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Do Bulgarian SMEs Differ from Their International Peers in Adoption of AI?

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Abstract. *Artificial Intelligence (AI) technology as a disruptive technology of the 21st century,is leading an exceptionally profound technological revolution on a global scale. Existing studies indicate that AI adoption is a complex task compared to previous information technology revolution. The paper explores the adoption of AI technologies by Bulgarian Small and Medium-sized Enterprises (SMEs) in comparison to their international peers. Through a scoping literature review and empirical data analysis, this study aims to identify unique challenges, opportunities, and trends in AI adoption among Bulgarian SMEs. Specifically, this study founded in theory of Technological-Organizational-Environmental (TOE) framework and collected empirical data through a designed questionnaire. The survey distributed via social media and professional network. Through this approach, 140 responses were received from 16 countries, with 108 were fully filled. Moreover, factor analysis and variables correlations and liner correlated analysis ran for identifying factors leading to AI adoption in various countries. The findings reveal there is statistically significant difference in AI understanding and organizational readiness between two samples and Bulgarian companies demonstrated a higher level in this regards. Moreover, they exhibit diverse levels of AI adoption across different applications. Additionally, AI adoption is associated with the understanding of AI, organizations' preparedness and competitive environment, and innovation. The paper concludes by suggesting strategies for enhancing AI adoption among Bulgarian SMEs to foster innovation and competitiveness.*

Keywords: Bulgarian SMEs, International Peers, AI Adoption, Organizational Readiness, AI Understanding.

Introduction

Artificial Intelligence (AI) as a disruptive technology of the 21st century, is leading an exceptionally profound technological revolution on a global scale. Bulgaria is often categorized as a modest or an emerging innovator mostly because the statistics on research, development and innovation is not quite visible, SMEs do not patent and foreign investors, even if they patent they do with their headquarters in Europe or USA. However, often Bulgaria scores very high on some indicators like utilizing RFID or digital public services for businesses. Formally SMEs lack linkages with academia, but informal academic engagement increases the process innovation and have significant effect on product innovation (Yalamov, 2021).

With the annual increase in open-source model[1], it becomes feasibly for different scales to adopt AI. As of now, there is no definitive figure to quantify the diffusion of AI technologies. Instead, IMF[2] reported in 2024 that world readiness for AI shows diversities based on four dimensions that cover digital infrastructure, human capital, labour polices, and innovation, integration and regulation. In this context, adopting AI is seen as AI project to be accomplished by teams. It is a matter of time, cost, and quality. Existing researches focus on factor analysis to AI

[1] https://aiindex.stanford.edu/report/
[2] https://www.imf.org/external/datamapper/map/AI_PI@AIPI/ADVEC/EME/LIC

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adoption. Some studies explored the factors influencing the adoption of AI in a specific industry, while others investigated the factors that impact the development of AI within the context of a particular country. Additionally, there are studies that delve into the key factors determining the success or failure of AI projects. Despite the growing interest, there remains an empirical gap concerning the detailed comparison of AI adoption across different countries and regions. Moreover, the existing literature provide little about relevant AI adoption underlying international. Most studies focus on specific regions (e.g., Europe, India) or industries (eg., manufacturing, fintech), lacking a global perspective. For instance, companies in the Information Communication Technology sectors, as well as those in northern Europe, are more likely to disclose AI-related activities (Bonsón et al., 2021). Larger companies and those in Southern Europe also show a higher tendency to disclose AI activities.

The aim of this study is to conduct a comparative analysis between Bulgarian companies and their international peers from other 15 countries related to the adoption of AI. This study founded in theory of Technological-Organizational-Environmental (TOE) framework and collected empirical data through questionnaire. Factor analysis and liner correlated analysis ran for identifying factors leading to AI adoption in various countries. This empirical study addresses three research questions (RQs). RQ1: What is statistical characteristics of Bulgarian SMEs and their international peers in AI adoption? To answer this RQ1, we measure ten kind of AI applications selected by them and make comparison. RQ2: What factors influence the adoption of AI by Bulgarian SMEs and their international peers? RQ2 specifies the factor and forms the core component of our analysis. By adoption factors, we mean the factors that influence the use of AI and that must therefore be analysed and take into account.

This paper is organized as follows. Section 2 presents a scoping literature review related to AI adoption across countries. Section 3 outlines the methodology of the research. Section 4 demonstrates the results of factor analysis and liner correlated analysis. Section 5 discuss the differentiation. Last section concludes research implications and limitations and points out the directions of future study.

Literature review

Artificial intelligence

AI is broadly defined as a system's ability to perform tasks that traditionally require human intelligence. It has been recognized that adopting AI is a more complex endeavour compared to previous information technology revolution. AI heavily relies on large-scale data and expands its coverage by algorithms and models in order to achieve specific goals and tasks through flexible adaptation. Cao and Michael (2022) argued that AI development is centred on data-driven approaches after the year 2000. AI-enabled applications have been applied across diverse fields. The emergence of mature AI products and services - such as ChatGPT, DeepSeek, Virtual assistants, and recommendation system - has demonstrated the transitional potential of AI in all lines of work. How companies implementing AI are to do data analysis, make information retrieval, automate repetitive tasks and customer support, optimize and maximize marketing and sales activities, and automate internal systems, according to European enterprise survey 20243. Despite its promise, the actual adoption rate of AI remains relatively low.

[3] https://www.dmcforum.net/wp-content/uploads/2024/12/AI-adoption_survey-report_-slides_CC-1.pdf

Factors influencing AI adoption

The success of AI project has been discussed in the literature. From the perspective of project management, Miller and Gloria (2022) asserted that time, costs, and quality are key determinants of AI project success. They highlights the need for alignment between technical capabilities and organizational goals. In the management literature, Technological-Organizational-Environmental (TOE) Framework addresses factors from the technological, organizational, and environmental dimensions. It helps organizations leverage internal resources and adapt to external conditions to facilitate technology adoption.

The technological dimension of AI adoption focuses on the technical feasibility, usability, and performance of AI systems. Key considerations include ease of use, integration with existing systems and technologies, and the ability to scale solutions effectively. These aspects generally discussed in the frame of Technology Acceptance Model. Gupta and Mukherjee (2024) explained that the technical characteristics of AI itself are potential drivers of adoption. They suggested uncertainty as one of AI features has impact on adoption intentions. Customers are uncertain about how AI works which results in losing trust in AI and in return affects their willingness to adopt AI. Roh et al. (2023) also confirmation that conclusion. They suggested attitude, trust and convenience conditions are indirectly influencing user's willingness to adopt AI applications.

The organizational dimension concentrates on leadership, organizational culture, budget, and characteristics of company. Transitional leadership is a crucial factor in driving the adoption of AI. Technical infrastructure, data processing capabilities, and a skilled AI workforce are foundational to AI adoption. Chatterjee et al. (2021) founded that leadership support plays a mediator role in promoting AI adoption. Moreover, Kinkel et al. (2021) identified key factors for AI adoption from the viewpoint of TOE framework. They found digital skills, company size and innovation intensity were vital in the organizational context. In the technological context they were technology infrastructure and compatibility. Organizational and environmental correlation play a moderating role between perceived benefits and AI adoption. Polisetty et al. (2023) suggested that organizations are more ready at firm level in terms of technical capability and management support, the more likely to adopt AI. This will help companies to gain competitiveness in the market. Van Hoek (2024) presented the main reason for the generally low level of AI practices lies in the lack of AI readiness. Factors such as executive support and willingness to invest, human perception and supplier readiness often considered in the literature. On the boundaries between the organizational and environmental dimensions is cluster participation, which contributes to the organizational capacity to innovate (Angelov, 2021).

Environmental dimension covers a wider range of roles such as market competition, regulatory polices, and societal acceptance. Chatterjee and Sheshadri (2020), in their study of India, used a combination of multi-party data and analytical methods and emphasized the importance of making AI policy. AI policy should be favouring data and privacy protection, research and investment and social implications. Kinkel et al. (2021) suggested the environmental context, industry competition and government support are also important to driving AI adoption to some extent. Regulatory requirements often stimulate introduction of AI in diverse areas as classical modelling of loan default (Boutchaktchiev, 2023) or personal identification with image recognition algorithms.

Research question

The exploratory study addresses three research questions (RQs) to advance understanding of AI adoption particularly among Bulgarian SMEs and their internal peers.

RQ1: What is statistical characteristics of Bulgarian SMEs and their international peers in AI adoption?

RQ2: What factors influence the adoption of AI by Bulgarian SMEs and their international peers?

Methodology

The study adopted a quantitative approach. In this regard, data were collected through online questionnaire divided into two parts. The first part collected the demographic information of participates and business details of their companies while the second part collected data relating to the three variables and three research questions was answered in the study. A snowball sampling technique was employed to obtain participants, regardless of country, industry, job position. The survey was distributed on social media (Facebook, Linkedin, and WeChat) and professional networks. Through this approach, 140 responses were received from 16 countries, with 108 were fully filled. The predominance of responses was from Bulgaria (81 cases, 57.6%), followed by Asia (35 cases, 23.1%), and Europe (19 cases, 13.6%), with smaller contributions from Africa (5 cases, 3.6%), the Middle East (2 cases, 1.4%), and Latin America (1 cases, 0.7%).

For each construct in the questionnaire, a series of statements developed from the existing literature but modified to fit the research topic was provided. Respondents were required to suggest the level of agreement with each statement using a 5-point Likert scale. The collected data was analysed through SPSS software. The analysis entailed two major steps. The first step used factor analysis with an aim to reduce dimensions and obtain key components, whereby Cronbach's coefficient confidence test and indicator reliability were determined. The second step of analysis entailed correlation and regression models. Furthermore, the study used TOE framework because it offers a structured approach to understanding the factors associated with AI adoption.

Results and discussions

Profile of samples

The seven demographic characteristics considered in the study were country, firm size, ownership, area, stage of business development, job level of respondent, whether has AI been introduced previously. As Table 1 shows, most respondents in Bulgarian companies were the owner/investor, while professional/technical staff and administrative/support positions play a smaller but still notable role. In non-Bulgarian companies, the distribution is more balanced. Owner/investor, professional/technical staff, and administrative/support staff collectively represented the majority of respondents. Regarding their industry, it spans both traditional industries such as catering, energy, education, and manufacturing, as well as emerging fields like IT, AI, digital marketing, e-commerce, and green energy. In terms of their stage of business development, Bulgarian companies are more likely to be in the mature period (18 out of 58) or undergoing business model transformation (7 out of 58). Non-Bulgarian companies are more concentrated in the development period (high growth) (23 out of 50). Bulgarian companies also show a higher presence in the shrinkage period (10 out of 58) compared to non-Bulgarian companies (5 out of 50). The early start-up phase is relatively evenly distributed between the two groups with a slight majority in Bulgarian companies. The Bulgarian sample accounted for a larger overall proportion, characterized by a higher percentage of SMEs, a greater prevalence of autonomous operations, and a relatively higher distribution in capital city. In contrast, the international peers while representing a smaller overall proportion, exhibited a relatively higher share of autonomous firms, along with a slightly higher concentration in capital city. Prior to their experience with AI in the past, a higher

proportion of companies from Bulgaria (42 out of 81) have experimented with AI compared to companies not from Bulgaria (29 out of 59).

Table1. Demographic data of samples

	Category	Bulgaria	International peers
	Sample size	57.9%	42.1%
	SME	47.2%	34.2%
Job level	Senior management	6	8
	Professional/Technical staff	10	13
	Administrative/support position	6	12
	Junior employee/intern	3	4
	owner/investor	32	13
	Not specified	24	9
Ownership	autonomous	45	30
	partner enterprise	3	6
	linked enterprise	10	14
Area	village	2	2
	town	10	6
	regional centre	18	13
	capital	51	38
Industry	Traditional business	47	38
	Emerging industry	15	11
stage	Early start-up period with high-uncertainty	10	8
	Development period, hight growth	13	23
	Mature period, optimization of process	18	13
	Transformation of business model	7	1
	Shrinkage period	10	5
AI experiment	yes	42	29
	no	39	30

Source: Authors' own research results/contribution.

The extent of AI understanding and AI adoption in the samples

Firstly, the survey result on the statement "To what extent do you know about AI?" reveals an insight into the level of perception of AI, including AI algorithms, AI use cases in Business, and social and ethical implications of AI. As Figure 1 shows, among Bulgarian companies, a significant majority of respondents (55.6%) indicated that they are "fully aware" of AI, while 33.3% reported having a "general understanding" of AI. Only a small fraction expressed uncertainty, with 7.4% stating "they were not sure about the exact definition" and 2.5% admitting they had only "heard of the term". In contrast, international peers showed a more distributed level of awareness. While 32.2% claimed to be "fully aware" of AI, a larger proportion (37.3%) reported having a "general understanding". Notably, 23.7% expressed uncertainty about the exact definition of AI, and 6.8% had only "heard of the term". The results suggest that respondents from Bulgarian companies generally exhibit a higher self-reported level of AI awareness compared to their international peers.

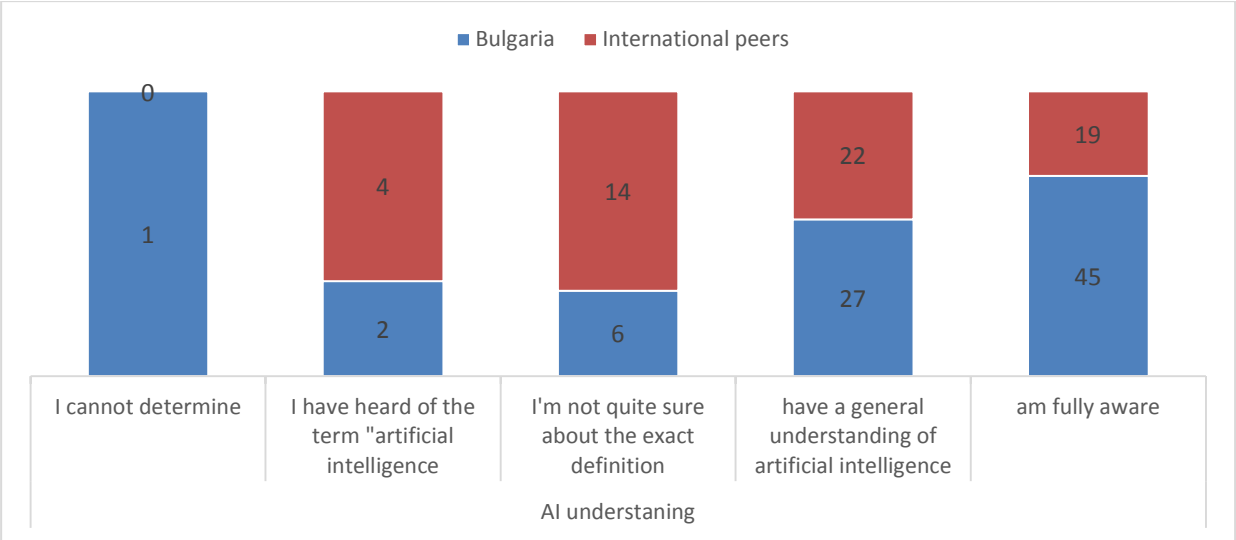

Figure 1. The level of understanding AI between Bulgarian companies and international peers

Source: Authors' own research results/contribution.

Secondly, the study also examined the extent of AI adoption in the samples from two perspectives. Regarding the exploration of which AI applications are currently being used within the enterprise, ten AI applications are examined in the Table 2 below. The top three AI applications that currently used in both Bulgarian companies and their international peers are dominated by natural language processing, computer vision, and anomaly detection. Furthermore, the statistics showed that process optimization, recommendation engines, and process automation are being considered for adoption in the next 2 years. Sentiment analysis also stands out as a key area of interest in Bulgarian companies.

Table 2. Current and future adoption of AI applications in Bulgarian companies and international peers

AI applications	Bulgaria		International peers	
	Now	Future	Now	Future
1.Visual diagnostics, face or image recognition, also know as computer vision	15	12	19	14
2.Speech recognition, machine translation or chat-bots, also known as natural language processing	34	16	23	17
3.Fraud detection or risk analysis, also known as anomaly detection	9	20	17	12
4.Analysis of emotions or behaviours, also known as sentiment analysis	4	18	4	20
5.Forecasting, price optimisation and decision-making using machines learning algorithms	14	25	13	17
6.Process or equipment optimisation using artificial intelligence	11	20	11	20
7.Recommendation&personalisation engines using AI to produce customised recommendations, via matching algorithms or information retrieval	9	18	14	18
8.Process automation using artificial intelligence, including warehouse automation or robotics process automation (RPA)	11	15	14	17
9.Autonomous machines, such as smart and autonomous robots or vehicles	8	6	11	18
10.Creative and experimentation activities, such as virtual prototyping, data generation, artificial music or painting	18	14	10	14

Source: Authors' own research results/contribution.

Regarding the diversity of AI applications within enterprises, it is determined by the sum of AI applications, ranging from 0 to 10. The bigger number means that a greater diversity of AI applications in business operations. Each level corresponds to the number of companies for Bulgaria and the rest. Additionally, the ratios compare the number of international peer companies to the number of Bulgarian companies at each level. These ratios provides insight into the relative strength of Bulgarian companies in AI adoption compare to the rest. The value above 100% suggests that Bulgaria is weaker than international peers. Conversely, Bulgaria advances than the other. Looking at the variety of AI applications adopted by two groups respectively (see Figure 2), mostly Bulgarian companies obtain no more than 3 types of AI applications internally. Oppositely, most international companies report using between 4 and 7 AI tools.

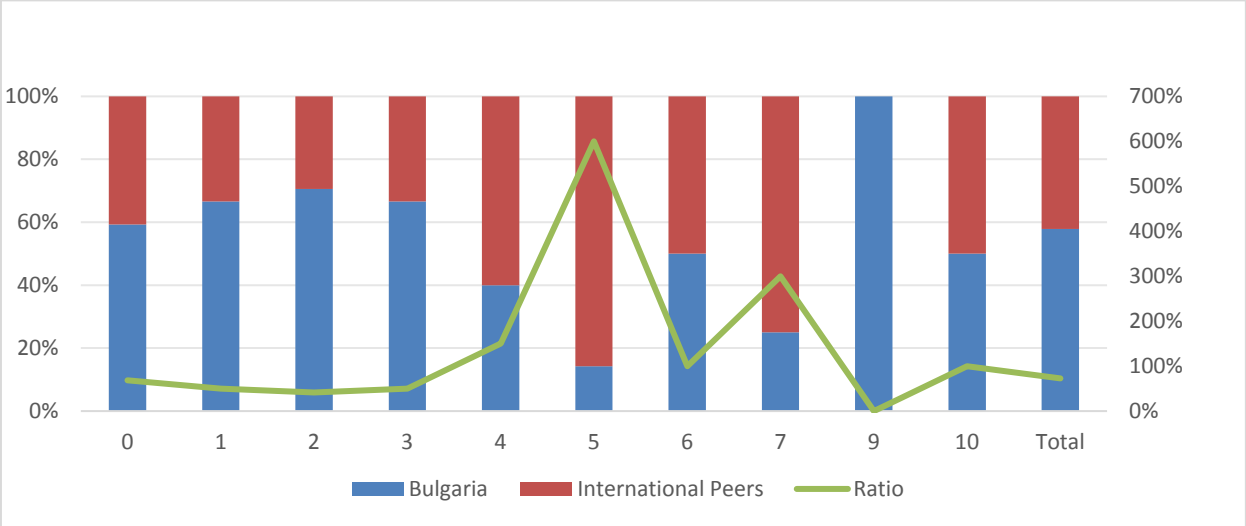

Figure 2. Diversity of AI applications in Bulgarian companies and international peers

Source: Authors' own research results/contribution.

Factor analysis

The questionnaire passes the Cronbach's coefficient confidence test (0.900) and is reliable for subsequent analysis. We observe that the value of Kaiser-Meyer-Olkin (KMO) is 0.808 higher than standard. It is preformed to confirm that data is adequate for exploration. Four factors (see Table 3) emerge from factor analysis and explain 68.91% of total variance.

Factor 1 named organizational readiness, contains 7 items and is strongly associated with organizational culture in risk-taking and failure tolerance, technical skills and knowledge among employees, leadership support from management, and data-driven decision-making style. These items are grouped under a theme related to organizational readiness towards innovation and adaptability. Factor 2 named competitive environment, contains 3 items and represents the extent to external market power including competitors, industry leaders, and customers. Their perspectives and acceptance are vital for the intention to adopt AI. Factor 3 named innovation, contains 2 items, focuses on the AI practice and innovation taken in the organization. Factor 4 named Data availability, strongly links to the challenge of accessing data such as insufficient data, poor data quality, and lack of resources to manage data.

Table 3. Rotated Component Matrix[a]

Item	Factor 1	Factor 2	Factor 3	Factor 4
Risk-taking and failure tolerance	846			
Innovation and experimentation	.817			
Continuous learning and development	.779			
Technical skills and knowledge among your employees	.695			
Support for AI adoption among your leadership team	.693			
data-driven decision-making	.661			
Your competitors is using AI		.846		
Your industry leader is using AI		.796		
Your customers are ready to use AI-enabled interface with your company		.724		
AI applied in the organization			.764	
Innovation taken in the organization			.749	
Challenge to data availability				.915

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

Source: Authors' own research results/contribution.

In order to determine whether the difference on AI adoption is statistically significant, an independent sample T test, complemented by the Mann-Whitney U test, was applied for Bulgaria and international peers. This approach ensures robustness in the statistical analysis, accounting for potential non-normal distributions in the data. Table 4 presents the values and statistical significance for Bulgaria compared to international peers regarding different influencing factors, and AI understanding. Firstly, Bulgaria has a higher mean rank for organizational readiness. This suggests that Bulgarian companies are generally more prepared for AI adoption and this difference is statistically significant. Secondly, Bulgarian companies show a slightly lower mean rank for environmental readiness, although this difference is not statistically significant. Thirdly, there is no statistically significant difference between two samples, in terms of AI adoption and mean rank for data availability, but this difference is not statistically significant. Lastly, there is a statistically significant difference in AI understanding between two samples and Bulgarian companies demonstrated a higher level in this regard.

Table 4. Independent sample T test results

	organizational_ readiness	Competitive environment	Innovation	Data availability	AI understanding
Bulgaria (Mean Rank)	62.63	52.57	54.15	58.97	79.03
International peers (Mean Rank)	46.94	59.02	57.12	51.34	58.79
Mann-Whitney U	1072	1324	1419	1292	1698.5
Z	-2.569	-1.057	-0.486	-1.249	-3.147
Asymp. Sig. (2-tailed)	0.01	0.291	0.627	0.212	0.002

Source: Authors' own research results/contribution.

In order to investigate the relationship among variables, partial correlation analysis was adopted. seven demographic characteristics were selected as control variables. Table 5 presents the results of correlation among six constructions. This approach was used to assess the strength and direction of the linear relationship between two variables. Specifically, organizational readiness

was significantly positively related to AI understanding and AI use (defined as organization is currently using AI). This suggested the higher preparedness of organization, the higher rate of understanding in AI and using AI applications. Environmental readiness was significantly positively related only to AI understanding. Innovation was significantly positive related to AI use. Data availability showed no significant relationship with any of the variables.

Table 5. Correlation matrix of factors

	Organizational readiness	AI Understanding	Competitive environment	Innovation	Data availability	AI use
Organizational readiness	1					
AI understanding	0.203*	1				
Competitive environment	-0.006	0.232*	1			
Innovation	0.081	0.309**	-0.003	1		
Data availability	-0.005	0.136	-0.027	-0.012	1	
AI use	0.311**	0.348**	0.171	0.753**	0.003	1
* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).						

Source: Authors' own research results/contribution.

The difference on understanding AI may reflect a higher emphasis on AI technology with Bulgarian businesses or more widespread education and promotion of AI. Prior to the introduction of Bulgaria, Bulgaria have a strong technical foundation in IT and software development, which enhances the AI concept among businesses. International peers reflect varying national circumstances. The study finds that the higher proportion of AI experimentation experience in Bulgaria also reflect its greater interest and readiness in AI. In accordance with the finding of Van Hoek (2024). He suggests that the lack of AI readiness generally leads to low level of AI practices. However, international peers may be more focused on high-growth stages, which could lead to different attitudes towards AI adoption. The respondents primarily include company owners, investors, professional technical staff, and support personnel, and their companies stay different stages of development from start-up to mature and even decline. This could leads to different opinion on AI. Owners are preferred cost-effectiveness, while technical staff may prioritize technical feasibility. Chatterjee et al.(2023) suggest that leadership support plays a mediator role in promoting AI adoption.

In terms of AI adoption, both sides primarily focus on more mature AI technologies such as NLP, CV, and anomaly detection at present and show strong interest in optimization and automation, as well as sentiment analysis. The high adoption rates in these areas likely reflect a universal demand for improving operational efficiency and reducing cost, as well as meeting the growing needs in customer experience management and market analysis. In line with the finding in the literature, the gap in the diversity of AI applications between Bulgarian SMEs and international peers, this may reflect limitation in resources (Polisetty et al., 2023), technical capabilities (Kinkel et al., 2021), or application scenarios (Gupta and Mukherjee, 2024). AI-enabled business development significantly inclines to governmental financial support (Ma, 2024).

Furthermore, Kinkel et al. (2021) identified that organizational and environment correlation play a moderating role between perceived benefits and AI adoption. This study emphasizes the

importance of competitiveness and innovation for market players as shown in the Table 3. This study discussed the decision of using AI made by competitors and industry leaders, and the acceptance of customers. Firstly, the AI strategies of industry leaders provide enterprises with directional guidance and experiential insight. Secondly, the acceptance of AI by customers drives enterprises to adopt AI technologies to meet demands and seize market opportunities. As Gupta and Mukherjee (2024) suggest, customer are uncertain about how AI works which results in losing trust in AI and in return affects their willingness to accept AI. Lastly, both competitors and industry leaders' behavioural intention to use AI compel enterprises to accelerate their pace of innovation to avoid behind.

Despite this study has no statistically result on managing data and AI use in between, AI policy is still an important factor to be considered (Chatterjee and Sheshadri, 2020). AI policy should be favouring data and privacy protection.

Conclusion

The present study aims to compare Bulgarian companies with their international peers in AI adoption. First of all, this study was grounded in the technological-organizational-environmental framework and extended the existing literature by examining AI adoption on a global scale. Secondly, through factor analysis, the study identified four key factors including organizational readiness, competitive environment, AI adoption and innovation, and challenges related to data availability. Thirdly, this study investigated the relationships and influences among these factors. Furthermore, the study revealed that Bulgarian companies tend to adopt a more uniform application of AI, although this finding lacks of statistic proof. Finally, the study concluded that Bulgarian companies differ from their international peers in AI adoption on the level of organizational readiness and the understanding of AI. The findings have significant managerial implications for enhancing the effective adoption of innovative technologies like AI. Managers should concentrate more on the organizational capacities for AI adoption.

The study has limitations. The study is exploratory in nature and based on data collecting from survey. This could have selection bias because of a limited number of responses from certain countries and regions. The results explain potential trends, but may not fully represent the overall situation. Additionally, the research does not delve into specific factors influencing AI adoption (e.g., company size, industry type, technical infrastructure), which cold significantly impact the findings. Future study could consider expanding the sample size and through a broader sample selection strategy and diverse data collection methods. In addition to the factors mentioned in this study, future study could also consider other factors that may influence the adoption of AI by SMEs, such as the policy environment, technological maturity, and data quality.

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