ARTIFICIAL INTELLIGENCE FOR SMALL AND MEDIUM BUSINESS: PERSPECTIVES AND CHALLENGES

Anna KRAMARENKO[1]

[1]V.N. Karazin Kharkiv National University, 61022, Maidan Svobody 4, Kharkiv, Ukraine
Corresponding author. E-mail: a.o.kramarenko@karazin.ua
ORCID ID (https://orcid.org/0000-0001-5987-1247)

This research examines the perspectives and challenges of artificial intelligence (AI) implementation in small and medium-sized enterprises (SMEs). Through analysis of academic literature, industry reports, and survey data from 63 companies, the study investigates the potential applications, benefits, and barriers to AI adoption among SMEs. The findings reveal that while AI offers significant opportunities for SMEs in areas such as process automation, data analytics, customer experience personalisation, and operational optimisation, adoption rates remain low. The research identifies several key barriers, including limited access to industry data, insufficient financial resources, lack of technical expertise, and challenges with data integration. Survey results indicate that only 13% of surveyed companies have experience working with AI, despite widespread use of basic information management systems. The study highlights five primary areas where generative AI can enhance SME performance: content creation, automated operations, venture business ideation, financial management, and operational optimisation. The conclusions emphasise the need for targeted support mechanisms, improved educational programmes, and policy frameworks to facilitate AI adoption among SMEs. This research contributes to understanding the role of AI in SME development and provides practical insights for business leaders, policymakers, and researchers working to enhance AI integration in small and medium-sized businesses.

Keywords: Artificial Intelligence, Small and Medium Enterprises (SMEs), Digital Transformation.

INTRODUCTION

In the coming years, as generational artificial intelligence continues to advance, its role may evolve from a mere assistant to a coach, mentor, or even a specialised partner. The steady progress of generational artificial intelligence can also blur and redefine the boundaries between individuals, organisations, and systems, highlighting the need for a fresh perspective on entrepreneurial success. This transformation is particularly critical for small and medium-sized enterprises (SMEs), which form the backbone of many economies (OECD, 2024).

Generational artificial intelligence presents entrepreneurs with entirely new avenues for achieving entrepreneurial success, social impact, and wealth creation. This underscores the importance of interdisciplinary research to fully grasp these possibilities. Such research fosters collaboration between technology innovators, policymakers, entrepreneurs, and educators. The collaboration between the three key players in the «triple helix» — the government, universities, and businesses — reveals the underdevelopment of the business component and the ambiguity of the role of universities in the innovation ecosystem. To address this issue, it is crucial to implement artificial intelligence technologies that enable seamless communication between all parties involved and enhance decision-making processes. The theoretical framework of this study emphasises the significance of responsible and people-centric utilisation of AI tools that foster entrepreneurial endeavours.

Despite the potential challenges associated with the implementation and utilisation of artificial

intelligence, there is a significant interest in these systems. According to Deloitte, the investment in artificial intelligence is expected to surpass $6.4 billion by 2025, and PNB predicts that the widespread adoption of artificial intelligence will result in a 14% increase in global GDP by 2030 (World Bank, 2021). This trend may not only affect large corporations but also small and medium-sized enterprises. For this group of companies, this can be a significant issue due to their limited resources or lack of experience in utilising such advanced technologies. Therefore, it is crucial to identify the potential opportunities and risks associated with the use of artificial intelligence in management (KPMG, 2023). Recent research emphasises that AI adoption can significantly enhance SME competitiveness and innovation (Tsyfrovyi intelekt, 2024). However, the specific challenges faced by SMEs, such as limited access to data and expertise, require tailored strategies (Ivanov et al., 2024).

Small and medium-sized enterprises and their investors appreciate the significance of data for their operations. Today, companies worldwide are embracing data-driven innovation not only to modernise and improve their competitiveness but also to expand into new markets, meet government regulations, and enhance their sustainability. Studies show that SMEs leveraging data analytics and AI-driven insights experience improved decision-making and operational efficiency (Petrenko, 2023). However, many SMEs still struggle with data integration and the skills needed to effectively utilise AI technologies (Sydorenko, 2024).

This research aims to explore the practical applications of AI techniques and tools and to evaluate the feasibility of AI implementation in small and medium-sized businesses. The findings contribute to understanding the role of AI in SME development and provide practical insights for business leaders, policymakers, and researchers working to enhance AI integration in small and medium-sized businesses.

THEORETICAL BACKGROUND

Artificial intelligence (AI) is a field of computer science that focuses on creating machines that can mimic human thinking and actions. The first research in this area began in the middle of the 20th century when scientists began to develop algorithms capable of self-learning (Kureljusic &

Metz, 2023). Then projects like IBM Deep Blue and Watson helped to publicly demonstrate the capabilities of AI in solving complex problems and processing large amounts of data (Davenport et al., 2020). With the development of the Internet, increasing amounts of data, and improved machine learning algorithms, AI has become an integral part of many technological processes, from automation and analytics to creating new ways of interacting between humans and machines.

Neural networks are a special class of algorithms within the framework of artificial intelligence, which is based on mimicking the work of the human brain. These networks consist of layers, or "neurons," that are interconnected and can process data in a complex, multi-level process (Dabbous et al., 2022). The use of neural networks has demonstrably improved AI's ability to process speech, recognise images, predict weather conditions, and even help with medical diagnostics.

The main types of neural networks:
1. Convolutional neural networks (CNNs) are effective in working with images, videos, textures, and objects.
2. Recurrent neural networks (RNNs) are used to process sequences such as text or sound, due to the ability to "remember" previous data while processing new.
3. Feedforward Neural Networks are the main form of neural networks used for forecasting based on static data (Marcinkowski & Gawin, 2020).

Modern researchers and developers are actively working to improve neural network architectures to create faster, more efficient and affordable solutions in various fields.

The impact of neural networks on various industries:
– Healthcare: Neural networks are revolutionising the ability to diagnose diseases by analysing medical images with high accuracy. White et al. (2022) conducted a systematic review of AI adoption in healthcare SMEs, highlighting unique challenges including regulatory compliance and data privacy concerns. Their study identified successful implementation frameworks that balanced innovation with patient safety and data security requirements.

- Finance: AI helps banks and financial institutions detect fraud, manage risks, and automate credit decisions. Investors can make more informed decisions using intelligent algorithms. In essence, investors are focused on maximising capital gains and diversifying risk. Kumar and Singh (2021) developed a multidimensional index for measuring AI readiness in financial services SMEs, identifying critical factors such as regulatory compliance, technical infrastructure, and workforce capabilities. Their work provides a valuable framework for assessing implementation readiness across different financial service segments.
- Automotive Industry: Autonomous vehicles using AI implement networks to process information from sensors and cameras in real time for safe driving (Bhardwaj, 2022).
- Art and Entertainment: Neural networks have also had a significant impact on the entertainment and art industries. AI's ability to learn and create content has opened up new perspectives for designers, musicians, and artists. For example, AI algorithms are used to create complex graphic images and even to compose music, which allows for exploring new forms of visual and sound creativity.
- Electric Power Industry: AI helps optimise energy consumption in real-time, predict loads, and manage networks. New technologies reduce the cost of electricity. For example, using smart thermostats reduces heating costs by up to 30%. Smart grids provide stable power supply even in hard-to-reach places. The first intermediary is the share of renewable energy consumption. We assume that AI significantly contributes to the development and consumption of renewable energy; at the same time, renewable energy is an essential component for increasing green productivity (Miaomiao, 2024).
- Manufacturing Sector: Williams and Johnson (2021) conducted a comprehensive analysis of Industry 4.0 implementation in manufacturing SMEs, identifying key barriers including technical expertise shortages and integration challenges with legacy systems. Their findings were reinforced by Nielsen et al. (2022), who documented significant variations in AI readiness across European manufacturing sectors, with particular emphasis on the role of regional innovation ecosystems.

- Retail and Services: The retail sector has shown distinctive adoption patterns, as documented by Martinez and Chen (2023), who found that customer service automation and inventory management were primary drivers of AI adoption. Their cross-national study revealed that retail SMEs in developed economies were more likely to implement advanced AI solutions, while those in emerging markets focused on basic automation tools.

Geographic variations and context:
- Developed Economies: Schmidt et al. (2023) surveyed European SMEs, revealing significant variations in AI adoption rates across different regions. Their findings suggest that strong institutional support and access to technical expertise were key enablers of successful AI implementation.
- Emerging Markets: Research by Li and Park (2022) in Asian markets highlighted unique challenges faced by SMEs in emerging economies, including limited access to technical expertise and infrastructure constraints. Similarly, OECD (2021) documented specific challenges in African contexts, emphasising the role of local innovation ecosystems and technical education.
- Global Comparisons: Thompson et al. (2023) provided a comprehensive analysis of AI adoption disparities between developed and developing economies, highlighting how different economic contexts influence adoption strategies and outcomes. Their work emphasises the need for contextualized approaches to AI implementation.

METHODS

In the course of the study, academic literature and practical experiences were reviewed, enabling to synthesis of theoretical and empirical materials. The conducted research is based on general and special methods of scientific knowledge: a systematic approach, classification, and comparative analysis. In the literature review, the search was primarily in such databases as Web of Science, Scopus, Business Source Complete, and Google Scholar (publication timeframe: January 2020 - April 2024). The search was conducted using keywords including: "artificial intelligence," "AI," "machine learning," "ML", "SME," "small and medium enterprise," "small business" etc. The main criteria for the inclusion in the literature

study were: peer-reviewed academic articles and conference proceedings, publications in English, focus on SMEs (as defined by EU/World Bank standards), explicit discussion of AI adoption or implementation, empirical studies with clear methodology, theoretical papers with substantial conceptual contribution, geographic coverage across developed and developing economies.

The selection of keywords was guided by a combination of theoretical considerations and practical experience. We began by identifying key concepts related to the research topic, such as "artificial intelligence," "small and medium enterprises," and "digital transformation." We then expanded the list of keywords by including synonyms and related terms (e.g., "AI," "machine learning," "SME," "small business"). We also considered the specific context of AI implementation in SMEs, including potential applications (e.g., "process automation," "data analytics") and challenges (e.g., "lack of technical expertise," "data integration").

To ensure the effectiveness of the keyword search, we followed several guidelines:

– Use of Boolean operators: We used Boolean operators (e.g., "AND," "OR," and "NOT") to combine keywords and refine the search results.
– Truncation and wildcards: We used truncation and wildcards (e.g., "AI*" to capture variations such as "AI," "artificial intelligence," and "AI-driven") to broaden the search and capture relevant studies that may not have used the exact keywords.
– Database-specific search strategies: We tailored the keyword search strategies to the specific requirements and features of each database (e.g., Web of Science, Scopus, Business Source Complete, Google Scholar).
– Iterative refinement: We iteratively refined the keyword search based on the initial search results, adding or removing keywords as needed to improve the precision and recall of the search.

To work out the scope of material the following research methods were used:

– A systematic approach for applied thematic analysis for content categorisation and cross-validation of findings across multiple sources. Thematic analysis, as described by Braun and Clarke (2006), was employed to identify, analyse, and interpret patterns of meaning (themes) within the qualitative data gathered from the literature review. This involved a

systematic process of familiarisation with the data, coding, theme development, review, and refinement. The thematic analysis allowed for a nuanced understanding of recurring perspectives and challenges related to AI implementation in SMEs (Nowell et al., 2017). We followed the six-phase framework proposed by Braun and Clarke (2006) to ensure a rigorous and transparent analysis process.

– Classification methods for industry-based categorisation, geographic clustering, implementation stage classification, technology type grouping, and adoption barrier categorisation. Classification methods were used to categorise and group studies based on various criteria, such as industry sector, geographic location, AI implementation stage, technology type, and adoption barriers. This enabled a structured overview of the existing research landscape and facilitated the identification of trends and gaps. We consulted relevant literature on classification techniques (Bailey, 1994) to guide the selection of appropriate classification schemes and ensure the validity and reliability of the categorisation process.

– Comparative analysis for cross-industry comparison, implementation framework comparison, and success factor analysis. Comparative analysis was conducted to compare and contrast AI adoption patterns, implementation frameworks, and success factors across different industries, geographic regions, and SME types. This involved a systematic examination of similarities and differences, as well as an assessment of the underlying reasons for these variations. We drew upon established frameworks for comparative analysis (Ragin, 1987) to ensure a rigorous and structured approach.

In addition to the specific methodological literature mentioned above, we consulted several general guidelines and methodological resources to ensure the rigour and validity of our research. These included:

– PRISMA guidelines: We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) to ensure a transparent and comprehensive reporting of our literature review process.
– Cochrane Handbook for Systematic Reviews of Interventions: We consulted the Cochrane

Handbook for Systematic Reviews of Interventions (Higgins et al., 2019) for guidance on conducting systematic reviews and meta-analyses.
- Methodological textbooks and handbooks: We consulted several methodological textbooks and handbooks on qualitative and quantitative research methods (Creswell & Creswell, 2017) to inform our selection and application of appropriate research methods.

By incorporating these methodological details and citing relevant literature, we aimed to provide a clear and transparent account of our research process and enhance the credibility and rigour of our findings.

Nevertheless, the methodology used has some limitations. Language bias is possible due to English-only inclusion. Also, there is limited access to proprietary industry data. Due to geographic limitations, there may be an overrepresentation of developed economies as there is limited data from certain regions (particularly Africa and South America). Another limitation is an uneven distribution of studies across sectors and technology-sector bias in adoption studies.

RESULTS

AI awareness and understanding among SMEs

In business, artificial intelligence can be used to support three important areas of development:
- when automating structured and repetitive processes through the use of robotics;
- when presenting conclusions based on an exhaustive analysis of structured data, most often using machine learning;
- When interacting with customers and employees using chatbots processing natural language, virtual assistants and machine learning (Babber & Mittal, 2023).

In particular, the possibilities of using AI in business are outlined as follows, as shown in Figure 1:
- Personalisation of consumer experience: Neural networks process data from social networks, IoT and other sources, helping companies understand their customers and respond effectively to their desires. Google uses neural networks to analyse user behaviour – it

is not just data, it is human emotions, aspirations, and fears transformed into numbers. One of the most popular examples of using AI in everyday life is recommendation systems such as those used by Netflix or Spotify. These platforms analyse previous preferences to suggest movies, shows, or music that are most likely to be chosen (Klein & Todesco, 2021). The complexity of these systems is to take into account a huge number of factors and preferences that can change over time. Neural networks can read between the lines and understand moods that can be extracted from social media posts or product reviews turning them into a powerful tool for adapting marketing strategies. It's not just data, it's living human emotions. Chatbots and voice assistants based on neural networks have already become the standard in customer service. They can process requests, solve problems, and sometimes even offer additional services based on an analysis of customer behaviour.
- Data analytics: Neural networks are great at processing huge amounts of data. Instead of spending days analysing reports, it is enough to connect AI and get insights about consumer preferences, sales forecasts or weaknesses in the supply chain in just minutes.
- HR Management: Neural networks help to search for talent by analysing resumes and evaluating candidates' compliance with corporate requirements. They can also give recommendations on staff training, suggesting which skills are important to develop (Prentice et al., 2023).
- Process automation: Neural networks take on routine tasks, freeing up time for strategic decisions. Neural networks can be used to build supply chains in such a way as to avoid disruptions, reduce costs, and improve order fulfilment times. For example, predictive planning helps to find bottlenecks in advance and eliminate them before problems arise. In the banking sector, credit scoring automation leads to instant decisions rather than weeks of waiting (Marcinkowski & Gawin, 2020). Every click and every decision becomes easier and faster. Scans, contracts, invoices — neural networks cannot only process all this quickly, but also check for errors, compliance with standards, and even highlight potential legal risks.
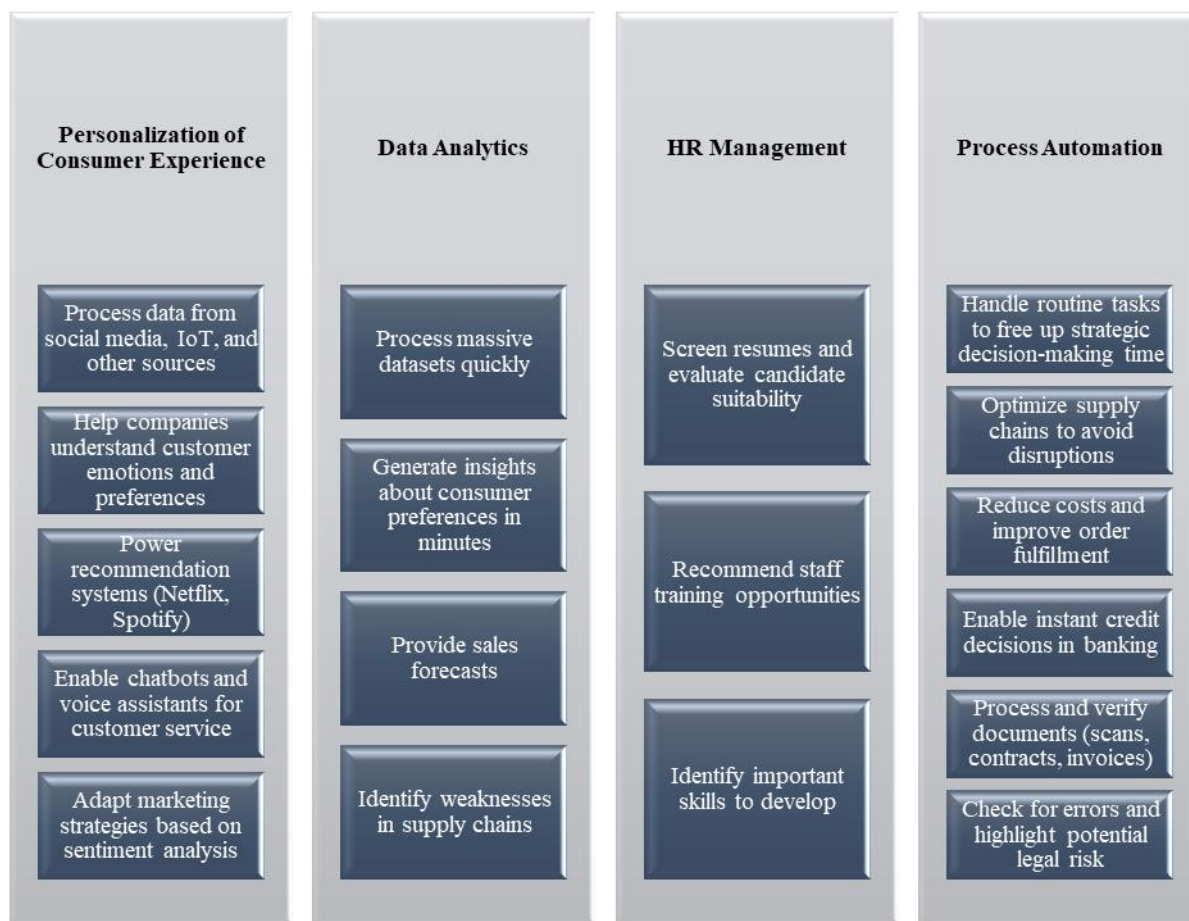
Figure 1. Applications of AI in Business

It is important to note that artificial intelligence is a point-based solution. It is designed for a specific forecast and is being developed to solve a specific problem. One algorithm, one forecast, one solution. In order to transfer a business process to artificial intelligence, it must first be broken down into functions, which must be broken down into tasks. Thus, it is necessary to engage in an accurate and detailed analysis. Only after that, by creating AI for each task, synthesise functions into a business process.

When implementing AI systems, organisations should divide processes into tasks, calculate the profits and costs of developing or acquiring AI for each specific task, arrange AI according to the degree of return on capital from maximum to minimum, and then, move from the high-return option in order, implement the systems (if the expected return justifies it). Despite the fact that in some cases the benefits of implementing AI at the level of a separate business process may be immediately noticeable, in most cases it is possible to obtain real benefits only when the entire business process is transformed.

Before implementing AI at the enterprise level, it is necessary to develop detailed scaling plans, for which it is necessary to organise the joint work of technology experts with those responsible for transformable processes. Since AI does not rebuild entire processes, but solves individual tasks, scaling in most cases involves integration with existing processes and systems (Qi et al., 2019). Before starting the implementation of AI systems, it should be checked whether such integration is possible. Ensuring continuous communication between specialists makes it possible to achieve the best solution.

Despite the impressive progress of AI and neural networks, several challenges and limitations need to be considered:

− Privacy and data security issues are among the most pressing. In this regard, it is important to develop strict data protection protocols and privacy mechanisms so that users can trust

technologies that enhance the possibilities of their daily lives. Processing huge amounts of data implies responsibility (Lateh, et al., 2017). As a rule, customer information is collected from various sources: social networks, purchases, and websites. This creates a valuable resource, but at the same time puts personal data at risk. Information protection should be a priority for companies using neural networks. One of the ways to eliminate this risk is to use consent mechanisms and regulations. Targeted and proper regulation is important to ensure security, accountability, clarity, and confidentiality. Protecting public trust is relevant to any new and evolving technological application, but this is especially true for generative artificial intelligence.

- The social impact associated with automation can lead to job losses in certain areas (Solheim et al, 2023). The approach to implementing AI should include social adaptation strategies as well as educational initiatives so that people can effectively participate in the changing economic landscape.
- Responsible use: The use of neural networks should be based on the principles of responsibility. It is necessary to consider the possible consequences of automation: Who is responsible for the mistakes? How can we prevent biases that may arise as a result of data analysis? Companies should have clear internal rules to ensure that their technologies serve the benefit and not harm.
- New professions and skills: With the growth of technology, new professions are also emerging - data scientists, algorithm developers, analysts, and ethics experts. Education will have to change, focusing on skills that will help people work in new conditions (Papadopoulos et al., 2020). Companies must invest in training their employees to prepare them for this rapidly changing world.

Observed AI adoption rates and types of AI applications

An online survey was conducted to investigate the potential for the adoption of artificial intelligence (AI) technologies among various businesses. The survey included 41 small businesses with an annual revenue of less than €10 million and 22 medium-sized businesses with a revenue between €10 and less than €50 million. A total of 63 questions were answered by 28 chief executive officers (CEOs), 18 senior managers, 11 chief information officers (CIOs), and 6 chief financial officers (CFOs). All the businesses surveyed use transaction processing systems as operational support applications to define their business processes.

According to the survey findings, 61 businesses use information management systems on top of their transaction processing systems to manage their business units and departments. However, only about 62% of the businesses surveyed utilise decision support systems for strategic planning and integrated decision-making. These results are in line with previous research by Paschek et al. (2018), which found that while AI has the potential to transform businesses, its adoption is still limited in some sectors.

Considering modern technologies, only 8 companies reported that they had experience working with AI. The reasons for this were:
- Uncertainty about AI and its use cases for implementation and support;
- Lack of skills and resources within the company to implement AI;
- The database, as well as available and trained expertise, in addition to external factors, were crucial for all respondents. Based on these factors, all respondents noted the use of an internal knowledge management system with multiple levels of information and technical support.

Note that the main dilemma is to identify a priority area for implementing AI systems between internal operations and the outside world, including product improvement and customer relations (Figure 2):
1. In the internal environment of an organisation, AI can be used to automate existing processes in order to reduce costs or optimise decision-making in the field of financial or supply chain management. In addition, the use of AI systems to increase the validity of decision-making is widespread (Wamba, 2022). The system can analyse more dynamic and detailed data in real-time, including incoming data from external sources. By providing a more accurate picture of the current situation, this algorithm supports the decision-making process in the organisation.
2. In the external environment, an enterprise can direct efforts to study its customers to

personalise offers, which will be able to increase sales by forecasting needs and building long-term relationships with them. At the same time, the company can introduce AI into its products in order to change the customer's experience with it (Wamba, 2022). AI can also

be used to meet regulatory requirements and manage risks. The implementation of AI at the external level depends on the specifics of a particular industry or product.
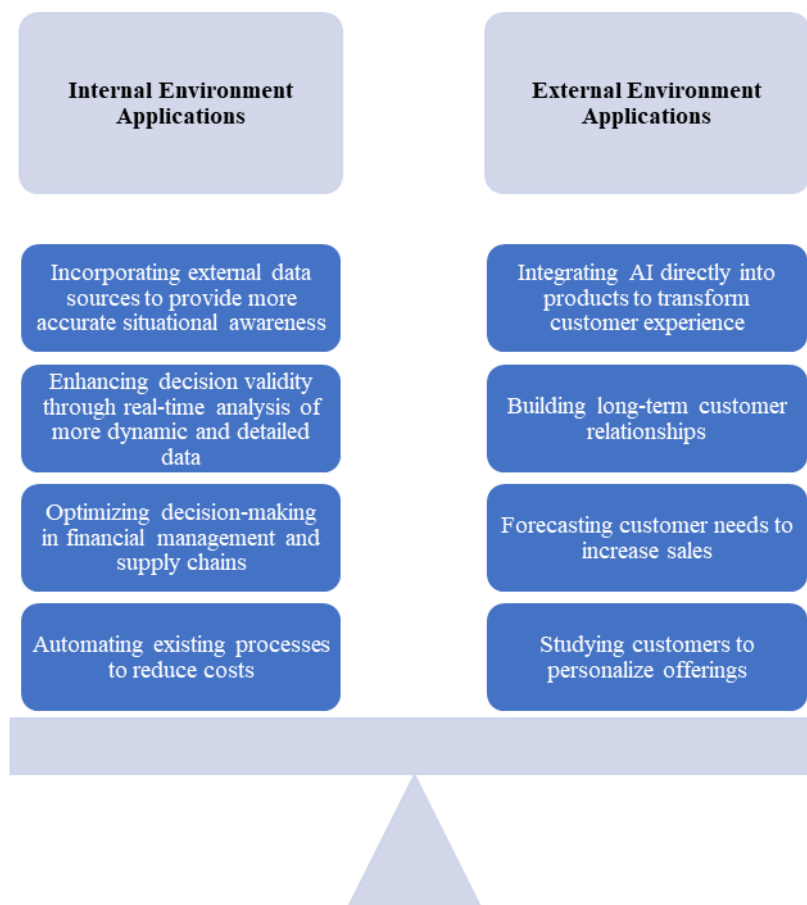
Internal Environment Applications

- Incorporating external data sources to provide more accurate situational awareness
- Enhancing decision validity through real-time analysis of more dynamic and detailed data
- Optimizing decision-making in financial management and supply chains
- Automating existing processes to reduce costs

External Environment Applications

- Integrating AI directly into products to transform customer experience
- Building long-term customer relationships
- Forecasting customer needs to increase sales
- Studying customers to personalize offerings

Figure 2. AI Implementation Dilemma

Perceived benefits of AI by SMEs

Overall, the emergence of generative AI has created new opportunities to increase equity and access, as well as to more fully democratise vital entrepreneurial resources. This is especially true for small and medium-sized businesses.

Content and Asset Creation: Generative AI can assist entrepreneurs with automating content creation. This includes generating copies of websites, social media posts, news articles, mission descriptions, and political statements. Although the initial results may be approximate, additional editing can improve the quality and accuracy of the content. Overall, the efficiency of content creation has increased significantly.

In addition to text and simple images, AI tools can also assist entrepreneurs in creating 3D models and advanced graphic design elements. These assets were previously only available through expensive solutions that required the work of specialists. However, AI tools are now able to create reliable assets at a faster pace and with less effort. Due to low costs, high production efficiency, and high-quality work, entrepreneurs can save time and energy on their core business and enterprise development.

Automated Operations: Automation is essential for improving productivity as it increases work efficiency. Common aspects of marketing, customer support, accounting, and back-office operations can be automated using artificial intelligence (AI). Small businesses can benefit from "dialogue bots" available online (Griesch et

al., 2023). These tools can be used to optimise processes, reduce costs, and identify trends in workflow and productivity. Generative AI can also help build predictive models for business models and automate operational structures. By exploring these tools, entrepreneurs can create and scale solutions using code-free or low-code platforms with minimal technical knowledge.

New Ideas for Venture Business: Generative AI Can Monitor Community and Market Behavior, Identify Problems and Trends.

Generative AI has the power to monitor community and market behaviour, identifying problems and trends that can be used to formulate new ideas and develop product concepts. It combines knowledge and information from different fields in unique ways, making it a valuable tool for entrepreneurs who may not have a formal education.

Entrepreneurs can use generative AI tools to supplement creativity and turn ordinary business ideas into original breakthroughs. One such tool, developed by the company of the first author, functions as a business intelligence application, utilising data-driven analytics and process automation to save time and money for entrepreneurs. Thus, it can indirectly support creative entrepreneurial activity. This impact has an effect on the financial performance of entrepreneurial firms.

Financial Management: Generative artificial intelligence (AI) tools can also help manage cash flow and create financial plans for businesses. These tools utilise language models that analyse information and data from various financial sources, such as financial literature and financial reports, to create personalised investment plans (Tran & Murphy, 2023).

Generative AI can analyse a company's financial situation and provide suggestions for budgeting, retirement planning, tax optimisation, and other financial strategies. Entrepreneurs can leverage automated wealth management tools powered by generative AI to make informed investment decisions at both the individual and corporate levels.

Additionally, generative AI can perform accounting tasks such as analysing cash flow and expenses, tracking assets, liabilities, savings,

income from investments, and debt payment schedules.

Optimised Operations: Generative AI can predict demand, make suggestions for lean manufacturing design, and provide the information needed to maximise profits. For full-time businesses, generative AI can offer strategic decision-making insights. It can generate financial forecasts based on various assumptions (Tran & Murphy, 2023). Sales and marketing tools like advertising, email campaigns, and website design can be optimised using generative AI, allowing for the generation of thousands of variations and iterations. Entrepreneurs can choose the best options. Generative AI helps reduce transaction costs by analysing asset values and identifying potential savings.

Barriers to AI adoption

The main obstacles preventing small and medium-sized businesses from adopting new data-driven technologies and artificial intelligence include:

- Lack of industry-specific data: AI and big data analytics are relatively new in certain sectors, so there is a lack of analytical data available for successful implementation. Although small and medium businesses may have valuable data, it may not be sufficient for supervised machine learning models. Additionally, there are no established mechanisms for these businesses to share their limited data (Meng et al., 2020).
- Low awareness of the value and potential of open data: In many cases, government databases are made available for free and become publicly accessible due to their openness. These datasets can be valuable for small businesses, but they often go unnoticed by the IT departments. As more small and medium-sized companies understand the benefits of open data and how to use it to achieve positive results, they will be able to create more innovative products and services at a lower cost. However, managing data effectively is a challenge for these businesses, as they often struggle to determine which types of data should be collected about their operations (Tawil et al., 2024).
- Data Integration: The demand for businesses to share information in real-time has increased with the advent of technologies such as mobile commerce, electronic money transfers, supply chain management, and online transaction

processing. Organisations can benefit from integrating their IT systems to meet this demand. However, in many cases, measures for mobility and interoperability for small and medium-sized businesses are still being implemented at a relatively slow pace (Mancini, 2021). Data integration is a significant challenge for small and medium-sized companies due to high costs and technical requirements and is often referred to as an obstacle faced by organisations.

− Limited internal and external financial resources: During our research with representatives from small and medium-sized businesses, we found that most of them can recognise the value of data and analytics for their businesses. They also expressed a willingness to invest in data analytics tools and technologies to extract meaningful insights from their data. However, despite efforts to introduce information technology, these businesses' capabilities are limited due to a lack of knowledge, experience, and budget to hire specialists or outsource analytical work. Additionally, SMEs face challenges in accessing finance and credit, which can hinder their ability to invest in new technologies and strategies (OECD, 2021).

− The obvious ease of traditional business: Many small and medium-sized companies operate in specific industries and rely on traditional methods. For this reason, many business owners prefer to continue using these methods rather than introducing new technologies like artificial intelligence and data analysis. This means they are not using data for more than just accounting purposes. As a result, valuable data-driven opportunities for small and medium businesses are being missed. The decision-making process in these companies could become more data-driven, leading to changes in their business models (Tawil et al., 2024).

− Lack of domain-specific data analysis specialists: Effective business data analysis often requires a combination of data analysis skills, business context, and domain knowledge. Due to the limited number of professionals who meet these criteria, small and medium-sized businesses often outsource their data analysis needs. This can lead to relatively high costs for the services of specialists in certain fields, such as additive manufacturing, data science, and machine learning for process management and modelling. In these fields, the lack of specialists

with a deep understanding of the business context can hinder the development of new technologies and processes. Small and medium-sized manufacturing companies are less likely to utilise data for analysis and decision-making, making it difficult for them to use data to stimulate growth and increase productivity.

− Lack of Technical Knowledge: Small businesses need to develop and improve their employees' skills in order to stay competitive. Lack of resources, data processing, machine learning, and awareness of innovation funding, among other factors, prevent many small and medium-sized businesses from keeping up with technological advancements in terms of their employees' skills and competencies. This is particularly true for companies in manufacturing and technology industries, which face challenges in designing, developing, and testing new products, or upgrading existing products to meet new market demands (Ridho, 2023).

− Insufficient knowledge of data processing tools and financial resources: Our research revealed that small and medium-sized businesses are unaware of available financing options, especially for implementing innovative digital and data-driven solutions (Ridho, 2023). Only a small percentage of micro-enterprises are familiar with some of the most commonly used data management and analysis tools and the benefits they provide. For many small and medium businesses, it has become essential to support the adoption of these tools.

− Limited capabilities in data processing and machine learning: Another significant challenge faced by small to medium-sized companies in digitising and implementing artificial intelligence and data processing technologies is a lack of practical knowledge and skills in this field.

DISCUSSION

The findings suggest several important implications for policymakers, business leaders, and the academic community:

1. There is a clear need for enhanced support mechanisms to help SMEs overcome the identified barriers to AI adoption, particularly in areas of funding access and technical expertise development.

2. Educational institutions and industry bodies should focus on developing targeted programs

to bridge the knowledge gap in AI implementation and management for SME staff.
3. Policy frameworks should be developed to facilitate data sharing and integration while maintaining appropriate privacy and security standards.
4. Further research is needed to develop industry-specific AI implementation models that account for the unique constraints and requirements of SMEs.

Looking forward, the successful integration of AI technologies in SMEs will likely depend on the development of more accessible, cost-effective solutions specifically designed for smaller organisations, combined with improved support infrastructure and knowledge-sharing mechanisms. The transformation of SMEs through AI adoption represents a crucial factor in maintaining their competitiveness in an increasingly digitalised global economy.

The findings of this study align with previous research that has identified similar benefits and barriers to AI adoption in SMEs. However, this study has important implications for SME strategies. SMEs should prioritise AI investments that align with their specific business goals and resources. They should also focus on developing the necessary technical skills and data infrastructure to support AI implementation. Collaboration with AI experts and technology providers can also help SMEs overcome the barriers to AI adoption. The results also connect to the dynamic capabilities framework, which emphasises a firm's ability to adapt, integrate, and reconfigure internal and external resources and capabilities to address changes in the business environment. In the context of AI, SMEs need to develop dynamic capabilities to effectively identify, evaluate, and deploy AI technologies to create new products, services, and business models.

CONCLUSIONS AND RECOMMENDATIONS

The research conducted demonstrates that artificial intelligence presents both significant opportunities and notable challenges for small and medium-sized enterprises. While AI technologies offer transformative potential across multiple business functions—from operations automation to customer experience personalisation—the adoption

rate among SMEs remains relatively low due to various structural and resource-related barriers.

AI applications can substantially enhance SME competitiveness through improved operational efficiency, data analytics capabilities, and customer service delivery. Particularly promising areas include content creation, automated operations, venture business ideation, financial management, and operational optimisation. These applications can help level the playing field between SMEs and larger enterprises by democratising access to sophisticated business tools and capabilities.

The research identifies critical barriers to AI adoption among SMEs, including:
– Limited access to industry-specific data
– Insufficient awareness of available data resources and their potential value
– Challenges with data integration across systems
– Financial constraints affecting both implementation and ongoing operation
– Resistance to changing traditional business practices
– Shortage of domain-specific data analysis expertise
– Technical knowledge gaps among existing staff
– Limited understanding of available tools and funding opportunities

Successful AI implementation requires a strategic, phased approach where processes are carefully divided into discrete tasks, with implementation prioritised based on return on investment calculations. Integration with existing systems and processes must be carefully planned and executed.

While AI offers significant opportunities for SMEs to improve their performance, adoption rates remain relatively low due to a number of barriers. To address these challenges and promote AI adoption among SMEs, the following recommendations are made:
1. For policymakers:
– Implement targeted support programmes (e.g., grants, subsidies, tax incentives) to help SMEs invest in AI technologies and infrastructure. These programmes should be tailored to the specific needs of SMEs in different sectors.
– Develop educational and training initiatives to improve AI skills and awareness among SME employees. These initiatives should include

workshops, online courses, and mentorship programmes.

− Promote data sharing and access to AI infrastructure for SMEs. This could involve creating a national data platform or providing access to cloud-based AI services.

2. For business leaders:

− Prioritise AI projects with clear ROI and alignment with business goals. Start with small-scale AI projects that can deliver quick wins and build momentum for broader AI adoption.

− Invest in employee training and development to build AI skills. Encourage employees to experiment with AI tools and technologies.

− Collaborate with AI experts and technology providers to implement AI solutions. Seek out partnerships with universities, research institutions, and AI startups.

Future research should focus on the following areas:

− Conduct longitudinal studies to track the long-term impact of AI on SME performance.

− Perform comparative studies to examine AI adoption in SMEs across different countries or industries.

− Undertake qualitative research to gain a deeper understanding of the challenges and opportunities faced by SMEs in implementing AI.

REFERENCES

Babber, G., & Mittal, A. (2023). Achieving sustainability through the integration of lean, agile, and innovative systems: Implications for Indian micro small medium enterprises (MSMEs). *Journal of Science and Technology Policy Management*. https://doi.org/10.1108/JSTPM-02-2023-0023

Bailey, K. D. (1994). Typologies and taxonomies: An introduction to classification techniques. Sage Publications. https://doi.org/10.1002/(SICI)1097-4571(199604)47:4<328::AID-ASI10>3.0.CO;2-Y

Bhardwaj, S. (2022). Data analytics in small and medium enterprises (SME): A systematic review and future research directions. *Information Resources Management Journal, 35(*1), 1–18. https://doi.org/10.4018/IRMJ.293236

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.)*. Sage Publications.

Dabbous, A., Aoun Barakat, K., & Merhej Sayegh, M. (2022). Enabling organizational use of artificial intelligence: An employee perspective. *Journal of Asia Business Studies, 16*(2), 245–266. https://doi.org/10.1108/JABS-06-2021-0246

Davenport, T., Guha, A., Grewal, D., & Bressgott, T. (2020). How artificial intelligence will change the future of marketing. *Journal of the Academy of Marketing Science, 48*, 24–42. https://doi.org/10.1007/s11747-019-00696-0

Griesch, L., Rittelmeyer, J., & Sandkuhl, K. (2023). Towards AI as a service for small and medium-sized enterprises (SME). In B. Shishkov (Ed.), *Practice of Enterprise Modeling: PoEM 2023* (pp. 37–53). Springer. https://doi.org/10.1007/978-3-031-47064-6_3

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2019). *Cochrane Handbook for systematic reviews of interventions (2nd ed.)*. John Wiley & Sons. https://doi.org/10.1002/9781119536604

Ivanov, A., Petrenko, A., & Koval, I. (2024). *Challenges and strategies for AI implementation in small businesses*. Lviv: Technology Press

Klein, V. B., & Todesco, J. L. (2021). COVID-19 crisis and SMEs responses: The role of digital transformation. *Knowledge and Process Management, 28*(2), 117–133. https://doi.org/10.1002/kpm.1650

KPMG. (2023). *Globalne trendy technologiczne 2023*. https://kpmg.com/pl/pl/home/insights/2023/11/globalne-trendy-technologiczne-2023.html

Kumar, A., & Singh, R. (2021). Measuring artificial intelligence readiness in financial services SMEs: Development and validation of a multidimensional index. *Journal of Financial Innovation, 7*(2), 145–168. https://doi.org/10.1186/s40854-021-00263-2

Kureljusic, M., & Metz, J. (2023). The applicability of machine learning algorithms in accounts receivables management. *Journal of Applied Accounting Research, 24*(4), 769–786. https://doi.org/10.1108/JAAR-09-2022-0234

Lateh, M. A., Muda, A. K., Yusof, Z. I. M., Muda, N. A., & Azmi, M. S. (2017). Handling a small dataset problem in prediction model by employ artificial data generation approach: A review. *Journal of Physics: Conference Series, 892*, 012001. https://doi.org/10.1088/1742-6596/892/1/012001

Li, X., & Park, S. (2022). Understanding barriers and facilitators of artificial intelligence adoption in Asian small and medium enterprises: A mixed-methods approach. *International Journal of Information Management, 63, 102444*. https://doi.org/10.1016/j.ijinfomgt.2021.102444

Mancini, J. (2021). *Data portability, interoperability and digital platform competition: OECD background paper*. OECD. https://www.oecd.org/competition/data-portability-interoperability-digital-platform-competition-2021.pdf

Marcinkowski, B., & Gawin, B. (2020). Data-driven business model development: Insights from the facility management industry. *Journal of Facilities Management, 19*(2), 129–149. https://doi.org/10.1108/JFM-11-2019-0058

Martinez, C., & Chen, H. (2023). Artificial intelligence adoption patterns in retail SMEs: A cross-national comparative analysis of implementation strategies. *International Journal of Retail & Distribution Management, 51*(3), 278–296. https://doi.org/10.1108/IJRDM-08-2021-0361

Meng, L., McWilliams, B., Jarosinski, W., Park, H. Y., Jung, Y. G., Lee, J., & Zhang, J. (2020). Machine learning in additive manufacturing: A review. *JOM, 72*, 2363–2377. https://doi.org/10.1007/s11837-020-04280-5

Miaomiao, T. (2024). Digital brains, green gains: Artificial intelligence's path to sustainable transformation. *Journal of Environmental Management, 370*, 121247. https://doi.org/10.1016/j.jenvman.2024.121247

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine, 6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Nielsen, K., Schmidt, R., & Anderson, M. (2022). Regional variations in SME artificial intelligence implementation: Evidence from European manufacturing sectors. *Small Business Economics, 58*(4), 891–912. https://doi.org/10.1007/s11187-021-00509-4

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods, 16*(1), 1–13. https://doi.org/10.1177/1609406917733847

OECD. (2021). *The digital transformation of SMEs. OECD Studies on SMEs and Entrepreneurship*. OECD Publishing. https://doi.org/10.1787/bdb9256a-en

OECD. (2024). *OECD SME and entrepreneurship outlook 2024*. OECD Publishing. https://doi.org/10.1787/ee0d08ec-en

Papadopoulos, T., Baltas, K. N., & Balta, M. E. (2020). The use of digital technologies by small and medium enterprises during COVID-19: Implications for theory and practice. *International Journal of Information Management, 55*, 102192. https://doi.org/10.1016/j.ijinfomgt.2020.102192

Paschek, D., Luminosu, C. T., Draghici, A., & Mateescu, A. (2018). Artificial intelligence and the way of changing decision-making for business management. *In Proceedings of the Technology, Innovation and Industrial Management Conference* (pp. 451–459).

Petrenko, A. (2023). Data analytics and AI-driven insights for SMEs. *Economic Journal, 12*(3), 45–62.

Prentice, C., Wong, A. I., & Lin, Z. C. J. (2023). Artificial intelligence as a boundary-crossing object for employee engagement and performance. *Journal of Retailing and Consumer Services, 73*, 103278. https://doi.org/10.1016/j.jretconser.2023.103278

Qi, X., Chen, G., Li, Y., Cheng, X., & Li, C. (2019). Applying neural-network-based machine learning to additive manufacturing: Current applications, challenges, and future perspectives. *Engineering, 5*(4), 721–729. https://doi.org/10.1016/j.eng.2019.01.019

Ragin, C. C. (1987). *The comparative method: Moving beyond qualitative and quantitative strategies*. University of California Press.

Ridho, W. F. (2023). An examination of the opportunities and challenges of conversational artificial intelligence in small and medium enterprises. *Review of Business and Economics Studies, 11*(3), 6–17. https://doi.org/10.26794/2308-944X-2023-11-3-6-17

Schmidt, R., Weber, M., & Brown, J. (2023). Artificial intelligence adoption in European SMEs: Results from a comprehensive multi-country survey. *Journal of Small Business Management, 61*(2), 223–248. https://doi.org/10.1080/00472778.2022.2092177

Solheim, M. C. W., Aadland, T., Eide, A. E., & Haneberg, D. H. (2023). Drivers for agility in times of crisis. *European Business Review, 35*(1), 57–73. https://doi.org/10.1108/EBR-09-2021-0241

Sydorenko, I. (2024). Data integration and skills needed for AI technologies in SMEs. *Management Science, 15*(1), 78–93.

Tawil, A.-R. H., Mohamed, M., Schmoor, X., Vlachos, K., & Haidar, D. (2024). Trends and challenges towards effective data-driven decision making in UK small and medium-sized enterprises: Case studies and lessons learnt from the analysis of 85 small and medium-sized enterprises. *Big Data and Cognitive Computing, 8*(3), 79. https://doi.org/10.3390/bdcc8030079

Thompson, R., Garcia, M., & Lee, S. (2023). Digital transformation disparities between developed and developing economies: Analysis of AI adoption patterns in small and medium enterprises. *World Development, 161*, 106089. https://doi.org/10.1016/j.worlddev.2022.106089

Tran, H., & Murphy, P. J. (2023). Generative artificial intelligence and entrepreneurial performance. *Journal of Small Business and Enterprise Development, 30*(5), 853–856. https://doi.org/10.1108/JSBED-04-2023-0182

Tsyfrovyi intelekt. (2024). *AI adoption and competitiveness in SMEs*. Kyiv: Publishing House.

Wamba, S. F. (2022). Impact of artificial intelligence assimilation on firm performance: The mediating effects of organizational agility and customer agility. *International Journal of Information Management, 67*, 102537. https://doi.org/10.1016/j.ijinfomgt.2022.102537

White, M., Johnson, K., & Smith, P. (2022). Implementation challenges and success factors of artificial intelligence adoption in healthcare SMEs: A systematic review. *Health Technology Assessment, 26*(4), 1–198. https://doi.org/10.3310/XWNC4470

Williams, J., & Johnson, P. (2021). Industry 4.0 and artificial intelligence integration in manufacturing SMEs: Barriers, enablers and implementation frameworks. *Journal of Manufacturing Technology Management, 32*(6), 1119–1142. https://doi.org/10.1108/JMTM-08-2020-0318

World Bank. (2021). *A review of national AI strategies and policies*. https://thedocs.worldbank.org/en/doc/2e658ef2144a05f30e254221ccaf7a42-0200022021/original/DD-Analytical-Insights-Note-4

VEŠTAČKA INTELIGENCIJA ZA MALA I SREDNJA PREDUZEĆA: PERSPEKTIVE I IZAZOVI

Predmetno istraživanje ispituje perspektive i izazove primene veštačke inteligencije (VI) u malim i srednjim preduzećima (MSP). Kroz analizu literature, izveštaja iz industrije i podataka iz ankete sprovedene u 63 preduzeća, istraživanje razmatra potencijalne primene, koristi i prepreke za usvajanje VI u MSP. Rezultati pokazuju da VI nudi značajne mogućnosti za MSP u oblastima kao što su automatizacija procesa, analiza podataka, personalizacija korisničkog iskustva i optimizacija poslovanja, ali da je stopa usvajanja i dalje niska. Istraživanje identifikuje nekoliko ključnih prepreka, uključujući ograničen pristup industrijskim podacima, nedovoljna finansijska sredstva, nedostatak tehničke stručnosti i probleme sa integracijom podataka. Rezultati ankete pokazuju da samo 13% ispitanih preduzeća ima iskustva u radu sa VI, uprkos širokoj upotrebi osnovnih sistema za upravljanje informacijama. Studija ističe pet glavnih oblasti u kojima generativna VI može unaprediti poslovanje MSP: kreiranje sadržaja, automatizovane operacije, razvoj poslovnih ideja, upravljanje finansijama i optimizacija poslovanja. Zaključci naglašavaju potrebu za ciljanom podrškom, unapređenjem obrazovnih programa i razvojem politika koje olakšavaju usvajanje VI među MSP. Ovo istraživanje doprinosi razumevanju uloge VI u razvoju MSP i pruža praktične uvide za poslovne lidere, donosioca odluka i istraživače koji rade na unapređenju integracije VI u mala i srednja preduzeća.

Ključne reči: veštačka inteligencija, mala i srednja preduzeća (MSP), digitalna transformacija.