IMPACT OF AI TECHNOLOGIES ON OPERATIONS OF SMALL AND MEDIUM TRANSPORT BUSINESSES

Vojislava Nićin[1,*], Slobodan Nićin[2], Milovan Mirkov[3,4]

[1]The College of Vocational Studies for Management and Business Communication, Belgrade, Serbia
[2]The College of Academic Studies "DOSITEJ", Belgrade, Serbia
[3]ONB Veljko Petrovic, Zabalj, Serbia
[4]University Business Academy in Novi Sad, Novi Sad, Serbia

*E-mail of corresponding author: nicin.vojislava@gmail.com

Vojislava Nićin 0000-0002-9984-2632, Slobodan Nićin 0009-0001-6579-5321,
Milovan Mirkov 0009-0008-0568-5121

Resume

In this article, the authors present a study on artificial intelligence (AI) integration in transportation and storage SMEs, focusing on research questions, literature reviews, hypotheses, sample selection, and data analysis. They explored current AI support and perceptions and plans of SMEs in this sector. The authors addressed the lack of literature on AI use in transport SMEs and investigated factors, such as AI adoption, benefits perception, company size correlation, and investment willingness. Data was collected from 163 SMEs in Serbia and Slovakia, revealing challenges in participant identification due to low AI use. Declining AI adoption rates authors attributed to financial, technological, regulatory, and awareness issues. The research aims to enhance the AI adoption in transportation and storage SMEs and give some directions for future work.

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1 Introduction

The transport and logistics sectors face challenges like congestion, delays, and traffic accidents leading to time, cost, and environmental impacts, which affect economic sectors and overall growth. The AI innovations effectively address these challenges by leveraging generative artificial intelligence (AI) technology. Recent advancements include OpenAI's ChatGPT and GPT-4, Anthropic's generative AI, Claude, and Google's new AI-driven features, [1]. The AI plays a crucial role in combinatorial optimization for transport and logistics problems, solving various issues such as vehicle routing and warehousing location. The AI applications, as seen in Drydakis's research [2], are predominantly used in recruitment (~ 14 %), customer communication (28 %), and online targeting (30.54%). The number of applications used per company is 1.6, while 52.72 % of SMEs do not use a single AI application. Despite the small businesses (SMEs)[1] lagging in AI adoption [3], the accessibility of AI suggests a potential narrowing of this gap in the future, offering automation, improved customer experiences, and support for business growth.

The AI in small businesses automates tasks, enhances customer experience, and supports growth. For instance, platforms like ChatGPT aid in customer service, marketing, and sales [4]:

- *Customer Experience:* Chatbots improve service by mimicking human conversations, reducing wait times, and offering personalized support, fostering loyalty.
- *Marketing:* AI enables personalized campaigns, recommendations, and targeted offers across various platforms. As AI advances, investing in AI-powered marketing solutions offers a competitive edge.
- *Content Creation:* As in large businesses, in SMEs, AI assists in generating content, analyzing

1 There is no single definition for SMEs [22], and we used the European SME definition in our work [32].

preferences, and maintaining quality and brand alignment.

The AI is a crucial technological component that enhances existing productivity methods in Industry 4.0, without replacing them [5]. It empowers companies, enabling smart task performance, strategic decision-making support for managers, and real-time remote operations management. Notably, sectors such as transportation, logistics, automotive, and technology are early adopters of AI, as evidenced in the literature [6].

While many associate AI with autonomous vehicles, its application extends deeper into the transportation processes and logistics chains. The integration of AI has revolutionized decision-making in transport and logistics, leading to improved efficiency, safety, and sustainability. Key impacts include predictive analytics for demand forecasting, optimized route planning, enhanced freight security, real-time tracking, and intelligent inventory management [7]. The MHI/Deloitte research indicates that only 12 % of businesses currently utilize AI in warehouses, highlighting opportunities for further adoption and growth.

Transportation SMEs can leverage AI differently, including services and low-tech solutions, to enhance their operations and participation in supply chains [8]. The AI-powered tools optimize efficiency in autonomous vehicles and ride-sharing services, improving traffic forecasting and route optimization through sensor networks. Transport and logistics SMEs specifically benefit from transforming practices, reducing accidents, and savings in maintenance, insurance, and fuel consumption [9].

However, the SMEs exhibit slower adoption rates of data analytics compared to larger enterprises, as evidenced by OECD data, indicating that big data analysis was conducted by 34.1 % of large firms, 18.8 % of medium-sized enterprises, and only 10.6 % of small enterprises in OECD countries in 2018. A significant gap in data analytics adoption between the large and small businesses is especially evident in countries like Belgium, Denmark, the Netherlands, and Slovenia, where large corporations position themselves as late majority adopters [8].

The business environment impact of AI on SMEs is profound due to their reliance on business ecosystems and resource allocation strategies. The SMEs dedicate more resources to administrative tasks and trade smaller volumes to manage fixed costs, making them susceptible to framework constraints, market deficiencies, and economic instabilities. Limited infrastructure hampers their market access and availability of critical resources, hindering their ability to secure funding, skilled workforce, and innovation support. Public policies and governance play a pivotal role in influencing the SME performance outcomes [8].

The AI, such as Generative Pre-trained Transformers (GPT), can have a profound impact on several facets of the SME business landscape. These include:

- *Public administration*: The integration of AI and automation boosts efficiency, streamlines tasks for civil servants, and enhances the comprehension of user requirements. Policymakers can leverage machine learning techniques for improved decision-making [10].
- *Tax compliance*: The adoption of AI empowers tax authorities to combat tax evasion and implement a proactive "tax compliance by design" strategy tailored for SMEs [11].
- *Courts*: AI-driven efficiencies in case analysis, law enforcement processes, and dispute resolution mechanisms can reduce the resources SMEs allocate to resolving commercial conflicts [12].
- *Market competition*: Given the significance of market competitiveness for SMEs, algorithms wield influence over market dynamics, potentially fostering tacit collusion practices and sustaining profits beyond equitable competitive levels [13].
- *Infrastructure*: While the AI fortifies digital security measures for information and communication technology (ICT), transportation, and energy infrastructure, it introduces vulnerabilities to cyber-attacks, as well.
- *Access to finance*: AI tools enhance credit assessment procedures, mitigate default risks, and streamline SMEs' access to credit facilities, even catering to those lacking established credit histories [14].
- *Labor markets*: The advent of AI and "people analytics" will reshape recruitment, termination practices, occupational health guidelines, data privacy protocols, performance evaluations, and skills alignment processes within SMEs [15].
- *Knowledge and innovation access*: The AI automation accelerates scientific breakthroughs, curtails experimentation costs, and bolsters data-sharing practices and reproducibility standards within the realm of SME operations [8].

2 Background to the study

Artificial intelligence is currently a highly relevant topic, with experts examining it from diverse angles, ranging from technology to practical application, encompassing security and societal implications.

Sustainable practices play a pivotal role in defining the growth within the AI transportation market. Emphasizing environmental stewardship, societal impact, and ethical governance has emerged as critical benchmarks for success in this dynamic market space, fostering innovation, collaboration, global engagement, and sustainability to propel progressive advancement [16].

The TNO/TKI [17] position paper (from 2020) underscores the three key dimensions of implementing artificial intelligence within the transportation and logistics sectors:

Table 1 *SMEs and transportation and storage businesses having performed big data analysis and using AI in 2023 [21]*

Activity →	Big data analysis			Application of artificial intelligence		
Indicator →	Small and Medium Businesses having performed big data analysis (%)		Transportation and storage companies performing big data analysis (%)	Small and medium businesses using artificial intelligence (%)		Transportation and storage companies using artificial intelligence (%)
Breakdowns→ ↓Country	Small - 10 to 49 employees	Medium - 50 to 249 employees		Small - 10 to 49 employees	Medium - 50 to 249 employees	
Denmark	44.09	69.28	43.80	12.37	22.56	15.16
Hungary	51.11	62.58	52.14	2.98	5.54	2.23
Slovak Republic	25.16	44.27	25.18	5.95	8.57	3.32
Croatia	47.67	69.84	59.20	6.98	11.17	7.58
Romania	19.10	30.99	26.45	1.07	2.38	0.36
Average	28.55	48.34	28.17	6.42	12.96	6.03
Median	29.83	50.38	25.81	5.77	11.17	5.61
Data extracted on 17 Feb 2024 from OECD.Stat [21]						

1. *Sense*: Building a data fusion-based worldview to interpret the environment poses challenges in system communication and interaction with external entities during the development of AI systems.
2. *Think*: Analyzing the world model with AI systems to forecast the future scenarios and outcomes entails complexities, particularly in intricate mobility and logistics scenarios. For instance, in predicting the traffic congestion, leveraging real-time roadwork status, traffic flow data, radar imagery, and historical information could prove beneficial.
3. *Act*: Recognizing potential actions, envisioning outcomes, and delivering decision-making guidance autonomously or under human oversight. The current constraints of fully autonomous decision-making AI systems encounter uncertainties.

The SMEs are progressively integrating AI into their operations, utilizing it for enhancements across multiple functions, such as automating customer service, extracting data insights, and facilitating decision-making. Despite facing challenges like cost implications and skill gaps, the availability of user-friendly AI tools is fueling increased adoption rates. Successful SMEs are positioning themselves for expansion and competitiveness in today's technology-driven realm. In the domain of logistics and supply chain management, AI systems streamline route optimization, monitor shipments, oversee inventory, and predict demand, leading to cost efficiencies and heightened delivery effectiveness [18].

According to Eurostat [19], SMEs account for 99.8 % of European non-financial companies, illustrating their significant presence in the economy. Therefore, the economic growth of any country hinges on development of SMEs and their adoption of technology. While the AI presents a competitive advantage for SMEs, there exists a lack of acceptance and understanding. Simplifying the utilization of AI, quantifying its benefits, and elucidating the potential time and cost savings can aid SMEs in effectively embracing AI to enhance operational efficiency and effectiveness [20].

A considerable portion of SMEs operate in the transport and logistics sector, with a particular focus on last-mile delivery. Despite its criticality, the SMEs in this sector are often overlooked. Hence, exploring the applications of AI in transport SMEs becomes an imperative.

The analysis of big data forms a pivotal aspect of artificial intelligence, enabling machines to derive insights from vast volumes of data and identify patterns and trends. Table 1 displays the percentages of SME companies, as well as companies involved in transportation and storage, in 2023 that engaged in big data analysis. The data indicates that, across fifteen countries, the reported values for transport and storage companies are slightly higher than those for small companies, but notably lower than those for medium-sized enterprises. The average value for transport companies in the analyzed countries closely aligns with that of small companies, with a similar pattern observed for the median values. Medium-sized companies exhibit a more advanced standing in both categories.

The implementation of artificial intelligence in transport and storage companies lags behind big data analysis. The adoption of AI within the industry across just ten countries exceeds that of small businesses. Furthermore, the average and median rates of AI adoption are significantly lower (4.7 and 4.6 times less, respectively). This disparity stems from the timing of widespread artificial intelligence deployment. Additionally, various factors influence AI adoption among SMEs, including cost and resource limitations, skill gaps, data quality and availability issues, change management challenges, integration hurdles with existing systems, ethical and privacy concerns, scalability issues, and a lack of awareness.

To tackle these obstacles, SMEs are embracing

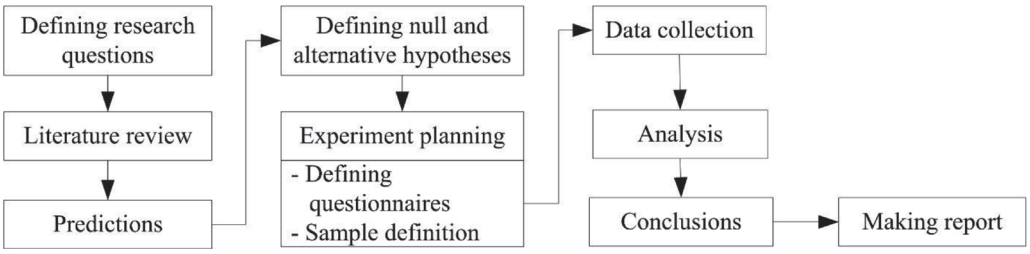

Figure 1 *Methodological approach to the creation of the paper*

proactive and strategic approaches, such as meticulous budgeting, exploring cost-effective solutions, engaging in pilot projects, seeking expert guidance, collaborating with industry associations, and drawing insights from successful AI implementations in other SMEs. Those who can navigate these challenges ahead of the curve will stand at a significant competitive advantage.

3 Research methodology and sample

This research was motivated by a keen interest in exploring the impact of artificial intelligence on the operational dynamics of small and medium-sized enterprises (SMEs) operating within the realm of transportation and supply chain management. The methodological framework employed in this study is outlined in Figure 1.

One of the inherent challenges in investigating social phenomena lies in the absence of controlled laboratory settings. Consequently, researchers often resort to statistical analysis to mitigate this limitation, striving to minimize extraneous variables that could potentially confound their results. Despite the thorough preparations, unforeseen factors may still influence the outcomes, accentuating the importance of cautious interpretation and generalization of findings to ensure reliability. Therefore, a prudent approach involves beginning with the study of simpler phenomena before delving into more complex subjects, recognizing distinct patterns within each research phase and methodological strategy [22].

This study delves into how the integration of artificial intelligence impacts the performance and sustainability of SMEs at the microeconomic level. An empirical approach was adopted in this research, as a synthesis of theoretical and empirical insights is imperative for generating meaningful and relevant data. Categorized under the integral research group, this investigation encompasses logical, epistemological, technical, and scientific-strategic components reflective of the scientific method. Primarily exploratory, this research also comprises elements of explanatory and descriptive analyses, shedding light on the "what," "why", "how much," and "how" aspects underpinning the integration of AI in SME operations.

3.1 Defining research questions, reviewing literature, and setting scientific hypotheses

Research Question

The study delves into the multidisciplinary nature of transport SMEs and their varied activities. Current AI implementations in this sector reflect a diverse range of applications, with no singular dominant technology in use among SMEs. In 2021, only a small percentage, around 1 to 2%, of transportation and storage companies have integrated artificial intelligence, with a focus on areas such as ICT security (28%), logistics (24%), and operational efficiency [3].

The convergence of artificial intelligence and management in small and medium-sized enterprises operating within logistics chains was investigated in this study. Specifically, investigated were the managerial functions and evaluated how the AI can potentially enhance the SME operations and outcomes.

Objective of this study was to address the following questions:

RQ_1. To what extent does AI currently support transport and storage SMEs?

RQ_2. What are the perceptions of transport and storage SMEs regarding AI applications, and what are their plans for the future AI implementation?

Literature review

In 2021, 293.48 thousand papers about AI were published in journals, and 85.09 thousand at conferences. The number of AI repository publications was 65,210 [23, p. 32, 36, 40]. To address the research question, we selected key terms (such as Artificial Intelligence, SMEs, Transport*, and Management) and conducted a thorough review of the available literature from the WoS database, Scopus Source List (1-4 quartile), the EBSCO database, and the OECD iLibrary. Additionally, we utilized official reports and statistics from reputable organizations and leading institutions available online when appropriate. Most of our sources were of open-access type.

For the keywords "Artificial Intelligence + SME*," the Clarivate Master Journal List (MJL) offered 286 academic journals (103 with open access). For "Artificial Intelligence + Transport*," MJL provided access to 426 academic journals (163 with open access), and for "SME* + Transport," 150 academic journals are available on

MJL (65 with open access), [24].

Of the academic journals from the Scopus list that dealt with artificial intelligence, less than 4% simultaneously dealt with management, and less than 1 % dealt with logistics and transportation [25].

For the keywords AI + SMEs, the EBSCO database offered 115 peer-reviewed journals with 117 papers. Only one paper included the "logistics and supply chain management" criterion, and another corresponded to the third keyword, "Transport*." From such a modest result, we concluded that the application of AI in SMEs dealing with transport services, for now, is insufficiently researched.

Based on the analysis, we also concluded that very few academic journals deal with the problems of applying artificial intelligence to the needs of transport and SMEs. As a result, the number of published works in this area is small, and this work should contribute to improving the understanding of the potential impact of artificial intelligence on SMEs.

Hypotheses

In setting hypotheses, how a hypothesis is formulated is crucial. When drawing statistical conclusions, it is expedient to start with the null hypothesis (H_0), which essentially serves as a general statement or default position positing no association between two measured phenomena or no differences between the observed groups [26].

Based on the research question, study area, studied literature, defined variables, limit values, and our expectations, we have set the null hypotheses. To answer the first research question, we set null hypotheses $H_{0,1}$ and $H_{0,2}$.

$H_{0,1}$: Transportation and storage SMEs have not widely adopted the implementation of artificial intelligence in their operations.

$H_{0,2}$: There is no strong correlation between the size of transportation and storage SMEs and the adoption level of artificial intelligence implementation in business operations.

To answer the second research question, we set the null hypotheses $H_{0,3}$ to $H_{0,5}$

$H_{0,3}$: Transportation and storage SMEs are hesitant to adopt artificial intelligence in their operations, as they doubt its potential benefits.

$H_{0,4}$: There is no strong correlation between a company having a defined strategy for integrating artificial intelligence into business processes and utilizing some form of artificial intelligence in its operations.

$H_{0,5}$: Transportation and storage SMEs are reluctant to invest in the application of artificial intelligence.

We also set the alternative hypotheses:

$H_{A,1}$: Transportation and storage SMEs have widely adopted the implementation of artificial intelligence in their operations.

$H_{A,2}$: There is a strong correlation between the size of transportation and storage SMEs and the adoption level of artificial intelligence implementation in business operations.

$H_{A,3}$: Transportation and storage SMEs are willing to adopt artificial intelligence in their operations, as they believe it will bring benefits.

$H_{A,4}$: There is a strong correlation between a company having a defined strategy for integrating artificial intelligence into business processes and utilizing some form of artificial intelligence in its operations.

$H_{A,5}$: Transportation and storage SMEs enthusiastically invest in artificial intelligence.

3.2 Defining the sample and the questionnaire and data processing

Sample

We interviewed a balanced number of respondents from all the SME categories in the transportation and storage sector without differentiation based on their primary focus, as their shared sectoral similarities and activities justified this approach. We conducted the study in Serbia and Slovakia, with 210 SMEs surveyed. Of these, 163 SMEs responded to the survey, including 47 medium-sized enterprises, 54 small enterprises, and 62 micro-enterprises. Challenges we faced in identifying suitable survey participants due to low levels of artificial intelligence utilization. For instance, in Serbia in 2021, only 1.1 % of companies used AI, with the transportation and storage sector representing 6 % of this figure [3]. In 2023, Slovakia reported a 3.3 % utilization rate of AI technologies [27]. Unexpectedly, there was a decline in AI adoption rates in 2023 compared to 2021, with Denmark experiencing a decrease from 21.3 % to 15.2 % and Slovenia from 12.5 % to 7.5 %. Factors contributing to this decline include financial constraints, technological challenges, regulatory issues, and the impact of the pandemic. One significant factor was the lack of awareness regarding the benefits of artificial intelligence. However, the introduction of ChatGPT and other technologies has sparked increased interest in AI. By 2024, there was a noticeable improvement in AI adoption, although official data for 2024 is pending. In Slovakia, the utilization rate of AI among transportation and storage companies stood at 3.32 %.

Questionnaire

For the experiment, we developed a structured questionnaire with 26 questions and 16 sub-questions. It included predefined answer options and open-ended questions to ensure unbiased feedback from diverse SMEs and avoid unintentional bias. The questionnaire was designed to collect company information, digitization level, AI relationship, past experiences, elements used, plans, and investment size. The target group included owners (6.75 %), directors (3.07 %), PR (11.04 %), and other high-ranking employees (49.08 %), with one respondent per company. A total of 49 (30.06 %)

of the surveyed did not give data about who filled the questionnaire out. Potential risks include respondent comprehension and availability of information, as well as variations based on the specific nature of each SME. Despite the individual variances, the sample size aimed to provide a general overview.

Data processing

The survey data have been organized in an Excel spreadsheet and can be requested via e-mail from interested parties. Statistical analysis of the experimental data was conducted using the Excel ANOVA tool.

3.3 Analysis of results with discussion

We grouped the analysis results into two categories: literature review findings and experimental research results. Within the experimental research category, we further divided the data into two subgroups based on research questions RQ_1 and RQ_2. Statistical methods were then applied to test and determine the rejection of null hypotheses using predefined limits.

3.4 Defining conclusions

The study's conclusions were derived from the analysis and interpretation of collected data and research findings, following these key steps:

1. Review relevant results to identify trends, patterns, and deviations.
2. Interpret results within the research question framework, linking them to existing theories.
3. Discuss implications, emphasizing research significance, practical applications, theoretical contributions, and future research directions.
4. Confirm or reject hypotheses based on results, guiding subsequent research efforts.
5. Formulate conclusions summarizing main findings, addressing research questions, and providing guidance for future studies.

4 Results and discussion

4.1 Benchmarking criteria for successful implementation of AI in SMEs

The application of artificial intelligence in logistics, transportation, and other industries is still in its early stages. To assess the success of AI implementation in SMEs engaged in transportation and storage, the following criteria can be used:

- Companies using at least one AI application rank among the top 8 % of companies in the EU in terms of AI implementation success.
- Companies in the transportation and storage sector using AI applications place among the top 0.48 % in successful AI implementation.
- Companies employing AI for autonomous decision-making in machine movement rank among the top 1 % of most automated companies in the EU.
- Companies utilizing AI software/systems in logistics are among the top 10 % of advanced companies.

4.2 Literature review findings

The AI technology and machine learning can support small and medium-sized enterprises by enhancing their data comprehension and automating intricate and routine tasks [28].

A recent McKinsey Global Survey indicates a growing adoption and significant benefits from AI. As businesses increasingly utilize AI, tools and best practices are more refined. Companies experiencing the highest AI-driven earnings boost employ a core and advanced practices combination, including machine-learning operations, allocate the AI spending more effectively, leverage cloud technologies, and actively address the AI-related risks (a shortfall in many AI strategies). Most companies prioritize data science and make significant investments in it. This study shows an increase in the adoption of artificial intelligence across various functions, rising from 50 % in 2020 to 56 % in 2021. Additionally, 27 % of respondents reported that at least 5 % of earnings were driven by AI applications, up from 22 % in the previous year [29].

McKinsey's latest survey from 2023 affirms the rapid growth of generative artificial intelligence (gen AI) tools. In less than a year since their introduction, a third of respondents report regular gen AI use in business functions. The AI has transitioned from a tech-focused topic to a leadership priority, with C-suite executives and boards increasingly leveraging gen AI. As advances in gen AI drive investment, 40 % of organizations plan to boost their overall AI funding. However, managing gen AI risks is still in its early stages. Less than half of respondents indicated sufficient mitigation efforts within their organizations. Even the risk they consider the most relevant: inaccuracy [30]. The survey results demonstrate widespread business adoption and personal use of gen AI across regions, industries, and job levels. A total of 79 % of respondents have interacted with genetic artificial intelligence, with 22 % regularly incorporating it into their professional tasks. One-third of respondents, representing 60 % of organizations with AI adoption, regularly employ generative AI in a business function. Additionally, 40 % of AI adopters expect increased overall investments into generative AI, and 28 % have board discussions on its implementation. Common functions for these tools align with broader AI usage, including marketing, sales, product development, and service operations. This focus on high-value areas

reflects the potential for significant annual value from generative AI. The share of reported gen AI uses in companies participating in supply chain management was only 3 %. The situation is better with service operations (10 %), product and service development (13 %), and marketing and sales (14 %) [30].

There is a high optimism about the impact of gen AI. Three-quarters of respondents anticipated significant competitive changes in the next three years, particularly in the tech and financial sectors. The level of impact is projected to vary across industries, with knowledge-intensive sectors likely to experience greater disruption and value creation. Tech firms are poised to benefit the most, potentially increasing global revenue by up to 9%, followed by knowledge-driven industries (up to 5 %) and education (up to 4 %). Conversely, manufacturing sectors, like aerospace, automotive, and advanced electronics may see more modest effects, compared to past technological shifts focused on production improvement [1, p. 3].

The generative AI is revolutionizing work structures by automating tasks that currently absorb 60 to 70 % of employees' time. With the advancements in natural language understanding, the generative AI can now streamline activities that involve speech comprehension, accounting for 25 % of work time. Industries requiring higher education levels will experience a more significant impact as automation potential increases. The workforce transition will intensify over time, with predictions suggesting that up to half of all work activities could be automated between 2030 and 2060 [1, p- 3].

However, the SMEs have encountered challenges in the AI project preparation and implementation. Oldemeyer, Jede, and Tauteberg [31] identified lack of knowledge, costs, and inadequate infrastructure as the most common barriers to implementation, emphasizing social, economic, and technological aspects.

4.3 Research according to the null hypothesis $H_{0,1}$

As a criterion for the reference level of implementation of artificial intelligence, a limit of 8 % was adopted, which corresponds to the EU average for SMEs [3]. Out of 163 surveyed SMEs, 17 of them (10.4 %) use some artificial intelligence applications. The reason for this result may lie in the current mass availability of ChatGPT to which business individuals turn for help and advice on matters related to the company's current operations. The situation would be different when looking at strictly dedicated AI applications. However, the use of AI is even more intense considering that many business software applications are powered by artificial intelligence (e.g. MS Office, Grammarly, Google Translate, etc.). In that case, 130 respondents (79.8%) declared that they use artificial intelligence. The obtained results provide sufficient evidence to reject the null hypothesis $H_{0,1}$ that "*transportation and storage SMEs have not widely adopted the implementation of artificial intelligence in their operations*."

4.4 Research according to the null hypothesis $H_{0,2}$

There is no clear definition of the readiness of an enterprise to accept or not to accept the implementation of AI. To be able to gain insight into the company's readiness to accept AI, we created a coefficient (K_{AI}) that included three significant elements:

- Use of decision support tools (ξ_D)
- Having a strategy for applying AI (ξ_S)
- Use of artificial intelligence (at least one AI application) (ξ_A).
- Given that these criteria have different weights, we weighted them and created an expression:

$$K_{AI} = 0.4\ \xi_D + 0.2\ \xi_S + 0.4\xi_A. \quad (1)$$

Table 2 shows the results obtained by analyzing the entire sample to determine the correlation between the company size and AI adoption coefficient.

In the observed sample, 116 companies have K_{AI} equal to 0, which significantly affects the obtained results. One company did not provide enough data to create the K_{AI} coefficient. The analysis of the sample where the K_{AI} is greater than zero (46 cases) gave the results shown in Table 3.

In this case, the obtained P-value was close to zero,

Table 2 *Results of the regression analysis of the company size and K_{AI} coefficient correlation*

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	0.402505	0.402505	13.43214	0.000335
Residual	161	4.824489	0.029966		
Total	162	5.226994			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.056884	0.017206	3.306131	0.001166	0.022906	0.090863
X Variable 1	0.0007	0.000191	3.664989	0.000335	0.000323	0.001077

Table 3 *Results of the regression analysis of the company size and K_{AI} coefficient correlation for cases when $K_{AI}>0$*

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	0.115485	0.115485	3.866825	0.055577
Residual	44	1.314081	0.029865		
Total	45	1.429565			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.289347	0.035919	8.05546	3.36E-10	0.216956	0.361737
X Variable 1	0.000619	0.000315	1.966424	0.055577	-1.5E-05	0.001254

Table 4 *Results of the regression analysis of the correlation between SME size and lack of knowledge or resources for artificial intelligence applications.*

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	0.138566	0.13856613	0.626164	0.42993
Residual	161	35.62831	0.22129382		
Total	162	35.76687			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.6520689	0.046757	13.9459409	1.72E-29	0.559733	0.744405
X Variable 1	0.0004107	0.000519	0.79130499	0.42993	-0.00061	0.001436

as well, which means that for this sample there is no linear correlation between the size of the company and the coefficient of acceptance of AI and that there is no basis for rejecting the null hypothesis $H_{0,2}$ that "*there is no strong correlation between the size of a transportation and storage SMEs and the adoption level of artificial intelligence implementation in business operations.*"

4.5 Research according to the null hypothesis $H_{0,3}$

The value of 66.6 % supports the application of artificial intelligence we adopted as a reference criterion. We believe that a two-thirds majority would strongly separate belief and disbelief in AI applications. Out of 162 answers, 133 SMEs (82.1 %) believed that the use of AI would be beneficial for the company's work. This means that companies would like to use AI, and why they do not use it yet, the reasons we sought in the lack of IT experts (in 71 out of 162 surveyed companies, or 43.8 %), lack of AI experts (in 146 out of 162, or 90.1 %), and lack of funds (in 146 out of 162, or 90.1 %).

For a deeper analysis, we analyzed the impact of SME size on the use of AI in SMEs. We started with the hypothesis that the lack of knowledge or resources is not correlated with the size of the SME. Regression analysis of the survey data gave the results shown in Table 4.

The P-value of 0.4299 indicates a high probability that the relationship between the number of employees in SMEs and the lack of knowledge or resources for artificial intelligence is random. Therefore, there are no grounds for rejecting the hypothesis that the lack of knowledge or resources is independent of the SME size.

In addition, 113 companies (69.8 %) expressed readiness for outsourcing in the implementation of AI. The survey showed that the vast majority consider the application of AI to be useful, which created the conditions to reject the null hypothesis $H_{0,3}$ that *"transportation and storage SMEs are hesitant to adopt artificial intelligence in their operations, as they doubt its potential benefits"* at the expense of the alternative hypothesis $H_{A,3}$.

4.6 Research according to the null hypothesis $H_{0,4}$

Within the sample of 162 SMEs, 27 of them had a strategy for application of AI, and 17 used at least one AI application in practice. Based on the results of the analysis, the findings presented in Table 5 were obtained.

A P-value of 0.957 indicates a very strong correlation between these two values. However, due to the existence of many businesses that neither have a strategy nor use AI, the P-value is exaggerated. If we exclude those companies from the analysis and look only at companies that have at least one element, 42 SMEs remain for

Table 5 *Results of the regression analysis of the correlation between a having strategy and using AI applications.*

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	0.000274	0.000274	0.0029	0.957119
Residual	161	15.22672	0.094576		
Total	162	15.22699			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.103704	0.026468	3.918058	0.000132	0.051434	0.155973
X Variable 1	0.003439	0.063861	0.053853	0.957119	-0.12267	0.129553

Table 6 *Results of the regression analysis of the correlation between a having strategy and using AI applications when an SME has at least one of the parameters not equal to zero.*

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	7.440476	7.440476	111.1111	4.14E-13
Residual	40	2.678571	0.066964		
Total	41	10.11905			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1	0.06916	14.45914	1.77E-17	0.860222	1.139778
X Variable 1	-0.89286	0.084704	-10.5409	4.14E-13	-1.06405	-0.72166

analysis. In this case, the statistical analysis gave the results shown in Table 6.

The obtained results show that the P-value is very close to zero, indicating no linear correlation (higher-order correlation not excluded). The number of companies with an AI deployment strategy is significantly higher than those using AI. Furthermore, 14 companies using AI have no strategy. From this, we can infer that SMEs need to put considerable effort into translating their strategies into practice and that AI deployment is currently more responsive to immediate needs and opportunities rather than pre-planned strategies.

Based on the results, we can conclude that the analysis of this reduced sample does not provide sufficient evidence to reject the null hypothesis $H_{0,4}$ that '*there is no strong correlation between a company having a defined strategy for integrating artificial intelligence into business processes and utilizing some form of artificial intelligence in its operations.*'

4.7 Research according to the null hypothesis $H_{0,5}$

To assess the readiness of SMEs to invest in AI applications in their business, we considered two criteria. The first criterion was the company's plan to invest in AI in the next year, and the second criterion was the company's plan to invest in the next three years. We adopted 66.6 % as the threshold value by which the SMEs would clearly express their willingness to finance in AI. Processing the sample according to the first criterion, we saw that 54 of the 157 companies that answered this survey question plan to invest in AI in the next year. Unlike them, 103 companies (65.6 %) do not plan investments in the next year. A total of 86 out of 152 companies, or 56.6 %, indicated their intention to invest in artificial intelligence over the next three years. Based on the analysis of the answers received it can be concluded that the SMEs are still hesitant to invest in the application of AI. The results are more favorable in terms of investing in AI in the next three years. They are still lower, but they are closer to the set criterion. However, they should be taken with a grain of salt, as they may be the result of optimistic expectations and planning.

Based on the obtained results, we can conclude that there is no evidence to reject the null hypothesis $H_{0,5}$ that "*SMEs doing business in transportation and storage are reluctant to invest in the application of artificial intelligence*", and that it can be considered that SMEs are still hesitant to invest in AI.

For a more in-depth analysis of AI investments, we analyzed the impact of the SME size on the decision to invest in AI. We started from the assumption that SME size does not affect the AI investment planning. Through the regression analysis of the data from the survey, we obtained the results shown in Table 7.

A P-value of 0.489 suggests a high probability that the relationship between the willingness to invest in

Table 7 *Results of the regression analysis of the correlation between MSP size and readiness to invest in AI applications.*

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	0.107488	0.10748875	0.480674	0.489116
Residual	161	36.00294	0.22362075		
Total	162	36.11043			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.31122685	0.047002	6.6215549	5.05E-10	0.21841	0.404047
X Variable 1	0.00036173	0.0005217	0.6933068	0.489116	-0.00067	0.001392

artificial intelligence and the number of employees in the company is not significant. Therefore, we cannot reject the hypothesis that the size of SMEs does not affect the company's willingness to invest in AI.

We can conduct a χ^2 test for SMEs' willingness to invest in AI by classes, separately for small and medium enterprises. Assuming that the company size does not affect the willingness to invest in AI, we get a value of $\chi^2 = 0.05933$. In our case, it corresponds to a P-value of about 0.80494. Therefore, there are no grounds for rejecting the hypothesis that company size and willingness to invest are mutually independent.

However, we must mention that statistical significance does not necessarily mean practical significance. It is possible that although there is a statistically insignificant relationship, it may be practically significant in a real business context. The most common reasons for this can be:

1. Sample size: It may happen that the statistical test does not show significance because there is not enough data to confirm the relationship even if it exists.
2. High variability: This may lead to a smearing of the effect and may result in statistically insignificant results.
3. Measurement error: Improperly filling out the survey form can cause statistically insignificant results.

In our case, the main risk is related to the fact that the implementation of AI in SMEs is still in its initial phase. The relations of SMEs to application of AI have not yet been established, so it is difficult to establish the interdependencies of individual parameters. The more massive application of AI would stabilize results, so possible inaccuracies in conclusions would be lower.

5 Conclusions

Artificial intelligence (AI) and machine learning analyze traffic data, predict behavior, optimize flow, and enhance transport efficiency, particularly in urban settings, crucial for SMEs. The AI technology benefits small businesses by optimizing operations, reducing costs, enhancing safety, and supporting decision-making. It improves the customer service, marketing, content creation, and overall competitiveness, as well. This research addressed the readiness of SMEs to leverage these advantages.

RQ_1. To what extent does AI currently support transport and storage SMEs?

Based on the survey results and discussion of application of artificial intelligence in SMEs in today's conditions, in sections 4.2, 4.3.1, and 4.3.2, one can conclude that it is still at an early stage when individual initiatives are more pronounced than the planned approach. Many SMEs (89.6 % of surveyed) do not use AI as a specific application, although 79.8% use AI indirectly as a part of their business software; 16.67 % of surveyed SMEs have created strategies for application of artificial intelligence.

RQ_2. What are the perceptions of transport and storage SMEs regarding AI applications, and what are their plans for future AI implementation?

Most of the transport and warehousing SMEs are now recognizing the potential of AI applications, but are currently hesitant to fully leverage them. Various factors contribute to this hesitation, ranging from limited financial resources for AI utilization, shortage of AI experts, and inadequate IT support. Moreover, the reluctance to invest in necessary equipment and software to implement AI cannot be understated. These decisions are often influenced by fragile business conditions and insufficient management and owners' commitment toward AI adoption.

Future of AI application in transport and storage SMEs

The rapid advancement of artificial intelligence (AI) is paving the way for its extensive integration across various sectors, including transportation and storage. The potential implementation of AI in these industries presents significant opportunities for transformation. AI technologies can optimize route planning and logistical operations, leading to more streamlined transportation networks and decreased fuel consumption. The AI can enhance inventory management by accurately forecasting demand trends and maximizing storage

space efficiency within storage facilities.

Furthermore, the AI-powered predictive maintenance systems can preempt equipment malfunctions, limiting downtime, enhancing overall operational efficiency, and reducing operational costs. The AI-driven analytics hold the potential to deliver invaluable insights into supply chain operations, empowering companies to make the real-time data-informed decisions.

Transitioning from sporadic instances, the adoption of AI is on track to become pervasive, necessitating the integration of this technology within small and medium-sized enterprises for their survival. The willingness of managers and proprietors to outsource AI-related tasks may hasten the uptake of AI in SMEs within the transportation and warehousing sectors. Early implementation positions these businesses more competitively in the market. One can expect that SMEs will leverage AI for diverse purposes, even for operations not demanding advanced technological acumen.

Nevertheless, the successful integration of AI hinges on its harmonization with human cognition and collaboration, as AI serves as a complementary tool to personal reflection, societal norms, and cultural values. Apart from the willingness to adopt the AI, ensuring essential prerequisites for its application is imperative. Key among these is proficient employee training in AI system operations. Before widespread implementation, addressing ethical considerations is crucial to preclude potential conflicts. Consequently, taking a multidisciplinary and all-encompassing approach towards these matters in the forthcoming years is fundamental. States and large-scale enterprises will undoubtedly play pivotal roles in these endeavors, while the SMEs stand to reap the benefits from these ongoing discussions.

Finally, if we would like to provide some recommendations to SMEs involved in transport and storage regarding the future application of artificial intelligence, they could be summarized as follows:

- Utilize AI to automate as many routine tasks as possible,
- Implement artificial intelligence systems for predictive maintenance,
- Utilize data analytics and machine learning for data analysis,
- Use artificial intelligence to optimize business operations, track inventory, and find more efficient solutions,
- Invest in training employees on how to use the AI tools and technologies, and most importantly,
- Immediately initiate these activities.

These recommendations can help all the SMEs leverage artificial intelligence to enhance the efficiency and competitiveness of their transport and warehousing operations. As we are still in the early stages of AI adoption, these recommendations could be universally applicable and are relevant for companies in Slovakia and Serbia, as well.

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Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] CHUI, M., HAZAN, E., ROBERTS, R., SINGLA, A., SMAJE, K., SUKHAREVSKY, A., YEE, L., ZEMMEL, R. The economic potential of generative AI: the next productivity frontier [online]. McKinsey and Company, 2023. Available from: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier#business-and-society

[2] DRYDAKIS, N. Artificial intelligence and reduced SMEs' business risks. a dynamic capabilities analysis during the COVID-19 pandemic. *Information Systems Frontiers* [online]. 2022, **24**, p. 1223-1247 [accessed 2024-03-01]. ISSN 1387-3326, eISSN 1572-9419. Available from: https://doi.org/10.1007/s10796-022-10249-6

[3] Eurostat. Use of artificial intelligence in enterprises [online] [accessed 2024-03-01]. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Use_of_artificial_intelligence_in_enterprises#Enterprises_using_artificial_intelligence_technologies

[4] Paysafe. 3 ways small businesses can use AI to drive growth [online] [accessed 2024-03-10]. Available from: https://hbr.org/sponsored/2023/03/3-ways-small-businesses-can-use-ai-to-drive-growth

[5] RUESSMANN, M., LORENZ, M., GERBERT, P., WALDNER, M., ENGEL, P., HARNISCH, M., JUSTUS, J. Industry 4.0: the future of productivity and growth in manufacturing industries [online] [accessed 2024-03-01]. Available from: https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries
[6] KUEPPER, D., LORENZ, M., KUHLMANN, K., BOUFFAULT, O., WYCK, J. V., KOECHER, S., SCHLAGETER, J. AI in the factory of the future: the ghost in the machine [online] [accessed 2024-03-01]. Available from: https://www.bcg.com/publications/2018/artificial-intelligence-factory-future
[7] BROWN, T. V. The impact of artificial intelligence on freight transportation [online] [accessed 2024-03-02]. Available from: https://medium.com/@teressavbrown/the-impact-of-artificial-intelligence-on-freight-transportation-ef8d865f29f0
[8] OECD. Artificial intelligence: changing landscape for SMEs [online] [accessed 2024-03-02]. Available from: https://www.oecd-ilibrary.org/sites/01a4ae9d-en/index.html?itemId=/content/component/01a4ae9d-en
[9] OECD. OECD digital economy outlook 2020. Paris: OECD Publishing, 2020.
[10] CORBETTA, M. An insight into the innovative start-up landscape of Friuli-Venezia Giulia: a tale of two sub-regions? *OECD Local Economic and Employment Development (LEED) Papers* [online]. 2020, **2020**(8), p. 1-68. eISSN 2079-4797. Available from: https://doi.org/10.1787/20794797
[11] BERRYHILL, J., HEANG, K. K., CLOGHER, R., MCBRIDE, K. Hello, world: artificial intelligence and its use in the public sector. OECD Observatory of Public Sector Innovation (OPSI), 2019.
[12] OECD. OECD SME and entrepreneurship outlook 2019. Paris: OECD Publishing, 2019.
[13] OECD. Algorithms and collusion: competition policy in the digital age. Paris: OECD, 2017.
[14] OECD. Financing SMEs and entrepreneurs 2020: an OECD scoreboard. Paris: OECD Publishing, 2020.
[15] OECD. OECD employment outlook 2019: the future of work. Paris: OECD Publishing, 2019.
[16] MIG. 2024-2030: artificial intelligence in transportation market share, by product, by application and forecast. Frankfurt, DE: Market Insight Group, 2024.
[17] OMMEREN, C. V., WILLEMS, F., PAARDEKOOPER, J.-P., BAKRI, T., BEEKELAAR, R. Artificial intelligence in mobility and transport / Artificiele intelligentie in mobiliteit en transport (in Dutch) [online] [accessed 2024-03-08]. Available from: https://nlaic.com/wp-content/uploads/2020/07/Position-Paper-AI-in-Mobiliteit-en-Transport-1.pdf
[18] KARANPURIYA, H. The AI revolution: how SMEs are harnessing the power of artificial intelligence to supercharge their businesses [online] [accessed 2024-03-08]. Available from: https://www.linkedin.com/pulse/ai-revolution-how-smes-harnessing-power-artificial-karanpuriya
[19] Eurostat. Small and medium-sized enterprises: an overview [online] [accessed 2024-03-06]. https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200514-1
[20] RAFIQUE, S., MUJAWINKINDI, F. Changing the future. Umea: Umea School of Business, Economic and Statistics, 2023.
[21] OECD. ICT access and usage by businesses [online] [accessed 2024-03-06]. Available from: https://stats.oecd.org/Index.aspx?DataSetCode=ICT_BUS#
[22] BOGAVAC, M. Research of the influence of digitalization on small and medium enterprises. Doctoral dissertation. Belgrade: Faculty of Business and Law, 2019.
[23] MASLEJ, N., FATTORINI, L., BRYNJOLFSSON, E., ETCHEMENDY, J., LIGETT, K., LYONS, T., MANYIKA, J., NGO, H., NIEBLES, J. C., PARLI, V., SHOHAM, Y., WALD, R., CLARK, J., PERRAULT, R. The AI index 2023 annual report. Stanford, CA: AI Index Steering Committee, Institute for Human-Centered AI, Stanford University, 2023.
[24] Clarivate. Master journal list [online] [accessed 2024-03-06]. Available from: https://mjl.clarivate.com/search-results
[25] Scopus. Sources [online] [accessed 2024-03-06]. Available from: https://www.scopus.com/sources.uri
[26] EVERITT, B. The Cambridge dictionary of statistics. Cambridge, UK New York: Cambridge University Press, 1998.
[27] EC. Artificial intelligence by NACE Rev.2 activity [online] [accessed 2024-03-29]. Available from: https://ec.europa.eu/eurostat/databrowser/view/isoc_eb_ain2__custom_10370113/default/bar?lang=en
[28] Oracle. What is AI? Learn about artificial intelligence [online] [accessed 2024-03-06]. Available from: https://www.oracle.com/artificial-intelligence/what-is-ai/
[29] CHUI, M., HALL, B., SINGLA, A., SUKHAREVSKY, A. The state of AI in 2021 [online] [accessed 2024-03-20]. Available from: https://www.mckinsey.com/capabilities/quantumblack/our-insights/global-survey-the-state-of-ai-in-2021
[30] CHUI, M. The state of AI in 2023: generative AI's breakout year [online] [accessed 2024-03-29]. Available from: https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai-in-2023-generative-ais-breakout-year#research

[31] OLDEMEYER, L., JEDE, A., TEUTEBERG, F. Investigation of artificial intelligence in SMEs: a systematic review of the state of the art and the main implementation challenges. *Management Review Quarterly*. 2024, **2024**, p. 1-43. ISSN 2198-1620, eISSN 2198-1639. Available from: https://doi.org/10.1007/s11301-024-00405-4

[32] 2003/361/EC. Commission recommendation concerning the definition of micro, small and medium-sized enterprises. Official Journal of the European Union. 2003, p. L 124/36 - L 124/41.