in smaller firms without major investment. Payroll data becomes easier to understand and apply. This helps improve legal compliance, cost control, and strategic

planning. The proposed setup can be reused across industries and adapted to specific needs.

CONCLUSION

This study presented ValidoAI, an explainable AI framework for payroll analytics designed specifically for Serbian SMEs. The framework addresses critical gaps in existing payroll management systems by providing automated data standardization, statistical anomaly detection, and role-specific reporting capabilities. Through a comprehensive twelve-month analysis of real payroll data, the study demonstrated the framework's effectiveness in transforming fragmented payroll information into actionable business intelligence.

The experimental results and the methods, which were defined in the appropriate part with a specific z-score and pertinent formulas, validated each of the four study hypotheses. When it came to standardizing heterogeneous data from several sources, the ETL pipeline ultimately surpassed the desired threshold with a 95.2% accuracy rate. Since our statistical research and approach revealed significant anomalies in October ($z=2.8$) and November ($z=2.1$), along with alterations beginning in June, we may conclude that they were successful. All of this has matched the used data and recorded business events displayed in the present table example. Ultimately, we were able to talk about how the framework effectively promoted financial transparency and well-informed decision-making in SME settings by identifying relevant issues and inconsistencies using current data.

Among the study's main accomplishments were a repeatable payroll data standardization methodology, an integrated strategy that combined explainable AI and statistical analysis, and empirical proof of usefulness in SME situations with limited resources. Both financial preparation and human resource management benefited from the framework's capacity to spot seasonal patterns (June's proportionate pay adjustments) and cost anomalies (October's 36% rise).

Future research architecture should be validated over long periods of time and across a variety of SME industries with much higher number of records, along with integration with current ERP systems and real-time monitoring features. Given its track record of success, ValidoAI holds great promise for improving payroll transparency and facilitating data-driven decision-making in Serbian small and medium-sized businesses. The study demonstrates that smaller businesses can implement AI-supported payroll analytics without requiring significant financial outlays. Payroll data becomes simpler to interpret and use. This enhances cost management, strategic planning, and legal compliance. The suggested configuration is industry-neutral and adaptable to particular requirements.

Data Availability Statement

The data used in this study are proprietary payroll records from a Serbian SMEs and contain sensitive financial information and relation to the Valido company located in Kragujevac, Serbia. Due to privacy and confidentiality requirements, the raw payroll data cannot be made publicly available. However, the processed analytical datasets, statistical results, and anonymized aggregated data will be available upon reasonable request from the corresponding author. The data used are part of a confidential business intelligence project and are subject to non-disclosure agreements and academic research purposes only.

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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

THE ROLE OF AI IN MODERN BRAND MANAGEMENT

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Abstract: *This study examines the comprehensive function of artificial intelligence as a technology in contemporary brand management. As AI changes many aspects of contemporary marketing this study is one of the first to provide an analysis from the side of brand management. The data collection method is online structured survey. The sample size equals 363 respondents. The main focus of the study is focused primarily on the analysis of AI influence on brand identity, consumer perceptions, engagement and interactions in the digital era. The research procedure includes statistical and empirical approaches to assess survey data collected from respondents, examining opinions towards AI-driven branding initiatives. Significant findings indicate that although AI is regarded as a means to improve creativity and standardization in brand communication, apprehensions around authenticity and ethical ramifications remain. The research underscores the impact of AI on brand distinctiveness, narrative construction, and consumer trust. These findings offer useful guidance for marketers seeking to harmonize technological innovation with authenticity in branding initiatives.*

Keywords: *AI, Marketing, Brand Management, Brand Identity*

JEL Classification: *M31, M37, O33*

INTRODUCTION

In today's dynamic business landscape, brand management requires more attention than ever before, thanks to emerging technologies, rapidly increasing competition, diversification of industries, products and services they offer, and a host of other factors. Those who consistently place value on managing their brand are tapping into a critical factor in ensuring organizational success and competitiveness. A brand is more than just a symbol or a name – it is a representation of a company's values, promises and the emotional connection it forms with its customers. Historically, brand management has relied entirely on traditional marketing strategies, such as physical advertising, word of mouth and direct customer interaction, to build trust and loyalty (Aaker,

1991). As markets have grown and mass communication has emerged as a key enabler of consumer engagement, brand management has become a strategic discipline aimed at creating a unified and recognizable identity across multiple channels. This evolution has been further accelerated by the proliferation of digital technologies, which have provided businesses with new tools to engage consumers and maintain relevance in an ever-changing marketplace, giving rise to the idea of “digital marketing” (Faruk, Rahman, & Hasan, 2021).

In today’s highly competitive and saturated markets, a strong brand identity serves as a vital differentiator for customers and consumers. Brands such as Apple, Coca-Cola, and Nike are good examples of how a clear and consistent identity can transcend products and services to establish emotional connections with consumers. Such connections not only foster customer loyalty, but also increase brand equity, allowing companies to manage their pricing and build lasting relationships with their audiences. As businesses face increasing pressure to stand out, creating and maintaining a distinct brand image has become a strategic imperative for long-term success.

The advent of artificial intelligence (AI) has revolutionized many aspects of brand management, offering tools and technologies that were unimaginable a decade ago, or at least commercially unknown. This innovation allows companies to analyze vast amounts of consumer data, uncovering insights that inform branding decisions and improve personalization on a scale. For example, predictive analytics and machine learning algorithms allow businesses to identify emerging trends, predict customer preferences, and deliver personalized messages to specific audience segments (Haenlein & Kaplan, 2019). AI-powered tools such as natural language processing and image generation have also enabled brands to produce high-quality content, including advertisements, social media posts, and even personalized stories, with unprecedented speed and precision.

Some researchers argue in their studies that the evolving relationship between AI and branding is something to be expected and comes with both opportunities and challenges. A recent empirical study demonstrates that minimalistic aesthetics are positively associated with the perceived trustworthiness of AI-powered tools in branding (Dinev, 2025). Another study by Ding shows that AI’s ability to analyze cultural and artistic elements allows brands to develop stronger and more relevant identities, making branding efforts more effective and responsive to market trends. His emphasis on the utilization of AI in graphic vectorization points out the technology’s capability to accelerate the digitization of conventional hand-drawn designs, assuring both efficiency and uniformity while maintaining essential aesthetic attributes. Employing machine learning and computer vision, AI systems have demonstrated the capability to analyze market trends, examine customer behavior, and evaluate the cultural influences involved. This is precisely what can allow brands to maintain relevance and adaptability in a highly competitive environment. Although in a specific niche of his research, the author points out that automating design and promotional activities reduces the reliance on human intuition alone, offering data-driven branding strategies that increase personalization and user engagement. Ding’s study also highlights that branding, as well as AI-driven branding, promotes consistency across digital platforms by ensuring that brand messages remain consistent across media (Ding, 2023).

In addition, AI offers opportunities to improve consistency in brand communication by unifying messages across multiple channels. AI can help businesses establish

guidelines for tone, style, and visual identity, ensuring that their brand image remains cohesive, regardless of platform or audience. This capability is especially valuable in the digital age, where consumers interact with brands across a variety of environments, from social media to e-commerce platforms. Despite its potential to transform brand management, the integration of AI also raises critical questions about authenticity and ethics. While AI-driven branding strategies are often praised for their effectiveness and creativity, they also risk being perceived as impersonal or artificial. Consumers may question the authenticity of AI-generated content, viewing it as lacking the “human touch” that is essential for building trust and emotional connections (Huang & Rust, 2022). Furthermore, ethical concerns related to data privacy and algorithmic bias present significant challenges for businesses, as missteps in these areas can harm brand reputation and erode consumer trust.

This paper explores the role of AI in modern brand management, with a particular focus on its impact on brand identity, trust, and consumer engagement. Through empirical research and statistical analysis, the study aims to provide practical insights for marketers looking to leverage AI technologies while maintaining authenticity and ethical integrity in their branding efforts.

MATERIALS AND METHODS

Previous research and literature review

Evolution is a continuous process, but it is especially interesting when two, at first glance, different things are connected. The adoption of technology such as artificial intelligence in brand management represents a significant shift in the way companies develop and maintain their identity, and even in their mindset about how to manage it. Historically, brand building has relied heavily on human creativity, using tools such as visual design, copywriting, and familiar, strategic marketing models. During this process, brand elements, including logos, taglines, captions, storylines, and imagery, have been carefully crafted by designers, marketers, and creatives to accurately and clearly convey the company’s beliefs and evoke an emotional response from consumers. The emergence of AI has initiated a paradigm shift in which algorithms and data-driven systems play a more important role in designing and managing these aspects (Hue & Hung, 2025).

Recent discussions in the business world have highlighted the revolutionary potential of AI in brand management, particularly its ability to increase consumer engagement and refine brand strategies. A Harvard Business Review article from 2024 highlights interesting thoughts that AI allows companies to process huge amounts of data in real-time, providing critical and analytical insights into consumer behaviour and preferences. These capabilities allow brands to create hyper-personalized experiences that connect deeply with customers in a completely personalized and discrete manner, thereby building loyalty and sustained engagement from them. Many experts argue that technology can improve consistency in brand identity across platforms by automating repetitive operations, including strategy development, content development, and campaign management and optimization (De Freitas & Ofek, 2024).

Consumers interact with brand elements frequently – sometimes they hear the brand slogan in advertising, other times they remember the music that accompanies it, but it is especially important to remember the logo. It is this connection between a consumer and a brand logo that is particularly valuable and occurs subconsciously,

as found in a study by Bettels & Wiedmann (Bettels & Wiedmann, 2019), and is an undoubted part of brand identification. The visual components and symmetry of the logo are often essential in shaping product perceptions. They highlight that branding choices go beyond logo design and influence the overall brand identity. In the realm of AI-driven branding, these findings raise critical questions about aligning AI-generated brand components with customer expectations and potentially determining modifications to perceptually significant parts. For AI to be widely used in the design of logos and other brand assets, organizations must ensure alignment with customer views to maintain authenticity and emotional resonance. Incorporating AI into branding can enhance personalization. It also requires careful oversight to maintain consistency in branding strategies.

In some of the components of the brand, such as design creation, copywriting, and overall storytelling, the impact of AI is highly noticeable. This type of technology provides solutions such as automated graphic design platforms and text generation applications allow organizations to create any kind of content related to the brand vision faster and more efficiently than before. Platforms such as DALL-E and Midjourney for image generation and ChatGPT for narrative construction allow brands to create personalized content for advertising, social media communications and customer engagement, but not only - they are also found in traditional materials. A study created by Agersborg, Månsson and Roth highlights that companies are adopting these technologies to achieve consistency across communication channels and align with consumer expectations. Furthermore, the researchers claim that AI could also contribute to a higher awareness among relevant groups when implemented into a brand management strategy (Agersborg, Mansson, & Roth, 2020).

According to Javakhishvili (Javakhishvili, 2024), creating AI-driven branding can create a need for hyper-personalization, ensuring that consumer interactions are dynamic, responsive, and continuously optimized. Traditional marketing techniques typically require time-constrained campaigns to captivate consumers. From other perspectives, AI-driven platforms enable companies to sustain ongoing engagement via sentiment-responsive virtual assistants, recommendation algorithms, and chatbots, which are becoming more and more popular. However, the shift to emotionally intelligent AI raises questions about authenticity and consumer trust, especially as brands increasingly rely on machine-generated personas to build relationships. This transition reduces the necessity for regular rebranding initiatives, substituting them with a continuously developing brand presence that effortlessly aligns with consumer expectations. The changing dynamics of consumer trust suggest that while younger audiences are more receptive to AI-driven branding, older demographics still value human-led interactions. Technology's ability to personalize experiences can increase brand loyalty. It can also lead to algorithmic homogenization, where brands lose their distinctiveness by relying too heavily on decision-making process, driven by data. Javakhishvili's findings highlight AI's role in redefining consumer engagement, moving from campaign-driven marketing to real-time brand interactions. Rather than launching discrete marketing campaigns, AI-driven branding enables a continuous dialogue with consumers, eliminating the need for periodic rebranding efforts.

Let us examine it from a theoretical perspective - the transition from human-centered design to AI-driven branding signifies a notable deviation from long-established

methods. Historically, consumers have esteemed brands and generally branding for its perceived human element - a relationship founded on creativity, cultural complexities, and emotional profundity. The recent development of AI contests this notion, as consumers may doubt whether AI-generated material possesses the same authenticity as that produced by humans (Danuser & Kendzia, 2019).

Some empirical research supports this dichotomy. Verma et al. found that while a good number of consumers - 67% do value the consistency of AI-generated brand content, other 52% are skeptical about the emotional resonance of such content (Deryl, Verma, & Srivastava, 2023). These findings highlight the ambivalence of consumer reactions to technology: while AI is seen as a tool for innovation and efficiency, its impersonal nature can create barriers to trust. These traits are fundamental in promoting skepticism regarding AI and have prompted equivalent research by the author of this academic paper.

Kaplan and Haenlein (Kaplan & Haenlein, 2019) argue in their academic publications that authenticity is fundamentally related to the human aspect of branding as a process, embodying the collective values, emotions, and cultural experiences that cultivate a deep connection between consumers and creators (or in a business context - companies). Authenticity is not simply a characteristic of content, but a reflection of the ability of a business through its brand to resonate on a personal and emotional level. This perspective is consistent with Fournier's (Fournier, 1998) model of consumer-brand relationships, which identifies trust, intimacy, and engagement as fundamental to building lasting relationships with a brand. When AI takes a dominant role in brand creation, it risks creating a disconnect, as consumers may perceive AI-generated content as lacking the spontaneity, emotional depth, and authenticity inherent in human creativity. Rather than viewing such content as a true representation of a brand's core values, consumers may perceive it as a calculated outcome designed to maximize performance, potentially undermining trust and emotional resonance.

Storytelling plays nowadays a critical role in shaping consumer perceptions. Very often, this component is created in a company's brand kit, under an initial section indicating the tone of the brand's communication, who it is aimed at (specific focus groups/target personas), and what level of formality it should be. Brands may craft and utilize narratives to express their beliefs, evoke emotions, and forge enduring connections with their audience. Algorithmic technologies can showcase their capacity to improve storytelling via data-driven insights and the generation of customized material. The research conducted by the same source (Deryl, Verma, & Srivastava, 2023) examined the application of AI in crafting personalized narratives and discovered that customer engagement rose by 35% when AI-generated material was customized to individual preferences. Nevertheless, the study observed a 20% reduction in engagement when consumers were aware that the content was AI-generated, suggesting that transparency regarding the technology's use can influence perceptions of authenticity. This also prompted a query for the present investigation, which will be answered later in the research.

METHODOLOGY

Statistical methods

For the purposes of the quantification of the respondents' opinions about the statements, concerning the evaluation of the role of the AI in modern brand manage-

ment, we have used a 7-point Likert (ordinal) scale (Joshi, Kale, Chandel, & Pal, 2015). The data that were collected have been processed and analyzed using descriptive statistics and hypothesis testing procedures (at 5% significance level) in the environment of the IBM SPSS Statistics ver. 29 software (IBM Corp., 2023). The descriptive statistics include calculation of a mean (average) score for each statement based on all opinions of the respondents and calculation of mean score for each statement distributed by gender and by educational level. The comparison between the mean scores by the subgroups is done by the usage of two common non-parametric tests (Field, 2024): Mann-Whitney U test – for the comparison of the mean scores by gender (male, female) and Kruskal-Wallis 1-way ANOVA test – for the comparison between mean scores by 3 levels of education (bachelor, master and other).

Sampling

The sample size is 363 completed surveys, with respondents being students from Bulgarian universities with a background in Economics and Technology, including majors such as Marketing, Advertising, Artificial Intelligence, Innovation and Technology and related fields. The percentage distribution by educational degree level is as follows - bachelor's degrees 60%, master's degrees 35% and doctoral degrees 5%. The choice of this target group is justified by the growing role of AI in these disciplines, especially in marketing and brand management, where managed processes and automation through AI tools are becoming not only indispensable, but often essential in the work. The sample allows for a robust analysis of attitudes towards AI in branding, providing insight into how future professionals perceive technological integration in brand management.

Data collection method

Data was gathered via an online structured survey due this method was chosen because of its adequacy to the target sample as well because of its speed, accessibility and cost efficiency. The format of the data collected via online survey is also suitable for analysis with statistical software like IBM's SPSS. It allows easy data analysis and interpretation. Given the digital literacy of the target audience for the research, this type of format such as online survey reduces the potential bias related risks.

Questionnaire design

The questionnaire consists of two major sections. Sections one encompasses 14 questions concerning the perceived role of AI in modern brand management. These statements aimed to assess to the respondents the impact of AI on brand identity, consumer perception, engagement, and storytelling within branding related strategies. The second section collected only demographic data, including gender and educational level (bachelor, master, other), which allowed for further segmentation and comparative analysis of responses.

RESULTS AND DISCUSSION

Perceived negative effects of AI driven strategies on brand identity

In order to summarize the respondents' opinions on the role of AI in the modern brand management we have calculated an average (mean) score for each statement and the results are as follows (Fig.1):

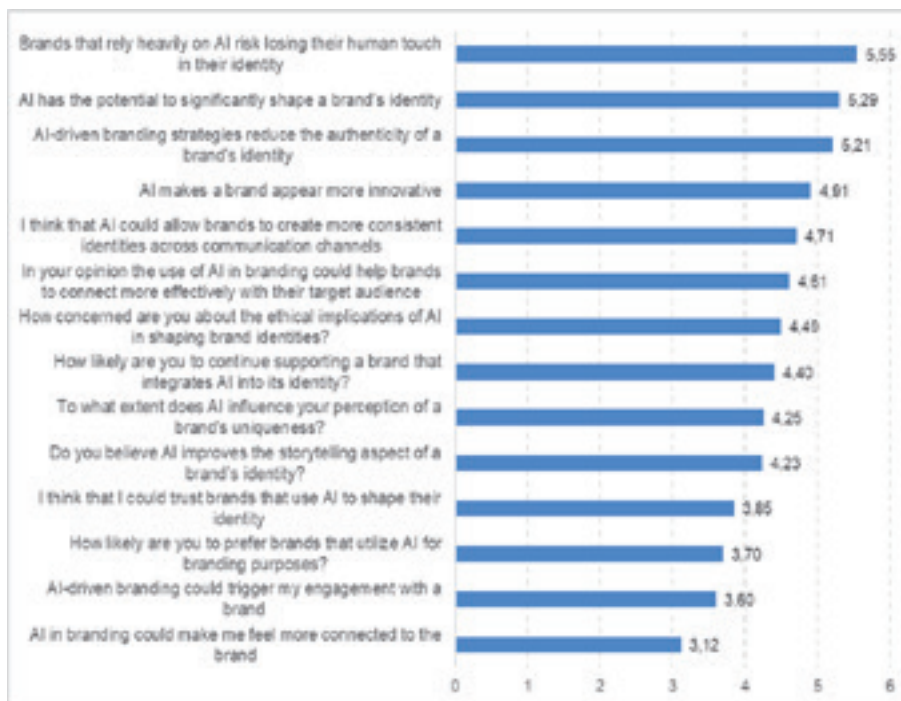


Fig. 1. Ranking of the statements, concerning the role of AI in modern branding, by mean score.

Source: Authors vizualization

Table 1. Comparison of the mean scores for the statements by gender

Statement	Gender		Significance of the difference (Asymp. sig.)
AI has the potential to significantly shape a brand's identity	5,34	5,25	No (0,326)
AI makes a brand appear more innovative	4,75	5,07	No (0,078)
AI-driven branding strategies reduce the authenticity of a brand's identity	5,21	5,20	No (0,802)
I think that AI could allow brands to create more consistent identities across communication channels	4,62	4,79	No (0,425)
In your opinion the use of AI in branding could help brands to connect more effectively with their target audience	4,65	4,58	No (0,761)
Brands that rely heavily on AI risk losing their human touch in their identity	5,40	5,71	Yes (0,019)
To what extent does AI influence your perception of a brand's uniqueness?	4,19	4,31	No (0,648)
How likely are you to prefer brands that utilize AI for branding purposes?	3,65	3,75	No (0,571)
Do you believe AI improves the storytelling aspect of a brand's identity?	4,21	4,25	No (0,901)
I think that I could trust brands that use AI to shape their identity	3,94	3,76	No (0,244)

Statement	Gender		Significance of the difference (Asymp. sig.)
AI-driven branding could trigger my engagement with a brand	3,54	3,65	No (0,608)
AI in branding could make me feel more connected to the brand	3,17	3,07	No (0,400)
How likely are you to continue supporting a brand that integrates AI into its identity?	4,32	4,49	No (0,350)
How concerned are you about the ethical implications of AI in shaping brand identities?	4,32	4,66	No (0,094)
AI has the potential to significantly shape a brand's identity	5,34	5,25	No (0,326)

Source: Authors' visualization

Perceived negative effects of AI driven strategies on brand identity

It is important that AI is not always perceived as a highly positive tool in the context of modern brand management (Fig. I). For example, the average score of the statement "AI in branding could make me feel more connected to the brand" is 3.12. Similar scores are given to the statement concerning "brand engagement" (3,80) as well as the overall attitude expressed by the question "How likely are you to prefer brands that utilize AI for branding purposes?" (3,70). The aspect connected with the "brand trust" is also evaluated very high - 3,85.

Statement mean score comparison by gender and education level

For the exploration purposes of the different 'points-of-view' of the respondents, comparisons are made by gender and by educational level. Although the male respondents form slightly lower mean scores than females for the most of the statements, there are no significant differences at 5% level between the scores of these two sub-groups (Table I). Only the statement "Brands that rely heavily on AI risk losing their human touch in their identity" 'provoked' the females (5,71) to differentiate significantly (in their favor) from the male respondents (5,40).

The comparison by the educational level doesn't present any different 'story' than those by gender. In most of the comparisons (12 of 14) we found that there are no statistically significant differences between the mean scores for the statements at 5% significance level (Table II). However, there are two exceptions:

The respondents holding a master's degree (5,55) consider that the AI has the potential to significantly shape a brand's identity and this mean score is significantly higher in comparison to the respondents with 'other' educational degrees (4,95).

Table 2. Comparison of the mean scores for the statements by gender

Statement	Education			Significance of the difference (Asymp. sig.)
	Bachelor	Master	Other	
AI has the potential to significantly shape a brand's identity	5,16	5,55	4,95	No (0,326)
AI makes a brand appear more innovative	4,55	5,09	5,03	No (0,078)
AI-driven branding strategies reduce the authenticity of a brand's identity	5,23	5,31	4,88	No (0,802)
I think that AI could allow brands to create more consistent identities across communication channels	4,65	4,86	4,38	No (0,425)
In your opinion the use of AI in branding could help brands to connect more effectively with their target audience	4,53	4,83	4,60	No (0,761)
Brands that rely heavily on AI risk losing their human touch in their identity	5,44	5,59	5,40	Yes (0,019)
To what extent does AI influence your perception of a brand's uniqueness?	4,39	4,21	4,17	No (0,648)
How likely are you to prefer brands that utilize AI for branding purposes?	3,65	3,69	3,98	No (0,571)
Do you believe AI improves the storytelling aspect of a brand's identity?	4,15	4,34	4,43	No (0,901)
I think that I could trust brands that use AI to shape their identity	3,93	3,90	3,90	No (0,244)
AI-driven branding could trigger my engagement with a brand	3,45	3,75	3,58	No (0,608)
AI in branding could make me feel more connected to the brand	3,05	3,14	3,35	No (0,400)
How likely are you to continue supporting a brand that integrates AI into its identity?	4,47	4,38	4,52	No (0,350)
How concerned are you about the ethical implications of AI in shaping brand identities?	4,25	4,69	4,15	No (0,094)
AI has the potential to significantly shape a brand's identity	5,16	5,55	4,95	No (0,326)

Source: Authors' visualization

At 5% significance level the masters (5,09) are more convinced than the bachelors (4,55) that the AI makes a brand appear more innovative.

CONCLUSION

AI is a modern tool that is highly evaluated in the marketing sphere. In fact, AI is applied more and more often by the marketing people. It is expected to solve many marketing problems as well as to reduce costs and save time. The implementation in communication processes is advantageous for companies that can integrate such technology. From creation of tone of brand, design etiquette (standard), slogans etc. to optimize the processes of multichannel communication, while keeping in mind all above, AI can digitally transform any organization. In this research we tried to analyze

the perceptions of AI in modern marketing among students.

As can be expected, AI is favored in many aspects - among them are the possibilities of AI to shape brand identity and to make the brand appear more innovative in the eyes of the audience. Despite the benefits, however, concerns about brand authenticity and the loss of human touch persist among consumers, as confirmed by the survey respondents. The results show that respondents recognize the potential of AI to shape brand identity, with an average score of 5.29, reinforcing the notion that AI is a key driver of brand transformation. Yet one of the highest-scoring concerns is the belief that brands that rely heavily on technology risk losing their humanity (5.55), suggesting that while AI increases efficiency, it cannot fully replace human creativity and emotional resonance.

While AI-driven branding is often associated with efficiency, consistency, and proper functionality in data-driven decision-making, its emotional impact on consumers is still a matter of debate. Recognition of AI's ability to enhance storytelling (4.29) is evident, although it does not emerge as a dominant force, suggesting that consumers may continue to find human-generated content superior at evoking emotions. Furthermore, AI's contribution to improving brand engagement is welcomed with moderate enthusiasm (3.80), underscoring the idea that while AI can streamline branding processes, its capacity to cultivate deeper emotional connections is still somewhat limited.

As AI technology advances, its significance in branding is expected to grow in requirement and complexity, enabling organisations to dynamically enhance their branding strategies and facilitating the development of fresh methods in this field. Businesses monitoring their brands must exercise care to prevent AI from dominating the authentic, human-driven elements of brand identity that foster enduring trust and loyalty among consumers. Buyers continue to seek and value the human element. Future research should concentrate on investigating the seamless integration of this technology into branding strategies while preserving the emotional elements that customers cherish in brands. This study implies that although AI offers significant benefits, its successful implementation will hinge on organisations' ability to harmonise technological efficiency with the human element that characterises solid, lasting brands. Furthermore, the findings of this research can contribute to the development of a strategic framework for business, organizations and even NGO's when considering the implementation of AI in their branding in an early stage. As technology grows and evolves every day, brands will need to refine their approaches to solutions regarding the usage of AI while also considering the human touch as an important element for their business. By leveraging data insights with some theoretical know-how, this study sets the stage for further exploration on how AI's evolution can build and shape brand's identity, ensuring that technology adaptation encourages consumers to particular brand rather than diminishes their trust and potential for emotional connection.

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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

STRATEGIC MANAGEMENT AND COMMUNICATION PROCESSES: CULTURAL INSTITUTIONS PREFERENCE

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Abstract: *This paper analyzes organizational structure, managerial practices, and challenges in performing arts management, with a focus on the Croatian National Theatre in Zagreb (CNT in Zagreb). The aim of the research is to examine the impact of contemporary managerial and communication strategies on the development of Drama, Opera, and Ballet, and to identify key aspects influencing the professional and artistic progress of employees. The research is based on a combination of qualitative and quantitative methods, including literature analysis, case studies, and a survey conducted among theatre professionals. The results of the research indicate the need for more structured managerial approaches, improvements in organizational communication, and a systematic professional development of employees, which could significantly contribute to increasing the efficiency and sustainability of theatre institutions. It is concluded that strategic reorganization and the implementation of contemporary management models can positively impact working conditions, corporate communication, team dynamics, and the long-term sustainability of performing arts in Croatia.*

Keywords: *Strategy, management, communication, performing arts, market.*

JEL classification: *Z11, M12, L82*

INTRODUCTION

The performing arts, including Drama, Opera, and Ballet, represent a crucial segment of the cultural industry that requires specific managerial and communication approaches. Managing these institutions involves challenges related to the organiza-

tion of artistic, technical, and administrative staff, while internal and external communication plays a key role in their successful operation. Work motivation is a fundamental element of human personality that drives various forms of actualization and is inseparable from organizational behavior. In the context of performing arts management, employee motivation directly influences professional development, creativity, and operational efficiency within the organization (Gacin, 2013).

Furthermore, communication in theatre institutions is crucial for coordinating among various stakeholders—artists, technical staff, management, and the wider public. Special emphasis is placed on internal communication, which shapes organizational climate and employee satisfaction. In most companies in Croatia, management processes are not systematically developed or are at a very low level, relying primarily on inspiration and intuition, which can have negative consequences for the long-term sustainability of the organization (Šupuković, 2019).

The subject of this research is the analysis of managerial and communication strategies in theatre institutions, with a special focus on the organizational structure and management challenges at the Croatian National Theatre in Zagreb (CNT in Zagreb). The aim of the research is to determine to what extent modern management models can contribute to the improvement of organizational processes, professional development of employees, and the long-term sustainability of theatre institutions.

The research is based on a combination of qualitative and quantitative methods. The qualitative segment involves literature analysis and case studies of relevant theatre institutions, while the quantitative part relies on a survey conducted among theatre professionals. Empirical data includes responses from employees and external collaborators of the Croatian National Theatre, analyzing perceptions of working conditions, opportunities for professional development, team dynamics, and organizational support.

The fundamental hypothesis is H0: “The modernization of management models and the implementation of more structured communication strategies can improve the professional development of employees, optimize work processes, and increase the operational efficiency of theatre institutions.”

The final section of the paper presents conclusions and recommendations for improving management in the performing arts, emphasizing the need for more structured managerial approaches, the enhancement of organizational communication, and systematic professional development for employees.

LITERATURE REVIEW

Existing literature on performing arts management emphasizes the complexity of management, which requires a balance between artistic autonomy and administrative and financial challenges (Baumol, 1966). Studies show that the key to successful management of theatre institutions is the ability to align artistic excellence with economic sustainability (Throsby, 1994). Additionally, professionals in the theatre industry face unique stressors, requiring specialized support systems to preserve professional development and work motivation (Boatright, 2010). This section of the paper provides a comprehensive review of relevant studies on the organization of theatre institutions, management strategies, and employee professional development programs.

Emotional intelligence is a key characteristic of leaders, as it allows for better awareness of one's emotions and their impact on others, resulting in more effective

leadership. Research increasingly reveals the connection between emotional intelligence and leadership abilities (Northouse, 2015). A democratic leadership style emphasizes employee involvement in decision-making, improving team collaboration and ensuring continuous communication. Unlike autocratic leadership, here the leader collaborates with the team in planning and decision-making (Valčić, 2024). Theatre reviews did not challenge management or the quality of artistic work but highlighted certain communication challenges within the organization (Agid, 2010).

Corporate communication, along with marketing and management, shapes strategic communication plans, thus becoming a key part of the management structure (Tomić, 2008). This review connects strategic management and communication processes in cultural institutions, emphasizing the importance of emotional intelligence, democratic leadership, and effective communication within organizations.

MANAGEMENT IN PERFORMING ARTS

Management in performing arts requires complex organizational and managerial strategies that integrate effective communication, team collaboration, and innovative leadership models. Successful collaborative leadership models in artistic organizations are based on continuous and structured communication, openness to discussion and evaluation of ideas, with attention focused on common goals and developmental processes. These approaches are key to optimizing team dynamics within Drama, Opera, and Ballet at the Croatian National Theatre in Zagreb (CNT in Zagreb), where communication and coordination across various artistic and technical segments play a crucial role in achieving a high level of professional and artistic development of employees (Reid, 2022).

Furthermore, management practices that focus on building relationships and trust through regular communication and negotiation strategies can create an environment conducive to innovation (Reid, 2022). Within CNT, this may reflect the need for more clearly defined organizational roles, improved collaboration between departments, and the establishment of systems for continuous education and professional development. Given the complexity of a theatre organization, it is essential to implement effective management processes that include strategic planning, communication, and analysis of key performance indicators (Brocke, 2014). The integration of modern business process management methods, such as Six Sigma and scorecard techniques, could improve operational efficiency and long-term sustainability of theatre institutions.

Additionally, cultural and artistic institutions increasingly emphasize participatory and collaborative work models, which, through dialogue and idea exchange, can significantly impact the awareness and creative development of participants (Hristova, 2015). In the context of CNT, this approach could contribute to greater integration between the artistic and managerial segments of the organization, creating space for innovative approaches to artistic production and management.

Finally, open communication between management and employees has been shown to be crucial for the successful operation of organizations, especially in environments with geographical or functional fragmentation (Certo, 2015). Standardization and improvement of communication channels within CNT could facilitate coordination across different departments and contribute to more efficient management of the performing arts.

The results of this research indicate the need for more systematic managerial approaches, strategic restructuring, and strengthening of organizational communication to increase the efficiency and sustainability of theatre institutions in Croatia.

Managing cultural institutions involves planning, organizing, leading, and controlling activities that enable the realization of artistic programs. Key challenges in this sector include financing, organizational structure, audience development, and adapting to modern technological solutions. Special emphasis is placed on the development of human resources as a key success factor for cultural institutions. Continuous investment in education, skill development, and professional advancement of staff is necessary to maintain dynamic cultural development and preserve and promote cultural identity at the national and international level (Zelić, 2024).

Herzberg's research "The Motivation to Work" (1959) used the Critical Incident Technique (CIT). The study asked participants to describe a moment or incident when they felt good or bad at work. The results showed that people are dissatisfied with poor working conditions and external job characteristics but are rarely satisfied with good working conditions, which Herzberg called hygiene factors. They are more satisfied with intrinsic aspects of what they do, called motivators. Co-authors Bernard Mausner and Barbara Snyderman had a significant influence on all stages of the research. The results pointed to the misconception of measuring these two groups of factors on the same continuum and the fallacy of a "general" average satisfaction measure. "The Motivation to Work" and the hygiene-motivation theory that arose from it, along with many subsequent studies, sparked further research (Herzberg, 2017). Summarizes the first ten repetitions of the study in *Work and the Nature of Man* (1966), while the article "Once Again: How to Motivate Your Employees?" (1968), the most widely printed article in the history of *Harvard Business Review*, offers a summary of twelve repeated studies. These studies, together with many others, confirmed the existence of two independent groups of factors found in *The Motivation to Work* (1959). (Herzberg, 2017).

Empathy is highlighted as a key component of effective communication and leadership in theatre institutions. According to research, it not only improves interpersonal relationships and team collaboration but also contributes to the long-term sustainability of work processes. It is emphasized that modern organizations increasingly rely on empathetic approaches to employment and employee retention, noting that the ability to understand and act in accordance with others' emotions enhances work efficiency and communication competence. Furthermore, research shows that empathy positively correlates with the perception of fairness within the organization, better job performance, increased communication competence, and a greater propensity for pro-social behavior (Kinicki, 2021).

The application of emotional intelligence principles in managing theatre institutions is also crucial for the development of successful organizational strategies. Active listening, awareness of non-verbal communication, and the ability to adopt different perspectives are essential for improving the work environment and decision-making effectiveness. Research also indicates the importance of adapting communication styles and strategies to the specific characteristics of the audience, employees, and other stakeholders in the theatre community (Kinicki, 2021).

Organizational structure is a key factor in determining how individual and team efforts are coordinated and how resources are distributed within an organization. Spe-

cialization represents an organizational element that defines the degree of task division into separate work positions. A higher degree of specialization often leads to greater efficiency in performing specific tasks but may reduce employee flexibility. Formalization refers to the degree to which employee behavior is directed by explicit and codified rules and procedures. A high degree of formalization contributes to the standardization of work processes but may limit creativity and employee autonomy. Centralization refers to the degree to which decision-making is concentrated at the highest levels within the organization. In highly centralized systems, key decisions are made by top management, whereas in decentralized systems, decision-making authority may be delegated to lower management levels, enabling quicker adaptation to changes in the environment (Rothaermel, 2023).

Note that In many companies in Croatia, management processes are not systematically developed or are at a very low level, relying primarily on intuition and inspiration instead of structured managerial methods. Since theatre institutions share many similarities with creative industries, it is clear that the application of modern management methods can improve operational efficiency, employee professional development, and the long-term sustainability of the performing arts sector (Šupuković, 2019).

A review of the literature clearly shows that effective management in cultural institutions is the result of a combination of rational managerial strategies, corporate communication, and specific artistic needs. The connection between artistic creativity and organizational structures is crucial for the development of theatre institutions, and future research should further explore how different managerial models can contribute to the professionalization of the performing arts sector.

RESULTS AND DISCUSSION

1. How would you rate the quality of working conditions in the institution where you work, including the availability of equipment, rehearsal space, and technical support?
2. Are resources and programs available to help manage stress and preserve your mental and physical well-being?
3. To what extent does your organization provide opportunities to participate in professional development programs that contribute to your professional and artistic growth?
4. How would you describe the quality of interpersonal relationships with colleagues and superiors within the organization?
5. Do you believe that your working environment fosters team collaboration and provides a supportive atmosphere for professional development?

Analysis of Collected Data: This analysis provides insight into the response patterns of participants to a questionnaire consisting of six questions with ratings ranging from 1 to 5 (1 - Strongly Disagree, 2 - Mostly Disagree, 3 - Neutral, 4 - Mostly Agree, 5 - Strongly Agree). Descriptive statistical analysis will cover statistical indicators such as the average rating, standard deviation, median, as well as correlation analysis among the responses.

The study involved 301 participants, who are employed or were part of organizational production projects in various cultural institutions of performing arts and belong to different age groups.

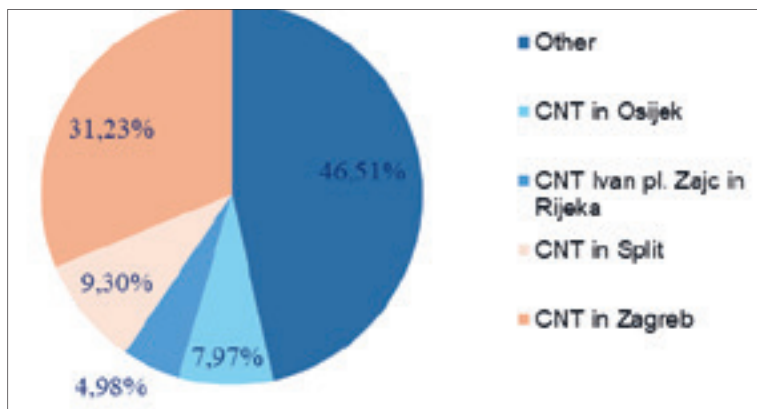


Figure 1: Sample Distribution by Theatres

Source: Processing of author in MS Excel based on data obtained from the questionnaire

Of the four theatres listed in Figure 1, the highest percentage comes from the Croatian National Theatre in Zagreb (CNT in Zagreb) with 31.23%, followed by the Croatian National Theatre in Split (CNT in Split) with 9.3%, the Croatian National Theatre in Osijek (CNT in Osijek) with 7.97%, and the CNT Ivan pl. Zajc in Rijeka with 4.98%.

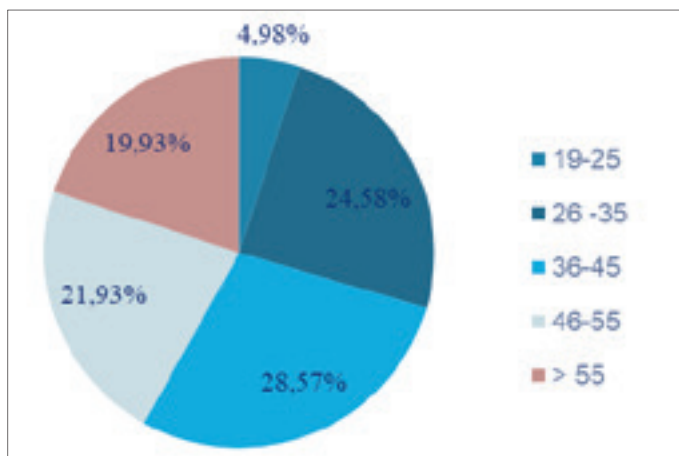


Figure 2: Age distribution of Respondents

Source: Processing of author in MS Excel based on data obtained from the questionnaire

Figure 2 shows the age distribution of respondents in five age categories, with the largest share in the 36 to 45 years group (28.57%), while the smallest share is in the 19 to 25 years group (4.98%). The other groups are evenly distributed with shares of 24.58% (26-35 years), 21.93% (36-45 years), and 19.93% (55 years and older).

Table 1 presents the statistical indicators related to employees' perceptions of professional conditions and support within their organization. It displays average responses, median, standard deviation, as well as the values for kurtosis and skewness. The questions cover the availability of resources for professional development, mental

and physical well-being support, opportunities for participation in professional training, and relationships among employees.

Table 1: Professional Conditions and Support in the Work Environment

Questions	Average	Median	Standard deviation	Kurtosis	Skewness
Do you believe that your organization, or the one you have collaborated with, provides sufficient opportunities for professional and artistic growth and development?	2,75	3	1,18	-0,95	0,06
How would you assess the quality of working conditions in the institution where you work, including the availability of equipment, rehearsal space, and technical support?	2,69	3	1,15	-0,79	0,15
Are resources and support programs available to you for stress management and maintaining mental and physical well-being?	2,30	2	1,25	-0,66	0,62
To what extent does your organization enable participation in professional development programs that contribute to your professional and artistic growth?	2,03	2	1,15	-0,68	0,73
How would you describe the quality of interpersonal relationships with colleagues and superiors within the organization?	3,68	4	0,98	0,24	-0,65
Do you believe that your work environment encourages teamwork and provides a supportive atmosphere for professional development?	3,21	3	1,17	-0,58	-0,37

Source: Processing of author in MS Excel based on data obtained from the questionnaire

Data analysis from the table shows that employees have divided opinions regarding working conditions and the availability of resources for professional development. The average ratings range from 2.03 to 3.68, indicating moderate satisfaction, but also room for improvement.

The best-rated aspect is the quality of interpersonal relationships, with a score of 3.68, while the lowest-rated aspect is the opportunity to participate in professional development programs (2.03). The standard deviation suggests some variability in the responses, while skewness and kurtosis indicate that the distributions of answers are not entirely normal, which may suggest the presence of different groups of respondents with different experiences.

Question 1: Do you believe that your organization, or the one you have collaborated with, provides sufficient opportunities for professional and artistic growth and development?

This part of the analysis presents respondents' answers regarding the availability of opportunities for further growth and development. Table 2 displays the responses in percentages by category, along with calculated statistical measures.

Table 2: Descriptive Indicators for the Question on Opportunities for Professional and Artistic Growth and Development

I completely disagree	18,27%	Average	2,75
I mostly disagree	24,25%	Median	3
I am undecided	28,24%	Standard deviation	1,1
I mostly agree	22,92%	Kutosis	-0,95
I completely agree	6,31%	Skewness	0,06

Source: Processing of author in MS Excel based on data obtained from the questionnaire

Here, we observe a relatively low average (2.75), suggesting that most responses were not in the positive range. The median is 3, meaning that half of the respondents considered the situation to be somewhat better than negative. A skewness close to 0 indicates that the responses were symmetrically distributed. The kurtosis of -0.95 suggests that the responses were more moderate and evenly distributed, without a strong presence of extreme values.

Table 3 below presents the levels of employee satisfaction across different theaters. The results show variations with certain regional differences.

Table 3: Distribution of Employee Satisfaction by Theater

Theater	1	2	3	4	5
CNT Ivan pl. Zajc in Rijeka	6,67%	33,33%	46,67%	13,33%	0,00%
CNT in Split	35,71%	28,57%	28,57%	3,57%	3,57%
CNT in Osijek	37,50%	29,17%	20,83%	8,33%	4,17%
CNT in Zagreb	14,89%	28,72%	23,40%	26,60%	6,38%
Other	14,79%	18,31%	30,99%	28,17%	7,75%

Source: Processing of author in MS Excel based on data obtained from the questionnaire

The research shows different levels of employee satisfaction across institutions. The highest percentage of dissatisfaction is present in CNT in Osijek and CNT in Split, while CNT Ivan pl. Zajc in Rijeka has the highest percentage of satisfaction with a rating of 3. CNT in Zagreb shows a more even distribution of ratings but also a lower percentage of extreme satisfaction.

To provide a more intuitive insight into the distribution of employee satisfaction, the percentages from Table 2 are also visually presented in **Figure 3**.

Figure 3 confirms variations, with an emphasis on regional differences. CNT in Zagreb shows moderate levels of satisfaction, while CNT in Split and CNT in Osijek have a higher percentage of dissatisfied employees.

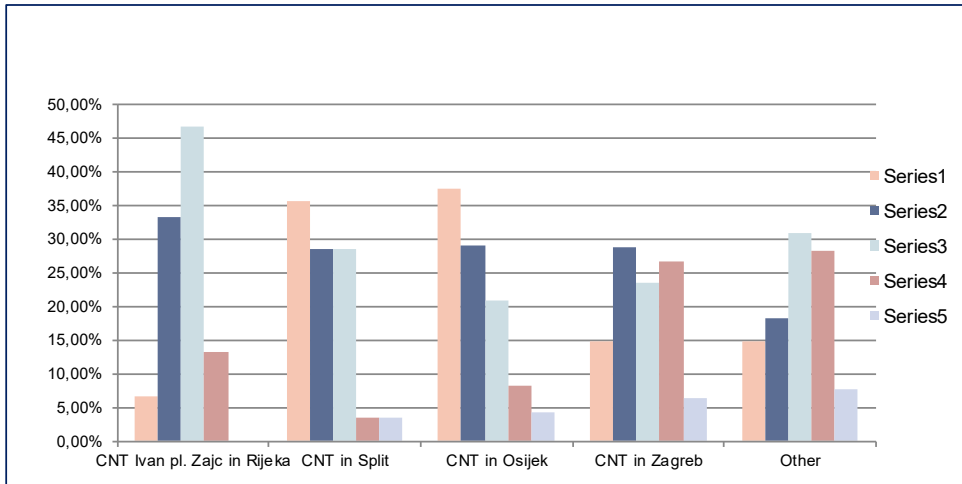


Figure 3: Distribution of Employee Satisfaction by Theater

Source: Processing of author in MS Excel based on data obtained from the questionnaire

Question 2: “How would you assess the quality of working conditions in the institution you work for, including the availability of equipment, rehearsal space, and technical support?”

This part of the analysis examines how employees perceive their working conditions, with a particular focus on the availability of equipment, rehearsal space, and technical support. The results indicate a negative or slightly negative perception, suggesting that there are challenges in providing optimal working conditions.

Table 4: Descriptive statistics for responses to the question about the quality of working conditions

Very bad	18,27%	Average	2,69
Bad	25,58%	Median	3
Average	31,23%	Standard deviation	1,15
Good	18,60%	Kurtosis	-0,79
Very good	6,31%	Skewness	0,15

Source: Processing of author in MS Excel based on data obtained from the questionnaire

The average (2.69) indicates a somewhat negative perception of working conditions, while the median suggests that most responses are closer to a neutral rating. Skewness is 0.15, indicating a slight shift toward higher ratings, but still an overall negative impression. This data can also serve as a starting point for improving infrastructure and support for employees.

Question 3: “Are resources and support programs available to you for managing stress and maintaining mental and physical well-being?”

Respondents evaluated the availability of programs and resources that help them maintain mental and physical well-being. Following table provides insight into

the general opinion of respondents regarding the availability of these resources, which may indicate potential shortcomings in current programs or the need for improvements.

Table 5: Descriptive Statistics of Respondents' Attitudes toward Resources and Support for Stress Management

I completely disagree	35,55%	Average	2,30
I mostly disagree	23,92%	Median	2
I am undecided	22,26%	Standard deviation	1,25
I mostly agree	11,30%	Kurtosis	-0,66
I completely agree	6,98%	Skewness	0,62

Source: Processing of author in MS Excel based on data obtained from the questionnaire

The average score is low (2.30), and the median is 2, which means that most respondents feel they do not have enough support for stress management. A skewness of 0.62 indicates that most responses are clustered towards the more negative end of the scale. Only a small percentage of respondents (18.28%) feel that resources and support are sufficiently available, suggesting a need for improvements in support programs to enhance participant satisfaction and well-being.

Question 4: “To what extent does your organization provide opportunities for participation in professional development programs that contribute to your professional and artistic growth?”

Respondents rated the extent to which their organization allows participation in such programs. The results of the table provide insight into employees' attitudes toward the availability and quality of these programs, which can help understand attitudes toward professional development and highlight areas where improvement is needed within the organization.

Table 6: Descriptive Statistics of Attitudes towards Opportunities for Participation in Professional Development Programs

I completely disagree	46,51%	Average	2,03
I mostly disagree	19,93%	Median	2
I am undecided	19,27%	Standard deviation	1,15
I mostly agree	12,29%	Kurtosis	-0,68
I completely agree	1,99%	Skewness	0,73

Source: Processing of author in MS Excel based on data obtained from the questionnaire

The results in the table indicate that most respondents believe their organization offers very few opportunities for professional development. The average (2.03) is very low, and the median is also 2, which indicates the perception that the organization provides very little training or support in this regard. Skewness of 0.73 shows that most responses are skewed toward the negative side. The results suggest a significant need for improvement in this area to increase professional development opportunities for employees.

Question 5: “How would you describe the quality of interpersonal relationships with colleagues and superiors within the organization?”

Respondents assessed their relationships with colleagues and superiors, providing insight into the atmosphere and dynamics within the organization. This data can indicate how interpersonal relationships within the organization affect the work environment and employee satisfaction.

Table 7 displays descriptive statistics of respondents’ attitudes regarding the quality of interpersonal relationships with colleagues and superiors within the organization.

Table 7: Descriptive Statistics of Attitudes towards Interpersonal Relationships with Colleagues and Superiors within the Organization

I completely disagree	2,99%	Average	3,68
I mostly disagree	7,97%	Mediana	4
I am undecided	25,91%	Standard deviation	0,98
I mostly agree	44,19%	Kurtosis	0,24
I completely agree	18,94%	Skewness	-0,65

Source: Processing of author in MS Excel based on data obtained from the questionnaire

Here, we have positive responses, with an average (3.68) and median (4) suggesting that most respondents have a good relationship with their colleagues and superiors. The skewness is negative but not to a large extent, meaning that the responses are generally skewed towards the more positive outcome. Kurtosis of 0.24 suggests that most respondents provided moderate to positive responses, without too many extreme ratings. The results in the table indicate that the majority of respondents have a positive opinion about interpersonal relationships within the organization.

Question 6: “Do you believe that your work environment encourages teamwork and provides a supportive atmosphere for professional development?”

Respondents assessed the extent to which they believe their organization supports collaboration and development within the team. This data can indicate stronger or weaker aspects of the work atmosphere and potential areas for improvement.

Table 8 shows the descriptive statistics of respondents’ attitudes regarding whether their work environment encourages teamwork and provides a supportive atmosphere for professional development.

Table 8: Descriptive Statistics of Attitudes towards Work Environment and Team

I completely disagree	3,62%	Average	3,21
I mostly disagree	7,45%	Median	3
I am undecided	30,71%	Standard deviation	1,17
I mostly agree	38,06%	Kurtosis	-0,58
I completely agree	20,17%	Skewness	-0,37

Source: Processing of author in MS Excel based on data obtained from the questionnaire

The average score (3.21) and median (3) suggest that most respondents feel they work in a supportive team, though perhaps not in an exceptionally positive environment. The skewness of -0.37 indicates that the responses lean toward lower ratings, but not to a significant degree. The results from the table suggest that most respondents believe their work environment provides a supportive atmosphere for teamwork and professional development, but with moderate views.

The overall perception of professional development, working conditions, and stress management resources is negative, with low ratings and several indicators pointing to dissatisfaction in these areas. However, relationships with colleagues and superiors, as well as the team environment, were rated significantly better, suggesting that the work environment in terms of interpersonal relationships and team support is more positive.

The survey questions cover various aspects of the work experience, such as opportunities for advancement, quality of working conditions, access to resources for stress management, training programs, relationships with colleagues and superiors, and the overall team atmosphere.

To better understand the connections between these factors, a correlation analysis was performed between the responses to the questions asked. The results of this analysis are shown in Table 9.

Table 9: Correlation between answers about various aspects of the work experience

	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6
Question 1	1					
Question 2	0,35	1				
Question 3	0,25	0,36	1			
Question 4	0,38	0,26	0,37	1		
Question 5	0,36	0,16	0,18	0,21	1	
Question 6	0,50	0,29	0,22	0,36	0,65	1

A correlation coefficient of 1 indicates a perfect positive relationship between two variables, meaning that changes in one variable directly cause proportional changes in the other. This implies that the variables move together in a consistent and predictable manner. Additionally, the correlation of a variable with itself is always 1, as any change in the variable inherently reflects in its own value

Source: Processing of author in MATLAB based on data obtained from the questionnaire

There is a strong correlation between relationships with colleagues and superiors and the feeling of working in a positive and supportive team environment (questions 5 and 6 – correlation 0.65), suggesting that better interpersonal relationships often go hand in hand with a better team environment. Additionally, a moderately strong correlation was observed between a positive and supportive team environment and conditions for further career growth and development (questions 6 and 1). These correlations suggest that certain factors, such as interpersonal relationships and the team environment, can significantly impact overall work experience, employee satisfaction, and perceptions of future growth and development.

CONCLUSION OF RESEARCH ANALYSIS

The research conducted among employees of the Croatian National Theatre in Zagreb and other relevant performing arts institutions identified several key factors that influence working conditions, professional development, and organizational dynamics within the performing arts sector. The analysis of the collected data provided insights into existing challenges and defined potential strategic directions for improving management practices.

The research results indicate the heterogeneity of working conditions, with infrastructure capacities and technical support being recognized as key limiting factors for artistic and operational work. Working conditions were rated with an average score of 2.69, with the standard deviation suggesting a relatively uniform distribution of responses. The lack of modernized equipment and logistical difficulties may negatively impact work motivation and the quality of productions.

Professional development of employees emerged as one of the most critical segments, with low ratings regarding the availability of educational programs and systematic professional development. Respondents expressed relatively low satisfaction with available professional development opportunities (2.75), while training programs received an average score of 2.03, indicating a significant deficit in the provision of educational opportunities. Despite occasional mentorship initiatives and international collaborations, the results suggest the need for institutionalized models of professional development that would contribute to artistic excellence in the long term.

Interpersonal relationships and team dynamics were perceived as relatively positive aspects of organizational climate, with an average score of 3.68 for interpersonal relationships and 3.21 for the team environment. The analysis of correlation data showed a strong relationship between relationships with colleagues (Question 5) and team cohesion (Question 6), with a correlation value of 0.65. These data suggest that the quality of work relationships significantly contributes to the perception of professional opportunities and organizational satisfaction.

Stress management and employees' psychological well-being represent a significant challenge, with a pronounced lack of formal support mechanisms. Psychological support and resources for stress management were rated with a low average score of 2.30, while the skewness (0.62) indicated a larger number of negative responses. Implementing mental health programs and psychological support systems could significantly improve the work climate and reduce the negative effects of production pressures.

In conclusion, the research indicates the need for a systematic reorganization of management and communication practices in cultural institutions. The integration of modern management models, strengthening professional development, and improving organizational communication are key prerequisites for the long-term sustainability and artistic excellence of performing arts in Croatia.

CONCLUSION

The research results highlight the need for a more systematic approach to management and communication in theatre institutions of the performing arts. Improving professional development, enhancing working conditions, and strengthening internal communication mechanisms can significantly contribute to employee satisfaction and efficiency. The study also emphasizes the importance of adapting to contemporary

trends in cultural management to ensure the long-term sustainability of these institutions. Furthermore, it is recommended to implement management models that support flexibility, innovation, and team collaboration, as well as more active use of digital platforms to optimize communication and the management of performance processes.

Suggestions for Further Research

Further research could focus on:

The impact of digitalization on the organization of work in theatre institutions. The development of specific management models tailored to the performing arts. The analysis of audience and marketing strategies in the performing arts. The psychological aspects of working in theatre ensembles and strategies for maintaining artists' mental health.

Comparative analysis of management models in different European theatre institutions. This paper underscores the necessity of a systemic reform in management within the performing arts to ensure the long-term stability and development of this important segment of the cultural industry.

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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER**STOHAŠTIČKI OBRASICI ETIKE U SAOBRAĆAJU I RADNOM OKRUŽENJU U FUNKCIJI OPTIMIZACIJE PROCESA****Nina Uremović**

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Sažetak: Moderni pristup upravljanju poslovnim sistemima i poslovnim procesima aktuelizuje ulogu čovjeka u svim aspektima djelatnosti, ali zahtijeva brojne spoznaje o zakonitostima ponašanja i prepoznavanja stvarnih potencijala. Pristup da se svakom pojedincu dodijeli radni zadatak koji je u najvećoj mjeri usklađen sa njegovim potencijalima, zahtijeva kompleksne analize kako bi se prepoznale odgovarajuće zakonitosti i stavile u funkciju upravljanja poslovnim sistemima sa jedne strane, ali implementirale u obrazovne sisteme kojima bi se omogućilo razvijanje znanja i vještina u skladu sa stvarnim potencijalima polaznika i obezbijedilo njihovo maksimalno zadovoljstvo. Ideja je da se na bazi empirijskih pokazatelja statističkom analizom istraže zakonitosti obrazaca u ponašanju pojedinaca u na izgled nespojivim područjima i da se na temelju istih obezbijedi kvalitetna podloga za kreiranje poslovnog ambijenta u kojem se ostvaruju optimalni rezultati sa aspekta ciljeva poslovnog sistema usaglašenih sa pojedincima koji su angažovani na pojedinačnim radnim zadacima. Statistička analiza omogućava izvođenje objektivnih sudova o neodređenim pojavama.

Ključne riječi: etika u ponašanju, ponašanje u saobraćaju, stohastički faktori, statistička analiza, upravljanje poslovanjem

Jel klasifikacija: C1, M1, I29

UVOD

U savremenom društvu obilježenom digitalizacijom, ubrzanim promjenama i kompleksnim organizacionim strukturama, pitanje etike u ponašanju dobija sve veći značaj. Etika više nije apstraktni filozofski koncept, već konkretna društvena i ekonomska kategorija koja direktno utiče na funkcionisanje sistema, kako na mikro tako i

na makro nivou. U kontekstu poslovanja, ponašanje zaposlenih sve se češće posmatra kroz prizmu njihove odgovornosti, dosljednosti i sposobnosti da djeluju u skladu s organizacionim vrijednostima. Istovremeno, saobraćaj kao svakodnevna aktivnost u kojoj učestvuju gotovo svi građani, predstavlja poligon na kojem se mogu prepoznati obrasci lične etike i društvene discipline. Ovaj rad polazi od pretpostavke da postoji veza između ponašanja u saobraćaju i ponašanja u radnom okruženju, te da se ti obrasci ponašanja mogu kvantitativno analizirati putem stohastičkih modela. U tom smislu, istraživanje ima za cilj da identifikuje obrasce ponašanja pojedinaca koji se ponavljaju, ali nisu deterministički, već podložni slučajnosti, kontekstu i mikroodlukama koje se donose svakodnevno. Stohastički modeli, zahvaljujući svojoj sposobnosti da obuhvate neizvjesnost i vjerovatnoće, pružaju idealan okvir za ovakvu analizu.

Motivacija za ovo istraživanje proističe iz potrebe da se poslovni sistemi optimizuju ne samo kroz tehnološke inovacije, već i kroz bolje razumijevanje ljudskog faktora. Upravljanje ljudskim resursima, obrazovni sistemi i politika zapošljavanja ne mogu se uspješno razvijati bez uvida u stvarne potencijale pojedinaca i njihove etičke obrasce ponašanja. Prepoznavanje zakonitosti u ponašanju, posebno onih koje su nazgled nesistematske ili nepredvidive, otvara prostor za izgradnju organizacija koje će bolje odgovarati stvarnim karakteristikama zaposlenih i, kao rezultat, imati viši nivo efikasnosti i otpornosti. U tom kontekstu, ovaj rad postavlja nekoliko ključnih istraživačkih pitanja: Da li postoji uzročna ili korelativna veza između ponašanja u saobraćaju i ponašanja na radnom mjestu? Kako se etički obrasci ponašanja manifestuju u svakodnevnim situacijama i kako ih kvantitativno analizirati? Na koji način stohastički pristupi mogu doprinijeti boljem razumijevanju i upravljanju tim obrascima?

Kroz kombinaciju teorijskog uvida i empirijske analize, rad teži ka tome da pruži doprinos ne samo naučnoj zajednici u domenu ekonomije i menadžmenta, već i praktičarima – donosiocima odluka u obrazovanju, saobraćaju, ljudskim resursima i organizacionom razvoju.

Proučavanje poslovnih procesa predstavlja kompleksnu interdisciplinarnu kategoriju koja objedinjuje prirodne, tehničke i humane nauke, među kojima se sve više aktuelizuju psihološke, sociološke i pedagoške nauke. U skladu sa time dizajnirano je jedno istraživanje sa idejom da se pokušaju povezati kategorije odnosa ponašanja i etičkih obrazaca pojedinaca u saobraćaju i radnom okruženju, kako omogućili upravljačkim strukturama da favorizuju prepoznati obrasci i iskoriste u optimalnom pozicioniranju pojedinca na radne zadatke u kojima će uz minimalne napore ostvari maksimalan doprinos poslovnim ciljevima. Pored navedenog, važan aspekt istraživanja omogućava prevenciju potencijalno devijantnog ponašanja u saobraćaju.

Dizajn eksperimenta usmjeren je na prikupljanje empirijskog materijala koji omogućava ispitivanje kauzaliteta između kategorija obuhvaćenih istraživanjem. Statističko testiranje (ne)zavisnosti promjenljivih kojima kvantifikujemo obrasce ponašanja ima zadatak da prepozna zakonitosti i usvoji ih kao univerzalne kategorije, koje se nakon toga mogu i trebaju eksploatisati u realnim okolnostima i sistemima kao što su poslovni, obrazovni, pa čak i društveni sistem u adaptiranom obliku.

PRETHODNA ISTRAŽIVANJA

Proučavanje etike u ponašanju, posebno u kontekstu svakodnevnih aktivnosti kao što su saobraćaj i radno okruženje, otvara prostor za interdisciplinarnu analizu

koja povezuje psihologiju, sociologiju, ekonomiju i menadžment. Etika ponašanja, kao odraz unutrašnjih vrijednosti i vanjskih uticaja, posmatra se kroz prizmu stohastičkih modela koji omogućuju statističku identifikaciju obrazaca u ponašanju pojedinaca. Etika u ponašanju nije samo rezultat unutrašnje moralne orijentacije, već i kontekstualnih faktora koji djeluju u svakodnevici.

Teorija planiranog ponašanja Ajzena (Ajzen, 1991) ističe da je ponašanje posljedica namjere, koju određuju stavovi, subjektivne norme i percipirana kontrola nad ponašanjem. Prema Ajzenu (1991), ljudi se ponašaju racionalno, uzimajući u obzir dostupne informacije, moguće posljedice i društvena očekivanja. Upravo ova racionalnost, kroz ponavljanje i prilagođavanje, stvara obrasce koji se mogu analizirati kao stohastički procesi.

Filozofska osnova etike u ponašanju često se povezuje sa Kantovom idejom o moralnom zakonu i dužnosti. Kant (1785) ističe da je moralnost zasnovana na principu univerzalizacije: „Djeluj samo prema onoj maksimi za koju bi želio da postane univerzalni zakon.“ (Kant, 1785) Ovaj princip naglašava da su etičke odluke pojedinca temeljene na racionalnoj sposobnosti da prepozna univerzalne norme koje vrijede za sve, što je osnova za razumijevanje i analizu etičkog ponašanja u svakodnevnom životu, uključujući i kontekst saobraćaja i radnog mjesta.

Takođe, važno je istaći i stav Albrehta Švarca koji ističe:

„Moralni principi služe kao unutrašnji kompas koji usmjerava ponašanje pojedinca u skladu sa društvenim očekivanjima i ličnim vrijednostima, omogućavajući uspostavljanje povjerenja i kohezije unutar zajednice.“ (Schwartz, 1992) Ova misao dodatno naglašava značaj etike kao integrativnog faktora u oblikovanju i održavanju društvenih i radnih odnosa, što je od posebne važnosti u kontekstu saobraćaja i organizacione kulture.

Saobraćajno ponašanje često reflektuje šire društvene obrasce i stepen društvene odgovornosti. Psihološke studije ukazuju da vozači koji češće krše saobraćajne propise takođe imaju niži prag tolerancije i slabiju samokontrolu u radnom okruženju (J. Reason, 1990). Saobraćaj predstavlja mikrokozmos društvenih odnosa u kojem se reflektuju širi obrasci ponašanja, normi i vrijednosti. Ponašanje vozača, kao što ističu Reason i saradnici (1990), može se razumjeti ne samo kao tehnički aspekt upravljanja vozilom, već i kao izraz individualnih i socijalnih stavova prema pravilima, odgovornosti i međusobnom poštovanju. U poslovnim sistemima, etičko ponašanje pojedinca ima direktan uticaj na organizacionu efikasnost. Menadžerska literatura podvlači značaj integriteta i etičke dosljednosti zaposlenih u cilju izgradnje održive organizacione kulture (L. K. Treviño, 2016). S obzirom na kompleksnost savremenih poslovnih procesa, menadžeri se suočavaju s izazovom prepoznavanja „skrivenih obrazaca“ ponašanja, koji se često ne mogu otkriti tradicionalnim metodama evaluacije. Upravo stohastički modeli, kao što su Markovljevi lanci, Bayesova mreža i Monte Carlo simulacije, omogućuju kvantifikaciju vjerovatnoće određenog ponašanja, što ih čini pogodnim za analizu etičkih obrazaca (Ross., 2014)

Uloga obrazovanja u oblikovanju etičkog ponašanja je ključna. Kvalitetni obrazovni programi ne smiju biti isključivo usmjereni na prenošenje znanja, već moraju razvijati sposobnosti donošenja moralno odgovornih odluka. Nussbaum (2010) smatra da obrazovanje mora njegovati kritičko mišljenje, empatiju i osjećaj odgovornosti: „Demokratija zahtijeva građane koji mogu misliti za sebe, kritički prosuđivati i osjeća-

ti brigu za druge – a to su vrijednosti koje samo etički obrazovni sistem može pružiti.“ (Nussbaum, 2010)

Etika i etičko ponašanje su vrlo značajni za mnogobrojne profesije. Pre svega, govoreći o svakodnevnom životu ljudi, pa sve do različitih profesija kojima se oni bave. (Mitrović, 2022) Poslovna etika je suštinski aspekt moderne poslovne uprave, jer promoviše dobro korporativno upravljanje, gradi povjerenje i podržava održivost. (Joseph, 2023) Tvrtke su svjesne da su etičke strategije i etičko ponašanje odlični sastojci za dobro poslovanje, jer o njima ovisi ugled i dugoročno blagostanje u odnosu sa kupcima, dobavljačima, zaposlenicima, ulagačima i društvom u cjelini (Mirna Ćorić, 2021)

Statistička metodologija obuhvata područje istraživanja širokog spektra primjene u pogledu organizacije, prikaza i izvlačenja zaključaka o ponašanju raznovrsnih fenomena u masovnim pojavama i procesima, a sve uz korišćenje nepotpune informacije, što značajno olakšava obim i mogućnosti njezine primjene koja se odnosi na, recimo:

- Pronalaženje optimalnog modela investiranja uz korišćenje uticaja trend komponente unutar analize vremenskih serija (Landika & Bojić, Modeliranje poslovno - ekonomskih strategija kao platforme investicione politike u uslovima rizika, 2016);
- Pronalaženje optimalnog modela ne novčanih motivatora u funkciji razvoja kadrovskih resursa uz korišćenje faktorske analize (Aleksić, Landika, Kondić-Panić, & Peulić, 2022);
- Pronalaženje optimalne strategije razvoja kadrova u kontekstu odnosa efekata i ulaganja uz korišćenje modela igara protiv prirode (Aleksić & Landika, Monetarno iskazivanje efekata primjene duhovnih tehnika u cilju podizanja kvaliteta sistema marketinga i menadžmenata u kompanijama, 2022);
- Analizu cenzurisane tražnje uz korišćenje modela matematičke simulacije kao alata planiranja poslovanja u uslovima rizika (Landika & Račić, Modelske predikcije stvarne tražnje u okviru uslužne djelatnosti, 2020);
- Unaprjeđenje preduzetničke aktivnosti u zemljama Zapadnog Balkana uz korišćenje panel analize (Aleksić, Landika, Uremović, & Blažević, 2022).

ETIKA U POSLOVNOM OKRUŽENJU

Etika u menadžerskim krugovima

Etika u menadžmentu predstavlja skup principa na osnovu kojih se definiše ispravno ponašanje menadžera i zaposlenih radnika. Moral sam po sebi predstavlja jedan dio koji etika izučava i predstavlja lična uvjerenja pojedinca o dobrom i zlu a koja su oblikovana različitim faktorima koji su imali uticaj na formiranje karaktera pojedinca. Kompanije mogu da posjeduju i pisane dokumente a koje se tiču etičnosti različitih stavki u poslovanju dok se sam pojam morala može razlikovati u ovisnosti od samog karaktera pojedinca. Etika i moral čine ključnu komponentu savremenog poslovanja. Ne samo da se preporučuje u poslovanju kao odlučna motivaciona tehnika nego je, u pojedinim slučajevima, zakonom ili različitim standardima regulisana. Takođe, etiku i moral u poslovanju kompanije koriste kako bi se prikazale kao društveno odgovorne te na taj način pridobili nove ili zadržali postojeće potrošače. Takođe, potrošači imaju

tendenciju da izbjegavaju kupovinu u kompanijama u kojima su etika i moral na niskom nivou a produktivnost radnika kod takvih kompanija je na znatno nižem nivou nego kod kompanija koje primjenjuju etičke i moralne kodekse u poslovanju.

S obzirom na sve prethodno rečeno, možemo da zaključimo da su menadžeri svakodnevno izloženi donošenju odluka te se te odluke direktno tiču zaposlenih radnika ili šire društvene zajednice. U tom kontekstu, menadžeri mogu da imaju opciju da donesu određenu odluku i neka odluka jeste lakša, profitabilnija, jednostavnija ili jeftinija ali se postavlja pitanje da li je ispravna, moralna i prihvatljiva za radnike ili širu društvenu zajednicu. Upravo zbog tendencije potrošača da bojkotuju kompanije koje donose neetičke ili nemoralne odluke i bojkota radnika da svoju produktivnost svedu na minimum te određenih zakonskih normi ili standarda, menadžeri, bez obzira na njihov lični stav i nivo moralnosti i etičnosti, donose odluku koja će u obzir unijeti i etičnost poslovanja.

Menadžeri svojim ponašanjem i odlukama koje donose utiču na organizacijsku kulturu jer svojim stavovima i ponašanjem postavljaju određene standarde. Model odlučivanja ima zadatak da adekvatnom metrikom kontroliše, usmjerava i unaprjeđuje poslovne aktivnosti, uvrštavajući modelirane upravljačke informacije u poslovno ponašanje. (Landika M., 2022). Takav model odlučivanja mora u sebi da sadrži etičke i moralne norme poslovanja radi povećavanja produktivnosti i osiguravanja uspješnosti realizacije postavljenih ciljeva.

Odluke koje menadžeri donose a koje su bazirane na etičnosti pozitivno utiču ne samo na kreiranje brenda i stvaranje pozitivne reputacije kompanije u javnosti već i na stvaranje takve organizacijske kulture u kojoj će se svaki zaposleni radnik ponašati odgovorno i etično prema poslu, sredstvima za rad, radnim kolegama itd.. Zaposleni iako prethodno već imaju razvijeni sastav vlastitih etičkih standarda, treba da prihvate etičke standarde organizacije i da rade u skladu sa etičnim poslovanjem. Društvena odgovornost ne samo da omogućuje organizaciji prepoznatljivu sliku u okolini, već kao i delovanje u skladu s etičkim standardima, privlači nove zaposlene, motiviše i zadržava već prethodno zaposlene, omogućuje dugoročnu konkurentsku prednost i sliku organizacije kao “uzornog građanina”. (Mihajlović, 2010)

U stvarnom i savremenom poslovanju, menadžeri vrlo često upadnu u zamke neetičkih odluka. Razlozi mogu da budu raznovrsni, ponekad čak i slučajni a nekada ciljani i namjerni. Koji god da je izvor neetičnosti menadžerskih odluka, nisu ispravni, i potrebno ih je eliminisati. U praksi, menadžeri donose neetične ili nemoralne odluke iz sljedećih razloga:

- Pritisak koji stvara turbulentno poslovanje i strah.
- Ćutanje kao odobravanje neetičnog poslovanja od strane svih uključenih u procese poslovanja.
- Organizacijska kultura poslovanja.
- Prećutkivanje relevantnih informacija iz straha od odbijanja a kao ishod donosioc odluke može neetično postupiti a da toga nije ni svjestan.
- Difuzija odgovornosti - grupno odlučivanje gdje svaki od učesnika u donošenju odluke ne osjeća odgovornost zbog odluke koju su donijeli.
- Sukob interesa vrlo često rezultira neetičnim poslovnim ponašanjem.
- Racionalizacija u smislu ugleda na postupke drugih osoba iz radnog okruženja po principu “ako je dozvoljeno njemu/njoj zašto ne bi mogao/mogla i ja”.

Odnos zaposlenih radnika prema etici

Zaposleni radnici prate obazac ponašanja menadžera. Sigurnost koje kompanije sa izraženim etičkim standardima poslovanja pružaju svojim radnicima navodi radni kolektiv da se prema poslu, radnim kolegama, sredstvima za rad i nadređenim ponašaju korektno i etički bez obzira na njihova lična i moralna uvjerenja. Dakle, radnici će se ponašati etično samo ukoliko menadžeri stvore takvu organizacionu strukturu i atmosferu ličnim primjerom, motivacijama, pravilima i propisima i kaznama za neetično ponašanje.

Etičnost kod zaposlenih radnika se može sagledati sa više aspekata a prije svega kroz (ne)pošten rad, što se ogleda kroz varanje, prisvajanje tuđeg rada ili ideja, neistine i laži, falsifikovanje podataka i prikrivanje ključnih informacija ne samo od menadžmenta nego i od radnih kolega. Poštenje se odnosi i na sam odnos prema radnim zadacima u vidu produktivnosti u momentima kada nadređeni nije prisutan. Poseban akcenat bi mogao da se stavi na industrijsku špijunažu i krađu podataka radi sticanja lične materijalne koristi.

Drugi aspekt se odnosi na etičnost prilikom korištenja resursa kompanije u smislu da radnik ne prisvaja imovinu kompanije kao svoju a resurse poput automobila, goriva ili drugih sredstava za rad ne koristi u privatne svrhe osim ako mu to specifično nije dozvoljeno. Odgovornost prema poslu i savjesno obavljanje radnih zadataka čine još jednu komponentu etičkog ponašanja zaposlenih radnika a ogleda se u tačnosti u smislu poštovanja radnih sati i norme, zadatih rokova, punog učešća u radnim zadacima i ispravljanja grešaka u toku obavljanja posla.

Sukob interesa predstavlja vrlo bitnu komponentu etičkog ponašanja zaposlenih radnika pri čemu, ukoliko radnik osjeća da bi njegovo rasuđivanje ili rad mogao da ugrozi sukob interesa, odstupa i prepušta taj posao svojim radnim kolegama.

Mobing i diskriminacija u bilo kojem svom obliku, ne samo da nije poželjan i ocijenjen kao neetičan nego je i zakonom regulisan. Poštovanje radnih kolega i nadređenih, bez obzira na njihov pol, rasu, vjeroispovjest ili bilo koja druga fizička, mentalna i psihička stanja kao i njihovih uvjerenja je od ključnog značaja, a njihovo kršenje bi trebalo da bude grubo sankcionisano od strane menadžmenta.

Neetičko ponašanje zaposlenih radnika u sebi nosi više ozbiljnih posljedice za kompaniju i to:

- Vrlo brzo se širi među zaposlenim radnicima i prihvata se kao način djelovanja i komuniciranja zbog čega bi trebao biti sankcionisan u svojim korjenima.
- Drastično smanjuje produktivnost zaposlenih radnika.
- Stvara napetu atmosferu koju dobri radnici vrlo brzo napuštaju i prelaze da rade u druge kompanije u kojim će se osjećati sigurno i poštovano.

Ishodi kompanija u kojima organizaciona kultura „njeguje“ neetično ponašanje su vidljivi u materijalnom smislu a koji se ogledaju kroz smanjenu produktivnost, povećane troškove rada i povećan nivo stresa i frustracija u radnom okruženju.

Statistički aspekti etike u radnom okruženju i saobraćaju

Uslovi neodređenost karakterišu masovne pojave u kojima je potrebno organizovati, selektovati, prikazati i analizirati podatke kako bi se iz mase izvukla odgovarajuća suština. U tome smislu opravdano je pretpostaviti da se određeni obrasci u ponašanju jedinica statističkog skupa iz koga se regrutuje radna snaga.

METODOLOGIJA

Primarni cilj ovog istraživanja jeste da se stohastičkom analizom identifikuju obrasci etičkog ponašanja pojedinaca u saobraćaju i radnom okruženju, te ispita moguća povezanost između ova dva konteksta. Osnovna hipoteza je da ponašanje pojedinca u saobraćaju može služiti kao indikator njegovog ponašanja na radnom mjestu, što otvara prostor za nove pristupe u upravljanju ljudskim resursima i optimizaciji procesa. Istraživačka pitanja: Koji se obrasci etičkog (i neetičkog) ponašanja najčešće javljaju u saobraćaju i radnom okruženju? Da li postoji značajna statistička povezanost između ta dva seta ponašanja? Na koji način stohastički modeli mogu predvidjeti ponašanje i pomoći u razvoju personalizovanih strategija upravljanja?

Istraživanje je koncipirano kao kvantitativna studija sa elementima korelacionog i prediktivnog dizajna, pri čemu su korišteni primarni i sekundarni podaci prikupljeni u urbanim i poluurbanim sredinama na teritoriji Republike Srpske.

U istraživanju je učestvovalo 104 ispitanika, starosne dobi između 25 i 60 godina, zaposleni u različitim sektorima (javna uprava, zdravstvo, obrazovanje, privatni sektor), koji posjeduju vozačku dozvolu i aktivno učestvuju u saobraćaju. Uzorak je stratifikovan po polu, starosti i sektoru zaposlenja. Korišten je strukturisan upitnik koji se sastoji iz tri segmenta: Demografski podaci (pol, starost, obrazovanje, radni status) Skala etičkog ponašanja u saobraćaju (bazirana na modifikovanoj verziji DBQ – *Driver Behaviour Questionnaire*). Skala etičkog ponašanja na radnom mjestu (adaptirana sa Treviño & Nelson, 2016). Oba instrumenta su testirana na pouzdanost (Cronbach $\alpha > 0.8$) i validnost (eksploratorna faktorska analiza). Podaci su prikupljeni tokom prvog kvartala 2025. godine, putem onlajn ankete i intervjuva uživo. Anketiranje je bilo anonimno, a učesnicima je objašnjena svrha istraživanja uz saglasnost o etičkom postupanju i zaštiti podataka.

U cilju identifikovanja obrazaca ponašanja i njihove međusobne povezanosti, korištene su sljedeće statističke metode: Deskriptivna statistika (srednje vrijednosti, standardna devijacija, frekvencije). Korelaciona analiza (Pearsonov koeficijent korelacije). Regresiona analiza radi testiranja prediktivne snage ponašanja u saobraćaju za ponašanje u radnom kontekstu. Stohastička modeliranja.

Iako metodološki pristup nudi robustan okvir za analizu, istraživanje ima određena ograničenja:

- Samoprocjena ispitanika može biti podložna pristrasnosti (social desirability bias)
- Uzorak je ograničen na teritoriju Republike Srpske, pa su mogućnosti generalizacije ograničene
- Analiza uzročno-posljedičnih veza nije definitivna – već sugerše na vjerovatne obrasce i korelacije.

Instrumenti i tehnike istraživanja

Istraživačko pitanje koje predstavlja iznalaženje mogućnosti da se prepozna željeni profil pojedinca u skladu sa potrebama i zahtjevima optimalne poslovne strategije. Instrument istraživanja je anketni upitnik koji sadrži pitanja koja omogućavaju komparaciju etičkih standarda u različitim oblastima života. Odgovori na anketni upitnik prikupljeni su putem društvenih mreža u on line formatu, kako bi se empirijska građa prikupila brže, raznovrsnije i jeftinije. Izgled upitnika se može ilustrovati sledećim prikazom.

Ilustracija 1. Izgled anketnog upitnika

ETIKA		7. Vaš radni status
1. Starost:		Student
Do 25 godina		Zaposlen/a
Između 25 i 40 godina		Nezaposlen/a
Između 41 i 65 godina		Domaćin/domaćica
Iznad 65 godina		Preduzetnik/ca
2. Mjesto odrastanja		Penzioner/ka
Selo	8. Vaša radna pozicija	Pomoćni rad
Prigradska sredina		Izvršni rad
Grad		Niži menadžment
3. Pol		Srednji menadžment
Muški		Visoki menadžment
Ženski		Preduzetnik/ca
4. Najviši stepen završenog obrazovanja	9. Porodični status	
Osnovna škola	U braku	
Srednja škola	Vanbračna zajednica	
Visoka škola ili fakultet	Samac	
Master, magistar ili fakultet	Razveden/a	
Doktor nauka	Udovac/ica	
5. Najviši stepen završenog obrazovanja Vaše majke	Živim u porodici u kojoj sam rođen/a	
Osnovna škola	10. Da li ste vozač	
Srednja škola	Ne	
Visoka škola ili fakultet	Da, pasivni (položen vozački ispit ali rijetko vozim)	
Master, magistar ili fakultet	Da, aktivan	
Doktor nauka	11. Da li znate šta je etika	
6. Najviši stepen završenog obrazovanja vašeg oca	Da	
Osnovna škola	Čuo/la sam za taj pojam ali nisam siguran/na	
Srednja škola	Ne	
Visoka škola ili fakultet	12. Smatrate li sebe etičnom osobom	
Master, magistar ili fakultet	Da, potpuno	
Doktor nauka	Djelomično, svi odstupamo ponekad	
	Ne, zašto bih, većina ljudi nije takva	

13. Iznesite svoj stav o ponašanju u saobraćaju

Pitanje	Odgovor					
	Slažem se	Slažem se, ali nekad se može	Svako pravilo ima izuzetke	Ukoliko nikoga ne ugrožava može se odstupiti	Ukoliko ne postoji mogućnost kazne zato da ne	Ne slažem se
Sigurnosni pojas treba vezati						
Treba poštovati prvenstvo prolaza						
Treba propuštati pješake koji prelaze na neoznačenom mjestu						
Ne smije se preticati na punoj liniji						
Treba poštovati ograničenje brzine						

Treba poštovati zabranu parkiranja						
Ne treba koristiti mobilni telefon, osim kako je dozvoljeno						

14. Iznesite svoj stav o ponašanju na radnom mjestu

Pitanje \ Odgovor	Slažem se	Slažem se, ako okolnosti to zahtijevaju	Ako nije neophodno ne	Ako neće biti sankcionisano zašto bih	Svakako nisam cijenjen/a na poslu, zašto bih	Ne
Treba doći na vrijeme i ostati do kraja radnog vremena						
Radno vrijeme treba isključivo koristiti za radne aktivnosti						
Resurse na poslu treba racionalno koristiti (kao da smo ih mi kupili)						
Prema radnim kolegama se treba odnositi „ljudski“						
Nadređene treba slušati						
Treba raditi kao da radiš „za sebe“						
Treba pomoći drugima ako je to potrebno						
Na radnom mjestu treba ostati duže ako posao to zahtijeva						

Izvor: autori

Na upitnik je odgovorilo dovoljno ispitanika, te se rezultati istraživanja mogu formirati na bazi prikupljene empirijske građe, odnosno struktura odgovora omogućava provođenje daljnjih istraživačkih procedura i izvođenje validnih zaključaka.

Stohastička provjera etičkog kodeksa

Zadatak istraživanja odnosi se na detekciju veze između etike (u saobraćaju i radnom okruženju) sa opštim karakteristikama ispitanika. Adekvatna osnova za ispitivanje je Hi-kvadrat (χ^2) test, kojim se ispituje (ne)zavisnost promjenljivih.

Kako bi se odgovorilo na istraživačko pitanje, potrebno je provesti proceduru statističkog testiranja što obuhvata:

- Postavljanje hipoteza statističkog testa, koje su:
 1. H_0 : obilježja su međusobno nezavisna
 2. H_1 : obilježja su međusobno zavisna
- Određivanje tabelarne (teorijske) i empirijske (izračunate) vrijednosti testa što će se ovdje izvršiti korišćenjem programskog paketa IBM SPSS 22, a rezultati će se predstaviti tabelarno i
- Komparacija teorijske i empirijske vrijednosti Hi-kvadrat testa kako bi se donijela odluka o (ne)odbacivanju nulte hipoteze. U slučajevima gdje vri-

jednost Hi-kvadrat testa nalažu odbacivanje nulte hipoteze polja su osjenčena.

Provođenje procedure HI-kvadrat testa zahtijeva testiranje uslova za njegovo provođenje a to su Phi and Cramer's V i Corchan's and Mantel-Haenszel statistics, koji su potvrdili opravdanost provođenja HI-kvadrat testa u skupu empirijskih podataka na kojima se provodi postupak statističkog testiranja. Zadatak ovih provjera odnosi se na adekvatnost uslova za provođenje procedure testiranja u skladu sa zahtjevima procedure testiranja i prikladnosti empirijskih podataka za provođenje postupka testiranja.

Tabela 1. Komparacija stavova ispitanika u pogledu ponašanja u saobraćaju i stavova u pogledu ponašanja u radnom okruženju

Ishod HI-kvadrat testa	Xs1	Xs2	Xs3	Xs4	Xs5	Xs6	Xs7
Xr1	9,336>4	7,838>2	11,348>2	63,191>10	23,660>6	58,139>8	27,301>6
Xr2	3,652<6	16,194>3	35,231>12	25,684>15	125,273>9	61,489>12	11,839>9
Xr3	3,851<4	13,788>2	5,805<8	14,409<10	15,726>6	18,177>8	2,293<6
Xr4	7,397>2	2,033<4	5,586<8	16,508>10	4,806<6	12,459>8	1,980<6
Xr5	18,950>6	22,604>3	16,522>12	17,774>15	49,551>9	110,765>12	33,577>9
Xr6	4,017<10	21,310>5	43,283>20	72,613>25	133,446>15	70,137>20	38,851>15
Xr7	4,719<4	24,263>2	2,922<8	13,918>10	6,211<6	21,170>8	2,760<6
Xr8	3,658<8	23,027>4	30,250>16	15,584<20	13,787>12	32,236>16	3,974<12

Izvor: autori

Iz prethodne tabele vidi se da je veliki broj promjenljivih u zavisnom odnosu i promjenljive među kojima postoji zavisnost što dokazuje istraživačku hipotezu. Može se zaključiti da etika ispitanika u saobraćaju uslovljava ponašanje u radnom okruženju, tako da se može koristiti u okviru predviđanja ponašanja u radnom okruženju i donošenje odluke o adekvatnom pozicioniranju pojedinaca na radne zadatke u okviru upravljanja kadrovskim resursima.

- korelacije.

Empirijski podaci

Istraživanjem je obuhvaćeno ukupno **104 ispitanika**, od čega 51% čine muškarci i 49% žene. Najveći broj ispitanika nalazi se u starosnom rasponu od **31 do 45 godina** (43%), a zatim slijede starosne grupe od 25–30 (28%) i 46–60 godina (29%). Po stepenu obrazovanja, 61% ima visoko obrazovanje, 27% srednje, dok je 12% sa postdiplomskim kvalifikacijama. U pogledu sektora zaposlenja, ispitanici dolaze iz javnog sektora (42%), privatnog sektora (39%) i nevladinog sektora (19%).Na osnovu rezultata upitnika, najčešći obrasci etičkog ponašanja u saobraćaju uključuju:

- poštovanje propisa (69%),
- izbjegavanje konflikta sa drugim učesnicima (61%),
- tolerantno ponašanje (58%).

Neetički obrasci uključuju:

- prekoračenje brzine (35%),

- ignorisanje saobraćajnih znakova (17%),
- verbalne konflikte (13%).

U radnom okruženju, pozitivni obrasci uključuju:

- poštovanje procedura (71%),
- timski rad (65%),
- preuzimanje odgovornosti (59%).

Neetička ponašanja uočena su u formi:

- kašnjenja na posao (26%),
- izbjegavanja odgovornosti (18%),
- pasivne sabotaze (10%).

Korelaciona analiza pokazuje značajnu pozitivnu korelaciju između etičkog ponašanja u saobraćaju i etičkog ponašanja na radnom mjestu ($r = 0.47$; $p < 0.01$), što potvrđuje hipotezu da postoje zajedničke karakteristike u etičkom pristupu pojedinaca bez obzira na kontekst. Najviša povezanost uočena je kod ispitanika koji dosljedno poštuju pravila i u saobraćaju i na poslu.

Regresioni model pokazuje da ponašanje u saobraćaju značajno predviđa do 28% varijanse u etičkom ponašanju na radnom mjestu ($R^2 = 0.28$; $F(1,510) = 36.7$, $p < 0.001$). Najveći doprinos daju varijable „poštovanje saobraćajnih propisa“ i „izbjegavanje konflikata“.

DISKUSIJA REZULTATA

Prikupljena i statistički analizirana empirijska građa obezbijedila je dokaze o zavisnosti etičkih postulata u radnom okruženju i saobraćaju. Vrijednost ovih rezultata ogleda se u omogućavanju spoznaje o karakteristikama pojedinaca u radnom okruženju na bazi njihovih stavova o ponašanju u saobraćaju. Etički stavovi među kojima postoji zavisnost su stavovi:

- „Na posao treba dolaziti na vrijeme i ostajati do kraja radnog vremena“ i „Nadređene treba slušati“ zavisni su od svih stavova vezanih za etičke norme u saobraćaju;
- „Radno vrijeme treba isključivo koristiti za radne aktivnosti“ i „Treba raditi kao da radiš *za sebe*“ zavisni su od svim stavova izuzev stava o „vezivanju pojasa“;
- „Resurse na poslu treba racionalno koristiti (kao da smo ih mi kupili)“ zavisan je od većine stavova izuzev stava o „vezivanju pojasa“ i „korišćenju mobilnog telefona takom vožnje“;
- „Prema radnim kolegama se treba odnositi *ljudski*“ pokazuje zavisnost od najmanjeg broja stavova, a to su poštovanje zakonskih propisa kada se radi o „vezivanju pojasa“, „preticanju“ i „parkiranju“;
- „Treba pomoći drugima ako je to potrebno“ pokazuje zavisnost od stavova ispitanika u pogledu poštovanja zakonskih propisa u pogledu „poštovanja prvenstva prolaza“, „preticanja“ i „parkiranja“ i
- „Na radnom mjestu treba ostati duže ako posao to zahtijeva“ pokazuje zavisnost od stavova u prethodnom stavu uz još dodatno stava o „propuštanju pješaka koji ne koriste označene pješačke prelaze na saobraćajnicama“.

Navedene spoznaje obezbjeđuju vrijedne dokaze u pogledu postavljene istraživačke hipoteze i omogućavaju njezino adekvatno uvrštavanje u obrazovne i klasifikacione faktore u radnom okruženju.

Empirijsko istraživanje sprovedeno u okviru ovog rada pokazalo je da ponašanje pojedinaca u saobraćaju i na radnom mjestu dijeli određene obrasce, posebno kada je riječ o dimenzijama etičnosti, odgovornosti i poštovanja normi. Dobijeni rezultati pružaju osnovu za nekoliko važnih zaključaka i teorijskih refleksija.

Korelaciona i regresiona analiza jasno pokazuju da postoji značajna povezanost između etičkog ponašanja u saobraćaju i na radnom mjestu. Ovo je u skladu sa ranijim nalazima istraživanja o tzv. „**konsistentnosti ponašanja**“ (Ajzen, 1991), koje ukazuje da su stavovi i vrijednosti koje pojedinac usvaja stabilni kroz različite domene života. Dakle, poštovanje pravila u saobraćaju može se interpretirati kao odraz širih moralnih i socijalnih vrijednosti koje se prenose i u profesionalni kontekst. Primjena stohastičkih modela (Markovljevi lanci, Monte Carlo simulacije, Bayesove mreže) pokazala se izuzetno korisnom za modelovanje ponavljajućih obrazaca ponašanja. Uočeno je da pojedinci koji jednom prekrše normu imaju povećanu vjerovatnoću da to ponove, što implicira postojanje tzv. **dinamike ponašajne inercije**. Ova inercija može biti korisna ako se radi o pozitivnim obrascima, ali i potencijalno štetna ako se radi o destruktivnim navikama. U skladu s tim, ovi modeli mogu poslužiti kao temelj za razvoj **sistemskih rješenja u ljudskim resursima**, gdje bi se etički potencijali kandidata mogli procjenjivati i van radnog konteksta, na osnovu ponašanja u svakodnevnim situacijama, poput učestvovanja u saobraćaju.

Rezultati upućuju na to da obrasci etike nisu samo individualna, već i **strukturno uslovljena** pojava. Bayesova analiza je pokazala da sektor zaposlenja (javna uprava, privatni sektor, nevladin sektor) ima značajan uticaj na obrasce ponašanja. To potvrđuje tvrdnju sociologinje Nancy Fraser da je etika „uvijek društveno ukorijenjena i ovisna o institucionalnim uslovima“ (Fraser, 1998). Posebno se ističe da su zaposleni u privatnom sektoru pokazali veću dosljednost u etičkom ponašanju, što se može objasniti većim stepenom organizacijske kontrole i mehanizama odgovornosti. Nasuprot tome, javni sektor karakterišu nešto veće stope pasivne neetičnosti, poput izbjegavanja odgovornosti i formalnog poštovanja procedura bez stvarne posvećenosti. Ovo istraživanje doprinosi teorijskom razvoju oblasti **etičkog ponašanja u menadžmentu i organizacionoj psihologiji**, ukazujući na važnost integrisanog pristupa u posmatranju pojedinca. Umjesto da se etičko ponašanje tretira izolovano po domenu (radno okruženje, saobraćaj, porodica), pristup koji koristi stohastičke modele omogućava razumijevanje **interdomenskih veza i predvidljivosti ponašanja**. Takođe, rezultati podupiru teoriju funkcionalne etike, prema kojoj etičko ponašanje ima ne samo moralnu, nego i **funkcionalnu vrijednost u optimizaciji procesa**, čime se prelazi granica između normativnog i operativnog poimanja etike.

Dobijeni rezultati sugerišu da organizacije mogu koristiti ponašajne obrasce u saobraćaju kao **indikator radne etike i profesionalne pouzdanosti**. U tom smislu, preporučuje se: **uključivanje pitanja o svakodnevnim navikama** u procjenu kandidata za zapošljavanje, razvoj **obrazovnih modula** koji integrišu saobraćajnu i poslovnu etiku, primjena **prediktivnih algoritama** u kadrovskim bazama, uz strogu zaštitu podataka i poštovanje etičkih standarda.

ZAKLJUČAK

Radno okruženje predstavlja kompleksan i interdisciplinarnan poligon za analizu i istraživačku aktivnost, kako bi se sagledali i analizirali aspekti procesa u integralnom formatu. Kada je riječ o kompleksnom pristupu analize elemenata statističkog skupa u uslovima neodređenosti moguće je pribaviti korisne informacije o njihovoj povezanosti.

Zavisnost pojedinih elemenata statističkog skupa daje kvalitetnu bazu poslovnog upravljanju i odlučivanju o pravcima kojima poslovni sistem treba da ide. Pored toga, moguće je predvidjeti ishode određenih upravljačkih situacija temeljem upravljačkog znanja proizašlog i rezultata statističke analize.

Među metodološkim konceptima izdvaja se HI-kvadrat test čiji rezultati daju kvalitetnu informacionu osnovu u smislu povezivanja kvalitativnih pojava unutar statističkog skupa i time omogućiti proračun konsekvenci odgovarajućih scenarija budućnosti sistema na koji se analiza odnosi.

Istraživanje predstavljeno u ovom radu ukazuje na snažnu povezanost etičkih obrazaca ponašanja u saobraćaju i na radnom mjestu, što potvrđuje hipotezu o dosljednosti ponašanja pojedinaca kroz različite društvene kontekste. Primjenom stohastičkih metoda, pokazano je da se etički obrasci ponašanja mogu kvantifikovati, modelovati i predviđati, čime se otvara prostor za njihovu primjenu u savremenom upravljanju poslovnim procesima. Zaključak koji se nameće jeste da etičko ponašanje nije izolovan fenomen, već sistemski oblikovana i relativno stabilna osobina pojedinca, koja zavisi kako od unutrašnjih vrijednosnih orijentacija, tako i od institucionalnih i organizacionih okvira u kojima pojedinac djeluje. Etika, u tom smislu, nadilazi granice moralne norme i postaje funkcionalni alat za optimizaciju procesa i efikasno upravljanje ljudskim resursima. Na osnovu rezultata istraživanja, mogu se formulisati sljedeće preporuke: Uvođenje procjene općih etičkih obrazaca u selekzione procese, uključujući i posmatranje ponašanja kandidata van radnog okruženja, kao što su navike u saobraćaju. Razvoj interdisciplinarnih obrazovnih programa koji objedinjuju poslovnu i saobraćajnu etiku, s ciljem formiranja stabilnih vrijednosnih sistema kod mladih i zaposlenih. Implementacija prediktivnih algoritama zasnovanih na stohastičkim modelima u okviru kadrovskih politika, uz punu zaštitu prava na privatnost i etičkih standarda. Povećanje odgovornosti organizacija za izgradnju etičke organizacione kulture, posebno u javnom sektoru, kroz jasne mehanizme kontrole i podsticaja. Na kraju, etika u ponašanju ne smije se posmatrati kao estetski dodatak poslovne prakse, već kao **temelj dugoročne održivosti, povjerenja i sistemске efikasnosti** u svakom savremenom društvu.

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STOCHASTIC PATTERNS OF ETHICS IN TRAFFIC AND THE WORK ENVIRONMENT FOR PROCESS OPTIMIZATION PURPOSES

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Summary: *The modern approach to managing business systems and processes emphasizes the role of the individual in all aspects of activity, while also requiring extensive knowledge of behavioral patterns and recognition of actual human potential.*

Ethics and morality in business and in the process of making management decisions have multiple benefits for the company. Companies that make ethical decisions and act in accordance with ethical business principles are evaluated as socially responsible companies, which plays a significant role in creating brand value and the public image of the company. The behavior of managers has a direct impact on the motivation and productivity of employees. The implementation of ethics in business creates a sense of security among employees, which is a key component for creating loyal and productive employees. Conversely, unethical and immoral business practices introduce insecurity among employees, create distrust and ultimately lead to unethical and immoral business practices introduce insecurity among employees, create distrust and ultimately lead to unethical behavior of employees towards the company, their work, resources, superiors, and colleagues.

Essentially, managers, through their behavior and decisions, directly create organizational culture and influence the productivity and loyalty of employees. Besides the fact that ethical business practices have a direct impact on brand creation and productivity, they also affect the creation of consumer loyalty, as consumers tend to boycott companies that operate unethically and make decisions that are not in line with the moral standards of society,

The study of business processes represents a complex interdisciplinary category that integrates natural, technical, and human sciences, among which psychological, sociological, and pedagogical sciences are becoming increasingly relevant. Accordingly, research project has been designed with the idea of attempting to connect categories of behavioral relations and ethical patterns of individuals in traffic and the working environment,

Assigning each individual a work task that aligns closely with their abilities demands complex analyses to identify appropriate behavioral patterns. These patterns should not only support business system management but also be implemented in educational systems to foster the development of knowledge and skills in accordance with the true potential of learners, ultimately ensuring their maximum satisfaction.

The idea is to use statistical analysis of empirical indicators to explore behavioral patterns in seemingly unrelated areas and provide a solid foundation for creating a business environment where optimal results are achieved. These results are aligned with both the goals of the business system and the individuals engaged in specific tasks. Statistical analysis makes it possible to make objective judgments about uncertain phenomena.

Keywords: behavioral ethics, traffic behavior, stochastic factors, statistical analysis, business management

Jel classification: C1, M1, I29



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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

OCJENJIVANJE UČINKOVITOSTI RAZDOBLJA POSLOVANJA BOLNIČKIH ODJELA MALMQUISTOVIM INDEKSOM PRODUKTIVNOSTI

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Sažetak: Ovaj rad analizira učinkovitost bolničkih odjela Opće bolnice Zadar u razdoblju od 2022. do 2024. primjenom metode DEA (DEA) i Malmquistovog indeksa produktivnosti (MPI). Cilj istraživanja bio je kvantitativno ocijeniti relativnu učinkovitost 11 odjela na temelju ulaznih varijabli (broj postelja, broj liječnika) i izlaznih varijabli (broj otpuštenih bolesnika, broj obavljenih pregleda). Rezultati pokazuju izražene razlike među odjelima: većina odjela bilježi rast produktivnosti, dok pojedini odjeli, poput infektologije i oftalmologije, bilježe pad učinkovitosti. Služba za kirurgiju ističe se iznimnim povećanjem učinkovitosti, što upućuje na uspješnu implementaciju inovativnih praksi i optimalno upravljanje resursima. Malmquistov indeks ukazuje na ukupni rast produktivnosti od 12,7%, pri čemu su tehničke inovacije i bolje iskorištavanje resursa glavni pokretači napretka. Unatoč ograničenjima modela, poput izostavljanja kvalitativnih pokazatelja, rad doprinosi razumijevanju dinamike efikasnosti bolničkih sustava u hrvatskom kontekstu. Preporučuje se daljnje istraživanje s proširenim skupom varijabli, uključujući kvalitativne aspekte i komparativnu analizu s drugim bolnicama, kako bi se formulirale ciljanje intervencije za poboljšanje učinkovitosti i kvalitete zdravstvene skrbi.

Ključne riječi: Malmquistov indeks produktivnosti (MPI), Analiza omeđenih podataka (DEA), Bolnička učinkovitost, Analiza produktivnosti, Upravljanje resursima

JEL klasifikacija: C31, C51, C61, C67, I11, O15, O47

UVOD

DEA metoda predstavlja neparametarski pristup mjerenju relativne učinkovitosti usporedivih jedinica odlučivanja (DMU), pri čemu se učinkovitost definira kao omjer ponderirane sume izlaza i ponderirane sume ulaza. Za razliku od parametarskih metoda, DEA ne zahtijeva a priori specifikaciju funkcionalne forme odnosa između ulaza i izlaza, što ju čini posebno prikladnom za analizu kompleksnih sustava poput bolnica (Emrouznejad & Yang, 2018). Ključna prednost DEA metode je što omogućava svakoj jedinici odlučivanja da odabere vlastite pondere za ulaze i izlaze, čime

se maksimizira njezina relativna učinkovitost u odnosu na druge jedinice. Međutim, važno je napomenuti da DEA mjeri relativnu, a ne apsolutnu učinkovitost, što znači da rezultati ovise o uzorku analiziranih jedinica (Hollingsworth, 2008). Hrvatsko društvo karakteriziraju negativne stope prirodnog priraštaja i neto migracije, niske stope fertiliteta, sve veći udio starijih osoba te nagli pad broja stanovnika. S obzirom na to da ljudi žive dulje, a rađa se sve manje djece, populacija će se i dalje stariti u nadolazećim godinama. Ovaj “srebrni tsunami”¹ starenja stanovništva uzrokuje sve veću potražnju za učinkovitim socijalnim i zdravstvenim uslugama. Bolnice čine između jedne trećine i polovice ukupnih troškova zdravstvene zaštite među zemljama OECD-a (Lorenzoni & Dougherty, 2022). Veliki dio tih troškova odnosi se na bolničku skrb za hospitalizirane pacijente, s rastućim trendovima u posljednjim godinama. Postotak bolničkih troškova još je značajniji u Hrvatskoj, gdje čini više od polovice godišnje potrošnje Hrvatskog zavoda za zdravstveno osiguranje (HZZO), pri čemu najveći udio u troškovima otpada na naknade za radnu snagu (Kalanj, 2022).

Zbog toga su performanse hrvatskih bolnica već godinama u fokusu interesa dionika, budući da je jedna od glavnih posljedica suboptimalne potrošnje resursa smanjena spremnost društva da doprinosi financiranju sustava, osobito u sustavu socijalnog zdravstvenog osiguranja.

CILJ RADA

Ovaj rad ima za cilj primjenu metode DEA u mjerenju efikasnosti odjela s bolničkim krevetima za period od 2022. do 2024. godine Opće bolnice u Zadru, na osnovi dvaju inputa i dvaju outputa. Jedan od troškovno glavnih inputa je broj liječnika. Od ukupnog broja zdravstvenih radnika, mali dio čine liječnici specijalisti i subspecijalisti, tako da je poseban fokus odjela ljudskih potencijala upravo na tom resursu koji je i najskuplji. Zato je odabir ovog inputa jedan od najvažnijih i koji mora odražavati interes analitičara u sustavu praćenja efikasnosti.

PREGLED LITERATURE

Nekoliko metoda ocjenjuje učinak bolnica u zdravstvenom sustavu, a najčešći su parametarski i neparametarski pristup (Blatnik et al., 2017; Mitropoulos et al., 2012; Nicola et al., 2014). Parametarski pristup oslanja se na Stochastic Frontier Analysis (SFA) za izračunavanje učinkovitosti svake bolnice. Međutim, ova se tehnika ne može nositi s višestrukim ulazno-izlaznim sustavima, poput bolnica, pa model odstupa od stvarnosti u kojoj jedna bolnica djeluje kao jedini sustav (Gautam et al., 2013). Ovi i drugi nedostaci većinu autora, poput Mitropoulos et al. (2012), De Nicola et al. (2014), Blatnik et al. (2017), Kao et al. (2020), navode na odabir neparametarskog pristupa, uglavnom DEA, pri mjerenju učinkovitosti bolnica i drugih zdravstvenih ustanova, iako DEA ne može razlikovati takozvani „white noise”² od neučinkovitosti bolnice. Produktivnost i učinkovitost organizacije međusobno su povezane. Međutim, učinkovitost je statična jer ne uzima u obzir vrijeme potrebno za proizvodnju, dok je vrijeme

1 Pojam “srebrni tsunami” odnosi se na globalni fenomen ubrzanog starenja stanovništva, pri čemu značajan porast starijih osoba (posebno onih iznad 65 godina) stvara demografske, ekonomske i društvene izazove.

2 Reziduali modela su slučajni i ne sadrže autokorelaciju

ključno za produktivnost. Kada se mjere produktivnosti promijene, to implicira promjene u učinkovitosti. Stoga postaje nužno mjeriti produktivnost. Indeksi se koriste za mjerenje promjena produktivnosti u različitim razdobljima. Jedan od popularnih indeksa je Malmquistov indeks produktivnosti, koji su uveli Caves et al. (1982). Oni su koristili ideju koju je predložio Malmquist (1953), a koja definira broj indeksa kao omjere funkcije udaljenosti. Zapravo, MPI se ponekad naziva Ukupnom faktorskom produktivnošću (TFP), koja može procijeniti napredak ili nazadak učinkovitosti tijekom vremena, kao i promjene u graničnoj tehnologiji u smislu napretka ili nazatka tijekom vremena. Nakon rada Färe i Grosskopfa (1992), MPI je postao standardna metodologija za procjenu produktivnosti tijekom vremena koristeći neparametarsku metodologiju te se koristi u brojnim studijama za DEA analizu promjena učinkovitosti različitih organizacija, industrija i zemalja.

METODOLOŠKI OKVIR

Za procjenu DEA-MPI podaci su dobiveni od voditelja Odjela za osiguranje i unapređenje kvalitete zdravstvene zaštite Opće bolnice Zadar, pomoćnika ravnatelja za kvalitetu Nediljka Jovića, dr. med. Skup podataka u razdoblju od 2022 do 2024., samo bolničkih odjela koji imaju smještajne kapacitete, te dvije ulazne i dvije izlazne varijable. Inputi su bili broj akutnih postelja (P) i broj stalno zaposlenih liječnika (L) na odjelu, a za izlaz su odabrane dvije varijable koje pozitivno utječu na učinak, a to su broj otpuštenih bolesnika (BOB) i broj obavljenih pregleda (BOP). DEA je ne-parametarska metoda koja se koristi za procjenu učinkovitosti jedinica odlučivanja u pretvaranju ulaznih podataka u izlazne. Razvili su ga Charnes, Cooper i Rhodes (1978), kao odgovor na rad Farrella (1957), koji se nije ispravno bavio neučinkovitošću kombinacije, pri čemu DEA koristi tehnike linearnog programiranja za procjenu relativne učinkovitosti jedinica odlučivanja, koji rade pod sličnim uvjetima, s tim da se mogu koristiti i različite kombinacije resursa. Temeljna premisa je stvoriti “granicu učinkovitosti” sastavljenu od najučinkovitijih jedinica odlučivanja, s kojima se uspoređuju sve druge jedinice. To omogućuje identifikaciju i učinkovitih i neučinkovitih jedinica unutar određenog skupa podataka (Cooper et al., 2007). Od rada Charnes, Cooper i Rhodes iz 1978., uvedeno je mnogo različitih modela analize omeđenih podataka, npr. BCC (*Banker, Charnes, Cooper*), SBM (*Slacks-Based Measure*), ADD (*Additive Model*) ili FDH (*Free Disposal Hull*) (Cooper et al., 2007), čak se neki drastično razlikuju od ovog izvornog modela, dok je DEA postala dobro uspostavljena tehnika mjerenja performansi.

DEA radi na principu relativne učinkovitosti, što znači da procjenjuje koliko dobro jedinica odlučivanja radi u odnosu na svoje konkurente, a ne u odnosu na apsolutni standard. U zdravstvenim ustanovama DEA se koristi za procjenu učinka bolnica analizom ulaznih podataka poput broja osoblja i opreme u usporedbi s rezultatima kao što su ishodi liječenja pacijenata i kvaliteta usluge (Peykani & Pishvae, 2024). Prepoznavanjem neučinkovitosti, organizacije mogu implementirati ciljne intervencije za povećanje produktivnosti i raspodjelu resursa. Fleksibilnost DEA dopušta različita usmjerenja, orijentirana na unos ili orijentirana na izlaz, ovisno o tome je li fokus na minimiziranju ulaza ili maksimiziranju izlaza. Ova prilagodljivost čini ga prikladnim za različite organizacijske kontekste i strateške ciljeve (Cook & Seiford, 2009). Nadalje, DEA može prihvatiti višestruke metrike učinka istovremeno, što ga čini vrijednim

alatom za organizacije koje žele uravnotežiti konkurentne prioritete u svojim operacijama. Unatoč svojim prednostima, DEA nije bez ograničenja. Metoda pretpostavlja da sve jedinice odlučivanja rade u sličnim uvjetima okoline i suočavaju se s usporedivim izazovima. Odstupanja od ove pretpostavke mogu dovesti do pristranih procjena učinkovitosti (Shewell & Migiro, 2016). Stoga, rezultati DEA su osjetljivi na odabir inputa i outputa, neprikladni izbori mogu iskriviti procjene učinkovitosti. Bez obzira na navedeno, pri razboritoj primjeni i uz pažljivo promatranje kontekstualnih čimbenika, DEA je robustan alat za mjerenje učinka u svim sektorima. Njegova sposobnost pružanja praktičnih uvida operativne učinkovitosti, čini ga neprocjenjivim za tvrtke koje teže stalnom poboljšanju.

Primijenjen je CCR (*Charnes, Cooper, Rhodes*) model za provedbu analize, jer je u radu (Jung et al., 2023, p. 5) prezentirana blaga prednost CCR modela u analizi učinkovitosti bolničkih objekata. Drugi razlog je što CCR model nudi prednosti u kontekstu mjerenja učinka zaposlenika, posebno kada se uspoređuje s BCC modelom (Charles & Kumar, 2012). DEA-MPI omogućuje mjerenje promjene performansi produktivnosti u različitim razdobljima. MPI temeljen na izlazu s tehnologijom vremena t , definirali su Caves et al. (1982). Fare i Grosskopf (1992) su rastavili DEA-MPI na komponente učinkovitosti i tehničkih promjena. Njihov je indeks geometrijska sredina dvaju istodobnih Malmquistovih indeksa, kako bi se izbjegle poteškoće pri odabiru referentnih tehnologija, tj. hoće li se koristiti vremenske t ili $t+1$ tehnologije. Dobili su pojednostavljenu formulu ukupne promjene faktorske produktivnosti, koja se može napisati kao:

$$UPFP = TP \times PU \quad (1)$$

PU je promjena učinkovitosti koja predstavlja promjenu DMU-a u odnosu na granicu proizvodnje. TP je tehnička promjena koja pokazuje pomicanje granice proizvodnje u dva vremenska razdoblja. TP veći od 1 označava poboljšanje produktivnosti između razdoblja t i $t+1$ dok TP manji od 1 označava pogoršanje produktivnosti između dva vremenska razdoblja. Jasno je da su izvori poboljšanja produktivnosti poboljšanje učinkovitosti ili tehničke promjene.

Malmquistov indeks produktivnosti omogućuje dinamičku analizu promjena učinkovitosti kroz vrijeme, što predstavlja značajnu prednost u odnosu na statičku DEA analizu. MPI se može rastaviti na dvije ključne komponente, promjenu tehničke učinkovitosti i tehnološku promjenu (Färe et al., 1994). U kontekstu bolničkih odjela, promjena tehničke učinkovitosti može odražavati bolje upravljačke prakse i organizaciju rada, dok tehnološka promjena može ukazivati na implementaciju novih medicinskih tehnologija ili protokola liječenja (Kohl et al., 2019).

Jedan od najvažnijih koraka pri korištenju DEA metode je pravi odabir varijabli koje treba uzeti u obzir u modelima (Štefko et al., 2018). Ovaj bi izbor trebao identificirati primarne varijable koje utječu na proces, a to je pružanje zdravstvene skrbi i, nakon toga, povezati ih na najrealističniji mogući način (Yaya et al., 2020). Ipak, tri kategorije predstavljaju najčešće korištene ulaze za ocjenu učinkovitosti, kao i za izlaze. Što se tiče inputa, većina autora odabrala je barem jednu varijablu koja predstavlja kapitalna ulaganja, radnu snagu i operativne troškove (Kao et al., 2020; Rabar, 2013). Što se tiče rezultata, glavne varijable koje se koriste odnose se na bolničku uslugu, ambulantnu službu i druge kritične usluge kao što su hitna pomoć ili kirurška služba (Rabar, 2013;

Yaya et al., 2020). Fokusrajući se na ulazne varijable, najčešća kombinacija ulaznih varijabli je ona koju su, kao primjer, koristili Almeida i suradnici (2015), koji su koristili broj kreveta kao varijablu kapitalnih ulaganja, broj liječnika i medicinskih sestara kao varijablu rada i samu vrijednost operativnih troškova kao mjeru operativnih troškova. Što se tiče varijabli kapitalnih ulaganja, broj kreveta je daleko najviše korišten, višestruko jedini koji predstavlja ovu kategoriju u mnogim radovima (Rabar, 2013; Štefko et al., 2018). Naprotiv, za predstavljanje radne snage unutar bolnice, u literaturi je prisutan širi skup varijabli. Osim broja liječnika i broja medicinskih sestara, nekoliko se puta razmatra i broj drugog osoblja, (Andrews, 2020), a neke studije uzimaju u obzir samo jedno varijabla, kliničko osoblje, koja u nekim slučajevima zbraja broj liječnika i medicinskih sestara (Kao et al., 2020; Yaya et al., 2020), a u drugima svo osoblje koje radi u bolnici (Gholami et al., 2014). Za ovu analizu, korištene su dvije ulazne i dvije izlazne varijable. Inputi su broj akutnih postelja (P) i broj stalno zaposlenih liječnika (L) na odjelu, a izlaz su varijable koje pozitivno utječu na učinak, a to su broj otpuštenih bolesnika (BOB) i broj obavljenih pregleda (BOP).

REZULTATI I RASPRAVA

Za rješavanje problema, koristio se input-orijentirani CCR model. U ovom slučaju za odjel i u godini t, udaljenosna funkcija definirana je kao:

$$D_o^t(P_i^t, L_i^t, BOB_i^t, BOP_i^t) = \max \left\{ \phi : \sum_{j=1}^n \lambda_j BOB_j^t \geq \phi BOB_i^t, \sum_{j=1}^n \lambda_j BOP_j^t \geq \phi BOP_i^t, \sum_{j=1}^n \lambda_j P_j^t \leq \phi P_i^t, \sum_{j=1}^n \lambda_j L_j^t \leq \phi L_i^t \right\} \quad (2)$$

gdje su λ_j težine koje određuju referentnu skupinu odjela.

Alternativno, output-orijentirani model bi bio prikladniji u situacijama gdje je cilj maksimizirati izlazne rezultate uz fiksne resurse, što može biti relevantno u određenim kontekstima zdravstvene politike ili kada je fokus na povećanju dostupnosti zdravstvenih usluga. Kako što je već i navedeno, Malmquist indeks mjeri promjenu produktivnosti između dvije vremenske točke koristeći koncept udaljenosnih funkcija iz DEA. Za izlazno orijentirani pristup, cilj je maksimizirati izlaze (BOB i BOP) pri zadanim ulazima (P i L), što odražava sposobnost odjela da postigne veći učinak bez dodatnih resursa.

Struktura Malmquist indeksa se izračunava kao geometrijska sredina udaljenosnih funkcija između godina t i t+1:

$$MI_{i,t+1} = \sqrt{\frac{D_o^t(P^{t+1}, L^{t+1}, BOB^{t+1}, BOP^{t+1})}{D_o^t(P^t, L^t, BOB^t, BOP^t)} \cdot \frac{D_o^{t+1}(P^{t+1}, L^{t+1}, BOB^{t+1}, BOP^{t+1})}{D_o^{t+1}(P^t, L^t, BOB^t, BOP^t)}} \quad (3)$$

Vrijednost $MI > 1$ ukazuje na povećanje produktivnosti, dok $MI < 1$ označava regres. Za svaku godinu zasebno provodi se DEA analiza za odjel k u godini t, za sve odjele i sve godine. Da bi dobili Malmquist indeks, moramo napraviti dekompenzaciju na dvije komponente.

Podaci pokrivaju razdoblje od 2022. do 2024. godine (3 godine). Prosječan broj liječnika je 36, a velika standardna devijacija (36,39) ukazuje na značajne razlike među

DMU jedinicama. Raspon se kreće od minimalno 9 do maksimalno 128 liječnika. Prosječan broj ležajeva je 18 uz standardnu devijaciju od 13,66. Raspon se kreće od minimalno 5 do maksimalno 54 ležaja. Prosječan broj otpuštenih pacijenata je 3.275, uz izrazito veliku standardna devijacija (8.425,83) ukazuje na ekstremne razlike u operativnim kapacitetima. Raspon se kreće od minimalno 303 do čak 49.016 postupaka. Prosječan broj otpuštenih pacijenata je 9.363. Velika standardna devijacija (10.525,08) također ukazuje na značajne razlike. Raspon se kreće od minimalno 1.598 do maksimalno 39.228 pacijenata. Ovi pokazatelji ukazuju na značajnu heterogenost među DMU jedinicama, što će se uzeti u obzir pri analizi efikasnosti i izračunu Malmquist indeksa. Velike razlike u ulaznim i izlaznim varijablama mogu utjecati na relativnu efikasnost pojedinih jedinica.

Tablica 5. Osnovni statistički parametri svih odjela

DMU	P_mean	L_mean	L_std	BOP_mean	BOP_std	BOB_mean	BOB_std
DMU1	12	26,33	1,53	572,67	5,13	3077,67	162,9
DMU2	60	23	1	4268	927,5	12004,33	517,96
DMU3	10	5,33	0,58	628,33	233,55	3506,67	877,59
DMU4	128	50,33	3,51	5960	785,6	37040,33	1979,76
DMU5	79	34,33	3,21	19177	25842,4	21288	2061,16
DMU6	24	11,67	1,53	1008	297,05	6076,33	514,4
DMU7	9	6,67	1,53	658,33	30,5	1760,67	139,08
DMU8	16	10,33	1,53	521,67	88,08	1861,33	260,55
DMU9	23	17,33	0,58	2022,67	276,68	8637	793,01
DMU10	24	10,67	0,58	333	26,06	3890,67	147,22
DMU11	16	7	0	878,33	101,04	3851	281,07

Izvor: rezultati istraživanja

Detaljnija analiza osnovnih statističkih parametara odjela, pokazala je određene specifičnosti, i to:

1. DMU4 - Najveći kapacitet, rekordni ulazi ($P=128$, $L=50.33$), najviši BOB (37,040 dana $\pm 1,980$) i stabilni outputi ($BOP\ std = 785.6$)
2. DMU5 - Ekstremni outlier, Eksplozivan rast BOP 2024. (49,016 pacijenata) i Visoka varijabilnost ($BOP\ std = 25,842$)
3. DMU7 - Minimalni resursi, najmanji P (9) i L (6.67) inajniži BOB (1,760 dana)
4. DMU9 - Ubrzani rast, kontinuirani porast BOP (+31.7% 2022-2024) i stabilno povećanje BOB (+20.2% u istom razdoblju)
5. DMU10 - Niska produktivnost, najniži BOP (333 pacijenta) uz srednje resurse i minimalna varijabilnost outputa

Nulta standardna devijacija za P, kod svih jedinica ukazuju da broj zaposlenika (P) ostaje konstantan kroz sve tri godine. Neujednačena distribucija resursa (P raspon 9-128, L raspon 5-54) zahtijeva korištenje neparametrijskih metoda u DEA analizi radi pravedne usporedbe jedinica različitih veličina.

Tablica 6. Malmquistov indeks produktivnosti po razdobljima

DMU	2022-2023	2023-2024	Prosjek
DMU1	1,0423	1,0097	1,026
DMU2	1,0248	0,7123	0,8686
DMU3	0,815	1,1889	1,002
DMU4	1,1519	1,0098	1,0808
DMU5	1,47	1	1,235
DMU6	1,6203	0,928	1,2742
DMU7	1,0443	0,5828	0,8136
DMU8	1,5189	0,737	1,128
DMU9	1,1973	1	1,0987
DMU10	1,3014	1,092	1,1967
DMU11	1,3702	0,9779	1,174
Prosjek	1,2324	0,9308	1,0816

Izvor: rezultati istraživanja

Izračunati rezultati efikasnosti (omjer izlaza i ulaza) su prikazani u tablici.

Tablica 7. Rezultati efikasnosti po DMU

Naziv	ER 2022	ER 2023	ER 2024	AER	TER
DMU1	94,45	91,05263	100,3514	95,28466	5,901351
DMU2	199,8554	183,0732	204,9643	195,9643	5,108864
DMU3	351,6667	207,5333	251,0625	270,0875	-100,604
DMU4	233,5143	236,1854	253,2692	240,9896	19,75495
DMU5	211,3839	253,1081	595,0855	353,1925	383,7015
DMU6	176,6944	205,9118	213,2703	198,6255	36,57583
DMU7	162,6429	161,625	140,8235	155,0305	-21,8193
DMU8	80,72	93,73077	96,21429	90,22168	15,49429
DMU9	232,3659	270	291,3	264,5553	58,93415
DMU10	116,8286	119,2286	129,6765	121,9112	12,8479
DMU11	193,6087	198,7826	224,4783	205,6232	30,86957

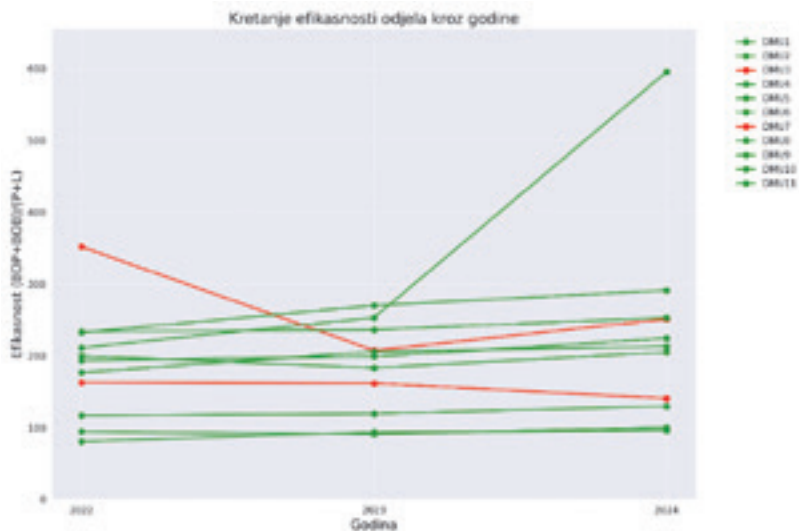
Izvor: rezultati istraživanja

ER = Efficiency Ratio; AER = Average Efficiency Ratio; TER = Total Efficiency Ratio

Efficiency Ratio predstavlja omjer izlaznih i ulaznih vrijednosti za svaki odjel. Konkretno, to je izračunato kao:

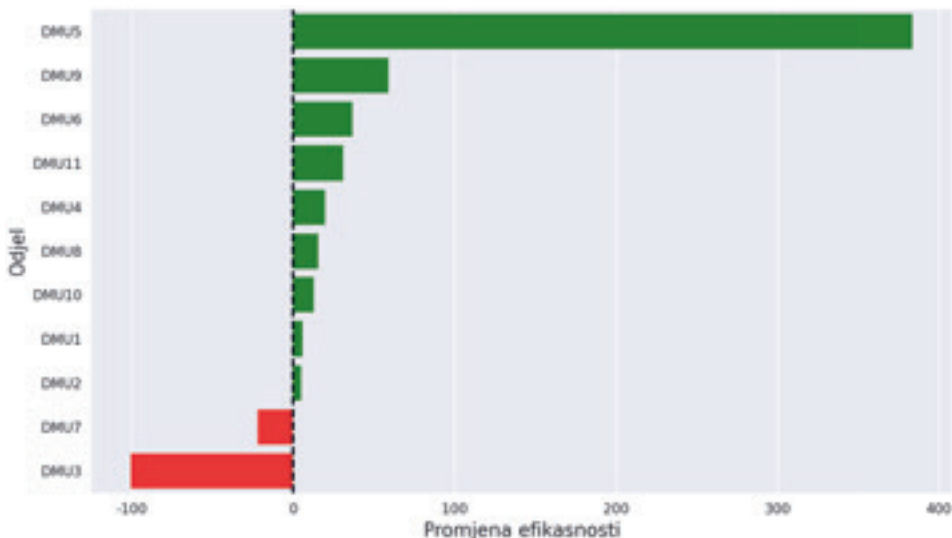
$$\text{Eff_ratio} = \text{BOP} + \text{BOB} / P + L \quad (4)$$

Ovaj pokazatelj mjeri koliko “outputa” (zbroj otpuštenih pacijenata i ostvarenih boravaka) generira odjel po jedinici “inputa” (zbroj postelja i liječnika). Veća vrijednost znači da odjel postiže više rezultata s raspoloživim resursima, što ukazuje na veću efikasnost. Grafički prikaz može nam bolje predložiti raspored podataka.

Slika 5. Grafički prikaz negativnog kretanja efikasnosti

Izvor: rezultati istraživanja

Linijski graf efikasnosti pruža vizualnu sliku promjena u operativnoj učinkovitosti odjela kroz vrijeme, što pomaže u donošenju odluka temeljenih na usporedbi trendova i rasta ili pada efikasnosti. Iz analize efikasnosti odjela vidimo da DMU5 pokazuje izvanredan rast efikasnosti (povećanje od 183%), DMU3 bilježi najveći pad (-28.6%), većina odjela (7 od 11) pokazuje kontinuirani rast efikasnosti, samo DMU7 ima kontinuirani pad kroz sve tri godine i linijski graf prikazuje dinamiku promjena kroz vrijeme, dok bar graf pokazuje ukupnu promjenu između početne i završne godine.

Slika 6. Ukupna promjena efikasnosti 2022- 2024

Izvor: rezultati istraživanja

Ovaj bar graf prikazuje ukupnu promjenu efikasnosti za svaki odjel između 2022. i 2024. godine. Zelene trake predstavljaju odjele koji su povećali svoju efikasnost tijekom promatranog razdoblja. Najznačajnije poboljšanje vidljivo je kod DMU5, koji je ostvario izvanredno povećanje efikasnosti od preko 380 jedinica. Crvene trake označavaju odjele koji su smanjili svoju efikasnost. Najveći pad zabilježen je kod DMU3 (oko -100 jedinica) i DMU7 (oko -20 jedinica). Poredak odjela na grafu je od najvećeg poboljšanja (na vrhu) do najvećeg pada (na dnu), što omogućuje brzu vizualnu identifikaciju najuspješnijih i najmanje uspješnih odjela. Crtkana vertikalna linija na nuli služi kao referentna točka koja razdvaja odjele s pozitivnom i negativnom promjenom. Ovaj graf omogućuje jednostavnu usporedbu ukupne promjene efikasnosti između različitih odjela i brzu identifikaciju onih koji zahtijevaju posebnu pažnju ili mogu poslužiti kao primjer dobre prakse.

Rezultati analize učinkovitosti bolničkih odjela OB Zadar trebaju se promatrati u širem kontekstu izazova s kojima se suočava hrvatski zdravstveni sustav. Demografske promjene, starenje stanovništva i ograničeni financijski resursi stvaraju pritisak na bolnice da optimiziraju korištenje resursa (Vehovec, 2014). Identificirani trendovi učinkovitosti mogu se povezati s nacionalnim reformama zdravstvenog sustava i specifičnim lokalnim inicijativama. Primjerice, izvanredno povećanje učinkovitosti Službe za kirurgiju može biti rezultat implementacije novih protokola, reorganizacije rada ili uvođenja minimalno invazivnih kirurških tehnika koje skraćuju vrijeme hospitalizacije. S druge strane, pad učinkovitosti Odjela za infektologiju mogao bi biti povezan s promjenama u epidemiološkoj situaciji nakon COVID-19 pandemije, što naglašava važnost kontekstualnih faktora pri interpretaciji rezultata DEA analize

ZAKLJUČAK

Analiza efikasnosti u Općoj bolnici Zadar za razdoblje od 2022. do 2024. godine pokazuje složenu dinamiku poslovanja među različitim odjelima, pri čemu su rezultati mjereni omjerom izlaza i ulaza u radne procese. Metodologija koja se koristila omogućila je kvantitativnu evaluaciju performansi temeljem podataka o zbroju izlaznih vrijednosti (BOP i BOB) i ulaznih vrijednosti (P i L). Time je dobivena precizna slika operativne učinkovitosti svakog odjela kroz tri godine, no istovremeno su identificirani značajni trendovi koji zahtijevaju daljnju pažnju.

Prema analiziranim podacima, većina odjela bilježi rast učinkovitosti, što je znak uspješnog prilagođavanja i optimizacije resursa u vrijeme promjena. Primjerice, Služba za kirurgiju pokazala je izvanredno povećanje učinkovitosti, što ukazuje na primjenu inovativnih praksi i efikasnije upravljanje resursima. S druge strane, određeni odjeli pokazuju pad učinkovitosti, a najizraženiji pad zabilježen je kod Odjela za infektologiju, što signalizira potrebu za detaljnijom analizom uzroka smanjenja operativne učinkovitosti u tom segmentu. Također, Odjel za oftalmologiju i optometriju bilježi kontinuirani pad učinkovitosti, što naglašava važnost usmjeravanja dodatnih resursa i prelaska na optimalnije modele poslovanja.

Znanstveni doprinos ovog rada očituje se u razvoju jednostavnog i istovremeno robusnog modela evaluacije učinka zdravstvenih odjela, koji integrira osnovne ulazne i izlazne varijable. Longitudinalna analiza omogućava praćenje dinamike efikasnosti tijekom godina, što nadilazi ograničenja presječnih studija. Nadalje, konkretni primjeri dobrih praksi, kao što je slučaj Službe za kirurgiju, doprinose empirijskom razumije-

vanju faktora uspjeha, dok rezultati s padom učinkovitosti u Odjelu za infektologiju i Odjelu za oftalmologiju i optometriju pružaju temelj za formulaciju strateških intervencija. Jedno od ključnih ograničenja ovog istraživanja leži u pojednostavljenosti korištenog modela, koji ne obuhvaća kvalitativne aspekte zdravstvene skrbi niti sve varijable koje bi mogle dodatno objasniti razlike među odjelima. S obzirom na to, daljnja istraživanja trebala bi se usmjeriti na integraciju dodatnih varijabli poput indikatora kvalitete usluga, zadovoljstva pacijenata i složenosti medicinskih slučajeva, čime bi se stvorila sveobuhvatnija slika performansi. Unatoč vrijednim uvidima koje pruža DEA-MPI analiza, važno je prepoznati metodološka ograničenja ovog pristupa. Prvo, DEA je osjetljiva na odabir varijabli i specifikaciju modela, pri čemu uključivanje ili isključivanje određenih ulaza ili izlaza može značajno utjecati na rezultate (O'Neill et al., 2008), i drugo, DEA pretpostavlja homogenost jedinica odlučivanja što može biti problematično u kontekstu bolničkih odjela s različitim specijalizacijama. Moguća istraživanja mogu biti: uključivanje kvalitativnih pokazatelja zdravstvene skrbi, primjena modela koji uzimaju u obzir heterogenost odjela kroz prilagodbu za težinu slučajeva (eng. *case-mix adjustment*), usporedba s drugim bolnicama sličnih karakteristika radi benchmarkinga, i kombiniranje DEA s kvalitativnim istraživačkim metodama za dublje razumijevanje organizacijskih faktora koji utječu na učinkovitost.

Ukupno gledano, rezultati ove analize pozitivno utječu na razumijevanje dinamike efikasnosti unutar bolnice, pružajući empirijski utemeljene smjernice za poboljšanje upravljanja resursima. Implementacija predloženih mjera može doprinijeti osiguranju bolje raspodjele resursa te, time, poboljšanju kvalitete pružene zdravstvene skrbi. Ovaj rad istovremeno predstavlja temelj za daljnja istraživanja koja će nastojati riješiti prepoznata ograničenja i unaprijediti modele evaluacije učinkovitosti u zdravstvenom sustavu.

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ASSESSING THE EFFICIENCY OF HOSPITAL DEPARTMENT PERFORMANCE PERIODS USING THE MALMQUIST PRODUCTIVITY INDEX

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Summary: This paper presents a quantitative assessment of operational efficiency across hospital departments at Zadar General Hospital, Croatia, over the 2022-2024 period, employing Data Envelopment Analysis (DEA) and Malmquist Productivity Index (MPI) methodologies. The research evaluates the relative efficiency of 11 departments by analysing the relationship between input variables (number of beds and

physicians) and output variables (number of discharged patients and outpatient examinations), providing insights into productivity dynamics within the hospital system. The study utilizes an input-oriented CCR model to establish efficiency scores and applies the Malmquist index to measure productivity changes over time. This methodological approach enables both static efficiency evaluation and dynamic tracking of performance trends, with productivity decomposed into technical efficiency change and technological change components. The longitudinal design overcomes limitations inherent in cross-sectional studies by capturing efficiency fluctuations across multiple time periods. Results reveal significant heterogeneity among departments, with substantial variations in resource distribution and operational capacity. The average number of physicians was 36 ($SD=36.39$), ranging from 9 to 128, while the average number of beds was 18 ($SD=13.66$), ranging from 5 to 54. The majority of departments (7 out of 11) demonstrated continuous efficiency improvements throughout the study period. The Surgery Department exhibited exceptional efficiency growth (183% increase), likely attributable to innovative practices and optimized resource management. Conversely, the Department of Infectious Diseases recorded the most substantial efficiency decline (-28.6%), potentially associated with post-COVID-19 pandemic epidemiological shifts. The Department of Ophthalmology and Optometry showed consistent efficiency reduction across all three years, indicating a need for resource reallocation and operational model optimization.

The scientific contribution of this research lies in developing a robust yet straightforward model for evaluating healthcare department performance that integrates fundamental input and output variables. The empirical findings provide evidence-based guidelines for resource management improvement and strategic interventions. Key limitations include the model's simplicity, which excludes qualitative aspects of healthcare delivery and other variables that might further explain interdepartmental differences. Future research directions should incorporate additional variables such as service quality indicators, patient satisfaction metrics, and case complexity measures to create a more comprehensive performance assessment. Furthermore, methodological advancements could address DEA limitations through case-mix adjustments accounting for departmental heterogeneity, benchmarking against similar hospitals, and combining quantitative analysis with qualitative research methods to better understand organizational factors influencing efficiency.

This study contributes to understanding efficiency dynamics within hospital systems, offering empirically grounded insights for healthcare resource management improvement while establishing a foundation for future research addressing identified limitations and enhancing healthcare system efficiency evaluation models.

Keywords: Malmquist productivity index (MPI), Data Envelopment Analysis (DEA), Hospital efficiency, Productivity analysis, Resource management

JEL classification: C31, C51, C61, C67, I11, O15, O47



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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

UPOTREBA VJEŠTAČKE INTELIGENCIJE U MARKETINGU I MENADŽMENTU- KORISNOST ALATA I APLIKACIJA ZA STVARANJE SADRŽAJA

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Sažetak: U savremenom poslovanju, vještačka inteligencija (AI) sve više zauzima značajno mjesto u marketingu i menadžmentu, posebno kroz alate za automatizovanje kreiranja sadržaja. Ovaj rad istražuje ključne AI alate i njihove primjene, ističući prednosti kao što su povećanje efikasnosti, unaprjeđenje kreativnosti i personalizacija sadržaja. Cilj ovog rada je pokazati prihvatanje AI alata u pozitivne svrhe kao i sa druge strane osvijestiti ljudsku važnost, kreativnost i autentičnost prilikom kreiranja sadržaja. Korištenje AI bez ličnog pečata je automatizovani robotski proces, ali uz pravilno korišćenje, omogućava nam lakši put do rezultata onoga što želimo kreirati. AI je pravi partner i prijatelj u kreiranju teksta. Jedan od najvažnijih segmenata u marketingu i menadžmentu je kvalitetan i relevantan tekstualni sadržaj — od blogova, društvenih mreža, email kampanja, do reklamnih slogana i opisa proizvoda. Ovi alati ne zamjenjuju kreativnost čovjeka, već djeluju kao pomoćnici koji smanjuju vrijeme potrebno za istraživanje i pisanje. Pomoću ovih alata se štedi vrijeme i resursi, a fokus može ostati na strategiji i kreativnom finaliziranju sadržaja. Kreiranje vizuala unutar AI aplikacija je takođe moguće. Pored teksta, vizuelni sadržaj je ključan u privlačenju pažnje publike. Moderne AI aplikacije omogućavaju generisanje slika, grafika, pa čak atraktivnih vizuale koji prate poruku kampanje, bez potrebe za angažovanjem dizajnerskih timova. Kokreiranje sadržaja tako postaje multidisciplinarni proces u kojem AI pomaže u sinhronizaciji tekstualnog i vizualnog dijela, vodeći računa o dosljednosti brenda i estetskoj privlačnosti. Umjetna inteligencija nije zamjena za ljudsku kreativnost — već njen saveznik. U kontekstu kokreiranja sadržaja, UI omogućava brendovima da uključe svoje potrošače na dubljem nivou, brže odgovore na njihove potrebe i zajedno stvaraju sadržaj koji je originalan, personalizovan i autentičan.

Ključne riječi: menadžment, marketing, kompanija, kreiranje sadržaja, AI

Jel kasifikacija: M3, M1, M12

UVOD

U savremenom poslovnom okruženju, digitalna transformacija i inovacije imaju ključnu ulogu u održavanju konkurentske prednosti. Vještačka inteligencija (AI), kao jedna od najznačajnijih tehnoloških revolucija poslednjih decenija, značajno mijenja način na koji organizacije funkcionišu, posebno u oblastima marketinga i menadžmenta. Upotreba AI alata za kreiranje sadržaja postaje nezaobilazna strategija koja omogućava bržu, efikasniju i kvalitetniju proizvodnju marketinških materijala, dok istovremeno podržava menadžerske procese kroz automatizaciju i analitiku.

Cilj ovog rada je da pruži sistematski pregled najvažnijih AI alata i aplikacija koje se koriste u marketingu i menadžmentu za kreiranje sadržaja, te da prikaže njihovu korisnost, prednosti i potencijalne izazove. Poseban fokus stavljen je na njihove primjene u realnom poslovnom okruženju, kao i na implikacije za budući razvoj i primenu AI tehnologija.

TEORIJSKI OKVIR

Vještačka inteligencija se definiše kao sposobnost mašina da imitiraju ljudsku inteligenciju, uključujući sposobnosti učenja, zaključivanja, rješavanja problema i razumijevanja jezika. AI obuhvata širok spektar tehnologija, kao što su mašinsko učenje, duboko učenje, obrada prirodnog jezika (NLP), i robotska automatizacija procesa (RPA).

U marketingu, AI se koristi za analizu velikih količina podataka u realnom vremenu, što omogućava precizniju segmentaciju tržišta, personalizaciju komunikacije i optimizaciju kampanja (Chaffey & Ellis-Chadwick, 2019). Kroz automatizaciju kreiranja sadržaja, AI može generisati tekstove, slike, video i druge medije prilagođene ciljnoj publici, čime se značajno povećava efikasnost i smanjuju troškovi.

Sa druge strane, u menadžmentu, AI podržava donošenje odluka kroz analizu podataka i prediktivnu analitiku, automatizuje rutinske zadatke i pomaže u upravljanju resursima i procesima (Davenport & Ronanki, 2018). Teorijski modeli inovacije i tehnološke adaptacije ukazuju na to da je integracija AI tehnologija ključni faktor za postizanje operativne izvrsnosti i strateške prednosti.

AI ALATI I APLIKACIJE ZA KREIRANJE SADRŽAJA

Savremeni marketing i menadžment sve više koriste AI alate koji omogućavaju automatizaciju i unapređenje procesa kreiranja sadržaja. Među najpopularnijim i najefikasnijim alatima izdvajaju se:

Canva — platforma za dizajn i vizuelni sadržaj koja je implementirala AI funkcije poput automatskog uklanjanja pozadine, predloga dizajna i generisanja grafičkih elemenata (Canva, 2024). Ovaj alat omogućava korisnicima, čak i bez dubokog znanja o dizajnu, da brzo i lako kreiraju vizuelno privlačne postove za društvene mreže, prezentacije i marketinške materijale.

InShot — aplikacija za obradu video sadržaja koja koristi AI za automatsku optimizaciju videa, dodavanje efekata, titlova i montažu. InShot je idealan za kreiranje kratkih i dinamičnih video formata koji su ključni za angažovanje publike na društvenim mrežama (InShot, 2024).

ChatGPT — AI model za generisanje tekstualnog sadržaja razvijen od strane OpenAI, sposoban za kreiranje kreativnih, informativnih i personalizovanih tekstova, blogova, oglasa i komunikacije s korisnicima (OpenAI, 2023). Njegova primena omogućava

marketinškim i menadžerskim timovima da uštede vreme i prošire kreativni kapacitet.

Jasper AI — alat specijalizovan za pisanje marketinških kopija, blogova i reklamnih tekstova sa naglaskom na SEO optimizaciju i angažovanje publike (Jasper AI, 2024). Jasper koristi napredne algoritme za prilagođavanje tona i stila pisanja prema ciljnoj grupi, što povećava efikasnost komunikacije.

Ovi alati zajedno čine snažan arsenal za kompanije koje žele da povećaju produktivnost, kreativnost i preciznost u kreiranju sadržaja, a istovremeno zadrže kvalitet i relevantnost.

PRETHODNA ISTRAŽIVANJA

Upotreba vještačke inteligencije (AI) u oblasti marketinga i menadžmenta postaje sve zastupljenija, s obzirom na potencijal AI alata da unaprijede efikasnost i kvalitet poslovnih procesa. Prethodna istraživanja pokazuju da AI značajno doprinosi automatizaciji kreiranja sadržaja, personalizaciji marketinga i optimizaciji odluka u menadžmentu.

Smith i kolege (Smith, 2022) ističu da alati zasnovani na AI, kao što su generativni modeli za tekst i slike, omogućavaju marketinškim timovima da brže i efikasnije kreiraju vizuelni i tekstualni sadržaj, smanjujući troškove i vrijeme produkcije. Slične nalaze imaju i Johnson i Lee (Johnson, 2023), koji su istraživali uticaj AI na odluke u menadžmentu, naglašavajući da AI podržava bolje donošenje odluka kroz analizu velikih podataka i prediktivne modele.

Istraživanje koje su sprovedi Martínez i saradnici (Martínez, 2022) fokusiralo se na percepciju korisnika AI alata u digitalnom marketingu i pokazalo je da je visok stepen prihvatanja povezan sa jednostavnošću korišćenja i kvalitetom generisanog sadržaja. Međutim, u radu se takođe navodi potreba za etičkim okvirima u primeni AI tehnologija, što potvrđuju i istraživanja Nguyena i ostalih (Nguyen, 2024), koji upozoravaju na rizike od dezinformacija i gubitka kreativne kontrole.

Na osnovu ovih istraživanja, jasno je da AI alati kao što su Canva, InShot, ChatGPT i drugi imaju veliki potencijal, ali zahtijevaju adekvatnu edukaciju korisnika i pravila upotrebe kako bi se ostvarili maksimalni benefiti.

METODOLOGIJA ISTRAŽIVANJA

Ovaj rad se zasniva na analizi dostupne literature i sekundarnih izvora, uključujući naučne radove, stručne članke i studije slučaja. Fokus je stavljen na identifikaciju i evaluaciju najvažnijih AI alata u marketingu i menadžmentu, kao i na procjenu njihovih prednosti i izazova u kreiranju sadržaja.

ANALIZA ISTRAŽIVANJA PREDNOSTI I RIZIKA

Upotreba AI alata za kreiranje sadržaja donosi brojne koristi:

Povećanje efikasnosti — automatizacijom repetitivnih i vremenski zahtevnih zadataka, kao što su pisanje tekstova, dizajn i montaža video materijala, omogućava se fokusiranje na strateške aktivnosti (Kaplan, 2020)

Podrška kreativnosti i inovacijama — AI može generisati neograničen broj varijacija sadržaja, predložiti nove ideje i stilove, što podstiče kreativni rad i smanjuje kreativne blokade (Davenport, 2020)

Personalizacija i angažovanje publike — pomoću analize podataka o korisni-

cima, AI prilagođava sadržaj potrebama i interesovanjima ciljnih grupa, što povećava relevantnost i angažovanost (Luo, 2021)

Ušteda troškova i resursa — smanjenje potrebe za velikim timovima za kreiranje sadržaja i outsourcingom, što je posebno značajno za mala i srednja preduzeća (Chen, 2020)

Unaprijeđenje menadžerskih procesa — alati poput ChatGPT mogu pomoći u automatizaciji komunikacije, izradi izvještaja i pripremi prezentacija, dok Canva i InShot omogućavaju brzo vizuelno izražavanje ideja i planova (Davenport, 2020)

IZAZOVI I OGRANIČENJA PRIMJENE AI U KREIRANJU SADRŽAJA

Uprkos brojnim prednostima, primena AI tehnologija nije bez izazova:

Etička pitanja — transparentnost u korišćenju AI, poštovanje autorskih prava, kao i pitanje odgovornosti za greške ili neprimjerene sadržaje koje AI generiše (Floridi, 2018)

Rizik od gubitka ljudske kreativnosti — prekomerno oslanjanje na AI može dovesti do uniformnosti sadržaja i smanjenja autentičnosti (Broussard, 2018)

Tehnička ograničenja i greške — AI modeli ponekad mogu dati netačne ili nerelevantne rezultate, što zahtjeva nadzor i dodatnu provjeru od strane ljudi (Marcus, 2019)

Zavisnost od tehnologije i kontinuirano učenje — kako se alati brzo razvijaju, neophodno je stalno usavršavanje i prilagođavanje zaposlenih na nove platforme i funkcionalnosti (Brynjolfsson, 2017)

Sigurnost podataka i privatnost — korišćenje AI često zahtjeva pristup velikim količinama podataka, što može predstavljati rizik za zaštitu informacija (Chen, 2020)

DISKUSIJA REZULTATA ISTRAŽIVANJA

Primjena AI alata kao što su Canva, InShot, ChatGPT i Jasper AI pokazala se kao izuzetno korisna za ubrzanje procesa kreiranja sadržaja i povećanje kvaliteta komunikacije sa ciljnim grupama. Ipak, uspjeh zavisi od balansiranog pristupa koji kombinuje snagu AI sa ljudskim nadzorom i kreativnim doprinosom. Organizacije koje investiraju u edukaciju i razvoj vještina svojih zaposlenih u oblasti AI tehnologija imaju veće šanse za dugoročnu konkurentsku prednost

Analiza pokazuje da AI značajno doprinosi produktivnosti i inovativnosti u poslovanju. Međutim, organizacije moraju pažljivo pristupiti implementaciji, balansirajući tehnološke mogućnosti sa etičkim i kreativnim aspektima.

ZAKLJUČAK

Vještačka inteligencija predstavlja jedan od ključnih pokretača savremene digitalne transformacije u oblastima marketinga i menadžmenta. Alati poput **Canve**, **InShota**, **ChatGPT-a** i **Jasper AI-a** omogućavaju organizacijama da unaprijede procese kreiranja sadržaja kroz automatizaciju, personalizaciju i inovaciju, što doprinosi većoj efikasnosti, uštedi resursa i boljoj komunikaciji s ciljnom publikom.

Analiza pokazuje da primjena AI tehnologija značajno poboljšava kvalitet poslovnih odluka i povećava kapacitete timova, posebno u segmentima koji zahtijevaju brzinu, kreativnost i prilagodljivost. Međutim, uz sve prednosti, neophodno je uzeti u obzir i izazove koje AI donosi — uključujući etičke dileme, tehnička ograničenja, sigurnost podataka i rizik od prekomjerne automatizacije.

Stoga se uspješna integracija AI alata ne smije posmatrati isključivo kroz teh-

ničku ili ekonomsku prizmu, već i kroz ljudsku, organizacijsku i društvenu dimenziju. Ljudski nadzor, strateško planiranje i kontinuirana edukacija zaposlenih ključni su faktori koji omogućavaju odgovornu i održivu upotrebu AI tehnologija.

Budućnost poslovanja, kako u marketingu tako i u menadžmentu, u velikoj mjeri će zavisiti od sposobnosti organizacija da na pravi način balansiraju između tehnoloških mogućnosti i ljudskih vrijednosti. Samo one kompanije koje razvijaju digitalne kompetencije, promovišu etičku upotrebu tehnologije i njeguju kreativnost moći će u potpunosti iskoristiti potencijal vještačke inteligencije u službi razvoja i inovacija.

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USE OF ARTIFICIAL INTELLIGENCE IN MARKETING AND MANAGEMENT – THE USEFULNESS OF TOOLS AND APPLICATIONS FOR CONTENT CREATION

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Summary: *In modern business, artificial intelligence (AI) is increasingly taking a significant place in marketing and management, especially through tools for automated con-*

tent creation. This paper explores key AI tools and their applications, highlighting advantages such as improved efficiency, enhanced creativity, and content personalization. The aim of this paper is to demonstrate the positive use of AI tools, while also emphasizing the importance of human involvement, creativity, and authenticity in the content creation process. Using AI without a personal touch results in an automated, robotic process; however, with proper use, it provides an easier path to achieving the creative outcomes we seek.

AI is a true partner and ally in text creation. One of the most important segments of marketing and management is high-quality and relevant textual content—from blogs, social media posts, and email campaigns to advertising slogans and product descriptions. These tools do not replace human creativity; rather, they serve as assistants that reduce the time needed for research and writing. They save time and resources, allowing the focus to remain on strategy and creative refinement of the final content.

Creating visuals within AI applications is also possible. In addition to text, visual content is essential for capturing the audience's attention. Modern AI applications enable the generation of images, graphics, and even attractive visuals that support a campaign's message, without the need to hire design teams.

Co-creating content thus becomes a multidisciplinary process in which AI helps synchronize the textual and visual components, ensuring brand consistency and aesthetic appeal. Artificial intelligence is not a replacement for human creativity—it is its ally. In the context of content co-creation, AI enables brands to engage their consumers on a deeper level, respond more quickly to their needs, and jointly create content that is original, personalized, and authentic.

Artificial intelligence represents one of the key drivers of modern digital transformation in the fields of marketing and management. Analysis shows that the application of AI technologies significantly improves the quality of business decisions and increases team capacities, especially in segments that require speed, creativity, and adaptability. However, despite all the advantages, it is necessary to consider the challenges that AI brings — including ethical dilemmas, technical limitations, data security, and the risk of excessive automation. Therefore, the successful integration of AI tools should not be viewed solely through a technical or economic lens, but also through human, organizational, and societal dimensions. Human oversight, strategic planning, and continuous employee education are key factors that enable the responsible and sustainable use of AI technologies.

Companies that develop digital competencies, promote the ethical use of technology, and nurture creativity will be able to fully harness the potential of artificial intelligence in the service of development and innovation.

Keywords: management, marketing, company, content creation, AI

JEL Classification: M3, M1, M12



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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

STRATEGIC PLANNING FOR MICRO-COMPANIES IN NETHERLANDS – USE OF AI-BASED TECHNOLOGY

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Abstract: *This paper examines how Artificial Intelligence (AI) can enhance strategic planning for micro-enterprises operating in an uncertain business environment, with a special emphasis on the Netherlands. Micro-enterprises often lack the time, financial resources, strategic knowledge or motivation to conduct formalized strategic planning. Existing strategic frameworks are often too complex or abstract for microenterprises, especially owner-managed enterprises (OMEs), whose primary objectives may be survival, autonomy or social value rather than growth. The research draws on the concept of bounded rationality to argue that micro-entrepreneurs make decisions under strong cognitive and informational constraints. It proposes that AI, when used as a cognitive enabler rather than a decision-maker, can help overcome these limitations by providing structure, clarity, and analytical support.*

Using design science research (DSR) and action research methods, the research develops and tests a customized twelve-step strategic planning process embedded in an AI-powered digital tool. The tool was developed iteratively and evaluated with micro-enterprise managers through surveys and prototype testing on a low-code platform.

The results show that participants recognize the value of structured planning when presented in a practical, non-intimidating format enabled by AI. The tool significantly increased users' confidence improved strategic planning skills, and their ability to formulate long-term goals. Features of explainable AI (XAI), such as the tool's ability to reason recommendations based on market data and user input, played a critical role in building confidence and enabling learning. The study shows that strategic planning for microenterprises can be democratized through intuitive, adaptive and explainable AI-driven tools. The paper offers recommendations for future research to investigate the long-term implications and ethical considerations of AI-enabled strategic decision-making.

Keywords: *strategy, decision making, AI, SME*

JEL classification: *L19, M13, M19*

INTRODUCTION

The importance of small and medium-sized enterprises (SME) in the Dutch business economy is widely acknowledged (Comité voor Ondernemerschap, 2022). They represent 99% of all companies, employ 70% of the workforce, and contribute 62% to the country's GDP. Micro-companies (those with fewer than 10 employees), as part of all SMEs, contribute 30% to the Netherlands' GDP, with 1.5 million companies employing over 50% of the workforce (CBS, 2024).

However, when the present-day business environment is assessed, it can be concluded that the variables are more unpredictable than ever (Milewska, 2022). Strategic planning (SP) is an effective and helpful tool for navigating the uncertain business environment (Ahmad, 2024). Numerous papers and books have been written discussing the significance of strategic management, with a particular focus on strategic planning within SMEs (Chaudhry, Ali, & Fakher, 2014). Kraus et al. (2006) found that these studies have demonstrated a positive correlation between formal strategic planning and business performance. Many SMEs frequently conduct their business without any formal SP or SP processes, primarily due to a lack of knowledge, skills, and resources (Cordeiro, 2013; Straková & Talíř, 2020), and this often results in comparatively lower performance compared to peer companies that have adopted a formalized strategic planning process. Recent research shows that AI can serve as an assistant or enabler instead of a replacement for strategists, enhancing their ability to analyze external and internal factors and support strategic decision-making processes related to external threats, opportunities, internal strengths, weaknesses, and other strategic considerations (Borges, Laurindo, Spinola, Gonçalves, & Mattos, 2021; Finkenstadt, Eapen, Sotiriadis, & Guinto, 2024; Kedding, 2021). They demonstrate that AI offers a range of appealing functionalities for strategists to employ in managing and coordinating strategic processes.

The primary objective of this paper is to examine the potential of a tailored strategic planning model and an AI-enabled tool designed explicitly for micro-businesses. This model aims to strengthen their operational framework, establish a foundation for long-term objectives, and enhance their preparedness for an unpredictable business environment, thereby increasing their sustainability prospects and supporting them in achieving their objectives. The first part of the paper will present strategic planning and discuss the possible role of AI in the strategic planning process. The second part of the paper will test the proposed AI model in strategic planning. In the final section of the paper, a conclusion and proposals for future research will be presented.

LITERATURE REVIEW

Micro, Small, and Medium Enterprises: Businesses and Strategic Planning

More than 40 empirical studies conducted in the 1970s have not produced conclusive results regarding the positive effect of SP on small business performance (Gibcus & Kemp, 2003). Robinson Jr. and Pearce (1984) also describe four reasons given by owner-manager entrepreneurs (OMEs) for not using SP: (1) lack of time, (2) minimal knowledge of the planning process, (3) lack of specialized expertise about the planning process, and (4) lack of push towards employees and external consultants. Straková and Talíř (2020) pointed out the lack of SP in SMEs, emphasizing the lack of awareness and knowledge about SP, calling it a lack of "managerial literacy".

The research conducted by Kraus et al. (2006) aimed to examine the performance implications of SP within smaller enterprises. They found that the formalization of SP had a significantly positive impact on growth performance. However, they did not find evidence supporting the contribution of other aspects of SP, such as time horizon, strategic instruments, and control, to overall performance. Authors underscored that small enterprises differ fundamentally from large ones, emphasizing that concepts developed for larger firms may not necessarily apply to small and micro businesses. Consequently, they advocate for the emergence of specially tailored SP concepts for smaller firms. Subsequently, in their later research, Kraus et al. (2008) revealed that 79% of the studies identified a positive correlation between SP and success, while 21% found no or mixed correlation.

George et al. (2019) reaffirm that strategic planning has a significant impact on organizational performance, spanning both the private and public sectors and transcending national boundaries. They advocate for integrating SP into contemporary managerial practices, emphasizing the pivotal role of formalization in driving organizational progress. However, despite the consensus on the benefits of strategic planning, specific nuances remain unexplored. Suklev and Debarliev (2012) stress the comprehensive and formalized nature of strategic planning processes, highlighting management involvement and the utilization of illuminates the multifaceted nature of strategic planning, emphasizing its relevance across organizational spectrums and the imperative of formalization in maximizing its impact. Addressing this gap, Gutterman (2023) and Maříková et al. (2022) note a lack of research on the strategic planning dynamics within smaller enterprises, highlighting its relevance across all business dimensions. They underscore the indispensable nature of strategic planning in navigating the ever-evolving business landscape, countering prevalent misconceptions that relegate it solely to the domain of larger corporations.

Wang et al. (2007) identified barriers to SP in SMEs, resulting in a lack of or low levels of SP in most of the SMEs. Among others, these include a lack of time, a lack of expertise, inadequate knowledge of the planning process, the type of industry, the size of the business, and internal implementation barriers. They also highlight another important issue: the motivation of owners. The authors assume that many OMEs do not want to grow but pursue non-economic goals, such as autonomy and personal satisfaction, and “buy” employment. Another obstacle pointed out by Stefanovska and Soluncovski (2015) is that, despite the desire of OMEs and other stakeholders to be involved in the formalization of strategic planning, their contribution to this process is minimal due to the distraction of day-to-day business activities.

However, for micro firms, several researchers conclude that formal planning mechanisms are often lacking due to a lack of resources, such as time, capital, skills, and knowledge (Cordeiro, 2013; Straková & Talíř, 2020; Málovics & Kraus, 2007; Wang, Walker, & Redmond, 2007). Charles et al. (2015) recognized additional factors such as organizational structure, leadership style, market conditions, competition, and environmental influences that play significant roles in determining the strategic management approach adopted by small businesses.

Which Strategic Processes Are Beneficial to Micro Businesses?

From the '60s onward, there has been a trend of viewing strategy use in organizations differently (Hamel & Prahalad, 1996; Mintzberg, Ahlstrand, & Lampel, 1998; Johnson, Scholes, & Whittington, 2009). Depending on profit-maximizing or other objectives, the importance of strategy is a dynamic mix of planned and unplanned elements.

Hunger and Wheelen (2020) state that strategic management encompasses the managerial decisions and actions that shape a corporation's long-term performance. It involves processes such as environmental scanning (both internal and external), strategy formulation, strategy implementation, and the evaluation and control of outcomes (Figure 1).

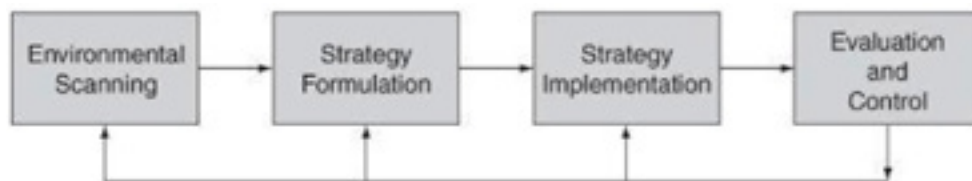


Figure 1. Basic elements of the Strategic Planning process

Source: Hunger and Wheelen (2020, p. 3)

Johnson et al. (2009) argue that the SP process does not follow a linear sequence because its components are interlinked and provide feedback to one another. These models primarily address the operational frameworks of large corporations, featuring numerous case studies on prominent enterprises, and can be adapted for SMEs and micro-businesses (Alade & Ehigbochie, 2019). The comparability of this methodology between non-profit and for-profit enterprises highlights its adaptability. However, it requires tailored adjustments for each sector to suit their unique context and objectives (Hill & Jones, 2009).

To better understand the concept of strategic process and planning tools, Stenfors et al. (2007) refer to these tools as “decision aids that are used methodically for specific purposes in decision-making or planning activities.” Pasanen (2011) emphasizes that the goal is to offer companies significant improvements and benefits. Like the studies by Aldehayyat and Anchor (2008), Stenfors et al. (2007) and Straková and Talír (2020), Pasanen (2011) also observes that the use of tools is more extensive in larger companies than in smaller ones. Williams Jr. et al. (2018) emphasize the central role of planning instruments. Authors advocate the use of a combination of instruments, citing better results compared to the isolated use of a single instrument. He also pointed out the risk of “paralysis by analysis” among small business managers due to their limited training, skills and experience with strategic planning tools. Small businesses focused on growth emphasize their relationships with funders and may consider SWOT analysis a fundamental tool (Johnson, Scholes, & Whittington, 2008). To determine which strategic management tools and techniques are appropriate for SMEs, it can be concluded that there is a lack of available research on this subject (Pasanen, 2011; Qehaja & Kutlllovci, 2020).

Pasanen (2011) selected fifteen strategic management tools and techniques for his study. He researched the topic and concluded that eight tools ranked above average in both usage and satisfaction: Mission & Vision Statements, Strategic Alliances, Business Strategies, Quality Systems, Outsourcing, Growth Strategies, Customer Satisfaction Measures, and SWOT Analysis. The most popular tools also received high satisfaction ratings. Five others, including the Balanced Scorecard, Benchmarking, and Scenario Planning, recorded low usage and low satisfaction ratings. Mission & Vision Statements, as well as Business Strategies, were utilized by 75% of the respondents. As the definitions of the various strategic management tools are not elaborated, and some are missing (e.g., PESTEL, BCG-matrix), it is not easy to assess this outcome other than to call for future research on the topic, as other scholars stated before (Aldehayyat & Anchor, 2008; Clark, 1997).

Strategic planning and the development of AI

Research in the intersection of entrepreneurship and AI is relatively scarce, with limited scholarly attention given to this area. However, in recent years, papers by Borges et al. (2021), Kedding (2021), and Acuña et al. (2025) have shown interest in integrating strategic planning and AI. Finkenstadt et al. (2024) highlight the potential of AI tools such as ChatGPT and Claude in enhancing organizations' scenario planning capabilities, particularly benefiting resource-constrained small companies. Miller (2023) underscores AI's role in strategic management, emphasizing its capacity to provide insights, identify growth opportunities, and optimize decision-making processes. The author further emphasizes the need for further research to harness AI's potential in strategic management applications fully. Similarly, Manuel et al. (2023) emphasize the potential of AI to enhance decision-making and confer competitive advantages in strategic planning tools. Minasyan (2024) and Patil et al. (2024) showcase the feasibility of using AI in business planning. As businesses integrate these advanced technologies, emerging applications such as AI-driven strategic planning and autonomous decision-making underscore the critical role of generative AI in enhancing organizational resilience and catalyzing innovation. Parsons (2023) addresses both the benefits and limitations of AI, acknowledging its ability to free up resources and noting potential drawbacks such as a lack of human ingenuity. Sayyadi and Collina (2024) argue that AI-powered business strategies, leveraging data analysis and digital technology, have significant potential to meet the evolving needs of modern businesses, including applications in scenario planning. Von Krogh and Shrestha (2021) further elaborate on AI's penetration into various areas of strategic analysis, including external factors such as PESTEL analysis and competitor analysis. The advantage of automated (AI) competitor analysis over traditional (manual and discrete) approaches is significant, as algorithms can continuously perform competitor analysis and adapt to dynamic market conditions, optimize resources, and achieve long-term business goals (Yilmaz & Demir, 2023). Von Krogh and Shrestha (2021) emphasize that AI should be viewed as an assistant rather than a replacement for strategists, augmenting their capacity to assess external and internal factors and facilitate strategic decision-making processes concerning external threats and opportunities, internal strengths and weaknesses, and other strategic issues. They also argue that AI presents numerous appealing functionalities for strategists to utilize in conducting and coordinating strategic processes.

Strategy scholars must continue investigating how these technologies can support the analysis, formulation, and implementation of strategies. Chowdhury (2024) concludes that the adoption of AI in business marks a new era of innovation and efficiency. By leveraging AI technologies to address the complexities of today's business environment, organizations can achieve transformative benefits, including enhanced decision-making, improved customer experiences, and streamlined operations. His conclusion is shown in the case study of Narne et al. (2024) at a Fortune 500 retail organization. The adoption of AI-driven decision support systems has led to notable improvements in strategic analysis, including a 50% reduction in planning cycles and a 558% increase in scenario modeling. Financial performance demonstrated significant gains, with a 23% increase in revenue and a 136% rise in profits following implementation. Narne et al. (2024) found in their research that user feedback highlighted that 79% experienced enhanced strategic foresight, and 83% reported increased confidence in their decision-making processes. Transparency and explainability remained challenges, as advanced machine learning models often lacked intuitive clarity. Successful implementation relied on participatory design, thorough testing, and training, emphasizing the importance of human oversight and collaborative integration with AI tools. According to Usman et al. (2024), the integration of AI strategies presents significant opportunities and intricate challenges in the dynamic realm of entrepreneurship. Effective AI deployment necessitates a balanced approach that considers both technological advancements and critical ethical dimensions, such as data privacy and algorithmic fairness. Entrepreneurs must adopt a comprehensive strategy emphasizing transparency, responsible governance, and adherence to evolving ethical standards to ensure sustainable and inclusive success in the AI-driven business. Acuña et al. (2025) confirm in their computational research that AI techniques enhance strategic planning by addressing information uncertainty more effectively and efficiently. The central insight derived from the literature on AI and Strategic Planning highlights the critical need for more extensive and rigorous research to explore the potential of AI-enabled strategic planning methodologies across a diverse range of organizational contexts, including large enterprises, small and medium-sized enterprises (SMEs), and micro-businesses such as startups. Jorzik et al. (2023) emphasize the need to bridge the existing gap between theoretical advancements and their practical application in this domain.

METHODOLOGY

The paper employs a mixed-methodology approach that combines Action Research and Design Science Research (DSR). Action Research is especially appropriate because it emphasizes the actions or cycles of action that members of an organization or community have undertaken, are currently undertaking, or plan to pursue to address a specific problematic situation (Herr & Anderson, 2014). DSR, also known as design-oriented research, was employed to iteratively develop a generative AI tool that incorporates feedback from the real-world environment.

DSR aims to provide practical solutions to specific challenges and develop generalizable knowledge that strengthens the evidence base. This makes it a valuable approach for professionals in various disciplines, such as information systems, management and engineering, who can apply this knowledge when designing solutions to similar problems (Mulder, 2012). The chosen AI model, also known as a large language

model (LLM), is ChatGPT-4, which is widely available on the OpenAI platform. It is integrated with application programming interfaces (APIs) and extended by Microsoft tools like Word and Excel.

An exploratory survey was conducted to validate the literature review’s findings, gather data, and provide insights into the strategic planning needs and challenges faced by participants, including limited resources such as time, capital, skills, and knowledge. The survey includes 22 questions, incorporating both open-ended and multiple-choice formats. It employs a 5-point Likert scale for measuring participant perceptions, with the following response options: 1 = Poor, 2 = Unsatisfactory, 3 = Good, 4 = Very Good, and 5 = Excellent. This scale evaluates attitudes towards strategic planning processes, the usability of tools, and overall satisfaction with AI-enabled outputs.

This paper focuses on micro-companies in the Netherlands, specifically those with a single owner-manager and a maximum of ten employees. Participants were recruited through the Prolific online research platform. Of the 100 potential participants invited to complete the survey, 60 provided valid responses. A purposive sampling strategy was employed, deliberately selecting OMEs who could offer diverse and insightful perspectives based on predetermined criteria, including geographical location, company size, and language.

In addition to the survey data, the objectives derived from each action research cycle were utilized to enhance the AI tool. This procedure entails ongoing learning and adaptation, consistent with the principles of design science and action research. This collaborative methodology facilitates the real-time evaluation of the AI’s impact and the execution of iterative enhancements. Such collaboration ensured that the tool remained practical and effectively addressed real-world challenges.

The survey data were analyzed using thematic analysis (TA) with a deductive approach. TA offers a structured method for examining qualitative data, allowing researchers to apply pre-existing theories while maintaining theoretical consistency. At the same time, openness to unexpected insights is essential for minimizing bias and enhancing the analysis (Braun & Clarke, 2006). To ensure analytical rigor, the method includes a two-stage review in which themes are assessed against the coded extracts and the entire dataset (Clarke & Braun, 2017; Pearse, 2019).

A deductive codebook was created to guide the thematic analysis of open-ended survey responses. The initial coding framework was shaped by existing literature on strategic planning in MSMEs and SMEs; however, the analysis process allowed for ongoing refinement and the development of nuanced sub-themes. It included categories such as time constraints, financial limitations, lack of strategic skills, and limited knowledge of the strategic planning process (Table 1).

Table 1. Excerpt of the codebook

Code Name	Strategic Intent – Mission, Vision, Goals
Theme	Mission, Vision, and Goals
Definition	Expressions of clear purpose, long-term vision, or specific goals, whether formally documented or not.
Indicators / Keywords	We have a “mission and vision”, “long-term objectives”, “short-term goals”, “increase sales,” and “start distribution”.

Theoretical Link	Informal strategic planning and entrepreneurial orientation in micro firms (Málovics & Kraus, 2007)
Example Quotes	"We have a mission and vision for our company." "This year, we want to increase sales up to 20% and start offering distribution."
Notes / Considerations	Intent may be informal, intuitive, or undocumented, but it is still strategic.

Source: authors, 2025

The research process has several limitations. As with many qualitative studies, the sample of this research may not fully represent the diversity of perspectives from different demographic groups, as it is limited to Dutch companies, organizational sizes, or industries. This limitation could impact the transferability of the findings, as the insights gained from the selected participants may not reflect broader contexts. This paper relies on self-reported data collected through surveys, questionnaires or interviews. Participants may provide misleading or inaccurate information due to recall problems, social desirability or misinterpretation. This paper may be subject to certain limitations regarding the use of AI tools to assess the feasibility of formal strategic planning. These limitations are manifold and may include concerns about data quality, inherent algorithmic biases, the potential for misinterpreting AI-generated results, and challenges related to effectively integrating such tools into existing strategic planning processes.

RESULTS AND DISCUSSIONS

For a better understanding of the demographic properties of the population, the relevant demographic data are highlighted in Table 2.

Table 2. Respondents' demographics

Educational level	Frequency	Percentage
Secondary vocational	11	18%
Bachelor	23	39%
Master	26	43%
Distribution of respondents across business sectors		
ICT	8	13%
Retail	6	10%
Healthcare	5	8%
Finance	5	8%
Education	5	8%
Multimedia	4	7%
Entertainment	4	7%
E-commerce	3	5%
Cultural	3	5%
Service	2	3%
Real estate	2	3%
Human resources management	2	3%

Coaching	2	3%
Research	1	2%
Public services	1	2%
Music	1	2%
Marketing	1	2%
Manufacturing	1	2%
Journalism	1	2%
Hotel and catering	1	2%
Consulting	1	2%
Building	1	2%
Number of employees		
1	27	45%
2-3	25	42%
4-6	5	8%
7-10	3	5%

Source: authors, 2025

Table 2 illustrates the level of education, revealing that the majority (82%) of the respondents hold a bachelor's or master's degree. This observation also aligns with the findings of Gibcus et al. (2009), who noted that 20% of OMEs have an educational level below that of a bachelor's degree.

For some respondents, the mission stems from personal values or a sense of community commitment. Many express a clear sense of strategic intentions, supported by well-defined missions (84%), vision (15%), and goals (79%) that guide their business operations. They often express their missions in personal and value-oriented terms, emphasizing the significance of purpose and service. These insights suggest that micro-firms often operate with strategic intentions, even if they do not adhere to a formal planning framework (Mazzarol, Reboud, & Soutar, 2009).

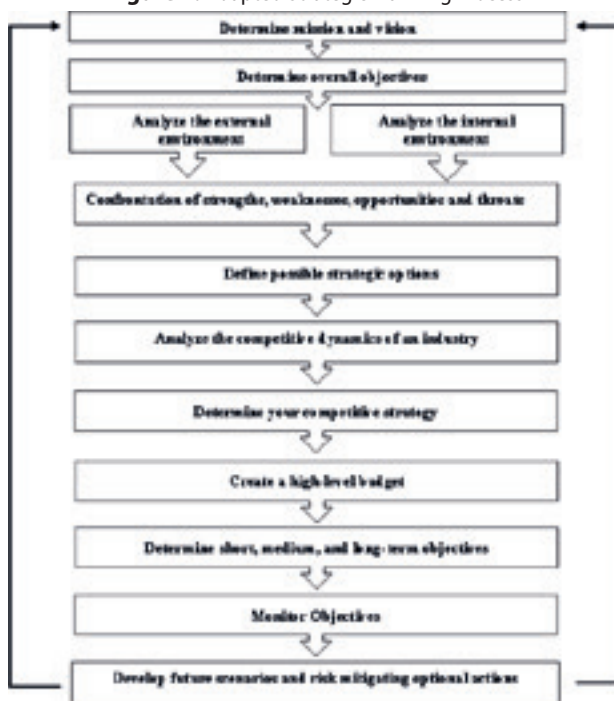
Despite the operational challenges reported by many micro-business owners, most respondents (66%) acknowledged the value and importance of SP. Although SP was often not formally implemented, it was frequently described as a desirable, even essential, activity, particularly for growth, stability, and long-term decision-making. The findings suggest that micro-firms do not reject strategic planning but often defer it. This supports prior literature indicating that micro-business owners are strategically aware but may lack the structure or resources to formalize planning processes (Sanda-da, Poee, & Dhurup, 2014; Damke Junior, Gimenez, & Damke, 2018).

Micro-enterprises engaged in some form of strategic planning widely use formal tools and models. Most participants preferred straightforward, practical frameworks over complex strategic models. These models include PESTEL analysis, SWOT, the 5-Forces model, Ansoff matrix, and BCG matrix, among others. One or more participants apply at least one of the strategic planning tools mentioned in the survey. Their choices were influenced by usability, familiarity, and relevance to the immediate business context. A SWOT analysis was reported as the most used tool by 47%

of business owners. Overall, the data suggests that while 92% of respondents widely adopt strategic planning tools, micro-firms utilize lightweight, customized versions of these methods to address their immediate needs. Their approach is pragmatic, flexible, and often driven by personal experience rather than formal education. This aligns with existing research (Pasanen, 2011; Stonehouse & Pemberton, 2002), which indicates that micro-firms favor accessible, low-complexity tools that can be easily integrated into daily operations without requiring significant resources. Respondents illustrated not only the significant limitations faced by micro-enterprises but also how these constraints are directly associated with firm size and owner dependency, emphasizing the importance of resource-based limitations in the strategic capacity of small firms. This confirmed previous research results (Cordeiro, 2013; Straková & Talíř, 2020).

The strategic planning process, for the research, was broken down into twelve manageable steps, making it easy to follow and understand (Figure 2). The purpose is to develop a comprehensive strategic plan specifically for micro-companies. This approach aligns with the constraints related to a lack of knowledge or skills concerning strategic planning.

Figure 2. Adapted Strategic Planning Process



Source: authors, 2025

To answer the research question, “How can AI help microenterprises to develop customized strategic planning processes and strategies?” it was essential to create an LLM input framework based on the twelve phases of the SP process. The LLM framework developed in FlutterFlow (2025) was chosen to facilitate the generation of multiple iterative actions by participants based on the results of each cycle. These

actions require minimal time and resources, allowing for efficient and cost-effective model improvement.

The company-specific information was organized into an input document and uploaded to the LLM, initiating an iterative process in which the formal SP is incrementally refined after each revision of the input document. (Figure 3)

Figure 3. LLM strategic planning process



Source: authors, 2025

Eight weeks were spent evaluating the FlutterFlow application for strategic planning, specifically examining how AI enables it. The iterative process included five test cycles. Fifteen OMEs operating in various business areas, including ICT, retail, services, and finance, as well as non-profit and non-growth OMEs, participated in these cycles and provided real-life business descriptions. After each iterative cycle, participants provided quantitative feedback using a 5-point Likert scale via a feedback section that included both quantitative and qualitative aspects. The participants assessed the quality of the application output during the iteration process.

Responses were subjected to thematic analysis to identify common challenges faced by participants in the sample. The most frequently mentioned issues included

the use of a wide range of planning tools, difficulties in distinguishing between strategic and operational planning, and cognitive overload due to excessive AI-generated content. The prototype was revised after each test cycle. This included fine-tuning the prompts, adding concise explanations for each step in the process and each strategic planning tool used, summarizing the results, and reorganizing the planning steps to improve the logical flow. Participants were encouraged to enter additional information and details into the input form (Table 3) that they had previously submitted in the application before starting a new cycle.

Table 3. Input form

Questions	Connecting the Strategic tool
What kind of company are you?	Mission statement
What is your company's ideal future state?	Vision statement
What goals do you have?	Goal setting
Where are you located?	PESTEL analysis
What is your organization doing well right now? What sets you apart from your competitors? What is your greatest strength? What is your organization not doing well?	SWOT Analysis (Strengths)
What are you currently lacking (a product, resource, or process)? What are your competitors doing better than you? What limitations, if any, are holding your organization back? What processes or products need improvement?	SWOT Analysis (Weaknesses)
What opportunities does your organization have? How can you leverage your unique strengths as a company? Are there trends that you can take advantage of? Is there a growing demand for your product or service?	SWOT Analysis (Opportunities)
What emerging competitors should you watch? Are there weaknesses that expose your organization to risk?	SWOT Analysis (Threats)
How is your annual budget allocated across key areas?	Mid-term Budget setting

Source: authors, 2025

This allowed LLM to further elaborate on this extended information. Usability ratings monitored during the iterations showed an upward trend in user satisfaction and understanding after each prompt change. In the final test cycle, all participants gave positive feedback on the formal SP generated by the test application. 53% rated it as “good” (3 on the 5-point scale) and 47% as “very good” (4 on the scale). Significantly, no participant selected “Unsatisfactory” or “Poor.” The combination of improved usability ratings and encouraging qualitative feedback confirms the successful completion of the iterative refinement process. Some participants suggested changing the test application from generating a formal Strategic Plan to developing a Business Plan. This distinction is likely blurred in small firms, particularly micro-companies, as owners may focus on short-term operational or financial issues and conflate strategic planning with writing a business or marketing plan. Stefanovska and Soluncevski (2015) already described this phenomenon.

The need for scaffolding strategic literacy becomes more pronounced when users have had limited exposure to formal strategic processes in the past. Design ele-

ments that support users' strategic understanding, such as an explanatory introduction to a strategic plan and an explanation of how it is constructed with building blocks (SP tools), mitigate the adverse effects of bounded rationality on engagement. To address this issue, a concise, AI-generated explanation or XAI of the purpose and structure of a formal strategic plan, as well as the function of the strategic planning tools used, was integrated into the tool, following the recommendations of Shick et al. (2024). Subsequently, this AI-generated explanation was incorporated into the formal strategic plan developed by the application. This intervention narrowed the knowledge gap related to strategic planning, leading to enhanced user comprehension and increased engagement in the strategic planning process.

The iteration process ceased when all participants provided positive usability feedback for the presented formal SP or their respective companies from the test application, with a rating of at least "Good" on a 5-point Likert scale. An analysis of the usability ratings revealed that 100% of participants assessed the AI-enabled strategic planning tool positively, with 80% assigning a 'Good' or higher rating. The absence of negative evaluations highlights the tool's acceptability among micro-entrepreneurs with varying educational backgrounds. Feedback from participants regarding the FlutterFlow application suggests that the input form, combined with the 12-step process and AI-enabled SP, facilitates a user-friendly SP that allows for rapid edits and seamless integration of new data, without resource constraints.

CONCLUSION

This paper examined how micro-enterprises, particularly those operating in resource-constrained environments, can use artificial intelligence to conduct effective strategic planning. Considering the well-documented barriers that prevent micro-entrepreneurs from utilizing formal strategic planning methods, such as limited time, capital, and strategic knowledge, the research aimed to develop, test, and evaluate an AI-powered planning framework specifically tailored to this business context.

Using a qualitative methodology supported by a Design Science Research (DSR) approach, a twelve-step strategic planning process was developed and iteratively refined. The process was operationalized in an AI-supported prototype and tested with a targeted sample of micro-entrepreneurs in the Netherlands. The research shows that strategic planning can be more accessible and impactful for micro-companies by thoughtfully integrating AI-enabled tools. By customizing the strategic planning process to align with the specific characteristics and limitations of micro-enterprises and utilizing AI as a cognitive partner, rather than merely a direct force, the research presents a strong argument for innovation in entrepreneurial support systems. The twelve-step planning model, backed by an AI-driven prototype, not only overcomes typical obstacles to strategic engagement but also enables users to think more clearly, plan more effectively, and act more purposefully.

The results showed that the tool significantly reduced cognitive load, improved user engagement and supported the formation of structured strategic insights, even among participants with no prior strategic planning experience. The results also suggest that AI served as cognitive support rather than a substitute for decision-making and helped overcome important limitations related to bounded rationality. Overall, the

results confirm the potential of AI-assisted planning to democratize access to strategic management practices for micro-enterprises.

This work provides a foundational understanding of AI-enabled strategic planning in micro-enterprises and highlights several opportunities for further research. First, it is essential to conduct longitudinal studies to evaluate the long-term effects of AI-enabled planning on key business outcomes, including resilience, adaptability, and performance. These studies can provide valuable insights into whether the initial use of AI tools promotes ongoing strategic behavior. Second, conducting comparative research across different cultural and economic settings can clarify the extent to which the findings are applicable and the specific adaptations needed in different contexts. Third, linking models of practical thinking to formal planning frameworks could enhance our understanding of hybrid decision-making among entrepreneurs. Since many micro-enterprises operate in an exploratory and satisficing manner, future tools could combine predictive and adaptive capabilities in a single planning platform.

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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

KULTURNA ZAPOSLENOST U ZEMLJAMA SREDNJE I ISTOČNE EUROPE: ANALIZA I IMPLIKACIJE

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Sažetak: *Kulturne i kreativne industrije važne su za europsko gospodarstvo što se, između ostaloga, očituje i u broju zaposlenih u ovoj industriji koji čine vrijedan doprinos u ukupnoj zaposlenosti. Cilj je rada identificirati ekonomski doprinos zemalja Srednje i Istočne Europe (EU-11) u ukupnom gospodarstvu EU koristeći pokazatelje kulturne zaposlenosti i BDP-a. Specifičnost tih zemalja očituje se u tranzicijskom procesu iz plan-skog u tržišno gospodarstvo u kojem kulturne i kreativne industrije imaju značajnu ulogu u transformaciji njihovog gospodarstva. Korištenjem deskriptivne statistike i korelacijske analize u radu se utvrđuju trendovi i razlike u kulturnoj zaposlenosti EU-11 zemalja u razdoblju 2013.-2022. godine te se ispituje postoji li statistički značajna povezanost kulturne zaposlenosti i BDP-a. Rezultati istraživanja pokazuju da postoje neravnomjernosti u distribuciji kulturne zaposlenosti tih zemalja što se, između ostalog, može povezati, kako s povijesnim razvojem i tranzicijom, tako i s njihovom prilagodbom promjenama i novim tehnologijama za što je ključna visokoobrazovana radna snaga koja doprinosi razvoju inovativnosti i konkurentnosti ovih industrija. Rad doprinosi razumijevanju specifičnosti kulturne zaposlenosti i njezinog potencijala u gospodarstvima zemalja u tranziciji što je važno za donositelje odluka i kreatore javnih politika.*

Ključne riječi: *kulturne i kreativne industrije, kulturna zaposlenost, nove tehnologije, visokoobrazovana radna snaga, zemlje Srednje i Istočne Europe*

JEL klasifikacija: E24, J21, O39

UVOD

Razvojem kulturnih i kreativnih industrija (KKI) brojni autori, kao i kreatori politika, primjećuju njihov značajan utjecaj na ekonomiju (Kalfas, Kalogiannidis, Am-bas, & Chatzitheodoridis, 2024; OECD, 2021; Đorić, 2020; KEA, 2019) čime se ujed-

no javlja potreba mjerenja i praćenja njihova razvoja. Naime, KKI postaju prepoznate kao pokretači gospodarstva, radnih mjesta i profita (Borić Cvenić, 2021; Mihaljević & Stanković, 2016; Todose, Titan, & Ghița, 2008) te imaju važnu ulogu u urbanoj regeneraciji i brendiranju gradova (Kalfas, Kalogiannidis, Ambas, & Chatzitheodoridis, 2024; Jocić, 2019; Šain, Bestvina Bukvić, & Haršanji, 2018; Strykiewicz, Męczyński, & Stachowiak, 2014). Rašić Bakarić, Bačić, & Božić (2015) navode da je mjerenje ekonomskog doprinosa KKI ukupnoj ekonomiji moguće kroz tri stupa: prvi se odnosi na doprinos KKI ukupnom bruto domaćem proizvodu (BDP) neke države, drugi se temelji na zaposlenosti, dok se treći stup bavi poslovnim sektorom, odnosno poduzetništvom. Mjerenjem zaposlenosti u KKI dobiva se uvid u karakteristike i potencijale industrije, što je iznimno važno za donositelje odluka i kreatore javnih politika (Kalfas, Kalogiannidis, Ambas, & Chatzitheodoridis, 2024; Demianova, Gershman, Kutsenko, Polyakova, & Vlasova, 2023; Suci, Stativă, & Mitucă, 2021; Primorac, 2014) jer je stopa zaposlenosti jedan je od najvažnijih faktora ekonomskog rasta u tranzicijskim promjenama. Veća zaposlenost povećava proizvodnju i potražnju, stabilizira ekonomiju te potiče institucionalne reforme i inovacije, što je ključno za uspješan prijelaz na tržišno gospodarstvo (Tica & Viljevac, 2023). To je posebno značajno za zemlje Srednje i Istočne Europe koje je krajem 80-ih i početkom 90-ih godina prošloga stoljeća obilježio tranzicijski prijelaz iz socijalizma u kapitalizam, odnosno iz planskog u tržišno gospodarstvo (Tomić-Koludrović & Petrić, 2005). Istovremeno, one se značajno razlikuju po svojoj „gospodarskoj strukturi, povijesti, raspoloživim vještinama radne snage, tehnološkim profilima, institucionalnim i upravljačkim kapacitetima i mnogim drugim aspektima“ (Drvenkar, Marošević, & Unukić, 2023, str. 361). Riječ je o zemljama u kojima KKI u posttranzicijskom razdoblju imaju značajnu ulogu u transformaciji njihovih gospodarstava (Jocić, 2019; Suci, Năsuela, & Năsuela, 2018; Strykiewicz, Męczyński, & Stachowiak, 2014; Tomić-Koludrović & Petrić, 2005), što ujedno doprinosi lakšoj integraciji u europski kulturni i ekonomski prostor (Astike & Skvarciany, 2024). Također, riječ je o uzorku koji je nedovoljno istražen, posebice u području kulturnog zapošljavanja (Demianova, Gershman, Kutsenko, Polyakova, & Vlasova, 2023), ali i ujedno zanimljiv zbog svoje političke prošlosti i trenutnog gospodarskog statusa u razvoju (Demianova, Gershman, Kutsenko, Polyakova, & Vlasova, 2023; Prouska, Argyro, & Phychogios, 2022).

Svrha je ovog rada ispuniti prazninu u postojećim studijama pružanjem sveobuhvatnog prikaza zaposlenosti u kulturi u kontekstu zemalja Srednje i Istočne Europe čime se nastoji doprinijeti povećanju važnosti zaposlenosti u kulturi u tranzicijskim zemljama kroz njihovu ulogu u ekonomskom doprinosu zemlje. Sukladno tome, u radu se analizira kulturna zaposlenost jedananest zemalja Srednje i Istočne Europe, članica Europske unije (EU-11): Bugarska, Hrvatska, Češka, Mađarska, Poljska, Rumunjska, Slovačka, Slovenija Estonija, Litva i Latvija u desetogodišnjem razdoblju (od 2013. do 2022. g.), pri čemu je cilj rada utvrditi trendove i razlike u kulturnoj zaposlenosti između tih zemalja te u odnosu na ukupnu zaposlenost EU-27. Također, statističkom analizom podataka cilj je rada istražiti povezanost kulturne zaposlenosti i BDP-a po stanovniku te identificirati ekonomski doprinos zemalja EU-11 u ukupnom gospodarstvu EU koristeći navedene pokazatelje. Kroz analizu dosadašnjih istraživanja cilj je rada utvrditi karakteristike tržišta rada u KKI s naglaskom na obrazovni status i njihovu ulogu u kulturnoj zaposlenosti.

Sukladno navedenom, postavljena su sljedeća istraživačka pitanja:

1. Kako se broj zaposlenih u kulturi i njen udio u ukupnoj zaposlenosti razlikuje među zemljama EU-11 te u odnosu na EU-27 u promatranom razdoblju? Kakvi su trendovi i razlike između zemalja?
2. Postoji li statistički značajna povezanost kulturne zaposlenosti i BDP-a po stanovniku u zemljama EU-11 u analiziranom razdoblju?
3. Kako visokoobrazovana radna snaga utječe na kulturnu zaposlenost i sposobnost sektora KKI da se prilagode novim tehnologijama u zemljama EU-11?

Rad nastoji odgovoriti na ova pitanja empirijskim istraživanjem te se u tu svrhu koriste statistički podaci sa službenih stranica Statističkog ureda EU – Eurostata. Pritom, u radu se koristi pojam kulturne zaposlenosti odnosno zaposlenosti u kulturi sukladno Eurostatu koji ne pravi razliku između KKI, odnosno, pod pojmom „kultura“ objedinjuje KKI (Eurostat, 2025a). Autori (Conor, 2021; Banks, 2019; Primorac, 2010; Primorac, 2012) govoreći o zaposlenosti u KKI, koriste termine: zaposlenost u kulturi, kulturna zaposlenost, kulturni djelatnici ili radnici u kulturi. Struktura rada koja slijedi sastoji se od pregleda literature, metodologije istraživanja, rezultata, rasprave te zaključka.

PREGLED LITERATURE

Teorijski okvir o kulturnoj zaposlenosti

Postoje brojne definicije KKI, no najčešća je ona britanskog Odjela za kulturu, medije i sport koja definira KKI kao „aktivnosti koje imaju svoj korijen u individualnoj kreativnosti, vještini i talentu, i koje imaju potencijal za bogatstvo i kreiranje radnih mjesta kroz generiranje i eksploataciju intelektualnog vlasništva.” (Goldstein 2016 u Borić Cvenić (2021, str. 43). Sektor KKI vrlo je heterogen – uključuje niz (pod)sektora od arhitekture, oglašavanja, izvedbenih i vizualnih umjetnosti, moda, dizajn, film, glazba, nakladništvo do proizvodnje videoigara (Haršanji, Bestvina-Bukvić, & Šain, 2020). Ovisno o svojim specifičnostima, svaka država, pa i grad na svom području, definiraju koji su to (pod)sektori koji pripadaju u KKI, što znači da broj sektora KKI nije jednoznačno određen (OECD, 2021). Upravo ta raznolikost sektora zasigurno je jedan od razloga otpornosti KKI na gospodarske krize (Borić Cvenić, 2021; Cellini & Cuccia, 2019; Suci, Stativa, & Mituć, 2021), ali i otežanog mjerenja i usporedbe njihova razvoja i doprinosa gospodarstvu, kako u pojedinim pod-sektorima, tako i u ukupnoj KKI (Mihaljević & Stanković, 2016).

KKI „predstavljaju jednu od ključnih industrija svjetske ekonomije. Jedan je od ključnih razloga taj što u svijetu zapošljavaju velik broj ljudi – “preko 29,5 milijuna – pri čemu pojedini sektori generiraju prihode veće oko 2250 milijardi američkih dolara, što čini 3 % svjetskog BDP-a” (Borić Cvenić, 2021, str. 41). Osim toga, Shaw (1992) se oslanja na studije koje sugeriraju da svako radno mjesto u kulturnim organizacijama stvara dodatna radna mjesta u širem regionalnom okruženju, što se naziva “ekonomski multiplikatori”. Na osnovu ovih procjena, autor dolazi do zaključka da KKI ne samo da direktno zapošljavaju ljude, već također doprinose stvaranju dodatnih poslova kroz potrošnju i turističke aktivnosti te na taj način veća zaposlenost u KKI može pozitivno doprinjeti povećanju BDP-a i, samim time, ekonomskom rastu (Tica & Viljevac, 2023). De Santana Ribeiro (2020), kako je navedeno u Astike (2022, str. 233) navodi

da je „kulturni sektor u posljednjih nekoliko desetljeća rastao brže od ostalih sektora u Europi, što pridonosi otvaranju novih radnih mjesta i poboljšava pokazatelje zaposlenosti.“ Osim toga, Astike (2022) utvrđuje da broj zaposlenih u kulturi i ulaganja u kulturu doprinose povećanju konkurentnosti zemalja EU pa je stoga ključno ulagati u kulturni sektor i razvijati ga jer se time povećava atraktivnost zemalja na globalnim tržištima i potiču nova ulaganja u zemlje. Haršanji, Bestvina Bukvić, & Šain (2020) također ističu da su ulaganja u kulturi nužna za održavanje i razvoj sektora, te da rast i podrška kroz financijska sredstva predstavljaju ključne elemente u jačanju kulturnog sektora i njegova gospodarskog utjecaja. S tim se slažu i Kalfas, Kalogiannidis, Ambas, & Chatzitheodoridis (2024) čije istraživanje pokazuje da ulaganje u KKI donosi veće ekonomske prinose i stope inovacija u usporedbi s drugim sektorima čime se naglašava potencijal KKI u poticanju inovacija i gospodarskog rasta.

Prema podacima Hauben, Born-Sirkel, Lhernould, Dupate, & De Carvalho (2024), EU-27 je 2022. godine u kulturnom sektoru bilo zaposleno približno 7,7 milijuna ljudi, što čini 3,8 % ukupne zaposlenosti. Zabilježene su značajne teritorijalne razlike, pri čemu je udio kulturne zaposlenosti viši u zapadnim i sjevernim državama članicama u usporedbi s istočnim i južnim. Najniži udio zabilježen je u Rumunjskoj (1,5 %), dok su najviši udjeli u Nizozemskoj (5,4 %), Švedskoj (4,9 %), Luksemburgu (4,8 %), Finskoj i Sloveniji (4,6 %), Danskoj i Estoniji (4,5 %). Šest većih država članica – Njemačka, Francuska, Italija, Španjolska, Poljska i Nizozemska – čine zajedno oko 71 % ukupne kulturne zaposlenosti u EU, što predstavlja oko 5,5 milijuna kulturnih djelatnika. Kako navodi (Đorić, 2020), između 2014. i 2019. godine broj zaposlenih u KKI porastao je sa 6,8 na 7,4 milijuna, što predstavlja porast veći od 8 %. Iako je apsolutni broj kulturnih djelatnika rastao, udio kulturne zaposlenosti u ukupnoj zaposlenosti u istom je razdoblju porastao neznatno – s 3,6 % (2014.) na 3,7 % (2019.), što ukazuje na relativno sporiji rast kulturne zaposlenosti u odnosu na ukupnu dinamiku tržišta rada. Pandemija COVID-19 imala je snažan negativan utjecaj na KKI u EU, koje su prema studiji EY (2021) bile među najpogođenijima, čak i više od sektora turizma. Tijekom 2020. godine kulturna zaposlenost u EU-27 pala je na 7,2 milijuna radnika, uz udio od 3,6 % u ukupnoj zaposlenosti. Zabilježen je pad zaposlenosti u kulturi od 2,6 %, dok je ukupna zaposlenost u EU pala za 1,3 %, što se izravno povezuje s posljedicama pandemije (UNESCO, 2021; Khlystova, Kalyuzhnova, & Belitski, 2022). Posebno su pogođeni sektori koji ovise o fizičkoj prisutnosti publike (npr. izvedbene umjetnosti, kina, festivali), kao i pripadajući opskrbi lanci, što je rezultiralo smanjenjem prihoda, otkazima i pogoršanjem radnih uvjeta (Suciū, Stativā, & Mítučā, 2021; UNESCO, 2021). Samozaposleni i freelanceri, koji čine znatan udio u kulturnom sektoru, posebno su osjetili posljedice, s izraženim padom prihoda i porastom nezaposlenosti (Primorac, 2021; UNESCO, 2021). U 2022. godini zabilježen je oporavak, s prosječnom godišnjom stopom rasta kulturne zaposlenosti od 4,5 % na razini EU, pri čemu su najveća povećanja evidentirana u Njemačkoj, Francuskoj i Nizozemskoj. Države članice, poput Cipra, Luksemburga i Irske, također su zabilježile značajan rast, dok su u nizu zemalja Srednje i Istočne Europe – uključujući Bugarsku, Hrvatsku, Češku i Estoniju – registrirani padovi u kulturnom zapošljavanju (Hauben, Born-Sirkel, Lhernould, Dupate, & De Carvalho, 2024; EY, 2021).

Zaposlenost u KKI obilježena je visokom razinom nesigurnosti i specifičnim radnim uvjetima koji proizlaze iz prirode samog sektora, usmjerenog na simboličku

proizvodnju i nepredvidive tržišne mehanizme (Dudu, 2020; Primorac, 2010). Visoka rizičnost poslovanja u ovom području usko je povezana s pojavom prekarnog rada, koji uključuje nestabilne poslovne pozicije, nepredvidive prihode, nesigurne uvjete rada, ali i individualizaciju karijera kroz tzv. portfolio pristup (Manske, 2023; Banks, 2019; Morgan, Wood, & Nelligan, 2013; Primorac, 2012). Rad u KKI najčešće zahtijeva visokoobrazovane stručnjake, ali i veliku radnu intenzivnost, fleksibilnost i sposobnost stalnog prilagođavanja promjenama u tehnologiji i tržištu (UNDP/UNCTAD, 2008 navedeno u Primorac (2012)). U tom kontekstu, inovacijski kapital i digitalne vještine postaju ključni elementi održivosti i rasta u KKI (Brodny & Tutak, 2024; Nuccio & Mogno, 2023). Lazzaretti (2020) kako je navedeno u Nuccio & Mogno, (2023, str. 16) naglašava važnost sinergije između kreativnih i digitalnih kompetencija, koja se sve češće prepoznaju kao temelj za stvaranje vrijednosti i pokretač inovacija unutar sektora. Digitalna transformacija izravno utječe na sve faze kulturne proizvodnje – od stvaranja sadržaja, distribucije do potrošnje, a ljudska kreativnost i inovativnost u tom su smislu ključni resursi za konkurentnost KKI (Mihaljević & Stanković, 2016). Tome je zasigurno pridonijela i pandemija COVID-19 kad se u području kulture uočava velika potražnja za virtualnim pristupom muzejima, kazalištima i drugim kulturnim aktivnostima (Resta, Dicuonzo, Karacan, & Pastore, 2021) koje u suvremenom okruženju postaje izuzetno prihvaćeno, čak i poželjno (Mavrin, Turšić, & Lupša Matichescu, 2024). Ono se može povezati i s Astike (2022) koja smatra da što je društvo modernije, otvorenije za inovacije i slobodnije, to je privlačnije radnicima koji rade na ugovore od djelu, a najčešće su ti djelatnici razni stvaratelji, umjetnici, izvođači i novinari koji pripadaju sektoru kulturnih djelatnika. Upravo porast udjela fleksibilnih oblika rada, koje je i karakteristično za rad u KKI, prema istraživanju Blažević Dević (2024), ima značajan utjecaj na smanjenje stope nezaposlenosti u zemljama EU.

Prema izvješću CISAC & EY (2015) djelatnike u kulturi karakteriziraju četiri obilježja: mladost (kreativne aktivnosti značajno pridonose zaposlenosti mlađe populacije), visoka produktivnost (KKI u pojedinim sektorima doprinose BDP-u više od prosjeka gospodarstva), neovisnost i poduzetništvo (Internet, digitalne tehnologije i masovna putovanja znatno olakšavaju pokretanje kulturnog ili kreativnog posla te stjecanje globalne publike i ugleda) te viša razina obrazovanja. Prema posljednjim podacima iz 2023. godine (Eurostat, 2025a), sociodemografski profil zaposlenosti u kulturi na području EU karakterizirala je općenito viša razina obrazovanja, pri čemu je 61,8 % kulturnih radnika imalo visoko obrazovanje, 30,9 % imalo je srednjoškolsko obrazovanje, a 7,2 % ih je imalo najnižu razinu obrazovanja. U ukupnoj zaposlenosti EU te su brojke činile 37,8 %, 45,7 % odnosno 16,4 % što znači da u KKI dominantno radi visokoobrazovana radna snaga u odnosu na opće gospodarstvo EU.

Kulturna zaposlenost u zemljama srednje i istočne Europe

Premda je u srednjoj, istočnoj i jugoistočnoj Europi kreativna ekonomija još uvijek relativno nova pojava (Jocić, 2019), zemalje koje su prošle kroz postsocijalističku tranziciju i postale članice EU omogućuju širenje znanja o kreativnoj ekonomiji te potencijalu KKI. Prema Brodny & Tutak (2024), zemlje EU-11 dijele brojne zajedničke značajke, uključujući slične kulturne i povijesne korijene, nižu razinu BDP-a po stanovniku te sličnu strukturu proizvodnje i makroekonomskih pokazatelja poput inflacije. Zbog tih sličnosti, prema istim autorima, navedene zemlje predstavljaju kori-

snu referentnu skupinu za proučavanje gospodarskih i društvenih razlika, kao i za analizu učinaka ekonomskih i institucionalnih promjena. Osim toga, zajednički izazovi i razvojni ciljevi ovih zemalja čine ih važnim dionicima u provedbi europskih strateških prioriteta, osobito u području inovacija, održivog razvoja i jačanja konkurentnosti.

Suciu i suradnici (2018) istražuju kulturnu zaposlenost u zemljama Srednje i Istočne Europe u razdoblju 2011.-2016. godine, pri čemu utvrđuju da je udio zaposlenih u kulturi u ukupnoj zaposlenosti u zemljama EU-11 najviši u Estoniji (5,3 %) i Sloveniji (4,6 %), a najmanji u Rumunjskoj (1,6 %). Iako navode da su Srednja i Istočna Europa regije bogate i raznovrsne kulturne baštine, talentiranih ljudi i velikog potencijala rasta, navedeni autori utvrđuju da je jedan od prvih izazova za zemlje Srednje i Istočne Europe, a posebno za Rumunjsku, fenomen odljeva talentiranih, visokoobrazovanih ljudi. Daljnje istraživanje EY (2021) pokazuje da su 2019. godine zemlje Srednje i Istočne Europe imale najveći rast KKI na prostoru EU. U Češkoj i Rumunjskoj tri specifična sektora (oglašavanje, arhitektura i videoigre), doživjela su dinamičan rast. Također, jedan od najvećih porasta na razini EU zabilježen je u Estoniji – porast udjela kulturne zaposlenosti u razdoblju od 2014. do 2019. godine povećao se sa 4,6 % na 5,1 %. Razlog tomu možda jest i politika Ministarstva kulture koja se, prema podacima Compedium (2022), već sedam godina zalaže za povećanje plaća zaposlenika u kulturnim ustanovama Estonije jer žele motivirane mlade ljude koje će u kulturu, između staloga, privući i materijalna kompenzacija. Osim toga, sudjelovanje u kulturi u Estoniji s godinama se povećalo te se u razdoblju 2014. – 2019. godine povećao broj kazališta i kina, ali i posjećenost koncerata, likovnih izložbi, muzeja i knjižnica. Prema istom izvoru, brojke posjećenosti kina, kazališta i muzeja u 2019. godini bile su najuspješnije ikada. Za razliku od Estonije, prema Suci, Năsuela, & Năsuela (2018), tržište u Rumunjskoj manje je razvijeno te je prisutno manje sudjelovanja u kulturnim aktivnostima, što se povezuje s nižim standardom života i dostupnošću ekonomski pristupačnih kulturnih sadržaja. Također, ulaganje u kulturne usluge nedovoljno je jer Rumunjska troši samo 0,4 % ili manje od svojih javnih sredstava na kulturne usluge, što je znatno ispod prosjeka drugih zemalja u regiji koje često potroše više od 1 %. Navedeni autori (Suci, Năsuela, & Năsuela, 2018) zaključuju da je razvoj KKI uvjetovan gospodarskim razvojem, kulturnom zaposlenošću te sudjelovanjem u kulturi.

S obzirom da KKI karakteriziraju visokoobrazovana radna snaga, kreativnost i inovacije (Eurostat, 2025a; Mihaljević & Stanković, 2016; CISAC & EY, 2015) navedeno se, između ostaloga, može povezati sa istraživanjem koje su proveli Brodny & Tutak (2024) koje pokazuje da je razina inovacijskog potencijala zemalja Srednje i Istočne Europe visoko diferencirana. Utvrđeno je da su Slovenija, Češka i Estonija zemlje koje puno ulažu u istraživanje i razvoj te imaju visoku razinu inovativnosti, dok su zemlje slabog inovacijskog potencijala bile Rumunjska i Bugarska. Međutim, iznimka je Hrvatska, koja je u analiziranom razdoblju (2013. - 2022. godine) ostvarila najznačajniji napredak u inovacijama, pomaknuvši se s 9. na 5. mjesto po razini inovativnosti. Drvenkar, Marošević, & Unukić (2023) dodaju da zemlje koje zaostaju u EU-11 trebaju temeljitu transformaciju svojih ekonomskih struktura kroz ulaganja u inovacije, kako bi smanjile regionalne razlike i povećale privlačnost za nove industrije i radna mjesta. Pritom europski fondovi imaju važnu ulogu te ih zemlje EU-11, prema istraživanju ovih autora, uspješno koriste za poticanje poduzetništva i digitalne infrastrukture čime se dodatno jača temelj za razvoj kulturnog sektora. Također, naglašava

se potreba uključivanja visokokvalificirane radne snage koja omogućava prilagodbu tehnologijama i tržištima, što je posebno važno za budući rast i razvoj zemalja EU-11. U istraživanju koje su proveli Nchor & Rozmahel (2020) u zemljama EU-11 (Bugarska, Češka, Mađarska, Poljska, Rumunjska i Slovačka), događa se redistribucija zaposlenosti pod utjecajem tehnologije i obrazovnih promjena, s naglaskom na porast visoko kvalificiranih zanimanja. Prema rezultatima istraživanja, Češka i Poljska su među onima koje pokazuju povećavanje udjela visokoobrazovanih radnika i najbržu prilagodbu na promjene uzrokovane novim tehnologijama. Naime, tehnološki napredak ima značajnu ulogu u rastu potražnje za visokoobrazovanom radnom snagom, budući da se očekuje da će nove tehnologije zahtijevati kompleksnije vještine i stručnost koju visokoobrazovani radnici nude. Rezultati istraživanja indeksa kulturne ekonomije u zemljama EU-11 (Astike & Skvarciany, 2024) pokazuju da su na prvih pet mjesta Rumunjska, Bugarska, Slovačka, Latvija i Litva što ukazuje na brzo razvijanje ovih zemalja nakon pridruživanja EU. Indeksi kulturne ekonomije koji se koriste u okviru ovog istraživanja uključuju različite faktore, kao što su sudjelovanje u kulturnim aktivnostima, broj kulturnih institucija i infrastrukturu, potrošnja kućanstva na kulturu, doprinos kulture BDP-u i broj zaposlenih u kulturi.

Važno je naglasiti da razlike u uvjetima rada unutar kulturnog sektora među državama članicama ne proizlaze isključivo iz specifičnosti samog sektora, već odražavaju širi kontekst nacionalnih tržišta rada. Primjerice, učestalost oblika zaposlenja, poput rada na nepuno radno vrijeme, u značajnoj je mjeri određena općim gospodarskim i društvenim okolnostima pojedine zemlje (Eurostat, 2025a). Naime, osim navedenih sličnosti (Brodny & Tutak, 2024), EU-11 zemlje karakteriziraju i različite institucionalne povijesti uključujući promjene u političkoj ekonomiji i društvenim institucijama zbog čega je njihov prijelaz na demokraciju neujednačen (Prouska, Argyro, & Phychogios, 2022). Drvenkar, Marošević, & Unukić (2023) i Astike (2022) navode da svaka država ima drugačiji stupanj razvoja ovisno o povijesnom razvoju zemlje, pravnom sustavu, zemljopisnim značajkama, prirodnim uvjetima, raspoloživim vještinama radne snage, tehnološkim profilima i kulturnim karakteristikama. Upravo razlike u početnim razinama razvijenosti zemalja u tranziciji, prema Tica & Viljevac (2023), objašnjava dio razlika u rastu između njih, a što je za posljedicu imalo i utjecaj na dinamiku njihova pristupanja EU (Hrvatska – 1.7.2013., Bugarska i Rumunjska – 1.1.2007., ostale zemlje EU-11 pristupile su 1.5.2004.)

METODOLOGIJA

Ovo istraživanje temelji se na metodološkom okviru Eurostata predloženog od Mreže europskog statističkog sustava za kulturu (ESSnet-Culture) koje je razvilo standardizirani statistički pristup za mjerenje zaposlenosti u KKI unutar EU. Eurostat u kulturnu zaposlenost uključuje sve koji rade u gospodarskim djelatnostima koje se smatraju kulturnim, bez obzira na to je li osoba zaposlena u određenom kulturnom zanimanju ili ne. Obuhvaća i osobe s kulturnim zanimanjem, bez obzira na to jesu li zaposleni u kulturno-gospodarskoj djelatnosti ili ne (Bina, i dr., 2012). Isto tako, Eurostat klasificira i izvješćuje o kreativnim i kulturnim aktivnostima koristeći naziv „kultura“, a ne „kreativan“.

Korišten je pristup temeljen na kombinaciji gospodarskih djelatnosti i zanimanja, pri čemu je klasifikacija gospodarskih djelatnosti provedena prema NACE Rev. 2

standardima, dok su kulturna zanimanja definirana prema međunarodnoj standardnoj klasifikaciji zanimanja ISCO-08 (Slika 1.). Ovakav pristup obuhvaća tri situacije: (1) kulturna zanimanja unutar kulturnog sektora, (2) kulturna zanimanja izvan kulturnog sektora te (3) ne-kulturna zanimanja unutar kulturnog sektora, čime se nastoji osigurati sveobuhvatna procjena ukupne kulturne zaposlenosti (Dent, i dr., 2020). Uzimajući u obzir metodološke izazove, iz procjena su, u okviru Eurostata, isključena zanimanja i djelatnosti s djelomično kulturnom komponentom za koje nije moguće precizno odrediti kulturni udio (npr. voditelji kulturno-sportskih centara). Također, sekundarni poslovi u području kulture nisu uključeni zbog ograničenja u podacima Ankete o radnoj snazi (EU-LFS), što potencijalno dovodi do podcjenjivanja stvarnog opsega kulturne zaposlenosti (Bina, i dr., 2012). Međutim, kao i u drugim zemljama, i u zemljama EU-11 prisutan je različit obuhvat sektora KKI, što otežava i ograničava mjerenje, praćenje razvoja i međunarodnu usporedbu (Hauben, Born-Sirkel, Lhernould, Dupate, & De Carvalho, 2024). Uz to, Todose, Titan, & Ghița (2008) navode da je svaka nacionalna država razvila vlastiti sustav za prikupljanje podataka. Većina zemalja ima nedostatan sustav za praćenje kulturnog sektora, ne prikuplja sveobuhvatne podatke, a s obzirom na različite statističke sustave, to rezultira nedostatakom usklađenosti i usporedivosti podataka u ovom području. Eurostat također priznaje da je opseg mjerenja zaposlenosti u kulturi različito određen u nacionalnim okvirima (Eurostat, 2019).

Slika 1. NACE Rev 2. i ISCO-08 standardi za kulturnu zaposlenost

Cultural sectors (economic activities) — NACE Rev. 2	Cultural occupations — ISCO-08
18 Printing and reproduction of recorded media	216 Architects, planners, surveyors and designers
32.2 Manufacture of musical instruments	2353 Other language teachers
58.1 Publishing of books, periodicals and other publishing activities	2354 Other music teachers
59 Motion picture, video and television programme production, sound recording and music publishing activities	2355 Other arts teachers
60 Programming and broadcasting activities	262 Librarians, archivists and curators
74.1 Specialised design activities	264 Authors, journalists and linguists
74.2 Photographic activities	265 Creative and performing artists
74.3 Translation and interpretation activities	3431 Photographers
90 Creative, arts and entertainment activities	3432 Interior designers and decorators
91 Libraries, archives, museums and other cultural activities	3433 Gallery, museum and library technicians
	3435 Other artistic and cultural associate professionals
	3521 Broadcasting and audio-visual technicians
	4411 Library clerks
	7312 Musical instrument makers and tuners
	7313 Jewellery and precious-metal workers
	7314 Potters and related workers
	7315 Glass makers, cutters, grinders and finishers
	7316 Sign writers, decorative painters, engravers and etchers
	7317 Handicraft workers in wood, basketry and related materials
	7318 Handicraft workers in textile, leather and related materials
	7319 Handicraft workers not elsewhere classified

U ovom istraživanju analizirani su podaci iz Eurostata za kulturnu zaposlenost i BDP po stanovniku u zemljama Srednje i Istočne Europe koje pripadaju EU prema definiciji OECD (1995), tzv. EU-11 (Bugarska, Češka, Estonija, Hrvatska, Latvija, Litva, Mađarska, Poljska, Rumunjska, Slovačka i Slovenija) u razdoblju od 2013. do 2022. godine. Istraživanjem se utvrđuju trendovi i razlike u kulturnoj zaposlenosti između EU-11 zemalja kao i u odnosu na ukupnu zaposlenost u EU-27 u promatranom razdoblju. Također, ispituje se povezanost kulturne zaposlenosti i BDP-a kako bi se identificirao ekonomski doprinos zemalja EU-11. Rezultati istraživanja analizirani su primjenom deskriptivne statistike, a odnosi među varijablama prikazani su provedenom korelacijskom analizom. Navedeni podatci omogućuju usporedivost između država članica EU te pružaju osnovu za uvid u ekonomski doprinos KKI. Statistička obrada podataka provedena je u statističkom programu JASP.

REZULTATI

U Tablici 1. prikazuju se podatci o BDP- u po stanovniku u zemljama EU-11 u razdoblju 2013.-2022. godine te se uspoređuje u odnosu na prosjek u EU-11 i EU-27.

Tablica 1. BDP po stanovniku u zemljama EU-11 u razdoblju 2013.-2022. godine u odnosu na prosjek EU-11 i EU-27 (€)

	2013.	2014.	2015.	2016.	2017.	2018.	2019.	2020.	2021.	2022.
EU 27	25.060	25.430	25.960	26.410	27.110	27.620	28.060	26.450	28.050	28.950
EU-11	11.092	11.415	11.841	12.199	12.796	13.359	13.824	13.316	14.298	14.789
Bugarska	5.390	5.470	5.700	5.910	6.120	6.330	6.630	6.400	6.950	7.680
Češka	15.160	15.480	16.290	16.670	17.490	17.990	18.460	17.400	18.020	18.460
Estonija	12.540	12.960	13.230	13.620	14.410	14.920	15.450	15.260	16.350	16.250
Hrvatska	10.480	10.480	10.810	11.290	11.800	12.250	12.740	11.700	13.610	14.660
Latvija	9.980	10.270	10.760	11.110	11.590	12.140	12.300	11.940	12.870	13.280
Litva	10.810	11.290	11.620	12.070	12.760	13.400	14.060	14.060	14.870	15.100
Mađarska	10.330	10.790	11.220	11.500	12.020	12.690	13.310	12.730	13.690	14.350
Poljska	10.030	10.420	10.890	11.220	11.800	12.500	13.070	12.810	13.770	14.620
Rumunjska	6.860	7.160	7.420	7.680	8.360	8.910	9.300	9.000	9.600	10.080
Slovenija	17.160	17.620	11.990	18.550	19.440	20.240	20.780	19.770	21.350	21.860
Slovačka	13.300	13.640	14.340	14.590	15.000	15.580	15.960	15.400	16.200	16.340

Izvor: izrada autora (prema podacima: (Eurostat, 2025b)

Podaci iz tablice utvrđuju da Slovenija i Češka imaju najviši BDP po stanovniku tijekom promatranog razdoblja, dok Bugarska i Rumunjska imaju najniži BDP po stanovniku koji je niži i u odnosu na prosjek EU-11. Tijekom cijelog analiziranog razdoblja uočava se da, u prosjeku, polovina BDP-a po stanovniku u EU-27 čine zemlje EU-11. Također, primjetan je kontinuirani rast prosječnog BDP-a po stanovniku tijekom godina za obje skupine zemalja.

Sljedeća tablica prikazuje podatke o broju zaposlenih u kulturi po zemljama EU-11, ukupno u EU-11 te na razini EU-27 u razdoblju od 2013. do 2022. godine.

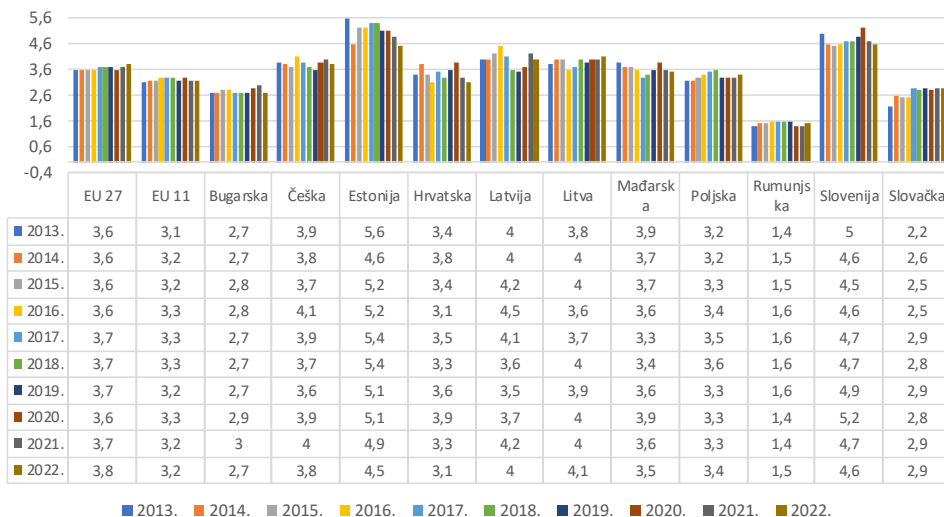
Tablica 2. Broj osoba zaposlenih u kulturi 2013.-2022. godine. (u tisućama)

	2013.	2014.	2015.	2016.	2017.	2018.	2019.	2020.	2021.	2022.
EU 27	6.758,7	6.807,7	6.829,9	6.958,8	7.175,9	7.267,6	7.358,5	7.135,8	7.401,3	7.732,6
EU 11	1.299,0	1.340,4	1.362,5	1.405,1	1.443,3	1.455,2	1.431,0	1.435,0	1.419,1	1.433,0
Bugarska	78,7	79,0	84,5	84,7	85,8	84,8	88,5	92,1	91,3	84,3
Češka	191,4	191,2	187,0	210,0	204,1	197,5	192,7	203,0	209,7	194,3
Estonija	34,7	28,8	32,8	33,4	34,9	35,7	33,5	33,3	32,2	30,5
Hrvatska	52,3	59,2	53,7	48,7	57,5	54,2	60,4	64,2	55,9	52,4
Latvija	35,5	35,6	37,2	40,6	36,6	32,7	32,0	33,4	36,3	35,4
Litva	49,1	53,2	53,3	48,9	49,8	55,4	53,7	53,9	54,2	57,6
Mađarska	151,2	150,0	155,5	157,0	147,1	150,0	164,0	174,7	166,4	163,5
Poljska	492,6	508,2	529,9	543,7	568,4	585,8	548,1	538,1	541,6	576,9
Rumunjska	116,3	130,5	126,1	133,7	141,1	141,1	135,7	120,4	111,2	117,3
Slovenija	44,9	42,6	41,5	42,3	45,4	46,4	44,6	50,5	45,5	44,9
Slovačka	52,3	62,1	61,0	62,1	72,6	71,6	73,8	71,4	74,8	75,9

Izvor: izrada autora (prema podatcima: (Eurostat, 2025c)

U cijelom razdoblju analize, zemlje s najvećim brojem zaposlenih u kulturi su Poljska, Češka i Mađarska, dok su zemlje s najmanjim brojem zaposlenih Estonija, Latvija i Slovenija. Najveći pomak u desetogodišnjem razdoblju u broju zaposlenih ostvarile su Slovačka (s 52,3 na 75,9 tisuća, što je povećanje od 45,12 %) i Poljska (sa 492,6 na 576,9 tisuća, što je povećanje od 17,11 %), dok Estonija jedina bilježi pad zaposlenosti (sa 34,7 na 30,5 tisuća, što je smanjenje od 12,10 %). Zbirno, zemlje EU-11 bilježe trend porasta kulturne zaposlenosti, a pad je jedino u predpandemijskoj (2019.) i prvoj postpandemijskoj godini (2021.). EU-27 bilježi također kontinuiran porast kulturne zaposlenosti, osim u pandemijskoj godini kada slijedi privremeni pad i brzi oporavak u daljnim godinama. Ukupan broj osoba zaposlenih u kulturi u zemljama EU-11 u odnosu na ukupan broj zaposlenih u kulturi u svim zemljama EU-27 čini oko 20 % zaposlenih tijekom promatranog razdoblja što znači da ostalih 16 zemalja EU čini oko 80 % ukupne kulturne zaposlenosti u EU.

Udio kulturne zaposlenosti razlikuje se u zemljama EU-11, pri čemu se prvotno isticala Estonija, koja je u prvoj promatranoj godini imala najviši udio (5,6 %), dok se u zadnjoj 2022. godini taj udio smanjio (4,5 %) te je Slovenija postala zemlja s najvišim udjelom kulturne zaposlenosti (4,6 %). Najniži udio kulturne zaposlenosti tijekom analiziranog razdoblja kontinuirano su imale Rumunjska, a nakon nje Bugarska i Slovačka. To su ujedno i jedine zemlje EU-11 koje imaju niži udio kulturne zaposlenosti od prosječnog udjela kulturne zaposlenosti EU-11 i EU-27. Ostale zemlje imaju ili približno jednak ili viši udio od prosjeka EU-27. Većina zemalja EU-11 bilježe pad udjela kulturne zaposlenosti u promatranom razdoblju, dok Litva, Poljska, Rumunjska i Slovačka bilježe neznatan rast. Promatra li se udio kulturne zaposlenosti u ukupnoj zaposlenosti, vidljivo je da je zaposlenost u kulturi 2022. godine činila 3,8 % ukupne zaposlenosti EU-27, što je ujedno i najveći udio kulturne zaposlenosti u ukupnoj zaposlenosti kroz promatrano desetogodišnje razdoblje. Udio kulturne zaposlenosti u ukupnoj zaposlenosti EU-11 nešto je manji od prosjeka EU-27 te je 2022. godine iznosio 3,2 % ukupne zaposlenosti.



Grafikon 1. Udio kulturne zaposlenosti zemalja EU-11 u ukupnoj zaposlenosti EU-11 i EU-27 tijekom 2013.-2022. godine (%)

Izvor: izrada autora (prema podacima: (Eurostat, 2025c)

Tablica 3. Deskriptivna statistika udjela kulturne zaposlenosti zemalja EU-11 u razdoblju 2013.-2022. godine (%)

	Min	Max	M	SD
EU-27	3.6	3.8	3.6	0.0
EU-11	3.1	3.3	3.2	0.0
Češka	3.6	4.1	3.8	0.1
Estonija	4.5	5.6	5.1	0.3
Hrvatska	3.1	3.9	3.4	0.2
Latvija	3.5	4.5	3.9	0.3
Litva	3.6	4.1	3.9	0.1
Mađarska	3.3	3.9	3.6	0.1
Poljska	3.2	3.6	3.3	0.1
Rumunjska	1.4	1.6	1.5	0.0
Slovenija	4.5	5.2	4.7	0.2
Slovačka	2.2	2.9	2.7	0.2

Izvor: izrada autora (prema podacima: (Eurostat, 2025c)

Iz tablice je vidljivo da u prosjeku Estonija i Slovenija imaju visoki udio kulturne zaposlenosti (5,1 % i 4,7 %), što je ujedno i veće od prosjeka EU-27 (3,6 %), dok Rumunjska, Slovačka i Bugarska u prosjeku imaju nizak udio kulturne zaposlenosti (1,5 %, 2,7 % i 2,7 %) te je ona ujedno niža i od prosjeka EU-11 zemalja (3,2 %).

U idućoj tablici prikazana je povezanost kulturne zaposlenosti i BDP-a po stanovniku u zemljama EU-11.

Tablica 4. Pearson's korelacija

	BDP po stanovniku	p
kulturna zaposlenost	0.598	< .001

*p < .05, **p < .01

Izvor: izrada autora (JASP)

U Tablici 4. Pearsonov koeficijent ($r=0.598$, $p<0,001$) pokazuje statistički značajnu pozitivnu, srednje jaku povezanost kulturne zaposlenosti i BDP-a po stanovniku.

RASPRAVA

Analiza kulturne zaposlenosti u EU-11 u razdoblju od 2013. do 2022. godine otkriva izražene teritorijalne razlike i specifične trendove. Dok ukupna kulturna zaposlenost na razini EU-27 pokazuje stabilan rast do pandemijske 2020. godine, nakon čega slijedi privremeni pad i brzi oporavak, dinamika u EU-11 zemljama je neujednačenija. Iako EU-11 bilježi ukupni porast kulturne zaposlenosti u promatranom razdoblju, pandemija je imala izraženiji negativan učinak upravo na ovu skupinu zemalja, što potvrđuju i prethodna istraživanja (Khlystova, Kalyuzhnova, & Belitski, 2022; Primorac, 2021; Suci, Stativá, & Mitučá, 2021; EY, 2021; UNESCO, 2021).

U cijelom razdoblju analize, zemlje s najvećim brojem zaposlenih u kulturi su Poljska, Češka i Mađarska, dok su zemlje s najmanjim brojem zaposlenih Estonija, Latvija i Slovenija. Zemlje poput Slovačke, Litve i Poljske istaknule su se značajnim rastom kulturne zaposlenosti, dok su Estonija i Latvija zabilježile pad, pri čemu je Estonija imala najsnažniji negativni trend. Unatoč tome, Estonija i Slovenija ostaju među vodećim zemljama po udjelu kulturne zaposlenosti u ukupnoj zaposlenosti, značajno iznad prosjeka EU-27 i EU-11. Suprotno tome, Rumunjska i dalje bilježi najniže vrijednosti kulturne zaposlenosti što je u skladu s istraživanjem Suci, Násuela, & Násuela (2018). Razlozi neravnomjerne distribucije razvoja KKI u EU-11 mogu se, između ostalog, prepisati sljedećem: osim heterogenosti zemalja u uzorku, kao što su početni uvjeti (pred-tranzicijska povijest), kvaliteta upravljanja, privatizacijske metode, kao i različiti indikatori institucionalne razvijenosti (Drvenkar, Marošević, & Unukić, 2023; Prouska, Argyro, & Phychogios, 2022; Eurostat, 2025a; Tica & Viljevac, 2023) na distribuciju može utjecati i brzina i način na koji tehnologija utječe na tržište rada u zemljama EU-11. U tom smislu, istraživanje Nchor & Rozmahel (2020) utvrđuje da Češka i Poljska bilježe najveći porast udjela visokoobrazovane radne snage i najbržu prilagodbu promjenama izazvanim novim tehnologijama, a ujedno je riječ i o zemljama koje u ovom istraživanju bilježe najveći broj osoba zaposlenih u kulturi. Visokoobrazovana radna snaga je jedna od značajnih karakteristika tržišta rada u kulturi (Eurostat, 2025a), a upravo takva radna snaga prema Nchor & Rozmahel (2020) doprinosi inovacijama u poslovnim procesima. Navedeno se, između ostalog, može povezati s istraživanjem koje su proveli Brodny & Tutak (2024) u kojem su zemlje s najvećim inovacijskim potencijalom bile Slovenija, Češka i Estonija, a zemlje slabog potencijala bile su Rumunjska i Bugarska. Upravo navedene zemlje bilježe najviše (Estonija, Slovenija, Češka) odnosno najniže (Bugarska i Rumunjska) rezultate u području kulturne zaposlenosti, ali i ekonomske razvijenosti prema pokazatelju BDP po stanovniku. Bugarska i Rumunjska su ujedno i zemlje koje su (uz Hrvatsku kao zadnju članicu EU) ušle kasnije u tu zajednicu u odnosu na druge zemalje EU-11 te još uvijek

bilježe razvojne razlike, ali sudeći po istraživanju Astike & Skvarciany (2024) riječ je o zemljama koja pokazuju brzo razvijanje nakon pridruživanja EU, iako podatci u ovom segmentu, trenutno to ne pokazuju.

Provedena statistička analiza potvrđuje srednje jaku pozitivnu povezanost kulturne zaposlenosti i BDP-a po stanovniku u zemljama EU-11, odnosno veća kulturna zaposlenost doprinosi BDP-u, što je u skladu s istraživanjima drugih autora (Tica & Viljevac, 2023; Astike, 2022; Shaw, 1992). To, između ostaloga, ukazuje i na važnost ulaganja u KKI, budući da brojna istraživanja

(Kalfas, Kalogiannidis, Ambas, & Chatzitheodoridis, 2024; Astike, 2022; Compedium, 2022; Haršanji, Bestvina-Bukvić, & Šain, 2020) ističu kako takva ulaganja ne samo da jačaju konkurentnost i privlačnost zemalja na globalnim tržištima, već donose i veće ekonomske povrate te potiču inovacije, čime kulturni sektor postaje važan čimbenik gospodarskog rasta. U tom slučaju, primjer Estonije može poslužiti kao referentni okvir za razvoj i implementaciju kulturnih politika u ostalim zemljama članicama EU-11.

Dobiveni rezultati potvrđuju postojanje izraženih razlika među zemljama EU-11 te ukazuju na potrebu za donošenjem i prilagodbom javnih, posebice kulturnih politika, u skladu s razvojnim potencijalima i specifičnostima svake pojedine države. U kontekstu različite raspoloživosti i strukture vještina radne snage unutar EU-11 (Drvenkar, Marošević, & Unukić, 2023), ovaj čimbenik, između ostalog, može imati značajan utjecaj na dinamiku i funkcionalnost tržišta kulturne zaposlenosti.

ZAKLJUČAK

KKI sve se više prepoznaju kao ključni segment u razvoju gospodarstva, što se očituje i u broju zaposlenih u toj industriji. Ovaj rad analizira kulturnu zaposlenost u državama članicama EU-11 u razdoblju od 2013. do 2022. godine, pri čemu dobiveni rezultati ukazuju na neravnomjernu distribuciju unutar promatrane skupine zemalja. Zemlje poput Estonije i Slovenije zadržavaju visok udio kulturne zaposlenosti, dok Rumunjska i Bugarska kontinuirano bilježe najniže vrijednosti. Ujedno riječ je o zemljama koje bilježe najviše odnosno najniže vrijednosti inovacijskog potencijala, ali i ekonomske razvijenosti prema pokazatelju BDP-a po stanovniku. Visokoobrazovana radna snaga pokazuje se kao ključni resurs u prilagodbi sektora KKI tehnološkim promjenama i tržišnim izazovima, što je naročito vidljivo u zemljama poput Češke i Poljske koje ujedno bilježe i veliki broj osoba zaposlenih u kulturi u odnosu na druge zemlje EU-11. Statistička analiza potvrdila je postojanje pozitivne povezanosti kulturne zaposlenosti i BDP-a po stanovniku, što sugerira da kulturni sektor može imati važnu ulogu u ukupnom gospodarskom rastu. Sukladno navedenom, utvrđuje se važnost ulaganja u KKI budući da se pokazuju ključnima za jačanje gospodarske konkurentnosti, poticanje inovacija i ostvarivanje dugoročnih ekonomskih koristi. U tom smislu, Estonija može poslužiti kao primjer dobre prakse za zemlje EU-11 u oblikovanju učinkovitih javnih (kulturnih) politika. Pristup analizi kulturne zaposlenosti koji se temelji na uzorku zemalja EU-11 ima određenih ograničenja. Iako je riječ o uzorku koji ima brojne zajedničke značajke, svaka zemlja ima svoje specifične društveno-ekonomske okolnosti koji utječu na njihov daljnji razvoj, pa tako i na kulturnu zaposlenost. Isto tako, iako su uloženi znatni naponi Eurostata kao statističkoj bazi o kulturnoj zaposlenosti u EU, i dalje su prisutni određeni metodološki nedostaci koji utječu na cjelo-

kupnu procjenu opsega kulturne zaposlenosti. Naime, mjerenje i usporedba razvoja KKI u zemljama EU-11 otežani su zbog različitog obuhvata sektora, neusklađenih nacionalnih statističkih sustava i nedostatka sveobuhvatnih podataka. Svaka država razvila je vlastite metode prikupljanja podataka, što dovodi do ograničene usporedivosti na međunarodnoj razini. Također, iako se u radu pokazalo da se razvoj kulturne zaposlenosti, između ostalog, može promatrati u kontekstu sa inovacijskim kapitalom i visokoobrazovanom radnom snagom, riječ je o tržištu rada sa izuzetno specifičnim čimbenicima. Kako bi se donio cjelovit zaključak o uzrocima promjena u strukturi zaposlenosti u ovom području, potrebno je uzeti u obzir sve te čimbenike. Identificirana ograničenja ujedno upućuju na potrebu za budućim istraživanjima koja će, kroz poboljšanje dostupnosti i kvalitete podataka, omogućiti donošenje učinkovitih javnih politika u zemljama u tranziciji.

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CULTURAL EMPLOYMENT IN THE CENTRAL AND EASTERN EUROPEAN COUNTRIES: ANALYSIS AND IMPLICATIONS

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Summary: *Cultural and creative industries are an important driver of economic development because they stimulate innovation, create new jobs, increase added value and strengthen the competitiveness and global recognition of the economy. They are important for the European economy, which is reflected, among other things, in the number of employees in this industry, which makes a valuable contribution to total employment. The aim of the paper is to identify the economic contribution of the countries of Central and Eastern Europe (EU-11: Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia, Estonia, Lithuania and Latvia) to the total EU economy using indicators of cultural employment and GDP. Through the analysis of*

existing research, the aim of the paper is to identify the key characteristics of the labor market in CCIs in the countries of Central and Eastern Europe, with a special emphasis on the educational status of employees and their role in cultural employment. The specificity of these countries is reflected in the transition process from a planned to a market economy in which cultural and creative industries play a significant role in the transformation of their economy. It is important because it also facilitates their integration into the European cultural and economic space.

This research is based on the Eurostat methodological framework and uses an approach based on a combination of economic activities and occupations, which seeks to provide a comprehensive assessment of total cultural employment. Using descriptive statistics and correlation analysis, the paper identifies trends and differences in cultural employment in the EU-11 countries in the period 2013-2022 and examines whether there is a statistically significant relationship between cultural employment and GDP. The research results show that there are inequalities in the distribution of cultural employment in these countries, which, among other things, can be linked to both historical development and transition, as well as to their adaptation to changes and new technologies, for which a highly educated workforce is key, contributing to the development of innovation and competitiveness of these industries. Likewise, a positive correlation between cultural employment and GDP is established, which indicates that the cultural sector has an impact on overall economic growth and long-term economic benefits and, following the example of some of the analyzed countries, it is necessary to invest in the aforementioned sector. The paper contributes to the understanding of the specificities of cultural employment and its potential in the economies of countries in transition, which is important for decision-makers and public policy makers.

Keywords: *cultural and creative industries, cultural employment, new technologies, highly educated workforce, Central and Eastern European Countries*

JEL classification: *E24, J21, O39*



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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

UNDERSTANDING CELEBRITY ENDORSEMENT OUTCOMES THROUGH THE LENS OF FAME TYPOLOGIES: A SYSTEMATIC REVIEW

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Abstract: *This aim of the paper is to investigate the link between a celebrity's social origin - categorized as achieved, ascribed, or attributed - and the success of brand endorsement campaigns. By applying Rojek's tripartite fame typology, the study analyses ten recent celebrity endorsement cases from various industries and world. Through comparative qualitative analysis, the research explores the degree to which a celebrity's fame origin influences consumer response (through purchase, brand recognition and perception) and endorsement outcomes. The findings suggest that while social origin plays a role in shaping public perception, the alignment between brand image and celebrity persona is a stronger determinant of campaign success. Most campaigns analyzed were successful, indicating that effective strategic branding can transcend the limitations posed by fame origin. This study introduces the social origin of celebrity status - based on Rojek's typology - as a key variable in understanding endorsement outcomes, offering a new perspective beyond traditional marketing models. Scientific contribution of this paper can be found in strategic insights for designing more targeted and socially - informed celebrity endorsement campaigns across diverse media and market contexts.*

Keywords: branding, celebrity endorsement, mass media, marketing campaigns, Rojek fame model

JEL Classification: M31, L82, D91

INTRODUCTION

In an era where celebrity endorsement remains a cornerstone of brand business strategy, the social origin of fame has emerged as a critical yet underexplored factor influencing endorsement success. This paper investigates the relationship between a celebrity's pathway to fame - whether achieved through personal merit, inherited from familial status, or constructed via media platforms - and its impact on brand

recognition and endorsement success. Drawing upon (Rojek, 2001) tripartite model of celebrity classification, the study examines endorsement outcomes across a spectrum of global industries and cultural contexts. Through a comparative analysis of recent empirical cases, this research seeks to uncover patterns in consumer perception and behavioral response that correlate with the endorser's social origin. This study aims to bridge the gap in existing literature by analyzing how a celebrity's social background is connected to endorsement campaign success. By evaluating case studies from various industries and regions, the research seeks to determine whether a celebrity's origin - be it through inheritance, merit, or media fabrication - are connected to the - affects success of brand endorsements. The research can open the perspective of connection between celebrity social origin and brand endorsements success.

LITERATURE REVIEW

As a century-old phenomenon (Erdogan, 1999) used more frequently in the past decade (White, Goddard, & Wilbur, 2009), celebrity endorsement is still a focal point of contemporary academic research. This strategy is employed due to several factors: celebrities hold significant influence within society (Eng & Jarvis, 2020), they effectively capture consumer attention (Muda, Musa, & Putit, 2012; Pavlović, Vuković, & Hunjet, 2020), shape consumer perceptions of brands (Osei - Frimpong, Donkor, & Owusu - Frimpong, 2019), and introduce an element of divergence (Shiva, Arora, & Rishi, 2022). When using this strategy, some of the authors claim there are lack of measurable objectives for the campaign success (Olmedo, et al., 2020), but according to Brooks et al. (2021) success can be measured in different ways such as increasing consumers' online attention via social media, building up online community, achieved key performance indicators and brand recognition. But, also in way of increased product sales (Jun, Han, Zhou, & Eisingerich, 2023), as well as through changes in customer-based brand equity (Alimpić, Slijepčević, & Madić, 2025). Nowadays, this topic is still the focal point of contemporary academic discourse and has been researched by various industries like the health industry (i.e. surrogate in vitro fertilization), the food industry in study by Ogunbola et al. (2024), beauty industry (Yanti & Zamrudi, 2025) and fashion industry (Chen, Wang, & Wang, 2024). Celebrities from various industries engage in endorsement activities; however, as noted by Wei (2024), celebrities from the entertainment and sports sectors continue to attract the most scholarly attention in this context. Interestingly, this trend has remained largely unchanged over the past decade, as Yen & Teng (2015) also reported that actors and athletes were predominantly used in celebrity endorsements - a pattern further illustrated in Table 1 of the following chapter.

As we are living in the era of immense influence of social media celebrities, famous people with no special skills, so called DIY celebrities, self-made figures leveraging digital tools to bypass traditional media (Turner, 2004), often constructed by media and industry mediators (such as publicists, journalists and producers), i.e. attributed celebrities, various research in recent years has shown that they are more frequently used for endorsements (Zahran, 2024; Kasuma & Rabbani, 2024) with digital user behavior (clicks, shares and recommendations) becoming a key mediator of campaign reach (Vojvodić & Matić Šošić, 2025). Various typologies of fame and celebrity classification have emerged in academic literature, reflecting the complexity and evo-

lution of celebrity culture. Turner (2004) distinguishes between “ordinary” and “extraordinary” celebrities, where the former gain fame through reality media exposure and the latter through notable achievements in fields such as sports or acting. Boorstin (1963) introduced the idea of the “pseudo-event” celebrity, arguing that many modern celebrities are famous not for their accomplishments but for their media visibility. Driessens (2013) proposed a sociogenetic model that considers celebrity as a form of mediated visibility shaped by both structural forces and individual agency. Marshall (2014) emphasized the performative dimension of celebrity, framing it as a product of public persona management in media space. Among these frameworks, Rojek’s (2001) tripartite model of celebrity classification - ascribed, achieved, and attributed - offers a particularly robust lens for analyzing the origins of fame. Ascribed celebrities inherit their fame through family lineage or social position (e.g., royal family members or children of celebrities), achieved celebrities earn their fame through individual talent and effort (e.g., successful athletes, artists), while attributed celebrities - or “celetoids” - gain short-lived fame primarily through media exposure, often without significant accomplishment. Rojek’s model is especially relevant for examining endorsement outcomes because it centers on the social origin of fame, which this study posits as a potentially significant factor in consumer perception and campaign effectiveness. By focusing on how fame is obtained, rather than just its visibility or function, Rojek’s classification allows for a deeper analysis of authenticity, credibility, and trust - key elements in successful brand endorsement strategies, which are also closely tied to the way media and marketing construct desirable public images (Velov & Kolev, 2021). Although the three - part model of celebrity classification was originally proposed by Rojek, it has since been adopted and adapted by other scholars such as Stewart & Giles (2019), Marshall (2014), and Turner (2004), further demonstrating its applicability and theoretical significance.

As noted earlier, they are various types of celebrities and there are lots of celebrity characteristics for consumers to trust them, like attractiveness, expertise, skills, good image, authenticity, etc. Studies show attractiveness is especially impactful (Can-su & Sezen, 2025; Sharma & Kumar, 2024). However, other factors like credibility, skills (Gofur & Shafariah, 2025; Gaikwad & Muley, 2024), charm, image (Mkerwa, 2024; Dankwah, Kwakwa, & Ibrahim, 2024) and social status (Pavlović, Vuković, & Hunjet, 2020) also play key roles in endorsement effectiveness.

This article aims to answer the next research questions via chosen up to date and relevant articles which include celebrities via endorsement campaign, covers up different industries where celebrities are coming from and meets the Rojek model criteria.

RQ1. Can there be a link between the social origin of celebrity fame and brand endorsement success?

RQ2. Does the success of a campaign vary depending on the estimated origin of the celebrity participating in the campaign?

METHODOLOGY

This study employs a qualitative, comparative case study approach to examine celebrity endorsement outcomes across different industries and markets. The ten articles included in Table 1 were selected from reputable academic databases (Google Scholar, EBSCO, ProQuest, Taylor & Francis, Wiley, and Elicit) and published within

the last ten years. The inclusion criteria focused on studies that analyzed **successful or unsuccessful celebrity endorsement campaigns**, as well as on the **metrics used to assess campaign effectiveness**, such as sales impact, brand attitude shifts, consumer engagement, or brand value. A further selection criterion concerned the **type of celebrity**, ensuring that the final sample represented all three categories of Rojek's (2001) fame typology—**ascribed, achieved, and attributed**.

Following the literature review, the celebrities in each study were classified using Rojek's typology, after which endorsement outcomes were analyzed through secondary data such as sales impact, brand recognition, purchase intention, consumer engagement, e-WOM responses, and shifts in brand attitudes. Prior research has shown that celebrity endorsement can positively shape brand image and purchase decisions (Anwar, Wibowo, Andrian, & Setiyani, 2023; Aprilia & Hidayati, 2020; Jun, Han, Zhou, & Eisingerich, 2023; Sari, Hayu, & Salim, 2021; Wong, Fock, & Ho, 2020; Đukić & Buljubašić, 2025), while other studies demonstrate that endorsement effects can be limited or negative, depending on perceived celebrity–brand fit, credibility, and authenticity (Srivastava, Tiwari, & Shastri, 2020). Findings by Chen et al. (2024) further highlight that endorsement performance can be linked to increased brand awareness, improved positioning, and sales growth, stressing the multidimensional nature of endorsement success. However, an important methodological limitation emerged: **empirical studies focusing on endorsement campaigns involving ascribed celebrities are significantly less common**, with most peer-reviewed work examining achieved or attributed celebrities. While additional examples of ascribed celebrity branding (e.g., members of royal families, celebrity heirs, “nepo babies”) were identified in practitioner reports and media analyses, these sources were excluded due to their non-academic nature. To address this gap, the study was expanded to include **experimental research designs** that provide robust measures of endorsement effectiveness despite not analyzing real-world campaigns. Two such studies were added due to their relevance: Rialti et al. (2024), who experimentally tested **Kylie Jenner's** endorsement effect through shifts in brand attitudes generated by her positive or negative e-WOM messages; and Duthie et al. (2017), who evaluated the endorsement impact of **Prince William**—an ascribed celebrity—through experimentally measured **willingness-to-engage (WTE)** with a conservation campaign. These studies enabled the inclusion of ascribed celebrities under controlled conditions, thus strengthening the dataset where real-world evidence is limited.

This two-phase analytical approach—first assessing fame origin and then comparing endorsement outcomes—allowed the identification of patterns between a celebrity's social origin and campaign performance. It further highlighted the centrality of **public perception, cultural intermediaries**, and the interpretative role of audiences (Bastian & Hajirah, 2025), especially in contexts where marketing communication transparency is limited (Yang & Battocchio, 2020). Rojek's typology was chosen because it provides a nuanced perspective on how fame origin shapes consumer response, complementing more traditional economic measures of endorsement success.

THE LINK BETWEEN CELEBRITY SOCIAL ORIGIN AND BRAND ENDORSEMENT SUCCESS – RESULTS AND DISCUSSION

The first criterion for analyzing recent works was to determine the social background of celebrities who are useful for endorsements. The authors selected three examples per social origin category, with four for “achieved” due to one involving scandal, reflecting research by Wong et al. (2020) that negative publicity can benefit endorsements and aligning with Rojek’s view of scandal-driven fame as a form of attributed celebrity (celetoids).

Looking from a perspective of successful campaign, measuring it via consumers purchasing, the celebrities who have been categorized in table as “achieved” have earned their celebrity status because of their skills and achievements, for example BTS boy band from South Korea are known for their skills of singing and dancing, and not only for mentioned skills but also according to Widyawati et al. (2020) for expertise in celebrity endorsement. Furthermore, in the same category of music industry is Kanye West, who also left an impact in the fashion industry as a designer. Celebrities can be successful across various industries, transferring their appeal from one product category to another and embodying a wide range of lifestyles. Several theoretical models help explain why such transfers can be effective. Wong et al. (2020) summarize these foundational perspectives. They note that, according to McGuire’s (1985) affect-transfer model (2020, p. 2), endorsement success may occur when consumers’ positive feelings toward an endorser are transferred to the endorsed product. Wong et al. (2020) also reference McCracken’s (1989) meaning-transfer model, which proposes that symbolic meanings associated with an endorser can move from the celebrity to the product and ultimately to the consumer. Furthermore, the authors draw on the source-credibility model, originally developed by Hovland and Weiss (1951) and later expanded by Pornpitakpan (2004), which posits that the perceived credibility of an endorser (expertise, trustworthiness, attractiveness) can influence how persuasive the brand or product message is (Wong, Fock, & Ho, 2020).

The category of achieved celebrities includes actors like Ini Edo and Ufoma McDermott from Ogunbola et al. (2024) study and Sajal Aly from Jabbar et al. (2024) study. These nationally prominent rather than globally recognized figures illustrate that achieved celebrities outside dominant Western media circuits can also serve as effective brand endorsers. Within the category of attributed celebrities, the studies identify social-media figures whose celebrity status is constructed through industry practices and self-production, often referred to as DIY (“do-it-yourself”) celebrities (Turner, 2006; Gamson, 2011). An example is Bilal Munir, a Pakistani Instagram influencer known for IT product reviews, featured in the study by Jamil et al. (2023). A prominent illustration of DIY celebrities includes American TikTok influencer Charli D’Amelio, whose fame emerged from self-produced dance videos, as well as YouTube creator Michelle Phan, recognized for her beauty content (Brooks, Drenten, & Piskorski, 2021). As noted by Deller and Murphy (2020), individuals who attain visibility and influence through platforms such as YouTube can also be understood as celebrities, further supporting the classification of these figures within the attributed category.

Within the category of **ascribed celebrities**, the selected studies include figures whose celebrity status is inherited through family lineage, social position, or dynastic prominence. Paris Hilton and Kylie Jenner exemplify celebrities whose fame orig-

inates from being born into globally recognizable and influential families, aligning with Rojek’s (2001) definition of ascribed fame. Their cases further demonstrate that inherited celebrity status doesn’t preclude endorsement effectiveness: for instance, Hilton’s influence on Rich Prosecco sales, as reported in Wong et al. (2020), illustrates that inherited visibility can translate into measurable commercial outcomes. Similarly, Kylie Jenner’s experimentally tested e-WOM effects (Rialti, Zollo, Kim, & Yoon, 2024) show that ascribed celebrities can shape brand attitudes even outside traditional endorsement contexts, particularly when promoting leading brands in competitive markets. Prince William, the Duke of Cambridge, represents another form of ascribed celebrity rooted in royal lineage. Experimental evidence from Duthie et al. (2017) demonstrates that his presence in conservation campaign materials significantly increased willingness-to-engage (WTE) among participants compared with non-celebrity controls, highlighting that inherited fame can function as a persuasive source within pro-social and charitable contexts. These examples collectively indicate that although scholarship on ascribed celebrity endorsement is more limited, available studies show that inherited fame can exert meaningful influence on consumer engagement and brand-related outcomes when tested under controlled conditions.

Table 1. Celebrity endorsement campaigns

AUTHOR(S) AND ARTICLE NAME	CELEBRITIES	SOCIAL ORIGIN	BRAND ENDORSMENT
(Jun, Han, Zhou, & Eisingerich, 2023) When is celebrity endorsement effective? Exploring the role of celebrity endorsers in enhancing key brand associations	BTS boy band (BTS is acronym of Bangtan Sonyeondan or “Beyond the Scene,” Grammy awarded boy band form South Korean active in genre of pop music)	Achieved (the boy band got this celebrity status through a combination of talent and hard work in singing and dancing)	Successful: McDonald’s launched the ‘BTS Meal’ across six continents and 50 countries worldwide in the year 2021. The celebrity endorsement helped to boost sales worldwide
(Mitra, 2023) Celebrity Endorsement and Its Impact on Sales	Kanye West (American grammy awarded rapper, song writer, music producer, fashion designer, music and movie director)	Achieved (K. West got this celebrity status with enormous skills and expertise in music, fashion industry, and setting trends)	Failed: In the year 2022, Adidas had to finish the collaboration with Kanye West when he made some antisemitic comments on the social media, which left the company at the risk of losing \$560million

(Ogunbola, Ogbeide, Subulola, Dipo-Adedoyin, & Ridwan, 2024) Influence of Celebrity Endorsement on Women Fertility on Social Media.	Ini Edo (Nigerian actress in Netflix series)	Achieved (Ini Edo got this celebrity status through an acting career lasting more than 20 years)	Successful: Ini and Ufuoma used their testimonies to preach about the good and the bad of surrogacy and IVF. There has been noted increase in the acceptability and exploration of surrogacy and IVF as an option for childbearing now compared to before endorsement
	Ufuoma McDermott (Nigerian actress, director, former model and beauty pageant titleholder)	(Ufuoma McDermott earned this celebrity status through her various skills and expertise in her career)	
(Jabbar, Sheikh, & Raza, 2024) The relationship between celebrity endorsement and masstige brand value: The moderating effect of brand credibility.	Sajal Aly (Pakistani actress and model)	Achieved (Sajal Aly earned this celebrity status via excellent skills in acting in TV shows and Pakistani movies)	Successful: If she is linked to a fashion brand, such as in a brand advertisement, it is possible to a great extent that her positive effects are transferred to the connected brand and enhance the brand's value
(Jamil, Qayyum, Hassan, & Khan, 2023) Impact of social media influencers on consumers' well-being and purchase intention: a TikTok perspective	Bilal Munir (Pakistani Instagram influencer for electronic products with 484k followers)	Attributed (Bilal Munir career got respected because he is educated as an engineer and his opinion on social media for electronic products has influence)	Successful: Most technology brands in Pakistan collaborate with Bilal Munir because he is credible, tech-savvy and consumers are tending to purchase more after his review
(Brooks, Drenten, & Piskorski, 2021) Influencer Celebrification: How Social Media Influencers Acquire Celebrity Capital	Charli D'Amelio (American Tik Tok influencer with 157.3m followers) Michelle Phan (American YouTube Influencer with 8,58m followers)	Attributed (Charlie D'Amelio has social media fame via dancing on Tik Tok videos) (Michelle Phan has social media fame via reviewing beauty products on her YT channel)	Successful: Charli endorsed Dunkin with her drink "The Charli" and it got more recognition among generation Z. Michelle Phan had a successful endorsement deal with Lancôme and the brand after that got more recognizing

(Sari, Hayu, & Salim, 2021)	Suhay Salim	Attributed	Successful: The research of the authors has proven that the endorsement of the beauty influencer has a significant effect on positive publicity and purchasing decision of Korean skin care product "Some By Mi"
The Effect of Trustworthiness, Attractiveness, Expertise, and Popularity of Celebrity Endorsement	(Indonesian Instagram influencer with 683k followers)	(Suhay Salim got her social media fame reviewing make up products and as make-up artist)	
(Wong, Fock, & Ho, 2020)	Paris Hilton	Ascribed	Successful: In 2010, the sales of Rich Prosecco increased from seven million to ten million cans in the first year of Paris Hilton's endorsement, and the company's revenues continued to grow by 65.24% in the second year
Toward a Process-Transfer Model of the Endorser Effect	(American celebrity, one of the heirs to the Hilton hotel chain founded by her great-grandfather Conrad Hilton)	(Paris Hilton was born into a rich and famous family; the family built an empire in the hospitality industry)	
(Rialti, Zollo, Kim, & Yoon, 2024)	Kylie Jenner	Ascribed	Successful (partially): In an experimental setting, her positive e-WOM posts significantly improved attitudes toward Nike, whereas for Adidas the experimentally measured e-WOM endorsement effect showed no significant impact.
Mega- influencers and brand dynamics: Shaping attitudes toward leading and challenger brands through electronic word of mouth	(American celebrity, daughter of Kris Jenner -TV producer, and Caitlyn Jenner-retired Olympic gold medalist, and half-sister of media personality Kim Kardashian)	(Kylie Jenner inherited fame from famous parents and siblings)	
(Duthie, Diogo, Keane, & Knight, 2017)	Prince William, the Duke of Cambridge	Ascribed	Successful: In an experimental copy-testing study, participants showed higher willingness-to-engage (WTE) with the conservation campaign when the advertisement featured Prince William compared with the non-celebrity control, indicating a successful endorsement effect measured through WTE responses rather than real-world behavioural outcomes
The effectiveness of celebrities in conservation marketing	(British royal celebrity/ younger son of King Charles III and Diana, Princess of Wales)	(Prince William also inherited fame from famous parents-royal family)	

The cases presented in Table 1 show that most analyzed endorsement campaigns were successful, supporting prior findings that celebrity endorsements can strengthen brand performance, sales, and consumer-based brand equity (Wang, Chen, Nie, & Wang, 2019; Nzuva, 2021; Alimpić, Slijepčević, & Madić, 2025). These results align with research on global brand visibility, such as Jun et al. (2023) who demonstrated that the BTS–McDonald’s partnership boosted international sales and enhanced brand recognition. Successful endorsements were also observed among attributed celebrities, where credibility, expertise, and popularity—key determinants identified by Sari et al. (2021) and Jamil et al. (2023)—effectively drove purchase intentions, exemplified by Bilal Munir’s influence in the tech sector.

Nevertheless, the literature acknowledges that endorsement outcomes can vary. Till & Schimp (1998) and Adiba et al. (2020) argue that scandals or negative publicity can damage brand image. This pattern appears in one of the unsuccessful cases within the sample: the termination of Adidas’ collaboration with Kanye West, where the celebrity’s inappropriate behavior created reputational harm and financial loss (Mitra, 2023). Huang (2020) similarly notes that the moral downfall of celebrities can undermine campaigns, especially when brands depend heavily on the celebrity’s perceived authenticity. At the same time, many brands deliberately engage celebrities who have become highly visible due to scandals or negative publicity. In Rojek’s framework, such figures may be classified as *celetoids*—a form of attributed celebrity whose fame is intensified by media attention rather than professional achievement. A well-known example is Nike’s 2018 campaign featuring former NFL quarterback Colin Kaepernick, whose public protest against the national anthem led to his departure from the league. Despite the controversy, the campaign proved successful (Marie, 2025), illustrating that scandal-associated visibility can, in certain contexts, enhance rather than diminish endorsement effectiveness. These findings support the view—consistent with Rojek’s typology—that celebrity visibility shaped by controversy may align more closely with attributed fame, resulting in unpredictable endorsement effects.

A particularly illustrative case regarding the complexity of fame is Paris Hilton. Despite being one of the least liked celebrities at the time, Hilton’s endorsement of Rich Prosecco was commercially successful. As explained by Wong, Fock, & Ho (2020), this outcome contradicts predictions based solely on affect-transfer, meaning-transfer, and source-credibility theories. Their proposed process-transfer model suggests that consumers may transfer not only positive attributes but also the *evaluation process* itself—whether valenced or not—onto the brand, explaining why ascribed celebrities with mixed public perceptions can still generate strong endorsement outcomes.

Across all examined studies, **nine out of ten** endorsement cases were successful. Although social origin didn’t independently determine campaign outcomes, it shaped the type of persuasive value each celebrity contributed. Achieved celebrities generally signaled credibility and expertise but carried reputational risks associated with high visibility. Ascribed celebrities—such as Paris Hilton, Kylie Jenner, and Prince William—enhanced symbolic value and aspirational associations, while attributed celebrities were especially effective at driving engagement and purchase intention through relatability and strong digital presence (Hameed, Malik, Hadi, & Raza, 2023; Jamil, Qayyum, Hassan, & Khan, 2023; Listiawati, Ahmad, Amelia, & Zaelani, 2024). Over-

all, the findings underscore that **brand–celebrity congruence and consumer perception**, rather than fame origin alone, are central to endorsement success.

CONCLUSION

This review demonstrates that a meaningful connection can be observed between the social origin of celebrity fame and the effectiveness of endorsement campaigns. Across the analyzed cases, achieved celebrities most consistently generated favorable outcomes due to their credibility and demonstrated expertise, attributed celebrities proved highly effective in digital environments where authenticity and audience engagement drive consumer behavior, while ascribed celebrities provided symbolic and aspirational value when aligned with appropriate brand identities. Although fame origin alone does not determine endorsement success, the comparative analysis shows that it shapes the type of persuasive capital each celebrity can contribute. As a review based on secondary data, the study synthesized findings from recent empirical and conceptual works selected according to clearly defined criteria, including publication recency (last ten years), relevance to celebrity endorsement practice, representation of all three categories in Rojek's typology, and the inclusion of measurable outcomes of endorsement success. This approach allowed for a comprehensive overview of contemporary endorsement dynamics, though it remains limited by the availability and heterogeneity of existing studies—particularly the scarcity of empirical research involving ascribed celebrities and the predominance of self-reported measures in primary sources. Overall, this review contributes not only to endorsement scholarship but also to broader celebrity studies and communication studies by demonstrating how different forms of celebrity capital—shaped through labor, heredity, and digital mediatization—influence audience perception and meaning-making processes. The findings underline the value of integrating fame typologies into analyses of mediated influence and highlight the need for future research to adopt more robust methodological designs, including behavioral and experimental approaches, as well as cross-cultural comparisons. Such work would offer a deeper understanding of how fame origin, media visibility, and evolving audience expectations jointly shape the influence and communicative power of contemporary celebrities.

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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

PERCEPCIJA UČINKOVITOSTI NOVOG PRISTUPA PRODAJI U DIGITALNOM OKRUŽENJU: TRANSFORMACIJSKI PRODAJNI LIJEVAK SA STANJIMA

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Sažetak: Digitalno doba omogućilo je potencijalnim kupcima brže i lakše prikupljanje informacija o proizvodu ili usluzi. Potencijalni kupci pritom se oslanjaju na različite izvore kako bi bili sigurni u svoju odluku prije zaključavanja same kupnje. Njihovi pretraživački upiti u digitalnom okruženju, dovode ih do web lokacija ili oglasa koje nude sveobuhvatnije informacije o oglašavanim proizvodima ili usluzi. S druge strane, oglašivači koriste Internet pretraživanje kako bi putem oglasa, potaknuli potencijalne kupce na daljnje korake u procesu odlučivanja o kupnji. Za bolje razumijevanje putovanja potencijalnog kupca kroz faze prodajnog lijevka, ovisno o vrsti pretraživačkog upita, razvijen je model Transformacijskog prodajnog lijevka sa stanjima. Svrha ovog istraživanja je utvrditi primjenjivost predloženog novog pristupa prodaji od strane prodajnih stručnjaka s ciljem optimizacije prodajnih strategija. Provedenim primarnim istraživanjem, dolazi se do zaključka kako prodajni stručnjaci izražavaju opće razumijevanje Transformacijskog prodajnog lijevka, naglašavajući pritom njegovu primjenjivost na stvarno ponašanje kupaca prilikom odlučivanja o kupnji. Rezultati istraživanja ukazuju da iako predloženi novi pristup prodajnog lijevka u digitalnom okruženju odnosno Transformacijski prodajni lijevak sa stanjima se koristi od prodajnih stručnjaka, ali je njegova primjena većinom intuitivna. Stoga, kako bi se potaknula njegova šira i svjesnija implementacija prilikom kreiranja i optimizacije prodajnih strategija, potrebna je daljnja edukacija prodajnih stručnjaka kao i praktične smjernice prilikom kategorizacije ključnih riječi u različitim granama djelatnosti. Zaključno, iako prodajni stručnjaci iskazuju upotrebnu vrijednost predložene modifikacije prodajnog lijevka, pojedine faze Transformacijskog prodajnog lijevka sa stanjima podložne su promjenama ovisno o vrsti poslovanja, faktorima poput sezonalnosti i preferencijama potencijalnih kupaca.

Ključne riječi: potencijalni kupci, digitalno doba, Transformacijski prodajni lijevak sa stanjima, ključne riječi, prodajni stručnjaci

JEL klasifikacija: M30, M31, M37

UVOD

Tradicionalni kanali oglašavanja putem televizije ili radija, ne omogućuju oglašivačima precizno ciljanje određene publike. Iako je moguće izabrati medijski kanal na kojoj će biti plaćeni oglasi, takav pristup ne doseže razinu preciznosti koju pruža internetsko oglašavanje. Internet omogućuje oglašivačima ciljanje potencijalnih kupaca prema različitim demografskim skupinama i geografskim regijama te prema njihovim interesima i mnogim drugim karakteristikama (Manjula, 2018).

U kampanjama oglašavanja, osobit značaj ima interes potencijalnih kupaca za proizvod ili uslugu, koji se utvrđuje kroz pitanja postavljena u web tražilice. Takvi pretraživački upiti mogu se kategorizirati u faze ovisno o njihovom potencijalu konverzije u stvarnog kupca. Faze pri vrhu prodajnog lijevka, odnosno na početku procesa pretraživanja, uključuju najveći broj potencijalnih kupaca s manjim potencijalom konverzije, dok se prema dnu broj potencijalnih kupaca smanjuje, ali raste vjerojatnost konverzije. Grafički prikaz tog procesa, očituje se u formi obrnute piramide, odnosno lijevka (Vasilieva & Loseva, 2019). Prodajni lijevak se definira kao marketinški model koji opisuje faze koje potencijalni kupac prolazi prilikom upoznavanja s uslugom ili proizvodom kojeg kupuje (Griva, Butorina, Sidorov, & Sanchenko, 2023).

Događaji iz 2020. godine ubrzali su razvoj digitalnih poslovnih modela i ukazali na nedostatke dosadašnjih poslovnih pristupa. U tom kontekstu, prodajni lijevak predstavlja jednostavan, ali učinkovit alat koji omogućuje povećanje profitabilnosti, optimizaciju prodajnih procesa i bolje korištenje resursa. Stoga, prodajni lijevak postaje konceptualni okvir za uspješnije upravljanje poslovnim procesima, u skladu sa zahtjevima današnjeg tehnološkog napretka (Grabozdin, Denisova, & Tatarovsky, 2021) te postaje nužnost za dobru optimizaciju prodajnih strategija. Praćenjem i analizom svake faze prodajnog lijevka, poduzeća mogu unaprijediti svoje strategije i povećati stope konverzije (Wiraguna & Nabila, 2024). Važnost ovakvog pristupa potvrđuju i statistički podaci. Tijekom 2024. godine, digitalni kanali činili su 70% ukupne oglašivačke potrošnje u Hrvatskoj, dok u Bosni i Hercegovini 66% ukupne potrošnje (Statista, 2024) što potvrđuje dominaciju digitalnog oglašavanja i ističe potrebu za preciznijim modelima analize ponašanja potencijalnih kupaca. Također, indeks gospodarske i društvene digitalizacije (DESI indeks) ukazuje da online prodaja kod malih i srednjih poduzeća (MSP) raste, odnosno postaje sve značajniji kanal prodaje koji ulazi i u strategiju razvoja digitalne Hrvatske (SDURDD, 2022). Tako je postotak MSP-a koji koriste online kanale prodaje u Hrvatskoj sa 29% (2022) porastao na 31,5% (2025) (European Commission, 2025), ali i u Bosni i Hercegovini prema dostupnim podacima taj postotak MSP-a je porastao sa 19% (2021) na 20% (2022) (Tintor, Jovanović, Bocarova, & Bugarski, 2022, str. 49), pri čemu je EU prosjek 18% (2022) odnosno 20% (2025). Navedeno također ukazuje na važnost online prodaje i prodajnih strategija u poslovanju.

Svrha rada je istražiti primjenu novog pristupa prodajnom lijevku, nazvan Transformacijski prodajni lijevak sa stanjima, u optimizaciji prodajnih strategija. Novi pristup prodaji opisuje stanje svijesti i promjene stanja svijesti potencijalnih kupaca, pritom se posebna pažnja stavlja na promjene u stanju svijesti. Navedeni lijevak, po-

maže oglašivačima pri optimizaciji prodajnih procesa i razvoja prodajnih strategija. Na način da se sukladno pretraživačkim upitima, određuje faza u kojoj se potencijalni kupac nalazi. Nakon određivanja faze, oglašivač pasivnim promjenama potiče daljnje napredovanje kroz lijevak, nudeći tako dodatne informacije o oglašavanom proizvodu ili usluzi. Sve s glavnim ciljem prelaska potencijalnog kupca u stvarnog kupca.

Huang (2020) naglašava kako je svjesnost o situaciji nužna kako bi prodaja bila uspješna, ali i za razumijevanja angažmana potencijalnih kupaca, dok Efendioğlu i Durmaz (2022) ističu da način na koji potencijalni kupci percipiraju oglašavanu ponudu, utječe na njihovu svijest i donošenje odluke. Sukladno navedenom, postavlja se istraživačko pitanje koje glasi: Kako prodajni stručnjaci ocjenjuju korisnost Transformacijskog prodajnog lijevka u razumijevanju i optimizaciji prodajnog procesa i razvoju prodajnih strategija?

Rad je strukturiran na način da se u uvodnom djelu iznosi svrha rada te se definira istraživačko pitanje. Zatim se predstavljaju najutjecajniji modeli prodajnog lijevka koji ilustriraju put potencijalnog kupca kroz različite faze upoznavanja proizvoda i usluga, odlučivanja i kupnje. Slijede dosadašnja istraživanja u kojima je korišten koncept prodajnog lijevka. Nakon toga, detaljno je prikazan novi, prošireni Transformacijski prodajni lijevak sa stanjima. U zadnjem djelu, prikazuje se metodologija provedenog istraživanja, rasprava o rezultatima te zaključci istraživanja kao i preporuke za buduća istraživanja.

PRETHODNA ISTRAŽIVANJA

Prodajni lijevak i kupčevo putovanje u digitalnom okruženju

Istraživanja u prodaji, pogotovo uz prodajne lijevke, često se pozivaju na teoriju ograničene racionalnosti te teoriju ograničenja. Pri čemu pojedinci koji prolaze kroz proces donošenja odluke o kupnji posebno u digitalnom okruženju, često umjesto odabira optimalnog rješenja, se zadovoljavaju rješenjem koje je dovoljno dobro, odnosno koje zahtijeva najmanje utrošene energije (Katsikopoulos & Lan, 2011). Također, u istraživanjima s ciljem optimizacije prodajnog lijevka, prepoznaju se faze u kojima najčešće dolazi do zastoja ili gubitka potencijalnih kupaca, te omogućuje se usmjerenje napora na otklanjanje ograničenja radi povećanja učinkovitosti strategija (Kalendar, Günay, & Vayvay, 2014).

Jansen i Schuster (2011) proveli su opsežno istraživanje učinkovitosti prodajnog lijevka u kampanjama digitalnog oglašavanja kroz analizu interakcije potencijalnih kupaca temeljem upita i korištenih ključnih riječi prilikom pretraživanja na web tražilicama. Istraživanjem se utvrdilo da su ključne riječi u fazi Svijest najčešće općenite, te služe za upoznavanje potencijalnih kupaca s proizvodom ili uslugom, dok su u fazi Kupnja, ključne riječi usmjerene na konačnu odluku za konverziju u stvarnog kupca. Također, prema pokazateljima uspješnosti oglašavanja, ključne riječi u navedenim fazama pokazale su se najvrjednijima s obzirom na broj klikova i prihoda od prodaje. Lehmann-Zschunke i Ampler (2025) ističu kako je važno uskladiti ključnu riječ s fazom u kojoj se potencijalni kupac nalazi s ciljem povećanja klikova i vjerojatnosti konverzije u stvarnog kupca. Stoga se oglašavanje može optimizirati i prilagoditi potencijalnim kupcima (Rothschild, Needell, Veverka, & Yom-Tov, 2025). Rezultati sveobuhvatne analize Jansena i Schustera (2011) ukazuju kako se jeftiniji proizvodi i usluge uglavnom prodaju u prvoj fazi, pri čemu kupci napuštaju prodajni lijevak ranije.

Nasuprot tome, skuplji proizvodi zahtijevaju detaljnije istraživanje, što potencijalne kupce zadržava u dubljim fazama prodajnog lijevka. Odabir lošeg prodajnog lijevka može generirati manje profita (Golik-Górecka, 2023) dok korištenje različitih analitika omogućava optimiziranje prodajnih strategija kroz identifikaciju ključnih faktora u svakoj od faza (Conde, 2025).

Novija istraživanja ukazuju kako prodajni lijevak ima značajnu ulogu u jačanju svijesti o marki, posebice u tekstilnoj industriji. Wiraguna i Nabila (2024) ističu suradnju s utjecajnim osobama koje svoj značaj iskazuju u ranijim fazama prodajnog lijevka. Tako što privlače pažnju i interes potencijalnih kupaca kroz predstavljanje proizvoda i pružanjem detaljnijih uvida o prednostima proizvoda, na način koji je potencijalnim kupcima blizak. Pa tako i korištenje oglašavanja na društvenim mrežama skraćuje prodajni lijevak te se često koristi u prvim fazama (Kiselicki, Josimovski, Pulevska Ivanovska, & Santa, 2021).

Prodajni lijevak se prvenstveno promatra kao model za razumijevanje kupčevog putovanja, od prepoznavanja potreba i njegovog ponašanja do konačne odluke o kupnji. No, sve više se ističe važnost razvoja prodaje u kontekstu prodajnog lijevka. Terho i suradnici (2023) u svom istraživanju objašnjavaju razvoj prodaje kao funkciju unutar organizacije koja omogućuje sveobuhvatno istraživanje, angažiranje i kvalifikaciju potencijalnih kupaca. Takav pristup doprinosi učinkovitijim prodajnim procesima, omogućavajući tako prilagodbu prodajnih strategija u skladu s fazom u kojoj se trenutno nalazi potencijalni kupac, povećavajući tako uspješnije rukovođenje konverzijama. Navedeno dodatno potvrđuje i istraživanje Ohiomaha i suradnika (2019), koje naglašava kako je za uspješno zatvaranje prodaje važno prilagoditi prodajnu strategiju potrebama potencijalnih kupca. Također, prilagodbom marketinških strategija i korištenjem segmentacije u digitalnim komunikacijama pridonosi se povećanju prodaje i popularnosti marke (Pirić, Korićan Lajtman, & Martinović, 2024).

Najutjecajniji modeli prodajnog lijevka

Prve principe modela prodajnog lijevka predstavio je američki stručnjak za oglašavanje E. St. Elmo Lewis, 1898. godine (Vakratsas & Ambler, 1999). Lewis je razvio model poznat pod akronimom AIDA, koji se sastoji od četiri faze u procesu donošenja odluke potrošača: Svijest (eng. Awareness), Interes (eng. Interest), Želja (eng. Desire) i Akcija (eng. Action) (Metili, 2023). U fazi Svijest, nalazi se najveći broj potencijalnih kupaca koji postaju svjesni postojanja proizvoda ili usluge. Potrebno je stvoriti sadržaj koji će privući njihovu pozornost. U sljedećoj fazi, potencijalni kupci pokazuju interes za proizvod ili uslugu te prikupljajući informacije uviđaju kako bi im proizvod ili usluga mogli pomoći u rješavanju određenog problema. Nakon što su potencijalni kupci prikupili dovoljno informacija, javlja se želja za određenim proizvodom ili uslugom. Dok u posljednjoj fazi, potencijalni kupci formiraju namjeru da kupe određeni proizvod odnosno uslugu. Odnosno, ranije faze prodajnog lijevka sastoje se od više informacija o potencijalnim kupcima proizvoda ili usluge. U daljnjim fazama, informacije opadaju, samim time i potencijalni kupci. Dok se u zadnjoj fazi pažnja pridaje onim kupcima koji će najvjerojatnije izvršiti kupnju (Kadić-Maglajlić, Drašković, & Tomašević Lišanin, 2019). Tristanto i suradnici (2021) u svom istraživanju naglašavaju da je najvažnije potaknuti potencijalne kupce na posljednji korak, Akciju. Isto tako, ističu važnost prilagodbe proizvoda potrebama potencijalnih kupaca kao i

korištenje promocijskih kanala za ostvarivanje marketinških ciljeva. Stoga, AIDA model predstavlja učinkovit alat prilikom oblikovanja marketinške strategije i promociju proizvoda ili usluga, pokazujući kako svaka faza zahtijeva različite pristupe koji povećavaju svijest i potiču na određene daljnje radnje.

Lavidge i Steiner (1961) razvili su model hijerarhije učinka, koji predstavlja proces donošenja odluke kroz šest koraka raspoređenih u tri faze. Prva, Kognitivna faza sastoji se od koraka Svijest i Znanje. Potencijalni kupci postaju svjesni proizvoda ili usluge te počinju istraživati o njihovim značajkama i prednostima, na način da čitaju, posjećuju web stranice i slično. U Afektivnoj fazi nastupaju koraci Sviđanje i Preferencija. U prvom se koraku potencijalnom kupcu proizvod ili usluga počinje sviđati, no važno je naglasiti da se to ne događa odmah. Prije toga, mora se uspostaviti povjerenje, najčešće kroz osvrt prethodnih kupaca ili druge vrste dokaza. Preferencija predstavlja odluku o kupnji određenog proizvoda ili usluge usprkos konkurentskoj ponudi. Autori naglašavaju kako sviđanje nije isto što i preferencija, potencijalnom kupcu se određeni proizvod ili usluga može sviđati, ali će na kraju ipak izabrati drugog prodavača. Stoga je važno na adekvatan način predstaviti prednost oglašavanog proizvoda. U Bihevioralnoj fazi, potencijalni kupac namjerava izvršiti konverziju kroz korake Uvjerjenje i Kupnja. U koraku Uvjerjenje potencijalni su kupci sigurni kako će određeni proizvod ili usluga zadovoljiti njihove potrebe ili riješiti problem. Krajnji cilj prodajnog lijeka je konverzija potencijalnog kupca u postojećeg. Ovaj cilj je postignut u posljednjem koraku ovog modela: Kupnja (Lavidge & Steiner, 1961). Zaključno, ovaj model pruža dublji uvid u proces donošenja odluke potencijalnog kupca te omogućuje bolju prilagodbu prodajnih aktivnosti za postizanje boljeg tržišnog uspjeha. Pauwels i suradnici (2020) potvrđuju kako je Model hijerarhije učinka relevantan za donošenje odluka i u oglašivačkim aktivnostima. Bihevioralna faza je ključna za poticanje prodaje, dok se Afektivna faza smatra najvažnijim polazištem u oglašavanju.

S obzirom na promjene u ponašanju potencijalnih kupaca, razvijeni su modeli koji dodatno proširuju i prilagođavaju prodajne lijevke. Modifikaciju AIDA modela predstavio je Derek Rucker (Kotler, Kartajaya, & Setiawan, 2017), kao Model 4A, odnosno Model putovanja kupca. Model 4A pojednostavljuje AIDA model, tako što spaja faze Interes i Želja u jednu fazu, Stav (eng. Attitude). Ključna razlika se očituje u dodavanju nove faze, Ponovno djelovanje (eng. Act Again), koja uzima u obzir zadržavanje kupaca, naglašavajući pritom važnost praćenja ponašanja nakon kupnje. Prema Kotleru i suradnicima (2017), digitalno doba omogućilo je neizravan i promjenjiv put potencijalnog kupca, što je dovelo do potrebe za proširenje Modela 4A u Model 5A. Model 5A fazu Stav (eng. Aware) iz 4A Modela, proširuje u faze Privlačnost (eng. Appeal) i Upit (eng. Ask) i dodaje fazu Zagovaranja (eng. Advocate). Hwang i Kim (2019) ističu snažnu povezanost između zadnje dvije faze Modela 5A. Ističu da kupci koji dijele svoja iskustva s drugima, zahvaljujući sve većoj prisutnosti društvenih mreža, imaju veću vjerojatnost da postanu zagovornici marke. Navedeno dokazuje spiralnu karakteristiku Modela 5A u kojem kupci oblikuju ponašanje drugih potencijalnih kupaca. Važno je naglasiti da Modeli putovanja kupca, dodajući nove faze, ističu značaj zadovoljstva i lojalnosti kupaca. Obje faze nastupaju nakon konverzije kupaca, dok prethodni modeli, kao što je AIDA model, ne uzima u obzir ponašanje kupaca nakon zadnje faze, Kupnje (Fortenberry & McGoldrick, 2019). Sljedeća Ilustracija 1. prikazuje razvoj i međusobnu povezanost faza unutar najpoznatijih modela prodajnih lijevaka.



Ilustracija 1: Najutjecajniji modeli prodajnog lijevka

Izvor: Izradili autori rada

Osim prethodno navedenih modela prodajnih lijevaka koji predstavljaju ponašanje kupaca, digitalne tehnologije potaknule su razvoj strategija poput sadržajnog marketinga, koji postaje ključna strategija poduzeća za izgradnju dugoročnih odnosa s kupcima (Jalolovna, 2024). Sadržajni marketing je marketinška strategija kojom se potencijalni kupci privlače i zadržavaju kroz kreiranje relevantnog i vrijednog sadržaja, a ne putem plaćenih oglasa. Ovakav sadržaj potiče potencijalne kupce da saznaju više ili stupe u kontakt s marketinškom ponudom (Opreana & Vinerean, 2015).

Hall (2017) opisuje tri faze prodajnog lijevka za sadržajni marketing. ToFu ili vrh prodajnog lijevka (eng. Top of the Funnel) koji odgovara fazi Svijest iz klasičnog AIDA modela. Vrh prodajnog lijevka usmjeren je na kreiranje korisnog sadržaja i povećanju vidljivosti, odnosno educiranje potencijalnih kupaca. MoFu, sredina prodajnog lijevka (eng. Middle of the Funnel), kroz fazu Razmatranje stavlja naglasak na predstavljanje proizvoda ili usluge kao potencijalnog rješenja za problem kupca. Navedena faza može biti izazovna, jer komunikacija mora biti precizna, jasna i prilagođena za široku publiku koja ima različite želje i potrebe. Posljednja faza Odluka, pripada BoFu ili dnu prodajnog lijevka (eng. Bottom of the Funnel) u kojoj su potencijalni kupci spremni donijeti odluku o kupnji. U ovoj fazi nastoji se odgovoriti na sva njihova pitanja i objasniti zašto su upravo oglašavani proizvod ili usluga najbolji odabir. Pandiya (2020) u vrh prodajnog lijevka svrstava sve posjetitelje web stranice, koji prelaze u potencijalne kupce u sredini lijevka, odnosno napreduju s obzirom na sadržaj koji im je dostupan. Dok dno lijevka prikazuje stvarne kupce koji su izvršili konverziju. Model omogućuje učinkovitije upravljanje interakcijama s potencijalnim kupcima kroz jasno definirane faze i prilagodbu sadržaja njihovim potrebama, što povećava angažman i šansu za konverziju u stvarnog kupca. Stoga, praćenje potencijalnih kupaca kroz cijeli prodajni proces omogućuje da se kreirani sadržaj prikazuje ciljanim kupcima (Mattos, Casais, & Braga, 2021).

Važno je istaknuti i ciklički Model zamašnjaka (eng. Flywheel) koji predstavlja novi pristup u odnosu na tradicionalne prodajne modele. Model ističe tri ključne faze, Privlačenje potencijalnih kupaca (eng. Attract), Angažiranje (eng. Engage) i Odušev-

ljavanje (eng. Delight). Naglasak ovog modela je na neprekidnoj povezanosti proizvođača proizvoda ili pružatelja usluge s kupcem, pri čemu se prodajne i marketinške aktivnosti usklađuju. Kupac se u ovom modelu nalazi u središtu i tako postaje ključan pokretač rasta. Ukoliko je zadovoljan kupljenim proizvodom ili uslugom, može ponoviti kupnju i preporučiti iste okolini u kojoj se kreće. Na taj se način stvaraju nove poslovne prilike i doprinosi stvaranju dodatne vrijednosti za proizvođače proizvoda ili pružatelje usluga (Vazirani & Jaiwant, 2023). Khalik, Siregar i Rosyid (2023) dokazali su da Model zamašnjaka ima pozitivan utjecaj na uspješnost poduzeća svih veličina. Njegova primjena omogućava poduzećima ostvarivanje boljih poslovnih rezultata kao i jaču društvenu prisutnost.

Ipak, ne postoji jedinstveni, generalni pristup prodajnom lijevku koji bi univerzalno bio primjenjiv na sve potencijalne kupce ili grane industrije. Umjesto toga, primjeri uspješnih marketinških pristupa često uključuju kombinaciju različitih modela, prilagođavajući strategije specifičnostima ciljane publike, dinamici tržišta kao i vrsti poslovanja (Grublješić & Čampa, 2016). Kombinirajući modele, marketinški stručnjaci mogu bolje razumjeti i zadovoljiti potrebe kupaca. Međutim, ključno je prepoznati da su zadovoljstvo i lojalnost kupaca povezani s uspjehom poduzeća. Potrebno je odabrati pristup koji donosi profit, ali i stvara temelj za dugoročni odnos s kupcima (Bhardwaj & Sharma, 2024).

Transformacijski prodajni lijevak sa stanjima

Analizom prethodnih istraživanja i modela, razvijen je novi model prodajnog lijevka nazvan Transformacijski prodajni lijevak sa stanjima (Pliško, 2024). Model je prvenstveno namijenjen klasifikaciji ključnih riječi upita pretraživanja u kampanjama oglašavanja. Odnosno razumijevanju prelaska potencijalnih kupaca iz jedne faze prodajnog lijevka u drugu s ciljem usmjeravanja kupaca prema konačnoj konverziji. Naglasak je stavljen na vrste upita koje se mogu pojaviti u pojedinim fazama. Razvijeni model podijeljen je u šest faza. Svaka se faza sastoji od po jednog stanja svijesti potencijalnog kupca i jedne promjene u stanju svijesti. Stanje se svijesti u ovom kontekstu odnosi na informacije i saznanja kojima potencijalni kupac raspolaže te na poticaje i preferencije koje se u njemu javljaju temeljem tih informacija. Za razliku od prethodno analiziranih modela prodajnog lijevka, u razvijenom prodajnom lijevku istaknute su promjene stanja potencijalnog kupca. Oglašivač ima za cilj dovesti potencijalnog kupca do posljednjeg stanja, odnosno konverzije u stvarnog kupca. Kako bi se takav cilj ostvario, oglašivač mora prvo prepoznati u kojem stanju se trenutno potencijalni kupac nalazi. Nakon toga mora u potencijalnom kupcu potaknuti promjenu u sljedeće stanje, sve do posljednjeg stanja. Transformacijski prodajni lijevak jasno ukazuje na promjene koje će u svakom stanju navesti promjenu stanja svijesti potencijalnog kupca. Faze prodajnog lijevka predstavljene su u nastavku.

0. Tabula

Promjena: Ovo je prva faza pa nema promjene iz prethodne faze u ovu.

Stanje: Ova faza nazvana je prazna ploča (lat. tabula rasa), jer to najbolje opisuje stanje svijesti potencijalnog kupca prema oglašavanom proizvodu ili usluzi – on ne posjeduje nikakve informacije o njima.

Opis: Upiti pretraživanja u ovoj fazi su općeniti i ne sadrže proizvod ili uslugu.

1. Svijest (eng. Awareness)

Promjena: Potencijalni je kupac saznao da određeni proizvod ili usluga postoji.

Stanje: Potencijalni je kupac svjestan da proizvod ili usluga postoji, no još nije svjestan namjene tog proizvoda ili nije svjestan kako ostvariti vrijednost koju pruža usluga.

Opis: Upiti pretraživanja u ovoj fazi usmjereni ka otkrivanju namjene proizvoda ili usluge.

2. Potreba (eng. Need)

Promjena: Potencijalni kupac je saznao na koji način mu proizvod ili usluga mogu povećati kvalitetu života (u suprotnom, ukoliko osoba nije ustanovila da joj je potrebna, onda će ta osoba prestati biti potencijalni kupac i napustiti će prodajni lijevak).

Stanje: U ovoj je fazi potencijalni kupac svjestan da mu je proizvod ili usluga korisna i potrebna, no još uvijek nije siguran koju marku preferira.

Opis: Upiti u ovoj fazi mogu sadržavati marke i imena proizvođača. Treba naglasiti da se većina potencijalnih kupaca, nakon konverzije u stvarne kupce (u posljednjoj fazi prodajnog lijevka), vraća u ovu fazu. Ovi, postojeći kupci, uoči sljedeće kupnje još jednom prolaze sve faze u nastavku.

3. Usporedba (eng. Compare)

Promjena: Potencijalni je kupac istražio i usporedio dostupne proizvode ili usluge na tržištu.

Stanje: Potencijalni je kupac u ovoj fazi suzio izbor na mali broj marka proizvođača ili pružatelja usluga, no nije siguran kako kupiti oglašavani predmet.

Opis: Upiti su pretraživanja usmjereni su k pronalaženju više informacija o trgovini ili mjestu gdje se pruža usluga.

4. Odluka (eng. Decision)

Promjena: Potencijalni je kupac istražio kako i gdje može kupiti proizvod ili uslugu.

Stanje: U ovoj je fazi potencijalni kupac već svjestan koje proizvode ili usluge i koje trgovine preferira. No nije se još odlučio na kupnju. Razlozi mogu biti višestruki: dvoji između dva proizvoda ili dvije trgovine ili mu je pak potreban dodatni poticaj, poput popusta.

Opis: Ovo je posljednja faza uoči Kupnje, odnosno konverzije potencijalnog u stvarnog kupca. U ovoj fazi potencijalni kupac posjeduje sve preduvjete za kupnju, odnosno njegov potencijal konverzije je najveći. Stoga se potencijalni kupci u ovoj fazi smatraju najvrjednijima, što opravdava veće troškove oglašavanja u ovoj fazi.

5. Kupnja (eng. Purchase)

Promjena: Potencijalni je kupac kupnjom proizvoda ili usluge konvertirao u stvarnog kupca.

Stanje: Stvarni kupac sada posjeduje i konzumira kupljeni proizvod ili uslugu.

Opis: Dodatne informacije koje postojeći kupac stječe o proizvodu ili usluzi sada prvenstveno proizlaze iz konzumacije kupljenog proizvoda ili usluge te iz daljnje komunikacije s prodavateljem ili proizvođačem (primjerice, sa službom za korisnike). Velika je vjerojatnost da će postojeći kupac ponoviti kupnju, pa je stoga vrijednost njegova izuzetno visoka. U ovoj fazi nema upita pretraživanja. Ukoliko je postojeći kupac zadovoljan kupljenim proizvodom ili uslugom i ima visoku razinu povjerenja u prodava

vatelja ili pružatelja usluge, neće se vraćati u ranije faze prodajnog lijevka (primjerice, neće u fazi Usporedba ponovno uspoređivati postojeće proizvode na tržištu), već će samo ponoviti kupnju. Obzirom da oglašivač već posjeduje mnoge informacije o kupcu, oglašavanje se u ovoj fazi ne mora provoditi kroz plaćene kanale.

Svaka promjena može iz perspektive potencijalnog kupca biti aktivna ili pasivna. Aktivna je ona promjena koju je potaknuo sam potencijalni kupac vlastitim naporima. Pasivna je ona promjena koja je izazvana tuđim naporima, bez inicijalnog poticaja od samog potencijalnog kupca. Primjerice, ako potencijalni kupac samostalno počne tražiti više informacija o nekom proizvodu ili usluzi, to se smatra aktivnom promjenom. S druge strane, ako potencijalni kupac slučajno sazna korisne informacije o proizvodu ili usluzi, to se smatra pasivnom promjenom stanja njegove svijesti. U tom smislu, odluke kupaca mogu biti aktivne ako ih oni donose svjesno, dok su pasivne odluke često potaknute vanjskim aktivnostima poduzeća (Roos & Gustafsson, 2011). U plaćenom oglašavanju se koriste oglasi kako bi se potaknula pasivna promjena u stanju svijesti potencijalnog kupca. Detaljan uvid u strukturu prodajnog lijevka pruža Ilustracija 2.



Ilustracija 2: Transformacijski prodajni lijevak sa stanjima

Izvor: Izradili autori rada

U posljednjoj fazi Kupnja, potencijalni kupac se odriče novca u zamjenu za proizvod ili uslugu. Stoga ova promjena može biti samo aktivna. Pasivna promjena u fazi Kupnja bi predstavljala krađu novca od kupca. Osim toga, postoji učestali primjer zaboravljene registracije. U tom primjeru se osoba pretplati na uslugu s automatskom mjesečnom naplatom. Nakon prestanka korištenja usluge, kupac zaboravi odjaviti pretplatu, pa se naplata nastavi i nakon korištenja. No, da bi se ostvario ovakav primjer pasivne kupnje, neophodno je da mu prethodi aktivni čin preplate. Može se zaključiti da vješt oglašivač može potaknuti potencijalnog kupca na prijelaz kroz sve faze prodajnog lijevka, osim posljednje, koju kupac mora sam ostvariti.

Analiza učinkovitost ključne riječi podrazumijeva stvaranje mehanizma evaluacije putem kojeg oglašivači analiziraju učinkovitost svake svoje marketinške ključne

riječi kako bi osigurali da se zadrže samo učinkovite i profitabilne ključne riječi (Jiang, 2018). Stoga, predstavljeni lijevak služi za razumijevanje ponašanja potencijalnih kupaca, ali i kao alat za optimizaciju digitalne marketinške strategije.

METODOLOGIJA ISTRAŽIVANJA

Za potrebe provjere razumijevanja i praktične primjene Transformacijskog prodajnog lijevka sa stanjima, provedeno je kvalitativno istraživanje metodom polu-strukturiranog intervjua. U istraživanju je sudjelovalo pet ispitanika, odabranih prema glavnom kriteriju njihovog iskustva u području prodaje. Ispitanici imaju između dvije i četiri godine radnog iskustva u struci, a dolaze iz područja maloprodaje, ugostiteljstva, turističkih i tehnoloških usluga. Svoje prodajne aktivnosti obavljaju u Kanadi, Ujedinjenom Kraljevstvu i Hrvatskoj, pri čemu je osigurana raznolikost u pristupu i kontekstu prodajnog procesa. Intervjui su održani online putem video poziva i trajali su između 20 i 25 minuta. Razgovori su uz prethodnu suglasnost ispitanika snimljeni, a potom transkribirani za potrebu daljnje analize.

Ciljevi intervjua bili su sljedeći:

1. Ispitati razumijevanje Transformacijskog prodajnog lijevka sa stanjima
2. Provjeriti način kategoriziranja ključnih riječi u faze prodajnog lijevka (prema percepciji ispitanika)
3. Prepoznati prednosti ili ograničenja Transformacijskog prodajnog lijevka sa stanjima
4. Istražiti postoji li razlika u ponašanju kupaca s obzirom na skupe i jeftinije proizvode
5. Identificirati koje faze predstavljaju ograničenja u procesu konvertiranja u stvarnog kupca
6. Definirati najvažniju fazu u prodajnom procesu

Detaljna analiza provedenog istraživanja prikazana je u nastavku.

Općenito razumijevanje Transformacijskog prodajnog lijevka sa stanjima

Svi ispitanici pokazali su solidnu razinu upoznatosti s pojmom prodajnog lijevka, što potvrđuje njegovu prisutnost u profesionalnoj svijesti. No, kod primjene prodajnog lijevka u poslovnoj praksi uočavaju se razlike. Dva ispitanika, sustavno i svjesno primjenjuju koncept prodajnog lijevka u različitim fazama poslovnog procesa, od planiranja pa sve do razvoja proizvoda, dok drugi pristupaju prodaji intuitivno, ne dovodeći faze prodajnog lijevka u kontekst. Jedan od ispitanika navodi: „Kod planiranja naših kampanja i razvoja proizvoda uvijek se osvrćemo na razinu na kojoj razgovaramo, da li je to riječ o gornjim fazama prodajnog lijevka ili o direktnom pristupu potencijalnom klijentu“. Posebno se ističe kako potencijalni kupci u određenim poslovnim modelima, preskaču faze, vraćaju se unatrag ili ulaze direktno u završne faze. Ispitanici navode, kako su potencijalni kupci sve više samostalni i informirani, zahvaljujući digitalnom okruženju. Ovo zapažanje podupire moderne modele prodajnih lijevaka, gdje se naglašava digitalizacija i promjenjiv put potencijalnog kupca.

Predstavljeni Transformacijski prodajni lijevak sa stanjima ispitanici su ocijenili kao razumljiv i logično strukturiran, što se uklapa u načela Modela hijerarhije učinka. Diferencijacija po stanjima svijesti omogućuje bolje mapiranje potencijalnih kupaca, za

razliku od linearnih modela poput AIDA modela. Ispitanici opisuju model kao “postupan model i logičan redoslijed”, “vrlo intuitivan” i “mislim da kupac tako razmišlja”, čime se potvrđuje da se mogu identificirati s njegovom logikom i da Transformacijski prodajni lijevak odražava stvarne psihološke procese. Važno je istaknuti kako je nova faza modela, Tabula, izazvala posebnu pažnju. Ispitanici primjećuju da ona popunjava prazninu u dosadašnjim modelima jer obuhvaća stanje potpunog neznanja potencijalnog kupca. Ističu sljedeće: „Shvaćam zašto je ta faza dodana, za kupca to znači da on zapravo ne poznaje neki proizvod i nije ni svjestan da mu je dostupan na tržištu...”, „...prati tu liniju od potpunog neznanja o proizvodu i nesvijesti...”. Ova nova faza proširuje razumijevanje početnih faza prodajnog lijevka i predstavlja novi pristup u digitalnoj komunikaciji.

Ključne riječi koje su predstavljene ispitanicima, odabrane su prema logici Transformacijskog prodajnog lijevka sa stanjima, odnosno u skladu s fazama lijevka. Tako se, primjerice, za ključnu riječ u fazi Tabula, pretpostavlja da potencijalni kupci nisu upoznati s pojmom održive odjeće. Kako napreduju kroz lijevak, prikupljaju informacije i njihovo stanje svijesti se mijenja. Odnosno, ključne riječi postaju specifičnije i vode ka krajnjem cilju. U današnjem okruženju, poduzeća sve više primjenjuju strategije održivosti u svom poslovanju zbog rastuće ekološke svijesti kupaca (Elysha, Melita, & Yoestini, 2025). Zbog toga su odabrane ključne riječi koje u svakoj fazi lijevka naglašavaju aspekt održivosti.

Unatoč razumijevanju koncepta Transformacijskog prodajnog lijevka, samo dvoje ispitanika precizno je rasporedilo sve ključne riječi u faze lijevka, dok ostatak pokazuje poteškoće u preciznoj klasifikaciji ključnih riječi po fazama. Razlog tomu dijelom leži u apstraktnosti pojedinih upita pretraživanja, a dijelom u specifičnosti poslovnog konteksta ispitanika. Stoga se ukazuje potreba za dodatnom edukacijom i praktičnim smjernicama za korištenje modela pri klasifikaciji ključnih riječi, kako bi se Transformacijski lijevak uspješnije primjenjivao u različitim prodajnim strategijama. Prema upitima pretraživanja može se odrediti u kojem stanju svijesti se trenutno nalazi potencijalni kupac koji postavlja određeni upit. Točna pripadnost ključnih riječi po fazama lijevka prikazana je u Tablici 1.

Tablica 1: Upiti pretraživanja prema stanjima svijesti

Faza	Primjeri upita pretraživanja
Tabula	Kako odabrati kvalitetnu odjeću?
Svijest	Prednosti održive odjeće
Potreba	Marke održive odjeće
Usporedba	Najpoznatije trgovine održive mode
Odluka	Popust na eko odjeću
Kupnja	–

Izvor: Izradili autori rada

Prilikom predstavljanja Transformacijskog prodajnog lijevka, navedeno je kako posljednja faza, Kupnja, nema upita pretraživanja. Odnosno postojeće kupce nije potrebno prepoznati putem upita pretraživanja. Oglašivač o njima već posjeduje mnogo podataka, primjerice e-mail adresu ili telefonski broj. Stoga, postojeće kupce nije potrebno uhvatiti putem plaćenih oglasa, moguće ih je dosegnuti putem drugih, neplaćenih kanala.

Primjena prodajnih lijevaka u praksi

U skladu s Teorijom ograničene racionalnosti, sudionici navode da ponašanje kupaca varira ovisno o vrijednosti i kompleksnosti proizvoda, ali i o prijašnjem iskustvu. Zanimljivo je da većina ispitanika ističe da se u njihovom prodajnom procesu, skuplji proizvodi brže prodaju od jeftinijih. Navode kako posjeduju bazu stalnih kupaca i da njima nije teško odvojiti određenu svotu novca za određeni proizvod ili uslugu. Odnosno, prodaja jeftinijih i skupljih proizvoda ovisi o visini profita, ali i o osobnim preferencijama. Također, pojavljuje se dimenzija sezonalnosti, dostupnosti proizvoda kao i percepcija kvalitete i efikasnost proizvoda. Faktor sezonalnosti utječe značajno na prodaju, sudionik ističe: „Za vrijeme zime odluka o kupovini je puno brža, dok tijekom ljetnih mjeseci teško je unaprijed prodavati zimske proizvode“, drugi ispitanik također ističe važnost navedenog faktora: „Prodaja ide sporo, iako mislimo da je to i zbog razdoblja u kojem se sad nalazimo, jer ide ljeto i nije tolika zainteresiranost za nešto što je u zimskim mjesecima“. Zaključuje se, kako ova dimenzija vremenskog pritiska upućuje na potrebu za prodajnim lijevcima koji su prilagođeni ovom kontekstu, čime se nadilazi dosadašnje, klasične modele.

U istraživanju su se početne faze prodajnog lijevka identificirale kao točka potencijalnog zastoja što je u skladu s Teorijom ograničenja, naglašavajući tako važnost identificiranja problema kako bi se lakše isti uklonio s ciljem povećanja učinkovitosti strategije. Sudionici naglašavaju da usporedba konkurencije na tržištu uvelike utječe na ponašanje kupaca, mala razlika pri ponudi omogućuje kupcu da selekcijom odabere najbolju opciju. Podijeljena su mišljenja sudionika oko najvažnijih faza prodajnog lijevka, naglašavaju sljedeće: „Teško je izvršiti tu motivaciju za donošenje odluke, finalne odluke.“, „Uvijek je odluka najbitnija jer često kupci sami odrade prijašnje faze“, i „Sve dok oni ne odluče da će odabrati nas, mi nemamo prodaju“. Dakle, većina sudionika naglašava Odluku kao najvažniju fazu, također ističe se faza Potrebe kao presudne. Važno je da kupac prikupljanjem informacija o proizvodu ili usluzi osjeti potrebu, odnosno kako bi mu određeni proizvod mogao riješiti problem ili poboljšati kvalitetu života.

Kada je riječ o prijedlozima za poboljšanje, većina sudionika nije predložila veće izmjene. Iako, neki sudionici naglašavaju da su u njihovom prodajnom procesu gornje faze lijevka često preklapaju, stoga pokušavaju tom problemu pristupiti na način da potencijalnim kupcima pristupaju fizički, a ne digitalnim kanalima. Također, daljnje poboljšanje uviđa se u razradi faze Potrebe po vremenskom okviru, stupnju hitnosti, ali i po prirodi same potrebe kupaca. Razradom navedene faze, kao i ostalim uvidima moguće je dodatno prilagoditi modele prodajnih lijevaka s obzirom na poslovanje, vrstu proizvoda i usluga, ali i dodatnih faktora kao što su emocionalne karakteristike kupaca i cjenovni rang proizvoda.

RASPRAVA I ZAKLJUČAK

Temeljem provedenog kvalitativnog istraživanja, usmjerenog na ocjenjivanje korisnosti Transformacijskog prodajnog lijevka u razumijevanju i optimizaciji prodajnog procesa i prodajnih strategija, dolazi se do sljedećih spoznaja.

Rezultati ukazuju kako je predloženi model prodajnog lijevka percipiran kao razumljiv, intuitivan i primjenjiv model prilikom oblikovanja prodajnih strategija i optimizaciji prodajnih procesa. Transformacijski prodajni lijevak nadilazi linearne modele kao što je AIDA model (Vakratsas & Ambler, 1999) i Model hijerarhije učinka (La-

vidge & Steiner, 1961), dodajući novu fazu Tabulu. Ta faza ocijenjena je kao vrijedan aspekt za poboljšanje prodajnih lijevaka jer omogućuje identifikaciju potencijalnih kupaca u stanju potpunog neznanja o proizvodu ili usluzi. Predstavljeni prodajni lijevak podupire promjenjiv put potencijalnog kupca u skladu s digitaliziranim Modelom 5A (Kotler, Kartajaya, & Setiawan, 2017). Rezultati potvrđuju kako potencijalni kupci često ulaze u kasnije faze prodajnog lijevka ili izlaze iz njega. Ipak, Transformacijski prodajni lijevak nudi sveobuhvatniji uvid za praćenje i razumijevanje faze u kojoj se potencijalni kupac nalazi na temelju pretraživačkih upita, odnosno ključnih riječi.

Iako Lehmann-Zschunke i Ampler (2025) naglašavaju važnost pravilnog svrstavanja ključnih riječi u odgovarajuće faze prodajnog lijevka radi poboljšanja prodajnih strategija, ovo istraživanje ukazuje na određene poteškoće prilikom kategorizacije. Poteškoće većinom proizlaze iz dvosmislenosti ključnih riječi i specifičnosti prodajnog okruženja, što otvara potrebu za dodatnim praktičnim smjernicama za primjenu modela u prodajnim praksama. U skladu s prethodnim istraživanjima (Kalender, Günay, & Vayvay, 2014) i (Katsikopoulos & Lan, 2011) rezultati ovog istraživanja ukazuju da su početne faze prodajnog lijevka, identificirane kao točke mogućeg zastoja za daljnji nastavak putovanja potencijalnog kupca. Nasuprot tome, kasnije faze, Potreba i Odluka prepoznate se kao ključne faze za uspješno zaključavanje kupovnog procesa. Navedeno se povezuje s istraživanjima Terha i suradnika (2023) te Ohiomaha i suradnika (2019), koji naglašavaju važnost prilagodbe prodajnih strategija fazama i potrebama kupaca.

Dok istraživanje Jansena i Schustera (2011) tvrdi da se jeftiniji proizvodi uglavnom kupuju u ranijim fazama prodajnog lijevka, odnosno brže, provedeno istraživanje ukazuje da prodajni proces skupljih proizvoda traje kraće. Ovo se objašnjava utjecajem različitih faktora, kao što je sezonalnost i dostupnost proizvoda i usluga, visina profita potencijalnih kupaca kao i postojanje unaprijed definirane stalne baze kupaca koji točno znaju što žele kupiti.

Zaključno, Transformacijski prodajni lijevak sa stanjima omogućuje dublje razumijevanje potencijalnih kupaca s obzirom na njihovo stanje svijesti. Stoga marketing menadžeri koji se bave digitalnim oglašavanjem mogu dobiti bolji uvid u aktivne i pasivne promjene koje sugeriraju daljnje napredovanje kupaca kroz prodajni lijevak. Također, nudi se praktični okvir za klasifikaciju ključnih riječi u kampanjama oglašavanja čime se poduzećima omogućava osnova za prilagodbu prodajne strategije te uspješnije poslovanje. Kako se sve veći postotak MSP-a okreće online prodaji, korištenjem predloženog modela Transformacijskog prodajnog lijevka sa stanjima osigurava se njihova uspješnost na konkurentskom tržištu.

Zbog malog broja ispitanika rezultati se ne mogu s pouzdanjem primijeniti na širu populaciju. Kvalitativni pristup pruža korisne uvide u percepciju predloženog modela, no ne omogućuje donošenje općih zaključaka. Stoga se interpretacija rezultata treba provoditi s oprezom. U budućim istraživanjima preporučuje se proširenje uzorka na veći broj ispitanika iz različitih ili istih industrijskih sektora kao i dodatno proširenje na geografske regije. Predlaže se korištenje i kvantitativnih metoda, strukturiranog anketnog upitnika za kvantificiranje percepcije modela i jasnoću faza. Također, predlaže se testiranje Transformacijskog prodajnog lijevka u različitim kampanjama digitalnog oglašavanja što bi dovelo do rezultata o metrikama uspješnosti oglašavanja. Posebnu pažnju potrebno je posvetiti fazi Potrebe, koja se pokazala ključnom za prijelaz potencijalnih kupaca prema konverziji. Razradom navedene faze prema određenim kriteriji-

ma, omogućilo bi se bolje razumijevanje ponašanja potencijalnih kupaca i preciznije definiranje aktivnosti za napredovanje kroz lijevak.

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PERCEIVING THE EFFECTIVENESS OF A NEW APPROACH TO SELLING IN A DIGITAL ENVIRONMENT: A CONVERSATIONAL SALES FUNNEL WITH STATES

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Summary: *The constant evolution of digital technologies is significantly changing the way potential customers receive information about products or services. In the digital environment, potential customers rely on various sources of information to sufficiently investigate all the advantages and possible disadvantages of a product or service before making a purchase decision. Their search in the digital environment leads them to advertisements and then to websites or web stores that offer more comprehensive information about the advertised products or services. On the other hand, advertisers use search engines to passively influence potential customers to take further steps in the purchase decision process through carefully crafted advertisements. To better understand the behavior of potential customers and their path through the different stages of the sales funnel, depending on the types of search queries they enter into web search engines, a Conversational Sales Funnel with states was developed. This model consists of six clearly defined stages, including a new initial stage, Tabula. Unlike previous sales funnel models, this stage represents a state of complete ignorance about the product or service. Each subsequent stage consists of a state of awareness of the potential customer and a change of state of awareness. The key for the advertiser is to recognize the state of awareness of the potential customer and persuade the potential customer to change. The primary research conducted concludes that sales professionals have a general understanding of the Conversational Sales Funnel and emphasize that the model accurately reflects real-life customer behavior during the purchasing decision process. The results of the research show that the proposed new approach to the sales funnel in the digital environment is used by sales professionals, but its application is still intuitive. The application of the sales funnel depends on the context, i.e. the specifics of the sales environment, the type of products or services, the complexity of the sales process and the target customers. Therefore, in order to promote a broader and more conscious application of the Conversational Sales Funnel in the creation and optimization of sales strategies, there is a clear need for further training of sales professionals, as well as practical guidelines for classifying search queries into the appropriate stages of the sales funnel. This is particularly important given the different industries in which the behavior of potential customers can vary greatly. To summarize, while sales professionals point out the usefulness of the suggested modification of the sales funnel, the individual stages of the Conversational Sales Funnel need to be adjusted depending on the type of business, factors such as seasonality and preferences of potential customers. Adapting the Conversational Sales Funnel according to certain guidelines would contribute to better overall results for the company.*

Keywords: *potential customers, digital environment, Conversational Sales Funnel with states, search queries, sales professionals*

JEL classification: M30, M31, M37



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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

THE ROLE OF POLITICS AND SIGNIFICANT FACTORS IN THE DEVELOPMENT OF FEMALE ENTREPRENEURSHIP IN BOSNIA AND HERZEGOVINA AND THE RUSSIAN FEDERATION

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Abstract: *This article discusses topics such as the influence of the state and other factors, which significantly influence the development of female entrepreneurship in Republic of Srpska, Bosnia and Herzegovina and the Russian Federation. The authors considered various issues related to research, the most important of which are related to the measures defined by both entities and national policies, to help create the best possible environment for development. In this connection, a hypothesis has been defined: State incentives are sufficient for the development of female entrepreneurship. Research was conducted in Republic of Srpska and Bosnia and Herzegovina, the most significant results of which are presented in the work. All relevant data, which indicate the importance and encouragement of female entrepreneurship in the Russian Federation, were also explored. In conclusion, it is stated that it is necessary to improve the policies that deal with this type of entrepreneurship in both countries to ensure sustainable growth.*

Key words: *Economic Development, Female Entrepreneurship, International Relations*

JEL classification: *J16, L26, O57, P48, M13*

INTRODUCTION

Recognition of the importance of the development of female entrepreneurship and its overall contribution to economic development is increasingly present at the global level. Entrepreneurship in a broader sense encourages the creation of new jobs, which is particularly important for the economy and for the entire economy of Bosnia

and Herzegovina (BiH). Young women and youth are the most common categories when analyzing unemployment (Novaković, Milovanović, & Škorić, 2024). This is confirmed by the data of the Agency for Statistics of Bosnia and Herzegovina, where it is stated that the country has the lowest rate of participation of women in the labor force in Southeast Europe (Agency for Statistic of Bosnia and Herzegovina, 2025) (Novakovic et all, 2025) From the above, it can be concluded that female entrepreneurship can represent a productive outlet for highly educated but underutilized talents. This paper analyzes the state of female entrepreneurship in the constituent parts of Bosnia and Herzegovina (the Republic of Srpska entity, the Federation of Bosnia and Herzegovina entity and Brčko District). Female entrepreneurship plays a significant role in improving and strengthening the social status of women, who, apart from challenges in the business environment, face a number of additional obstacles. They include difficulties in harmonizing family and professional obligations, limitations in realizing the right to property, due to the patriarchal principle, and concluding contracts. Women still have difficult access to the labor market and self-employment opportunities (Milovanović, Dušanić-Gačić, & Novaković, 2024). The importance of women's entrepreneurship was institutionally recognized through the establishment of councils for women's entrepreneurship at local chambers of commerce, as well as the central council for women's entrepreneurship at the Chamber of Commerce of the Republic of Srpska (Chamber of Commerce of the Republic of Srpska, 2025). The goal of these councils is to improve the representation and status of women in entrepreneurship through proposing legal measures, networking women entrepreneurs, providing information, support in project development, proposing professional training and applying the principle of gender equality. Entrepreneurship is an important driver of innovation, which in turn stimulates economic growth (Novaković, Peulić, & Matijević, 2020) (Novaković, Milovanović, & Škorić, 2024). Women who start entrepreneurship in Bosnia and Herzegovina mostly found micro-enterprises or craft shops (52%), limited liability companies (21%), home production (5%) or agricultural activities (5%). The same data show that 84% of women-owned businesses employ between one and five people. According to the data of the BiH Statistics Agency from 2023, the employment rate of women aged 20 to 64 was 40%, while for men of the same age group it was 67.7%, which indicates a gender gap in employment of 27.7 percentage points (Agency for Statistic of Bosnia and Herzegovina, 2025). In 2022, less than half of women (43%) with children under the age of six were employed full-time. Socially prescribed gender roles are the causes of lower rates of employment and activity among women. According to them, it is assumed that women have the primary responsibility for taking care of the family. In support of the above, research by the BiH Agency for Gender Equality on the impact of the gender division of household chores also speaks. It is shown that in 93.8% of partnerships, routine household tasks are performed by women, although there is a more even division in relation to childcare and occasional household chores. Bosnia and Herzegovina lags behind the countries of the region, especially when it comes to the procedures and time needed to establish a business (Agency for Gender Equality of Bosnia and Herzegovina, 2025). Long registration processes, bureaucratic formalities and political instability contribute to high costs and systemic inefficiency, which discourages the establishment of formal businesses and pushes many entrepreneurs into the shadow economy (Milovanović, Novaković, & Tsanov, 2024). On the other hand,

the specificity of female entrepreneurship in Russia is reflected in the degree of readiness of women to engage in entrepreneurial activities. In capitalist countries, this was historically hindered by the ideology of women as homemakers, while in the USSR the dominant ideology encouraged the emancipation of women and their inclusion in the system of social production. However, Russian women did not show a higher level of entrepreneurial activity compared to women in Western countries (Vasilevich Taranuha, 2024). Tatyana Ilyushnikova, Deputy Minister of Economic Development of the Russian Federation, pointed out that the main challenges in the development of female entrepreneurship are the lack of initial capital and insufficient knowledge about establishing a business. In order to overcome these obstacles, the Ministry of Economic Development of the Russian Federation implemented support measures within the national project for the SME sector. Today, female entrepreneurs have at their disposal general support programs, as well as specialized initiatives aimed at female entrepreneurship. According to available data, today in the Russian Federation there are 4.22 million registered individual entrepreneurs, of which 1.75 million are women. It is commendable that the participation of women among individual entrepreneurs has been stable in recent years. It amounts to 41.5%, according to data from the Corporation for Small and Medium Enterprises. Also, 4.96 million women are self-employed, which is 44.5% of the total number of self-employed persons. Some of the reasons why women in the Russian Federation are less likely to start their own businesses are lack of self-confidence and limited access to resources are the main reasons, regardless of equal education and women's interest in entrepreneurship compared to men. Government initiatives and digital tools provide some opportunities to encourage female entrepreneurship, but there is still a need for coordinated and multidimensional policies. To unlock the full potential of women in the SME sector, systematic research, local support and the fight against gender stereotypes are key (Nechemias & Bahry, 2021).

OVERVIEW OF STRATEGIC DOCUMENTS - BOSNIA AND HERZEGOVINA

The *Gender Action Plan of Bosnia and Herzegovina for the period 2023-2027* outlines specific measures aimed at eliminating gender-based discrimination in employment, labor, and the labor market, and at ensuring equal opportunities for women and men in access to economic resources (Gender Center of the Government of the Federation of BiH, 2023). This includes poverty reduction through the implementation of new macroeconomic and development strategies. One of the key measures involves identifying priority laws and conducting gender analyses of strategies, action plans, programs, and other legal acts in the field of labor, employment, and access to resources. The goal is to incorporate international and domestic standards on gender equality and to determine shortcomings, advantages, actual needs, and possibilities from the gender equality perspective. Another important measure is the support for research and programs aimed at improving the position of women in the labor market and in social and economic life, such as issues related to part-time employment, career breaks, and wage and pension gaps. The implementation of the *Strategy for the Development of Women's Entrepreneurship of the Republic of Srpska (RS) for the period 2019-2023* enabled strong coordination in the area of women's entrepreneurship, including a detailed situational analysis along with activities in fields that influence women's entrepreneurial engagement (Chamber

of Commerce of the Republic of Srpska, 2019). Support for women entrepreneurs in the Republic of Srpska is included in the *SME Development Strategy of the Republic of Srpska 2021-2027* (Government of Republic of Srpska, 2021). In addition, government representatives are working on the *Strategy for the Development of Women's Entrepreneurship RS for the period 2025-2030*, aimed at securing support for women's entrepreneurship through a variety of short- and long-term priorities and measures, including training, promotion, and financial and institutional support.

Several strategic projects have been identified, including: Establishing associations of women entrepreneurs; Creating a database of women entrepreneurs in the Republic of Srpska; Developing a specialized e-platform for women entrepreneurs; Building a network of entities engaged in traditional crafts; Establishing an annual exhibition of traditional handicrafts; Publishing documents relevant to the preservation of traditional crafts in the Republic of Srpska; Adopting a strategic document in the field of creative industries.

The *Action Plan for the Improvement of the Position of Rural Women in RS (2022-2024)* has also been implemented, including developed programs, measures, and monitoring indicators, with clearly defined responsible institutions (Regulation on the Conditions and Manner of Providing Financial Incentives for the Development of Agriculture and Rural Areas, 2025). (Agency for Statistic of Bosnia and Herzegovina, 2024)

The Rulebook on Conditions and Methods for Obtaining Financial Incentives for Agricultural and Rural Development, as well as the Rulebook on Capital Investments, have been revised to be more gender-sensitive. These changes have enabled women to access funding for capital investments and receive support for women's associations in rural areas for business development and agricultural product procurement (Government of Republic of Srpska, 2024).

At the level of the Federation of Bosnia and Herzegovina, women's entrepreneurship is addressed through several key documents: the *Development Strategy of the Federation of BiH 2021-2027*, the *Strategy for Agriculture and Rural Development 2021-2027*, and the *Employment Strategy of the Federation of BiH 2021-2027*. These documents recognize the underrepresentation of women in the active labor force and emphasize the need for the implementation of specific measures and programs (e.g., digital literacy education, entrepreneurship training) to motivate women to become more actively involved across all sectors of the labor market (Parliament of the Federation of BiH, 2021a) (Parliament of the Federation of BiH, 2022b).

The Ministry of Agriculture, Water Management and Forestry, together with the Ministry of Development, Entrepreneurship and Crafts of the Federation of BiH, has been working on strengthening women's entrepreneurship in six municipalities, and has developed a systemic model for women's entrepreneurship development, applicable across all municipalities in the Federation of BiH. Women entrepreneurs' clubs were established in these six municipalities, and expert teams were appointed, comprising municipal officials, women entrepreneurs, and civil society representatives, with the aim of creating favorable conditions for entrepreneurship development, especially women-led businesses (Parliament of the Federation of BiH, 2021c). The growing number of active entrepreneurs in Bosnia and Herzegovina suggests a gradually improving economic climate for business. According to a study conducted by the Global Entrepreneurship Research Association in 51 countries and territories, female

entrepreneurs are particularly prevalent in middle-income countries such as Ecuador, Guatemala, Jordan, and Thailand, as well as in developed nations like Saudi Arabia. High-income countries in the Americas - Canada, Chile, and the United States-also outperform their European and East Asian counterparts in terms of female entrepreneurial activity. In many developed European countries, the rate of female entrepreneurship remains very low, as it does in some Asian countries. Entrepreneurial activity in low and middle-income countries is often referred to as necessity-driven entrepreneurship, which typically arises due to the lack of formal employment opportunities. In contrast, in developed countries, innovation-driven entrepreneurship coexists with well-established formal labor markets. Nonetheless, within both economic models, there are vast differences in women's entrepreneurship rates.

For instance:

- 32% of adult women in Ecuador engage in entrepreneurial activity,
- Around 20% in Jordan start their own businesses,
- While Egypt (2.6%) and China (4.9%) report significantly lower rates,
- Poland (2.3%) has the lowest female entrepreneurship rate among all countries surveyed, just ahead of Egypt, China, Romania (3.7%), and Hungary (4.9%).
- Compared to other middle-income countries, India recorded a relatively low rate of around 10.3%, slightly higher than Germany and South Korea.

However, gender gaps in entrepreneurship are generally smaller in developing countries than in developed ones, where men are 50% to 100% more likely to engage in entrepreneurship than women. A larger gap may also signal greater labor market inequality. In South Korea, a country with a traditional corporate culture, the rate of female entrepreneurship has recently increased in response to limited career opportunities for women. This factor may also influence higher rates of women entrepreneurs in traditional Muslim nations of the Gulf, where structural barriers have led to alternative paths through entrepreneurship. The *Development Strategy of the Brčko District of Bosnia and Herzegovina 2021-2027* specifically recognizes the importance of women's entrepreneurship through Measure 1.1.2, which envisions systemic support for female entrepreneurs, including incentives and development programs aimed at improving access to capital and education. Within Measure 1.5.2, the need to employ hard-to-employ categories, including women, is emphasized, particularly through support for self-employment initiatives. These measures are intended to increase women's economic participation and to promote gender equality in the economic sphere of the Brčko District (BiH Assembly of Brčko District, 2021).

RESEARCH IN BOSNIA AND HERZEGOVINA

To examine the proposed hypothesis - "*The incentive measures provided by the state are sufficient for the development of women's entrepreneurship*" - a survey was conducted among women. The research was carried out during January and February 2025. A questionnaire was distributed to participants in electronic format. The questionnaire consisted of 11 questions, including inquiries related to age and educational background. The core questions relevant to the research topic addressed the perceptions of female entrepreneurs regarding institutional support for women entrepreneurs, as well as which measures, in their opinion, contribute most significantly to the development of women's entrepreneurship.

Table 1. Age structure of female participants in the study conducted in Bosnia and Herzegovina

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-25	3	5.0	5.0	5.0
	26-35	12	20.0	20.0	25.0
	36-45	21	35.0	35.0	60.0
	46-55	23	38.3	38.3	98.3
	55+	1	1.7	1.7	100.0
	Total	60	100.0	100.0	

Source: Author's analysis conducted in SPSS

The table 1. presents the age structure of female participants in the study conducted in Bosnia and Herzegovina, with the majority (38.3%) falling within the 46-55 age group, while the smallest proportion (1.7%) are aged 55 and above. The cumulative percentage indicates that as many as 98.3% of the respondents are under the age of 55, highlighting a strong representation of the working-age population in the sample.

Table 2. Level of education obtained by participants in the study

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Doctor of Science	7	11.7	11.7	11.7
	Faculty	36	60.0	60.0	71.7
	High school	5	8.3	8.3	80.0
	Master	7	11.7	11.7	91.7
	Master's degree	5	8.3	8.3	100.0
	Total	60	100.0	100.0	

Source: Author's analysis conducted in SPSS

The table 2. displays the educational qualifications of participants in the study, indicating that the majority (60%) hold a faculty-level degree. Additionally, 11.7% of participants have obtained a doctoral degree, while the cumulative percentage shows that 91.7% of respondents possess qualifications at or above the master's level.

Table 3. Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
How do you assess the support of institutional programs for women entrepreneurs in your country? * What institutional measures do you believe would contribute most to the development of women's entrepreneurship:	60	100.0%	0	0.0%	60	100.0%

Source: Author's analysis conducted in SPSS

The table 3. provides an overview of the complete dataset used in the chi-square test analysis. As shown, a total of 60 responses were analyzed for questions nine and

eleven, indicating that there are no missing data entries. This is further supported by the absence of any values in the ‘Missing’ column.

The table 4. presents the relationship between the perception of institutional support programs for women entrepreneurs and opinions on which institutional measures would most effectively contribute to the development of women’s entrepreneurship. The majority of respondents who rated the support as poor (29 out of 39) believe that financial grants are the most important measure. Respondents who assessed the support as satisfactory also predominantly indicated financial grants (14 out of 18), while significantly fewer considered more favorable loan conditions or mentoring to be the key factors.

Table 4. Crosstabulation

9. How do you assess the support of institutional programs for women entrepreneurs in your country? *
11. What institutional measures do you believe would contribute most to the development of women’s entrepreneurship: Crosstabulation

		Count			Total
		What institutional measures do you believe would contribute most to the development of women's entrepreneurship:			
		financial grants	loans with more favorable interest rates	mentoring	
How do you assess the support of institutional programs for women entrepreneurs in your country?	bad	29	6	4	39
	good	2	0	1	3
	satisfactory	14	1	3	18
Total		45	7	8	60

Source: Author’s analysis conducted in SPSS

In the table 5. we can see that the Pearson chi-square is 0.598, so there is a relationship between opinion “How do you assess the support of institutional programs for women entrepreneurs in your country?” and “What institutional measures do you believe would contribute most to the development of women’s entrepreneurship”. The hypothesis suggesting that state-supported incentive measures are adequate for the development of female entrepreneurship has been rejected.

Table 5. Chi-Square Test

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.764 ^a	4	.598
Likelihood Ratio	2.958	4	.565
N of Valid Cases	60		

a. 6 cells (66.7%) have expected count less than 5. The minimum expected count is .35.

Source: Author’s analysis conducted in SPSS

NATIONAL SUPPORT STRATEGY IN THE RUSSIAN FEDERATION

As President Vladimir Putin noted in 2018, the SME sector in the Russian Federation remained relatively underdeveloped. Moreover, a gender gap in entrepreneurship

persisted. Few government programs were specifically targeted toward women, and where such programs did exist, they were predominantly sponsored by Russian NGOs, international donors, or certain Western countries (Izyumov & Razumnova, 2000). In accordance with Presidential Decree No. 204 of May 7, 2018, titled “*On National Goals and Strategic Objectives of the Development of the Russian Federation through 2024*”, the Ministry of Economic Development of the Russian Federation designed a national project entitled “*Small and Medium Enterprises and Support for Individual Entrepreneurial Initiatives*” (hereinafter referred to as the national SME project). This initiative provided subsidies to regional subjects for the implementation of defined support measures. One of its central components was the establishment and development of *My Business* centers across the Federation. Today, the *My Business* network includes 84 institutions operating in nearly all federal subjects, with the exception of Moscow, supported by a widespread municipal service network. These centers function as integrated service hubs for SMEs, the self-employed, and individuals interested in launching entrepreneurial ventures. Based on the “one-stop shop” principle, they provide users with access to a range of institutional support mechanisms in one place. These include centers for entrepreneurship support, innovation in the social sphere, preservation of traditional crafts, regional engineering and prototyping, export promotion, and financial institutions (guarantee and microfinance organizations), among other relevant structures (My business, 2025). Since 2021, *My Business* centers have offered integrated services tailored to existing SMEs and residents of industrial and tech parks. These bundled services combine at least two interrelated forms of support and consulting, educational, or innovation-based designed to enhance business operations and stimulate growth. Their composition is determined individually based on the specific needs of each client.

Currently, six million women in the Russian Federation operate their own businesses, accounting for 44% of all entrepreneurs and self-employed individuals. In the previous year alone, 1.4 million women started new businesses. The federal *Mom Entrepreneur* program has contributed significantly to this trend, aiming to ease women’s entry into business and help them overcome common barriers-lack of knowledge, confidence, and start-up capital. The program targets women aspiring to develop entrepreneurial initiatives and provides comprehensive support throughout the business ideation process. It includes education in business and product marketing, development of sustainable market strategies, financial planning, profitability assessments, and breakeven analyses. Through workshops and mentoring, participants also gain skills in public speaking and pitching key to preparing for market entry and investor engagement. Moreover, the program fosters networking and mutual support among participants, helping build a sustainable community of aspiring women entrepreneurs (Mother entrepreneur, 2025).

The trend of gender rebalancing in entrepreneurship is increasingly leaning toward women. Digital marketplaces play a crucial role in this, allowing young mothers on maternity leave to earn income and contribute to household finances while offering a safe business entry point. The program’s effectiveness is evident: over the past ten years, it has facilitated more than 8,000 business projects, and 74% of participants rated it as beneficial. In the previous year alone, 3,500 women completed training. The program’s success is largely attributed to a committed implementation team, with

the Ministry of Economic Development overseeing national coordination and regional delivery managed through the *My Business* centers (Ministry of Economic Development of the Russian Federation, 2025). The SME Corporation (SME Corp), a federal agency established in 2015 to foster SME development, introduced in 2017 a special loan guarantee program for women entrepreneurs (Nechemias & Bahry, 2021). Additionally, the *National Strategy for Women 2017-2022* included measures to promote women's entrepreneurship, encourage professional education in high-tech industries, strengthen SMEs, and engage women in social entrepreneurship infrastructure. It also supported vocational training for women on maternity leave and those in need of re-skilling or upskilling, encouraged self-employment, and established resource centers for socially oriented non-profit organizations and innovation hubs in the social sector. The strategy also introduced specialized grant mechanisms and entrepreneurship competitions aimed at involving women in high-tech and innovation sectors across Russian regions (Besschetnova, Volkova, & Ostavnaja, 2021).

STRUCTURAL BARRIERS AND GENDER POLICY

As in Bosnia and Herzegovina, gender segregation in professions remains an issue in the Russian Federation, rooted in deeply ingrained societal stereotypes about the suitability of certain professions for men and women. Public discourse still reflects beliefs that women are naturally more suited for caregiving roles, resulting in their predominance in health and social care sectors such as nursing and social work. Concurrently, men are perceived as natural leaders, which privileges them in managerial and executive roles. According to Besschetnova, Volkova, and Ostavnaya (2021), key causes of gender-based occupational discrimination in Russia include an underdeveloped market economy, unequal employment conditions, low female representation in politics and business leadership, the burden of domestic responsibilities, and entrenched patriarchal beliefs. Their research found that women's entrepreneurial motivations at the regional level were primarily driven by material and professional incentives, aiming to improve quality of life, promote personal development, and acquire new skills.

Available data indicates that women in the Russian Federation are heavily represented in socially significant but lower-paid sectors: education (82.4%), health and social services (around 80%), hospitality (73.5%), culture and sports (65.7%), and retail (61.6%). In contrast, women are underrepresented in construction (12.2%) and mining (16.8%). In the IT and communications sector, women constitute about one-third of the workforce, yet it remains one of the highest-paying sectors for women. Although men still dominate numerically in entrepreneurship, the gender gap is gradually narrowing: women accounted for 46.2% of individual entrepreneurs in March 2022, 46.4% in March 2023, and 46.9% in March 2024 (SKB Kontur, 2024).

Following Presidential Decree No. 309 of May 7, 2024, titled "*On National Development Goals of the Russian Federation through 2030 and Beyond to 2036*," the Ministry of Economic Development initiated the creation of a new passport structure for the federal SME project. Its main objective is to achieve real income growth per SME employee at a rate 1.2 times higher than GDP growth.

Between 2019 and 2024, numerous support mechanisms were developed under the national project, including financial tools and regional infrastructure, significantly contributing to employment in the SME sector. For the 2025-2030 period, the *Efficient*

and *Competitive Economy* project will continue supporting SMEs, adapting measures to current challenges with a focus on qualitative transformation. This includes further industrial infrastructure development, with plans to build at least 100 industrial, technology, and business parks across Russia.

The overarching aim is to stimulate SME growth in priority economic sectors and facilitate business scaling-from micro to small, and small to medium-sized enterprises. Planned measures include directing financial resources to priority sectors, maintaining and modernizing SME infrastructure (e.g., *My Business* centers), and expanding the capabilities of the SME.RF digital platform (also available as an app¹)

By 2030, the goal is for at least 0.8% of SMEs to scale up into the next business category and for 80% of users to express satisfaction with infrastructure services (e.g., industrial parks, business centers, and digital platforms). According to the Ministry of Economic Development, key results include broader financial access for SMEs in priority sectors, preferential loans, regional guarantee mechanisms (covering up to 70% of loan amounts), and concessional funding via state microfinance institutions.

Moreover, the reach of SME support services will increase through the establishment of 100 business and industrial parks, accommodating 2,000 SMEs and reducing production setup costs. A flexible support mechanism based on lessons learned between 2019-2024 will cover all Russian federal subjects and be guided by project-based competition. More than 900,000 users are expected to receive support from infrastructure organizations, with over 3.5 million services delivered via the SME.RF digital platform. Additionally, the BRICS alliance has launched a digital platform for women's entrepreneurship, initiated in 2021 by the Russian branch of the alliance. This platform facilitates cross-country business matchmaking, knowledge exchange, and cultural engagement. Its design considers each member country's socio-cultural context and aims to simplify collaboration on joint projects and integrate new participants into the global women's entrepreneurship ecosystem (16th BRICS Summit, 2024). Regarding the research hypothesis stated at the beginning: *The incentive measures provided by the state are sufficient for the development of women's entrepreneurship*, based on the conducted research, it can be concluded that this hypothesis may be accepted in the case of the Russian Federation.

CONCLUSION

Female entrepreneurship in Bosnia and Herzegovina and the Russian Federation faces similar challenges, including gender stereotypes, limited access to capital, and lack of institutional support in the early stages of business development. In the first part of the work, the various factors, influences, and obstacles that women in Bosnia and Herzegovina face when they start or are already engaged in female entrepreneurship are presented. Regardless of educational level, and the research shows that the largest number of surveyed women are highly educated, the representation of women is still low. There is will and interest, but the support of the state and competent institutions is not enough. In this regard, the hypothesis that state incentive measures are appropriate for the development of female entrepreneurship has been rejected. Also,

1 Application My business. Accessed: March 04, 2025
<https://play.google.com/store/apps/details?id=ru.msp.rf.app&hl=hr>

non-reimbursed financial support is the most important for entrepreneurs, and only then loans with more favorable interest rates. Due to the complex territorial and the political situation in Bosnia and Herzegovina, the division into entities (the Republic of Srpska and the Federation of Bosnia and Herzegovina) and the Brčko District, the Strategies, which are inconsistently implemented, are considered separately.

In the Russian Federation, progress in the development of female entrepreneurship was initiated in 2018 by Decree No. 204 of President Vladimir Putin. Progress was made through a large number of strategic initiatives and implemented programs. This decree also defined the goals for the progress of the small and medium-sized enterprises (SME) sector, with a special focus on helping women's entrepreneurship. Network of centers called "My Business" was established, and women were provided financial and educational assistance. Special mention should be made of the "Mama Entrepreneur" program, which also connected future female entrepreneurs through a mentoring approach, education, and necessary knowledge.

The next significant step was again taken by the President with Decree No. 309 from 2024. It defines goals that include income growth in the sector of small and medium enterprises until 2030 and presents a perspective until 2036. The BRICS initiative, through the development of digital networking platforms for women, is also significant. What is common to both observed countries is gender stereotypes, on the one hand, and professional segregation, on the other, which together prevent women from entering and progressing in the field of entrepreneurship. This is why it is important to consistently and persistently implement the adopted measures, as well as to continuously monitor them.

The authors are aware of the complexity of the topic and its importance in modern society, so it is planned to continue cooperation with the academic community, as well as political institutions in both countries. New research and a deeper analysis of the Strategy, through the dynamics of their implementation, are planned in order to improve the status of women entrepreneurs. This would mean new international cooperation and the creation of more efficient models of support for female entrepreneurship.

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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

BUSINESS INTELLIGENCE MODEL FOR MULTIDIMENSIONAL ANALYSIS OF THE INSURANCE MARKET BASED ON OPEN DATA

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Abstract: *This paper explores the role of open data and business intelligence (BI) in analyzing the insurance market, with a specific focus on Bosnia and Herzegovina. Using available vehicle registration data, a system has been developed that enables territorial and temporal analysis of insurance companies' market shares. The system contributes to making informed business decisions through an overview of key indicators, such as the number of policies issued, changes compared to previous periods, and the geographic distribution of the market. The use of open data has enhanced transparency, accessibility, and repeatability of analysis, thereby encouraging broader adoption of analytical tools. The system does not require advanced analytical knowledge from users but facilitates result interpretation through visual indicators and automated reports. In addition to presenting the existing solution, the paper proposes expanding the system through the application of artificial intelligence, including predictive analysis, market segmentation and identification of customer churn risk. The proposed model shows how open data can serve as the basis for powerful BI systems, accessible even to smaller organizations, with the potential for wider application in the public sector, industry and scientific research. This paves the way for intelligent business analytics that support strategic decision-making, improve efficiency, and promote the development of data-driven practices.*

Keywords: *business intelligence, artificial intelligence, open data, analytics, insurance*

JEL classification: *C88, G22, L86, C81, O33*

INTRODUCTION

Business intelligence (BI) is widely applied across various business functions, including marketing, sales, finance, and operations, to support data-driven decision-making and enhance performance. As BI continues to evolve, emerging technologies and trends significantly influence its implementation within organizations (Kilanko, 2022). It relies on a combination of tools and methods to collect data from internal and external sources, transform it into actionable insights, and present it in a comprehensible format for decision-makers (Kilanko, 2023). The growing importance of processing both structured and unstructured data has led to advancements in data visualization and reporting tools, enabling more interactive and personalized insights (Mungoli, 2023). The integration of Big Data and artificial intelligence into BI systems has further improved analytical capabilities and operational efficiency (Bharadiya, 2023; Bickley, 2025). Over time, BI systems have progressed through four generations, culminating in intelligent business analytics (IBA) that enable real-time, AI-driven decision-making. These advanced systems embed analytics directly into business processes, allowing managers to act on system-generated recommendations without requiring deep analytical expertise, thus improving responsiveness to market dynamics (Azvine, 2003; Sun, 2022). Today organizations face increasing pressure to make timely decisions based on large volumes of data. This is particularly relevant in the insurance sector, where market complexity, strong competition, and evolving client expectations demand accurate and agile decision-making. Analyzing market share by geographic regions and over specific time periods is essential for strategic planning and operational control. This paper presents the development of an application for insurance market analysis in Bosnia and Herzegovina, with a focus on territorial (municipality, canton, entity, country) and temporal dimensions (current year versus previous year). The application provides insights into market shares and their trends over time, thereby supporting more informed managerial decisions. The theoretical foundation of the work is based on the principles of business intelligence, decision support systems, performance management, and geographic analytics.

THEORETICAL BACKGROUND

Business Intelligence (BI) implies the process of identification of the informational needs of decision-makers, collecting relevant data in a legal and ethical manner, and its analysis and delivery in a secure and applicable form (Klepić, 2020). In combination with Industry 4.0 technologies, BI contributes to the increase in competitiveness, operational efficiency, and decision-making quality (Kongthanasuwan, 2023). BI systems enable the identification of trends, patterns, and anomalies, and in the context of insurance market analysis, they make the visualization of market shares across territorial and time dimensions, and the recognition of growth potential easier.

Open data is defined as information available to everyone without legal or technical restrictions (Kitchin, 2014), with its key advantage lying in enhanced transparency, with the obligation to respect ethical and legal standards (Huber, 2022; Jetzek, 2014; Weerakkody, 2017). In the BI context, open data provides insight into market flows and customer behavior, and through the application of advanced analytical methods (e.g., machine learning, predictive analytics), it supports data-driven decision-making (Stodolsky, 1982). For example, the analysis of vehicle registration data and insurance

premiums can stimulate the development of risk assessment models in the insurance sector (IDDEEA & Agency, 2025). Open data also enables the verification and replication of analytical procedures, thereby increasing trust in the system and facilitating the development of similar solutions, especially for smaller organizations without access to proprietary databases and expensive tools.

By utilizing open data, analytical results can be replicated and verified, which boosts trust in the system and encourages the development of similar solutions in other contexts. This also reduces dependency on closed, commercial data sources, which is particularly important for small and medium-sized organizations lacking access to costly analytical tools or internal data repositories. In this approach, the BI system evolves toward open business intelligence, where the data foundation comes from publicly available sources, and analytical capabilities become accessible to a wider user community. In the context of the insurance industry, there are numerous publicly available sources of information, but publications from regulatory bodies in the insurance sector are particularly important. These publications provide both an overview of the historical development of the market and insights into its current state. In this case, open data from the Agency for Identification Documents, Registers and Data Exchange (IDDEEA) is used for analyzing the insurance market in Bosnia and Herzegovina (IDDEEA & Agency, 2025). The next chapter explains what IDDEEA is, how it collects data, and how that data was acquired and processed for business purposes.

Decision Support Systems (DSS) are defined as computer-supported systems that help managers process structured and unstructured data (Gorry, 1971; Stodolsky, 1982). Later upgrades (Liang, 2011; Sprague, 1980) incorporate BI functions such as multidimensional analysis and interactive visualizations. The application presented in this paper is based on these principles: it enables tracking of key market indicators across administrative units (e.g., municipality, canton) and visual coding of changes (e.g., red—decline, green—growth), allowing users to make fast and intuitive decisions without advanced analytical knowledge.

Socio-technical systems theory (Emery, 1959) emphasizes the importance of balance between technical solutions and human interaction. In accordance with this theory, the application is designed to increase the accessibility of analytical insights and to facilitate the use of BI systems among non-technical users. This is also linked to the concept of cognitive offloading (Risko, 2016), which involves passing on parts of the thinking process to external systems—in this case, analytical software that transforms data into productive insights.

In the context of decision-making under uncertainty (Simon, 2013) Decision Support Systems (DSS) assist managers in taking action despite incomplete information and limited cognitive capacities (Humphreys, 2013). The Business intelligence (BI) model developed in this study reduces the level of uncertainty by integrating visual and quantitative indicators. The use of geographic data in business decision-making is based on the concept of location intelligence, which is considered a part of the broader BI framework. Analyzing data by geographic units (e.g., municipality, county) enables targeted decision-making for specific regions and the recognition of regional trends in the insurance market.

Finally, the theory of information value (Lambe, 2011) emphasizes that information holds real value only when it contributes to more effective decision-making.

The BI system developed in this study confirms this theory by transforming open data into contextualized information that serves as a foundation for strategic and operational business decisions.

ANALYSIS OF THE BI MODEL FOR OPEN DATA PROCESSING

One of the key features of the developed system is its reliance on open data - publicly available datasets published by government institutions and regulatory bodies. Open data represents an important starting point for creating analytical systems that are scalable, transparent and accessible to various stakeholders, including the private sector, academia and public organizations (*Janssen et al., 2012*).

The Agency for Identification Documents, Records, and Data Exchange of Bosnia and Herzegovina (IDDEEA) regularly publishes data on registered vehicles, which is publicly available on its official website. You can see the data structure in Table 3.

This data comes in handy for a detailed analytics affair in the insurance market within the space of the country, indicating numerous aspects with regard to insured vehicles and their policies.

Table 1. Structure of data published in the IDDEEA bulletin

Column	Description
Request Type	Request type codebook
Registration Location	Municipality codebook in BiH
Vehicle Brand	Vehicle brand codebook
Vehicle Type	Vehicle type codebook
Vehicle Model	Vehicle model codebook
Vehicle Color	Color codebook
Vehicle Category	Vehicle category codebook
Vehicle Purpose	Purpose codebook
Body Type	Body type codebook
Year of Manufacture	Whole number, year
Engine Displacement	Whole number, cc
Maximum Engine Power	Whole number, kW
Fuel Type	Fuel type codebook
Eco Characteristics	Eco standard codebook
Catalyst	Y/N
Empty Vehicle Mass	Whole number, kg
Allowed Payload	Whole number, kg
Maximum Allowed Total Mass	Whole number, kg
Number of Axles	Whole number
Number of Driven Axles	Whole number
Number of Wheels	Whole number
Seating Capacity	Whole number
Standing Capacity	Whole number
Ownership	Codebook
Insurance	Codebook

Source: Authors, based on Structure of Data Published in the IDDEEA Bulletin.

A data warehouse is a centralized database entitled to house disparate records from different subject areas for the purpose of assisting in decision making. It enables total access, both historical and current, to users, who may analyze it based on the user's request and make decisions accordingly. Primarily, transaction data and processed data is time-variant and nonvolatile (Inmon et al., 2010; Sreemathy et al., 2021). In the middle of the data warehousing process is the ETL, which is extract-load-transformed. This involves bringing data together from various sources to include data cleansing and organization with the business rules as required by the formats already available in the data warehouse. Originally, these were directed towards data integration and computation, now, ETL prepares data for business intelligence and analytics while it ensures consistency and quality of data (Bergamaschi et al., 2011; Biplob et al., 2018).

An organization will frequently employ ETL to:

- Extract data from legacy systems
- Cleanse the data to improve data quality and establish consistency
- Load data into a target database

ETL processes are essential for ensuring data quality by cleansing and organizing raw information to remove inconsistencies and errors. These systems are designed to operate at scale, efficiently managing large volumes of data originating from diverse sources. By delivering structured and reliable datasets, ETL supports business intelligence and analytical processes, enabling more informed decision-making. Additionally, the implementation of automated workflows within ETL minimizes the need for manual intervention, thereby improving operational efficiency and consistency (El-Sappagh et al., 2011).

By leveraging this open data, a software solution has been developed to generate tabular and graphical reports through a web application. The system is designed to provide precise market analysis by utilizing the following input parameters:

Period from (month and year) – the start date for the analysis,

Period to (month and year) – the end date for the analysis,

Territory of interest – the ability to analyze data at the level of the country, entity, or canton/district,

Ownership type – classification of vehicles based on ownership (private individuals, legal entities, or the entire market).

Figure 1 System architecture



Source: Authors

For implementing Microsoft SQL Express 2022, the database management system was leveraged, while reports were visualized using Microsoft SSRS (SQL Server Reporting Services). The business logic developed through using a SQL programming

language in the database automatically updates data in machine-readable format on a monthly basis.

With a web-based user interface, the system is open to insurance companies and other stakeholders to keep track of market trends, changes occurring therein, and take informed business decisions. This data-processing model can also be extended to assess premium potential, market shares for vehicles, and factors influencing vehicle insurance in Bosnia and Herzegovina (Škobić & Šego, 2023).

Each report contains the following basic data, visible in the tables.

Table 2. Overview of the number of policies for the selected territory and period

Column	Description
Current Year	Whole number
Previous Year	Whole number
Difference	Whole number
Index	Difference

Source: Authors based on Škobić & Šego, 2023

Table 3. Statistic for the selected territory and period

Column	Description
Insurance	Insurance name
Number of Policies CY	Whole number
Number of Policies PY	Whole number
Difference	Whole number
Index	Index
Share CY	Percentage
Share PY	Percentage
Difference Share	Percentage

Source: Authors based on Škobić & Šego, 2023

TESTING AND VALIDATION

The application for calculating market shares of insurance companies underwent several testing phases to ensure accuracy. Functional testing confirmed correct market share calculations using data sourced from open data (IDDEEA) after an ETL process. Manual checks showed deviations of less than 0.2% for one month's data, with a comparison to the "First Release of Registered Road Motor Vehicles for 2024" by the FBiH Institute for Statistics showing deviations of less than 0.7%. The application processed data (6,038,851 vehicle registrations from 01.01.2020 to 31.01.2025) in an average of 7 seconds for demanding operations. Robustness testing confirmed resilience to incorrect or missing data. User feedback highlighted potential interface improvements. Data for 2024 is available on the FZS website (Federal Bureau of Statistics, 2025).

DISCUSSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

The developed business intelligence model for analyzing the insurance market in Bosnia and Herzegovina confirms the theoretical basis of business informatics

through the application of business intelligence, decision support systems, open data, location intelligence and key performance indicators. The model enables detailed analysis of market shares by territorial and time units, visualization of changes and creation of automated reports, thus providing managers with concrete support in decision-making. The business intelligence system was applied to transform raw and open data into useful, operational information.

The paper also confirms the elements of a decision support system through the processing of structured and unstructured data, which enables support for semi-structured business decisions. Location intelligence is used through geographically based displays of market data, while key performance indicators, such as market share, annual growth and portfolio stability, are consistently applied in accordance with the concept of balanced scorecards. The use of open data published by government institutions contributes to transparency, repeatability of analysis and wider availability, thus confirming the concept of open business intelligence.

In addition to the basic theoretical frameworks, the system also validates additional approaches. According to the information value theory, data only gains its true value when it is contextualized and interpreted for decision-making purposes. In conditions of market fluctuations and competitive dynamics, the system provides clarity and decision-making support in uncertain circumstances. Also, through the application of socio-technical principles, the application design enables ease of use, with visual cues and automated insights helping users without technical knowledge make informed decisions, thereby reducing the need for specialized analytical support.

Although the developed system represents a powerful tool for insurance market analysis, its accuracy is limited by the absence of certain data. Most notably, there is a lack of demographic information about vehicle owners, which would enable more effective segmentation and personalization of insurance offers. Additionally, since the data is available only on a monthly basis, tracking short-term market dynamics is constrained; daily or weekly insights would allow for more agile responses. The system also does not include information on previous insurance policies, which hinders the assessment of customer loyalty and the prediction of churn. Nevertheless, some behavioural patterns can be inferred by linking multi-year records based on the technical characteristics of vehicles. Furthermore, integrating the system with internal datasets from insurance companies could help bridge some of these data gaps and provide a more comprehensive view of clients, premiums, and insurance history.

Beyond its primary function of market share analysis, the system also supports broader analyses that may benefit other sectors, such as the automotive industry or public administration. Through a multidimensional analytical approach, it is possible to examine interdependencies between vehicle specifications, geographic distribution, and temporal trends. Based on available vehicle data, it is feasible to approximate the premium potential of specific regions, taking into account the calculation model for motor third-party liability insurance in Bosnia and Herzegovina. In this way, the system extends beyond its initial scope and emerges as a strategic analytics tool with wider applicability.

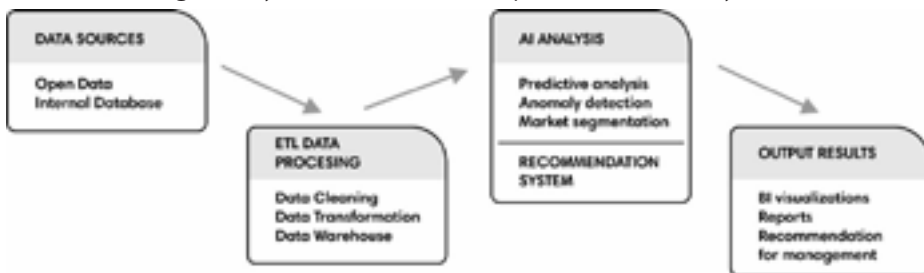
The integration of artificial intelligence (AI) and data analytics into business intelligence (BI) marks a key shift in the way business strategies and decision-making processes are developed. Žigiené et al. (2022) emphasize that this connection leads

to the creation of intelligent business analytics (IBA), which combines traditional BI with advanced AI and big data technologies (Žigienė et al., 2022). This transition to BI enables organizations to better manage data and make more informed decisions. According to the authors, intelligent business analytics represents a new dimension of BI that uses the potential of AI and big data to improve business decisions and strategic planning (Bickley, 2025; Syed et al., 2021).

Artificial intelligence (AI) is significantly transforming business intelligence (BI) systems, particularly in decision support. Through predictive modeling, machine learning, and automation, AI enhances data analysis efficiency and reveals hidden patterns (Eboigbe et al., 2023). This has enabled the development of self-service BI models, allowing non-technical users to generate insights and make data-driven decisions independently. Integrating AI into BI applications provides advanced analytical capabilities. AI algorithms automate data processing, identify patterns, and produce predictive insights that support informed business decisions (Ghasemaghaci, 2019). By leveraging technologies such as computer vision, machine learning, and natural language processing (NLP), AI can analyze both structured and unstructured data, including images, language, and video, thus broadening the analytical scope (Bharadiya, 2023). This synergy between AI and BI extends access to advanced analytics beyond large enterprises, fostering data democratization and promoting a culture of data-driven decision-making across organizations of all sizes (Chintala, 2024).

In this chapter, the proposal is made for upgrading the currently existing analytical system of the insurance market in Bosnia and Herzegovina through artificial intelligence. The usage of AI models is intended to advance the analysis of trends in the market and competition and also the geographical distribution of the insurance market. The actual implementation, however, is not in the purview of this work; it provides a specific target model that then serves concrete guidelines for an accurate improvement of business decision-making, as well as the optimization of existing analytical methods.

Figure 2. System architecture – development of AI- Driven BI system



Source: Authors

The system upgrade proposal may integrate key AI technologies for market analysis and strategic decision-making. Predictive analysis leverages machine learning models like ARIMA, Linear Regression, Random Forest, and Gradient Boosting to forecast seasonal fluctuations and market trends (Cheng et al., 2020; Ogunleye, 2023). Anomaly detection uses Isolation Forest and Autoencoders to identify unusual market changes, while K-means and DBSCAN clustering detect regions under abnormal conditions (Gupta & Tripathy, 2024; Hairach et al., 2023). Market segmentation

is achieved through K-means and DBSCAN, with neural networks optimizing personalized offers (*Hossain, 2017*). AI recommendation systems employ collaborative and content-based filtering to dynamically adjust business strategies, marketing campaigns, and policies in response to market shifts (*Fayyaz et al., 2020*).

As part of the proposal for further research and improvements to the insurance market analysis model, this paper relies on existing approaches and previous studies in machine learning and social network analysis. *Škobić et al. (2020)* examined the use of machine learning algorithms such as logistic regression, decision trees, and deep learning to analyze the profitability of casco insurance customers (*Škobić et al., 2020*). The results showed that decision trees had the highest accuracy (92.44%), while logistic regression was most effective in identifying unprofitable clients. A possible improvement to this model could include extending the analysis to mandatory auto liability insurance using IDDEEA data, allowing for customer profitability predictions by geographic regions and the optimization of premium pricing.

Another perspective on the proposed upgrade relates to churn rate detection based on the research conducted by *Mandić et al. (2018)* analyzing social networks of telecommunications service users. As noted, churn refers to the rate of loss of customers or users over a certain period of time (*Mandić et al., 2018*). For insurance, churn is a performance indicator on how well a company maintains its customer base, and customer loyalty is one of the top priorities. Several studies in the insurance industry have indicated that long-term clients require less time and that it is cheap to retain them compared to acquiring new ones (*Bolancé et al., 2016*).

Customer data are extremely valuable to insurance, and insurance companies have a lot of information about their customers. Therefore, a similar approach could be applied in the insurance sector by linking multi-year data from the IDDEEA database (which contains vehicle registration information) with insurer databases to identify key factors influencing churn rate and locations with the highest risk of customer loss. By connecting data using a generated key based on vehicle characteristics (registration municipality, brand, engine type, color), it would be possible to identify high-risk churn customers from the insurance database and develop a predictive model for customer attrition. This approach could be particularly beneficial for smaller communities, where the likelihood of many vehicles sharing identical characteristics is low. Notably, nearly 60% of municipalities in Bosnia and Herzegovina have fewer than 20,000 residents, while over 87% have fewer than 50,000 (*Federalni zavod za statistiku BiH, 2025*). Insurers may apply this approach to create tailored retention solutions such as some off-benefits available to a particular segment or even targeted marketing campaigns. Linking internal insurance data with identified churn customers would help optimize business strategies further, thus raising profitability.

CONCLUSION

This paper presents a tangible contribution of business informatics to the development of a system that leverages open data and BI tools for analyzing the insurance market in Bosnia and Herzegovina. Core components such as BI systems, decision support systems, location intelligence, and KPIs were successfully integrated into an application that enables multidimensional market analysis and data-driven decision-making. Visualizations and automated reporting facilitate interpretation and

reduce dependency on analytical experts, thereby reinforcing the socio-technical design principles of information systems. The system also supports information value theory—raw, open data attain business value only when interpreted in a meaningful context. The theory of decision-making under uncertainty is confirmed by the system's ability to help users detect market changes and risks even without complete data certainty. Ultimately, the system demonstrates how open data can form the foundation of effective BI systems accessible even to small organizations. The enhancement proposed through artificial intelligence extends the system's functionality into the domain of predictive analytics, anomaly detection, identification of regional patterns, and the generation of managerial recommendations. In doing so, the system is transformed into an intelligent analytical tool capable of significantly improving business strategy. Beyond insurance companies, this model holds substantial potential for public administration, the automotive industry, the transport sector, and the academic community particularly in the areas of market research, user behavior analysis, and the development of public digital solutions. It is also relevant for startups and the IT sector engaged in the development of data-driven services. In this way, the model transcends the boundaries of the insurance sector and becomes a tool for digital transformation in a broader socio-economic context. Future research should focus on evaluating the upgraded system in real-world business settings, as well as developing modules for customer churn detection, offer personalization, and dynamic market segmentation. The success of such systems will depend on achieving a balance between analytical sophistication and transparent, ethical data governance a continuing challenge in the field of business informatics.

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PREGLEDNI NAUČNI RAD / OVERVIEW SCIENTIFIC PAPER

TOWARD AI-ENABLED INSTITUTIONAL REPORTING: A CONCEPTUAL PROPOSAL WITH A CROATIAN HEI CASE STUDY

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Abstract: : *The aim of this paper is to assess the possibilities and limitations of applying AI—huge language models (LLMs) and retrieval-augmented generation (RAG)—to support the preparation of institutional quality and performance reports. The study explores the key challenges of current reporting practices and assesses the potential of AI to enhance the quality, efficiency, and usefulness of reporting in higher education. The methodology is based on a scoping literature review covering quality assurance in higher education, stakeholder information needs, institutional quality and performance reporting, and the use of LLMs and related AI technologies in reporting processes. A case study of a Croatian higher education institution was used to analyse stakeholder information requirements, types of existing reports, data sources and data-bases, reporting frequency, and the main limitations of current reporting practices. The findings show that stakeholders' needs differ significantly, requiring a range of report formats (e.g., KPIs, plans, self-assessment reports, survey results). Additionally, data sources are fragmented and dispersed across multiple systems, making data collection and analysis difficult and increasing the subjectivity of result interpretation. Based on these findings, the paper proposes a conceptual model that links specific business and reporting challenges with potential AI-based solutions. The results suggest that AI can streamline and accelerate report preparation, while tailoring outputs to diverse stakeholder groups. However, due to institutional diversity, a universal “one-size-fits-all” solution is unlikely. Instead, institutions should conduct pilot projects using real documentation enriched with metadata and AI models adapted to the Croatian language and institutional context. Following implementation, it will be necessary to critically evaluate the accuracy of AI-generated outputs, assess the ability to link conclusions with supporting evidence, and identify any unintended consequences.*

Keywords: *Higher education, Quality assurance, Institutional reporting, Large Language Models, RAG*

JEL classification: *I21, I23, C83, C88, O33*

INTRODUCTION

Business organisations today face an increasing need for data analytics, business reporting, and evidence-based decision-making. In some cases, data analysis for reporting purposes must be carried out in real time, which presents a significant organisational and human resources challenge. Higher education institutions (HEIs) require efficient management and transparency, which is further emphasised by international and national standards and regulatory requirements. Stakeholder information needs differ considerably, and with limited staff resources, data analysis and report preparation represent a challenge. Additional issues arise from the fragmentation and incomplete datasets, the use of multiple databases, the large amount of manual processing, and the subjectivity in information interpretation. Given that increasingly available artificial intelligence (AI) tools can automate specific processes and contribute to faster, simpler, and more efficient reporting, the motivation for this study emerged. AI applications are gradually entering a developmental phase mature enough to allow for experimentation with their implementation in HEI reporting. Therefore, this research aims to evaluate the opportunities and limitations of its use for institutional quality and performance reporting. Based on the identified issues and research aim, the following research questions were formulated:

RQ1: What challenges are faced by individuals responsible for quality and performance reporting in HEIs, and what are the shortcomings of existing reports?

RQ2: What are the potential applications of AI in improving institutional reporting on quality and performance in higher education?

To address the research questions, the study employed the scoping literature review method to explore the main theoretical and practical approaches and to establish a foundation for developing a conceptual model of an AI-supported reporting system. Furthermore, institutional documents and reports from one HEI in the Republic of Croatia were analysed as a case study to identify challenges, practices, and potential opportunities for applying AI in quality and performance reporting.

The paper is structured into five chapters. The introductory section outlines the study's problems, motivation, and objectives, as well as the research questions related to quality reporting and AI applications. The second chapter provides an extensive review of relevant literature concerning quality assurance (QA) in higher education, stakeholders and their information needs, digital transformation and communication with stakeholders, as well as generative AI, RAG, and the evolution of reporting systems. The third chapter presents the applied methodology, which includes a literature review and a case study. The fourth chapter discusses the results of the institutional report analysis, together with a proposed conceptual model for intelligent reporting. The conclusion highlights contributions, limitations, and directions for future research.

LITERATURE OVERVIEW

Context and definitions of quality assurance

Globalisation, technological changes, and the growing demand for accountability and transparency in delivering quality education influence the continuous development of higher education institutions (HEIs) (Pramono & Widiyanto, 2024). QA plays a key role in this process. QA in higher education is a complex process aimed at ensuring that HEIs meet educational standards while continuously improving and acting responsibly in line with the expectations of students, staff, and society.

The concept of QA encompasses all internal and external activities aimed at maintaining and enhancing educational standards within an institution (Jafarov, 2024). To ensure quality management and confirm institutional legitimacy, HEIs develop an Internal Quality Assurance System (IQAS). IQAS can be described as the way HEIs organise their operations based on processes, planning, documentation, and resources used to achieve their mission and goals, while fostering the continuous improvement of the services they provide (Senal et al., 2008). Responsibility for the development of IQAS lies with the institutions themselves, namely, their management. External QA monitors the compliance of educational practices and programs with established standards (Westerheijden et al., 2007). It is carried out through accreditation, a formal process in which an external body evaluates the extent to which an institution or a specific program meets established standards. Institutions that systematically develop and document their IQAS can demonstrate compliance with standards more effectively. Therefore, a well-structured IQAS plays a crucial role in monitoring institutional processes and preparing for accreditation procedures (Budir, 2020).

European and National Framework for Quality Assurance in Higher Education

The orientation toward quality standards and accountability in European higher education has deep historical roots (Charles, 2007). However, the development of policies related to QA and their systematic implementation in the European Higher Education Area (EHEA) began at the end of the 20th century. National governments perceived QAS as a tool for increasing management efficiency, establishing trust between authorities and HEIs, and strengthening the connection between higher education and the labour market (Westerheijden et al., 2007). The recognition of higher education as a driver of economic growth and national progress led to the establishment of accreditation bodies, quality assurance agencies, and evaluation systems designed to monitor and enhance the effectiveness of HEIs (Kayyali, 2024).

Cooperation among European countries in the field of QA began with the European Association of Universities' initiative to introduce the Institutional Evaluation Program in 1993. The European Council of Ministers endorsed it, and a pilot project for quality evaluation in higher education was implemented in 17 countries between 1994 and 1995 (Yeremenko, 2018). The cooperation continued, and based on the Bologna Declaration, the European Council set the objective in 2002 of achieving recognition of the quality of education systems by 2010, as well as measuring progress toward the goals in relation to the "Reference Levels of European Average Performance" or "European Benchmarks" (Reinalda, 2008).

To ensure a unified framework and standards for QA activities within the EHEA, the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) (European Association for Quality Assurance in Higher Education (ENQA), 2005) were established, soon becoming the cornerstone for promoting quality in the EHEA (Zhang et al., 2019). The introduction of ESG 2005 marked the first formal definition of common internal and external QA standards in the EHEA. ESG fostered the development of IQAS and introduced requirements for systematic reporting, the use of indicators, and stakeholder involvement, thus laying the foundation for today's institutional quality reporting. The 2015 revision of the ESG emphasised transparency and accountability to stakeholders (European Association for Quality Assurance in Higher Education (ENQA), 2015). Reporting systems must be consistent and evidence-based, with reports made accessible to different stakeholders. Particular importance is therefore given to stakeholder feedback, information from student surveys, and key performance indicators (KPIs).

Among the main objectives of QAS is the provision of relevant and reliable information on the functioning of higher education, recorded outcomes, and potential for improvement (Gh Rosca et al., 2008). KPIs are recognised as essential instruments for monitoring institutional goal achievement, benchmarking with other institutions, and making evidence-based decisions. They enable the quantification of the effects of educational and managerial processes through specific metrics that can be monitored over time and assessed in relation to strategic goals (Javed & Alenezi, 2023). Udam & Heidmets (2013) propose a classification of KPIs into three main categories: inputs (resources) such as staff–student ratio, funding (per student), facilities (per student); process (interaction) such as study load, student support, student feedback on course delivery, alumni feedback; and outputs (results) such as time to degree and employment rates. These indicators play an important role in strategic planning and reporting in accordance with ESG requirements, as well as in self-evaluation, external quality assurance, and accreditation processes. However, many authors emphasise that qualitative interpretations should complement quantitative indicators to avoid misleading or overly simplified conclusions (Hou et al., 2024; Mourad, 2013).

After the establishment of a common European framework for QA through the ESG, the EHEA member states committed to implementing it within their national systems. The Republic of Croatia introduced the Act on Quality Assurance in Science and Higher Education (Government of the Republic of Croatia, 2009) and its revised version from 2022 (Government of the Republic of Croatia, 2022). Under this Act, HEIs are required to establish, develop, and regularly evaluate their IQAS. Institutional reporting plays a key role in this process, encompassing the regular preparation of reports on quality and performance, as well as the implementation of strategic and other planning documents. The purpose of such reports is multifaceted. In addition to enabling management to make evidence-based decisions and effectively govern the operations of HEIs, their role is also to provide transparent information to internal and external stakeholders. The importance of these reports is particularly evident in external quality evaluation processes, especially accreditation.

As previously noted, the roots of QA lie in the establishment of accreditation bodies and the evaluation of quality. A culture of evaluation through internal and external quality reviews (audit, accreditation, assessment, external examination) (Hou et

al., 2024) is now well established worldwide. Accreditation represents a mechanism of external QA in which an authorised body evaluates the extent to which an institution or a specific program meets established educational standards (Jafarov, 2024). In organising their operations, HEIs today pay close attention to meeting national standards (Zadayeva et al., 2024) while in pursuit of stronger international positioning, some HEIs also undergo accreditation processes conducted by international accreditation agencies and ranking providers (Mourad, 2013). In the contemporary academic environment, accreditation represents a crucial process through which HEIs maintain their reputation and ensure the provision of quality education for students.

To strengthen trust in the higher education system and ensure independent quality evaluation, accreditation agencies are most often established at the national level. Their tasks include developing standards and evaluation methodologies, organising and implementing evaluation procedures, and ensuring transparency and credibility. An example of such an agency is the Croatian Agency for Science and Higher Education (ASHE). Based on ESG standards and in consultation with relevant stakeholders, ASHE developed the Quality Standards in Higher Education and Scientific Activity, as well as other documents used in external quality evaluation procedures (Agency for Science and Higher Education, 2023; Government of the Republic of Croatia, 2022). In external QA procedures, particularly accreditation, HEIs are required to prepare and submit a comprehensive self-evaluation (Westerheijden et al., 2007). A self-evaluation report typically involves an institution's evaluation against the standards and indicators defined by quality assurance agencies. It is based on both quantitative and qualitative indicators and must be evidence-based, with institutional reports playing a key role. Beyond serving as the foundation for critical evaluation by external reviewers, the self-evaluation also provides institutions with internal reflection on their own processes, outcomes, and strategies, offering opportunities for organisational learning and development (Hou et al., 2024; Westerheijden et al., 2007).

Stakeholder Information Needs

Effective reporting on quality and performance is shaped mainly by the requirements of stakeholders, the users of reports (Armijos et al., 2024; Bach et al., 2014; Beerkens & Udam, 2017; Lyytinen et al., 2017; Saurbier, 2021; Westerheijden et al., 2013). Stakeholders in the higher education system are typically divided into internal and external groups, and their interests influence the content, format, and purpose of institutional reports (Elken & Stensaker, 2018; Hou et al., 2024).

Internal stakeholders include the institution's management structures (e.g., deans, vice-deans, department heads), academic staff, administrative staff, and students. Their information needs are oriented toward strategic decision-making, operational management of teaching, monitoring learning outcomes, as well as participation in self-evaluation and quality enhancement processes (Westerheijden et al., 2013). Students are becoming increasingly important users of quality-related information, which they use to evaluate the value of study programs, employability, available support, and opportunities for personal and professional development (Saurbier, 2021). Their perception of quality also includes informal aspects, such as the study experience and sense of belonging to the community (Pramono & Widiyanto, 2024).

External stakeholders encompass a diverse range of actors, including public authorities and regulatory agencies, funding bodies for higher education, employers, the business sector, alumni communities, media, local and regional governments, and the general public (Elken & Stensaker, 2018; Zhang et al., 2019). This group expects reliable, comparable, and timely information that supports evidence-based policy-making, informs the allocation of financial resources, facilitates the assessment of how well educational provision aligns with labour market needs, and ensures the quality of both qualifications and institutions (Jafarov, 2024; Mourad, 2013). Regulatory agencies, for instance, expect structured reporting in accordance with predefined quality standards, evidence-based and supported by measurable indicators, including a comprehensive self-evaluation as a key element of evaluation (European Association for Quality Assurance in Higher Education (ENQA), 2015). The emphasis is placed on process transparency, stakeholder involvement, and public accessibility of reports. The general public, on the other hand, expects clear, concise, and understandable information that provides insight into the institution's work, its mission, social responsibility, and educational outcomes. Employers expect the QAS to guarantee graduates' competencies and the relevance of curricula to labour market needs, as well as data that allow inter-institutional comparison (benchmarking), thereby fostering competitiveness and institutional accountability (Kayyali, 2024). Ensuring the transparency, credibility, and accessibility of reports thus becomes an essential requirement for building stakeholder trust and ensuring the functionality of the entire quality assurance system (Hou et al., 2024).

Data Sources, Challenges, and the Need for Integration

QA processes, as well as the need for strategic management and transparency toward stakeholders, rely on a complex set of information concerning students, resources, teaching processes, research activities, industry cooperation, the achievement of strategic goals, and compliance with quality standards. This information is collected through various methods (e.g., surveys, internal reports), provided by different actors (e.g., students, staff, alumni, employers, scientific and professional organisations, local communities), stored in diverse formats (e.g., Excel, Word, PDF), and maintained within different information systems. All collected information is processed and used to prepare quality and performance reports.

Given the evident heterogeneity of stakeholders in the higher education system, quality and performance reporting must address the highly diverse information needs of these stakeholders. Regulatory bodies require structured, detailed, and comparable reports that include standards, key indicators, and supporting evidence; institutional management expects quantitative indicators, charts, and trend interpretations for strategic decision-making; students seek concise and accessible information about study quality, teaching, and employability; while the general public and external stakeholders prefer narrative, straightforward, and easily understandable presentations that confirm the institution's legitimacy and social responsibility.

To meet the diverse information needs of stakeholders, it is necessary to collect and process data from various sources, including student and teacher surveys, databases, strategic and financial documents, reports from internal and external evaluations, and stakeholder feedback. The lack of uniform formats, multiple data owners, reliance on manual data entry, and the absence of automated tools further complicate the consoli-

dation of this information into comprehensive and analytically meaningful reports. So-called “data silos” represent a problem in all business organisations. Patel (2019) provides a valuable overview of the challenges associated with structured and unstructured data, as well as the financial consequences of insufficiently integrated systems. Javed & Alenezi (2023) also emphasise that QAS must be integrated at the level of the entire institution (rather than “data silos”) and that processes must be interconnected, with standardisation and automation established before the implementation of analytics.

Pramono & Widiyanto (2024) analysed 2,578 articles published in the Scopus database between 2013 and 2023 on QA in higher education. They identified four developmental areas (clusters) of quality in higher education: (1) institutional and policy frameworks, (2) student perceptions, satisfaction, and service quality, (3) accreditation processes, and (4) leadership engagement. Although each of these clusters encompasses specific aspects of QAS, they share a reliance on diverse data sources and the need for integrated analysis within institutional reports.

In light of these challenges, there is a growing demand for the application of new technologies in reporting. As a logical step, the use of AI and digital tools is emerging, facilitating data processing, pattern recognition, and the creation of structured, evidence-based reports.

Digital Transformation and Communication with Stakeholders

From the above, it is clear that HEIs collect and generate large amounts of information, which they then store, analyse, systematise, and use for reporting or publishing through various media such as websites, social networks, or newspaper articles. When preparing and publishing such information, it is essential to consider the target audience, as texts and materials are tailored differently when intended for accreditation bodies and the relevant ministry compared to when they are aimed at students or industry professionals. Similarly, materials are prepared differently depending on the format—whether intended for print or for online and social media publication.

According to Tiron-Tudor et al. (2022) the reporting of public HEIs is shaped by various factors such as regulatory requirements, stakeholder profiles, and institutional objectives. These factors determine how information is collected, structured, and presented, which aligns with the need to adapt content to different audiences and formats.

The study by Fernández et al., (2023) examines the analytical methods used in higher education institutions and their digital transformation. The authors note that the introduction of new processes most often relies on advanced analytics (23%), cloud technologies (20%), and AI (16%), yet only 25% of institutions have adopted a digital strategy. Notably, more than half (56%) of the institutions studied had launched isolated projects that were not integrated into a unified plan, indicating that many HEIs manage information in a fragmented way and without clear direction. Therefore, a strategic, targeted, and format-adjusted approach to preparing and disseminating information is essential.

Generative AI, RAG and the evolution of reporting systems

At the time of writing, generative AI tools for text creation have become widespread. ChatGPT, Grok, DeepSeek, Perplexity, and a range of similar tools are avail-

able free of charge (with certain limitations) to a broad base of potential users. Until recently, such systems did not exist, and the turning point was the concept of “foundation models,” systematically described by Bommasani et al. (2022). These are large language models trained on extensive datasets and then fine-tuned for various tasks across different domains. This created, for the first time, opportunities to build systems capable of addressing problems across multiple domains while integrating previously disconnected systems. In short, the shift from “narrow” models—focused on specific tasks—to “general” models created the technological and organisational conditions for the widespread availability of today’s generative tools. At the same time, this raised a series of questions concerning risks and safety, access to computational resources, and broader social impacts, which the authors clearly emphasise (Bommasani et al., 2022).

A hallmark of such “general” LLMs is their versatility and broad knowledge across domains, making them comparable to encyclopedias of global expertise. With the release of ChatGPT at the end of 2022, as one of the first user-friendly applications powered by LLMs, there was an “explosion” of capabilities that users worldwide quickly embraced. Although earlier versions of OpenAI’s GPT were already available, they required Python programming, libraries such as Hugging Face Transformers, and substantial technical know-how. According to ChatGPT Usage Statistics: Numbers behind Its Worldwide Growth and Reach (2025), the service reached 1 million users within five days of its launch, surpassed 100 million users after two months, and is currently estimated to have around 800 million users. This represents one of the fastest-growing user bases among online services; for comparison, Facebook took more than seven years to reach 800 million users (ChatGPT Usage Statistics, 2025).

While highly effective for general research and text production, such general LLMs have limited applicability because they cannot deeply analyse an organisation’s internal documents and specific data sources, which significantly constrains business use. This led to the development of Retrieval-Augmented Generation (RAG), which combines the generative capabilities of LLMs with access to external knowledge bases (Lewis et al., 2020). Instead of relying solely on training data, RAG enables the retrieval and use of information from an institution’s own documents or databases. The technical backbone is vector databases, which enable semantic search over documents and their vector representations. Semantic search goes beyond literal keyword matching to “understand” the meaning of queries and documents, linking them by concepts and context. This reduces hallucinations, improves accuracy, and allows institutions—including HEIs—to use their own data effectively in combination with LLMs. Moving from concept to practice, Iusztin et al. (2024) propose an operational architecture (FTI) and implementation patterns (vector storage, retrievers, evaluation), making RAG repeatable and measurable in production (Iusztin et al., 2024; Lewis et al., 2020).

In just a few years—from 2021, when modern generative AI tools were practically non-existent, to today—technological progress has enabled numerous possibilities, including concepts such as GenAISys platforms. In his work, Tomczak (2024) introduces the term GenAISys to describe new and complex platforms. He argues that classical large models alone cannot solve today’s business problems because they lack modularity, integration with other systems, and additional encoders and modules for data storage and retrieval. In the GenAISys model (Rothman, 2025; Tomczak, 2024) the LLM is only one component of a larger AI system. GenAISys platforms use nat-

ural language as the main interface, add modality-specific encoders for input/output processing, and extend capabilities with tools (e.g., calculators, route planners) and knowledge sources that communicate via RAG modules for retrieval and storage (Bourne & Es, 2024; Rothman, 2025; Tomczak, 2024).

This concept provides sufficient capabilities to build business reporting systems applicable across sectors, including HEIs (Bourne & Es, 2024; Rothman, 2025; Tomczak, 2024). It is also notable that a growing number of studies on the application of various forms of AI in the field of R&D are being conducted by domestic authors. Papers exploring the possibilities of automation based on technologies that were previously unavailable are becoming increasingly common, whether in the hospitality, telecommunications, or banking industries (Lovrinčević et al., 2025; Nikolić & Sredojević, 2025).

METHODOLOGY

For the purposes of defining the theoretical framework of the research, a scoping review of relevant scientific literature was conducted on QA in higher education, the information needs of stakeholders, institutional reporting on quality and performance, and the application of large language models and AI-related technologies in reporting systems. According to Munn et al. (2018), a scoping literature review is used when the aim is to broadly map the field of literature, clarify concepts, and identify gaps in knowledge (research gaps). Since this study focuses on the application of large language models in QAS and institutional reporting—a field that has gained importance only recently due to the availability of AI technologies and related services—it is expected that the scientific literature still contains a limited number of works on this topic.

To cover the development of the system and the normative framework of reporting, papers, guidelines, and regulations published between 2005 (the establishment of ESG) and the present were included. To gain deeper insight into institutional practices, challenges, and limitations in quality and performance reporting, content analysis was applied through a case study. For this purpose, the institutional quality reporting system of one faculty in Croatia was analysed. The analysis included strategic documents, quality and performance reports, accreditation documentation, as well as internal databases and data sources used in the preparation of reports. This enabled the mapping of key reporting patterns of the HEI (Faculty).

In the first step, the categories of users, purposes of using reports, basic types of reports, types of information and data sources, frequency and method of report creation, content (i.e., the key information provided), as well as the challenges and shortcomings of each report were identified. Based on this mapping, the challenges and weaknesses of existing reports were summarised to identify priority areas suitable for applying AI technologies and large language models.

In the second step, the informational requirements and heterogeneity of existing databases/documents that need to be integrated for timely and reliable reporting were analysed. The scoping literature review also encompassed recent works on AI and advanced analytics in education and other sectors, exploring their potential applications in developing a more efficient and automated reporting system for quality and performance in higher education. Considering the identified requirements, the following

AI technologies were reviewed and conceptually considered: large language models (LLM), retrieval-augmented generation (RAG) with vector databases, and orchestration/agent workflow solutions (MCP). Their role was seen as a prerequisite for establishing an institutional AI server for business intelligence and reporting, as outlined in faculty documents.

Unlike previous studies, which address specific aspects of QAS or the application of AI technologies in other domains, this study connects the needs of different stakeholders with the possibilities of automating reporting using AI tools. Through the literature review, analysis of a real institutional environment (one HEI in the Republic of Croatia), and exploration of AI technologies (LLM, RAG, MCP), a framework was developed to identify areas where the reporting process can be improved. This creates opportunities for AI solutions tailored to the complex requirements and reporting practices in higher education.

RESULTS AND DISCUSSION

Challenges and Shortcomings of Quality and Performance Reporting

The analysis has shown that users' information needs vary significantly depending on their specific requirements. Internal decision-makers (management, heads of departments, teachers, quality committees, etc.) use reports for strategic and operational management, curriculum planning, and the improvement of teaching and student support. They require structured indicators, variance analyses, survey results, and trend data. External regulators (agencies, ministries) rely on reports for accreditation and supervision, where compliance with standards (through self-evaluation) and the precise documentation of indicators, quality reports, and improvement plans are essential. Students (both prospective and enrolled) need information that helps them make informed study choices, including employability, pass rates, teaching quality, and available support. External stakeholders (the public, media, alumni, employers, and the local and regional community) use reports to assess social responsibility, partnerships, employability, and the quality of education. For them, data on graduate profiles, industry connections, and community contributions are especially relevant. Although overlaps exist, they are not evenly distributed, which results in different reports being produced for different user groups.

The following reports on Faculty quality and performance were identified:

- Report on implemented improvement measures in accordance with the Quality Assurance Activity Plan
- Reports on the implementation of strategic action plans
- Report on key performance indicators
- Report on survey findings and performance outcomes
- Report on the implementation of stakeholder recommendations
- Dean's report on strategy implementation and operations
- Follow-up report on the implementation of the Quality Assurance Action Plan — internal audit
- Self-evaluation report
- Report on the implementation of the Quality Assurance Activity Plan in the follow-up phase – reaccreditation

In addition to these, quality and performance information is also prepared and

submitted as needed, including reports on the implementation of the university strategy, program contract implementations, study program elaborations, and various web and social media publications.

The results of the analysis indicate that reports are produced in annual cycles (ranging from 1 to 5 years) and are manually created in Word and/or Excel format. Considering the different information needs of stakeholders and the dynamics of reporting, it is necessary to continuously collect data from various sources (Higher Education Information System – ISVU, Croatian Research Information System – CroRIS, internal information systems, internal reports, internal records, surveys, evaluations, databases, the Faculty's website, various plans and documentation of internal committees). Discrepancies between these documents, duplication of work, and the risk of human error are evident. This results in a significant amount of time needed for preparing and verifying information.

Content analysis reveals that most reports contain a mix of descriptive, quantitative, and qualitative information. The following challenges and shortcomings were identified:

- Fragmented and misaligned data sources (ISVU, CroRIS, internal systems, internal documentation, etc.), different storage formats (Word, Excel, PDF, web, e-mail)
- Manual integration, verification, and subjectivity in assessment (depending on the person producing the reports)
- Lack of standardised templates for narrative interpretation of KPIs and variances
- Limited linkage to evidence and sources
- Poor searchability and lack of thematic filtering (e.g., by ESG, program, year)
- Limited data visualisation, status flags, and trend analysis
- Limited possibility of comparison over time and across different reports
- Weak alignment of reported results with goals, plans, and standards
- Reports are often voluminous (sometimes exceeding 100 pages), which makes them difficult to review and understand, as well as inadequate for decision-making

It is concluded that reporting on quality and performance in higher education suffers from dispersed data sources, manual processing, lack of clarity, and the use of unconnected digital solutions (platforms). This naturally increases the workload of staff, slows down decision-making, and complicates communication with stakeholders.

AI approaches, limitations, and implementation issues

As highlighted in the literature review, AI can support the automation of data processing, natural language analysis, and report generation, thereby accelerating processes, improving accuracy, and enabling the adaptation of reports to different users. Table 1 provides an overview of the main reporting challenges and potential AI solutions, linking the business perspective with technological capabilities to develop a more efficient reporting system.

Table 1. Business challenges and AI solutions in reporting on quality and performance

Problem/challenge (business perspective)	AI technology/approach (possible solution)
Dispersed and misaligned data sources (Word, Excel, PDF, ISVU, CroRIS, e-mail)	Automation of data collection and cleaning using Robotic Process Automation (RPA) + AI integrations with ISVU/CroRIS (ETL processes, semantic data mapping)
Manual data entry and slow consolidation of information	Natural Language Processing (NLP, LLM) for automatic recognition, categorisation, and linking of information from different formats
Limited clarity of reports, lack of visualisations	AI tools for visualisation and interactive dashboards (e.g., integration with BI tools + generative AI for explaining trends)
Subjectivity in interpretation (especially student surveys, qualitative comments)	Sentiment analysis and thematic clustering via NLP; LLM for generating consistent summaries and recommendations
Insufficient linkage between reports and strategic goals	Generative LLMs (e.g., ChatGPT, Claude), or local instances that reliably support Croatian, for drafting data-driven reports
Insufficient linkage between reports and strategic goals	LLM + RAG systems for linking data to ESG standards and strategic documents
Limited ability to search and compare reports	LLM + RAG systems (vector databases and semantic search) that enable quick retrieval and comparison of information across years
Disconnected islands (silos) of automation.	GenAISys platforms – modular AI systems that connect LLM, RAG, databases, and specialised tools into a unified architecture. Application of MCP.

Source: authors' elaboration based on the conducted case study analysis and literature review

Other authors report similar organisational challenges. Buaton et al. (2022) note that AI can significantly contribute to internal audits through a digitised framework (documentary and field audit, knowledge base, inference engine), thereby indirectly supporting the improvement of study programmes and graduate quality. Their study focuses on an AI-assisted internal system for QAS in higher education, with an emphasis on standards and accreditation criteria, representing an essential but narrower segment of the broader QAS.

Although RAG in combination with LLMs greatly facilitates the search of internal documents through vectorisation and semantic comparison, it should not be assumed to be an out-of-the-box solution for the specific reporting needs identified in this paper. Wang et al. (2024) point out that current RAG technologies still have limitations in understanding conversational context, analysing structural information, and managing interactions across multiple documents. The linguistic dimension further amplifies these challenges, as most systems are trained and optimised for the English language; therefore, the choice of a model that reliably supports Croatian—as well as related components (e.g., embedding models and the vector database)—will likely have a significant impact on the extent of required testing and the pace of implementation.

This also raises methodological questions about evaluating the effectiveness of the final AI information system. Fleischer et al. (2024) emphasise that classical LLM metrics (e.g., BLEU, ROUGE) are insufficient for RAG and recommend a two-layer

evaluation: (1) retrieval effectiveness and (2) generation quality, including accuracy, faithfulness, and usefulness relative to the retrieved context. Accordingly, future research will need to define and apply metrics that address both levels.

Aligned with this is the framework proposed by Es et al. (2024), which requires evaluation to explicitly cover: (a) faithfulness (whether the answer is grounded in the retrieved context), (b) answer relevance (whether the answer addresses the posed question), and (c) context relevance (whether the retrieved context is sufficiently focused). Such a three-layer approach to RAG evaluation increases the reliability of findings and reduces the risk of inconsistent model behaviour in real organisational tasks.

Finally, it is essential to highlight the problem of data security and the protection of confidential information stored in institutional RAG vector databases. When using public AI services (e.g., via UI or API), it is not always possible to know how the data will be handled or whether it will be used for further training of LLM models. Sending internal documents may be unacceptable if they contain confidential information, research data, or personal details. Therefore, before transmitting such data, it is necessary to apply minimisation, pseudonymisation, or anonymisation. One possible solution is to establish a dedicated AI server (on-premise) with a local vector database, or to implement a hybrid architecture that uses a local RAG on an internal server combined with a commercial LLM used as a frontend.

An on-premise solution raises questions about interoperability, Croatian language support, cost-effectiveness (including hardware, software, and electricity), and latency, but it ensures greater control over institutional data.

CONCLUSION

QAS is a complex and highly regulated system, and ESG standards require the publication of comprehensive and transparent reports, as well as regular cycles of internal and external evaluation. Different user groups demand different formats and content—from concise summaries with recommendations for students and the public to comparable, evidence-based KPIs for management. Although ESG guidelines are standard for all higher education institutions in the EU, their implementation largely depends on the specific needs and characteristics of each institution.

Moreover, the quality of reporting depends on clearly defined procedures and consistent interpretation of the available information. An effective system, therefore, requires standardised templates, a clear hierarchy of evidence, and systematic linking of findings with the mission, vision, and strategic goals, together with the public availability of complete reports and tailored summaries for different target groups. Such an approach entails considerable human effort in locating, verifying, systematising, and preparing information and evidence—tasks that, in today's technological context, can be significantly facilitated by advanced methods and tools.

The analysis of relevant scientific and professional papers, along with recent solutions related to key technologies (primarily AI/LLM and RAG) and the necessary supporting infrastructure, confirmed the fragmentation of data into various “data silos” and heterogeneous databases. At the same time, it highlighted the potential of these technologies to automate existing processes.

This raises key questions concerning the choice of models and technologies, the level of Croatian language support, and the accuracy of information stored and

retrieved through RAG. In addition, there is a need for systematic labelling of internal documents and the use of metadata, as well as for defining detailed procedures and guidelines according to which AI solutions will be implemented and subsequently evaluated with respect to accuracy, susceptibility to hallucinations, and execution speed.

It is reasonable to expect that there will be no universal one-size-fits-all solution, just as there is no single QA system that suits all HEIs. Nevertheless, the need to apply new tools is sufficiently strong that institutions should already be strategically planning and implementing AI-based reporting.

This study also has certain limitations. First and foremost, it is based on a scoping literature review and a case study of only one higher education institution, meaning that the results cannot be fully generalised. The analysed documents and reports reflect the particularities of the observed institution, which may limit their transferability to other institutions or national systems. Another significant limitation is the rapid development of technologies based on LLM and RAG architecture. Such dynamics create the possibility that many of the identified problems may, in the meantime, be mitigated or resolved through new software versions, without the need for more extensive interventions in system planning, testing, and implementation.

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Must include the title of paper, abstract, key words and JEL classification.

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It should define the problem, subject matter and aim of research, as well as the motive for undertaking such research. The Introduction should also offer one or several hypotheses of the paper, which should be developed in the final chapter of the paper – the Conclusion. The Introduction ends with the description of the paper's structure.

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Literature Overview involves the overview of relevant literature in the area of the paper, with key knowledge available to date or relevant results of research conducted to date. Exceptionally, the author may include Literature Overview in the Introduction.

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Methodology must be described clearly and precisely, the methodological contribution of authors (if available) must be established and it must all be done in a fashion that it allows for its testing by other authors.

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Empirical evidence represents the documentation background to the research conducted.

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Results and discussion represent part of the paper in which results of the research conducted are explained and compared to similar research, the limits of the interpreted results are analysed, as are their significance and potential implications.

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Conclusion is the final chapter of the paper. It should not be confused with the paper's abstract. It should contain the elaboration of the original hypothesis, the evaluation of the results of research, its contribution, the overview of limitations and problems relative to research implementation, the guidelines for future research, the recommendations stemming from the results of research etc. As is the case with abstract, the Conclusion should be contained in one paragraph.

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Chapters in books/papers in the collections of papers: last name, initials of the first name. (year) Title of chapter/section'. In: Title of book, last name, initials of the first name of author/editor. Place of publication: publisher: pages. (if there are two or three authors, their last names and initials should be listed in order, separated by a comma).

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Peter, C. (2013). Privatization, urban fragmentation, and sustainable development. In: *Institutional and Social Innovation for Sustainable Urban Development*, Mieg, H. A., Töpfer, K. (ur.). Oxon i New York: Routledge: 130-146.

Doctoral dissertations: last name, initials of the author. (year) Title of work, type of work and the institution where the dissertation was defended.

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Series of articles/official publications:

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Papers presented at conferences:

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Explanation (only if the answer is "NO"):

Final evaluation
Mark:

(Excellent -----Poor)

5 4 3 2 1

Explanation of the final evaluation (if reviewer sees it necessary):

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Confidential comments for the Editorial Board:

Comments submitted to the author:

IV. REVIEWER'S RECOMMENDATION FOR PUBLICATION OF THE PAPER:

RECOMMENDATION (put the selected recommendation in bold)
Accepted
Accepted after undertaking revision as per comments*
Not accepted

* The paper is returned to reviewer for opinion

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CLASS (put the selected recommendation in bold)
Original scientific paper**
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Review****
Professional paper*****

**paper which contains the results of an original scientific research unpublished to date;

*** paper which contains the new results of a scientific research useful to be published promptly;

**** paper which contains an original concise and critical overview of an area and provides a contribution given the papers published to date;

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Title	
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Economy and Market Communication Review



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(Izvršno-----Loše)

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* Rad se vraća recenzentu na uvid

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