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Artificial intelligence adoption dynamics and knowledge in SMEs and large firms: A systematic review and bibliometric analysis

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ABSTRACT

Artificial intelligence (AI) has quickly emerged as a top technological priority for companies in various sectors, radically altering business operations. However, the existing literature reveals a fragmented and inconsistent understanding of AI adoption dynamics between small and medium enterprises (SMEs) and larger, well-established firms. This dichotomy of the existing research raises important questions about whether the AI tools and application modalities used by these companies are inherently similar or if significant differences exist in their implementation and outcomes due to varying organizational sizes. This study evaluates whether small and large firms' efforts toward implementing AI differ significantly using bibliometric analysis and a systematic literature review from the Web of Science and Scopus databases. A total of 78 peer-reviewed articles were analyzed and categorized states and trends into 10 dimensions: (1) technology readiness, (2) customization, (3) AI tools and needs, (4) data requirements, (5) skills and competencies, (6) financial readiness, (7) management support, (8) market and competitive pressure, (9) partnership and collaboration, and (10) regulatory compliance, based on the technology–organization–environment (TOE) theoretical model. A bibliometric mapping approach was adopted to visualize bibliometric data using VOSviewer. The review brings together collective insights from several leading expert contributors to emphasize areas where SMEs need additional support to fully leverage AI technologies. The results provide pragmatic insights for policymakers, helping them develop tailored approaches for both SMEs and large enterprises to meet their unique needs while acknowledging AI's undeniable role in competitiveness and growth.

Introduction

In the past 10 years, state-of-the-art technologies such as artificial intelligence (AI), data analytics, and machine learning tools have revolutionized the performance of organizations from top to bottom across business functions (Hwang & Kim, 2021). The extensive implementation of such technologies within firms generates higher effectiveness, increases efficiency, and drives overall productivity (Czarnitzki et al., 2023; Damioli et al., 2021). Owing to the complexity of business, data availability, sophisticated techniques, and infrastructure advancement, AI has quickly emerged as a top technological focus for society and organizations to streamline operations, make data-driven decisions, and offer personalized solutions at scale (Hwang & Kim, 2021; Kumar et al., 2024; Makridakis, 2017; Mikalef & Gupta, 2021).

To increase the value of their products and services, several companies have made large investments in AI technologies, making it a crucial component of their operations (Brătucu et al., 2024). Numerous studies have revealed that several internal and/or external factors influence the use of AI in business operations, including the organizational setting in which the technology is used, the technology itself, and environmental aspects (Baabdullah et al., 2021; Kulkarni et al., 2024; Rana et al., 2024). Similarly, research documents a broad range of firm performance outputs, such as financial performance (Abrokwah-Larbi & Awuku-Larbi, 2024; Mousa et al., 2024), profitability and cost structure (Wamba-Taguimdje et al., 2020), learning and innovation-enhanced values (Feng et al., 2024), and economic and operational performance (Badghish & Soomro, 2024; Chen et al., 2024).

While AI has consistently been linked to positive organizational outcomes, providing a strategic advantage for firms of all sizes, the dynamics of AI implementation and its outcomes can differ significantly between small and medium enterprises (SMEs) and larger, well-established firms. These differences result from variations in resources, expertise, cost structure, and support systems, among other factors (Abrokwah-Larbi & Awuku-Larbi, 2024; Czarnitzki et al., 2023;

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Damioli et al., 2021; Kopka & Fornahl, 2024; Rammer et al., 2022; Schwaeke et al., 2024; Wamba-Taguimdje et al., 2020). For instance, Schwaeke et al. (2024) examined the current state of AI adoption in SMEs through a systematic review and found that infrastructure, culture, compatibility, and regulations are key factors influencing AI adoption. However, important components such as AI tools and needs, data requirements, and management support were not included in their study. Inclusion of these factors would have added further depth to the understanding of AI adoption patterns in SMEs. Studies also suggest that factors such as digital culture, partner pressure, and adoption costs play a crucial role in SMEs' adoption of emerging technologies (Faiz et al., 2024).

The contributions of this systematic review are threefold. First, existing research outcomes often focus exclusively on either SMEs (e.g., Baabdullah et al., 2021; Crockett et al., 2021; Lemos et al., 2022; Peretz-Andersson et al., 2024; Rawashdeh et al., 2023; Sharma et al., 2022; Wei & Pardo, 2022) or larger firms (e.g., Ahmad 2024; Bansal et al. 2024; Damioli et al. 2021; Fares et al. 2023; Manser Payne et al. 2021; Omoge et al. 2022; and Rahman et al. 2023), limiting comprehensive comparative insights across organizational sizes. This dichotomy prompts important questions about whether AI tools and application modalities are inherently similar or whether significant variations in implementation and outcomes stem from differing organizational dynamics. Second, although previous studies recognize AI's role in enhancing operational and strategic performance, little research consolidates the specific organizational, technological, and environmental factors that influence AI adoption across various firm sizes. Significant knowledge gaps remain regarding how SMEs and large firms can tailor their strategies for the best possible AI integration through comparable frameworks.

Third, while general academic knowledge is growing rapidly, AI-related research in the business field is occurring more rapidly. Breakthroughs in AI-related areas occur much more frequently than in other fields. With so much new information being produced, a systematic literature review is not only relevant but also necessary to distill and comprehend the most critical findings (Linnenluecke et al., 2020). It allows for a comprehensive analysis of many recent studies, synthesizing the most critical findings into a coherent narrative rather than duplicating efforts. This review brings together collective insights from several leading expert contributions to discuss how AI is commonly utilized and how it should be customized to more specific needs in various organizational settings.

This study addresses these gaps by systematically reviewing and categorizing 78 peer-reviewed articles through the lens of the TOE framework. A bibliometric mapping approach was used to visualize bibliometric data and the results of a systematic literature review. Robust comparisons by integrating bibliometric analysis with a thematic review contribute to a nuanced understanding of AI adoption dynamics, thereby helping to identify critical enablers and barriers as well as similarities and differences in the adoption of AI for each type of enterprise. Understanding such dynamics is very important in devising strategies that could enhance the smooth use of AI across varied organizational sizes and ensure that small businesses are also competitive in an increasingly AI-driven business.

The remaining sections of the study are structured as follows. In Section 2, key theoretical debates and overall themes within the literature are presented. Section 3 details the materials and methods used in different stages of the review process. Section 4 presents a discussion of the key clusters related to AI tools, applications, and modalities. The study concludes in Section 5.

Research questions

In light of the above discussion, the paper addressed the following research questions by thoroughly examining 78 peer-reviewed studies and categorizing states and trends into 10 dimensions through the lens of the TOE framework:

1. What are the key enablers and deterrents of AI adoption in SMEs and how do they compare to those of larger, well-established enterprises?
2. Are the factors influencing the adoption of AI tools by SMEs and large firms similar or significantly different?

Literature review

Definition, scope, and characteristics of AI

AI is an information communication technology that can perform tasks independently and normally requires human intelligence to make decisions, create greater efficiencies, and enhance productivity (Arakpogun et al., 2021; Ghosh et al., 2018). Others have defined it as the capacity of a machine to think like and imitate human intelligence (Varma et al., 2024). Haenlein and Kaplan (2019) assert that it is the system's capacity to accurately evaluate data and learn from it to accomplish objectives.

From automating repetitive operations to enhancing human abilities in complicated settings including image identification, processing, decision-making, natural language processing, and speech synthesis, AI spans a wide range of sectors and applications. In business, the potential impact is vast, influencing functions such as marketing (Abrokwah-Larbi & Awuku-Larbi, 2024; Kumar et al., 2024), production (Chatterjee et al., 2021c; Merhi & Harfouche, 2024), human resources (Li et al., 2023; Kapoor, 2024; Vedapradha et al., 2024), security (Rawindaran et al., 2022), and innovation activities and beyond (Feng et al., 2024; Rammer et al., 2022).

AI adoption uptake in contemporary business

AI covers a variety of industries and applications, such as image recognition, processing, decision-making, natural language generation, and speech synthesis, ranging from automating repetitive tasks to augmenting human capabilities in different domains like business, healthcare, engineering, and technology (Raman et al., 2024). AI investments and commercial applications have surged dramatically across several industries over the last 10 years (Babina et al., 2024). According to the literature, firms report greater growth in the use of AI technologies in different business operations and functions, with annual revenue growth increasing by 30% more for AI adopters than non-AI adopters (Lee et al., 2022). The report further underscored the cost savings and revenue growth in businesses where AI was used. The phrase *AI adoption* describes the initial stage in which a firm integrates AI into its business process. The term *utilization* refers to the actual implementation of AI tools in the firm's daily activities which involves the application, integration, and usage of AI in existing processes and systems (Tominc et al., 2024).

Technology-organization-environment (TOE) framework

Various frameworks, especially the technology acceptance model (TAM) developed by Davis et al. (1989) and its extensions, have investigated the drivers of users' acceptance and adoption of emerging technologies (Venkatesh & Bala, 2008; Venkatesh et al., 2012). Venkatesh et al. (2003) also examined technology adoption at the individual level using unified theory of adoption and use of technology (UTAUT). Other models, such as the diffusion of innovations (DOI), emphasize more aspects related to the spread of innovations within social systems (Arkorful et al., 2021). Taken together, these theories provide very powerful tools for understanding user behavior, but often along specific dimensions of technology adoption.

Similarly, the TOE model was developed to explain the influence of a broad composite of factors on the adoption and processes of technological innovation: (1) those related to the characteristics of technology itself, (2) organizational contexts, and (3) the external environment within which an organization operates (Baker, 2012). The framework has already been tested empirically for validity and reliability in several

previous studies and recognized as one of the strongest theoretical tools to explain technology implementation behavior in firms (Chatterjee et al., 2021c; Das & Bala, 2024; Ganguly, 2024; Mishra & Pathak, 2024; Nguyen et al., 2022).

Despite its strong theoretical basis to analyze technological adoption, the TOE framework has certain limitations. The TOE framework is said to oversimplify the complex triadic relationship constellations of the three elements involved (technology, organization, and environment), assuming that they are rigid and well-distinguished segments. According to Gwaka et al. (2023), the other limitation of this framework is a limited view on socioeconomic and cultural factors that can influence the technology adoption process. In the same vein, other findings criticize its reliance on quantitative views that may blindside the qualitative aspects of the technology adoption process (Baker, 2012; Lin & Chen, 2023).

In order to conceptualize the differences in AI adoption between SMEs and larger enterprises, as shown in Fig. 1, the paper build upon the TOE theoretical model for this study.

Materials and methods

The PRISMA framework–the preferred reporting method for systematic reviews and meta-analysis, was used to ensure that our methods were methodologically sound and enabled tracking data progress at different stages of the review process (Moher et al., 2015). Additionally, the bibliometric mapping approach was used to represent bibliometric data and results of a systematic literature review using VOSviewer software.

By analyzing and interpreting prior research in a particular domain, this method provides (1) repeatable, (2) reproducible (Kraus et al., 2023), and (3) reliable results (Snyder, 2019). It is considered the most rigorous technique because it provides reliable, unbiased, and reproducible results, thus allowing a comprehensive synthesis of the existing evidence to address the research objective (Tranfield et al., 2003). The review processe began by defining the research problem and objective. Second, a literature search was conducted based on PRISMA principles. Third, the data was synthesized and analyzed. Lastly, meaningful discussion and conclusions were provided, as shown in Fig. 2.

Data extraction and appraisal

In a systematic literature review approach, there are two important elements: (1) setting criteria for the inclusion and exclusion of records, and (2) evaluation of the quality of the selected records (Linnenluecke et al., 2020; Moher et al., 2015; Snyder, 2019). The databases chosen were Scopus and Web of Science (WOS), so the available information may complement each other to retrieve high-quality journals. These databases contain top scholarly journals and provide stable coverage, making them suitable for in-depth analysis (Garg et al., 2024; Harzing & Alakangas, 2016; Raman et al., 2024).

First, a database search was conducted for three main domain areas with Boolean search terms in the title, abstract, and keywords sections to cover all aspects comprehensively: (1) different mentions of AI such as artificial intelligence, AI, machine learning, and deep learning, as applied by the prior literature (Schwaeke et al., 2024); (2) processes or actions regarding the terms of AI adoption such as adoption, implementation, usage, and utilization, based on the previous studies; and (3) firm size-related terms such as small and medium enterprises, small and medium-sized enterprises, SMEs, SME, small and medium businesses, large enterprises, large firms, large businesses, multinational companies, global companies, and large organizations. These terms and phrases are relevant to the research objective of understanding how AI adoption dynamics may differ across firm sizes (see the full syntax used to access records in Appendix A).

In the next step, three eligibility criteria were established for the first search: (1) only articles written in English, (2) studies conducted in the previous 10 years (2015–2024), and (3) in the subject area of business, management, accounting, and computer science. Only articles classified as journal documents were included, excluding review articles, letters to the editor, commentaries, gray literature, case reports, and duplicates. The search result were further refined by eliminating keywords that were unrelated to the topic. Finally, by reading the titles and abstracts of the remaining records, a final sample of 78 peer-reviewed articles was selected (Fig. 3).

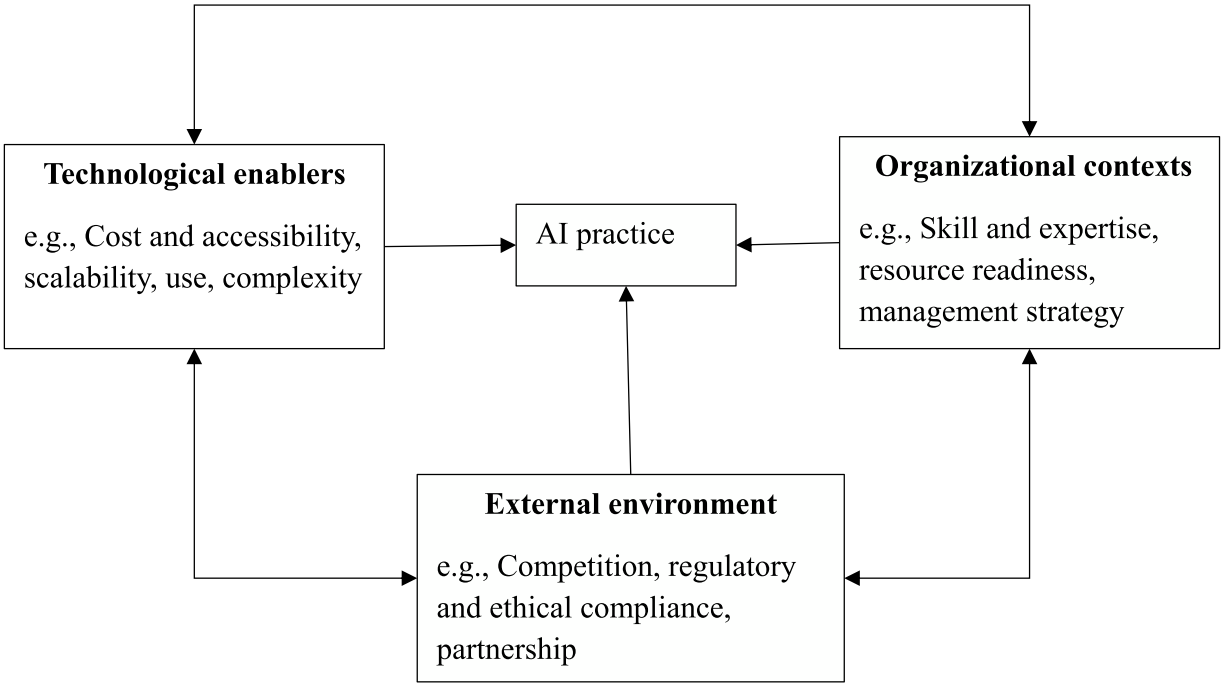

Fig. 1. Conceptual model of the study.
Source: The conceptual model is based on the TOE framework adapted from Nguyen et al. (2022).

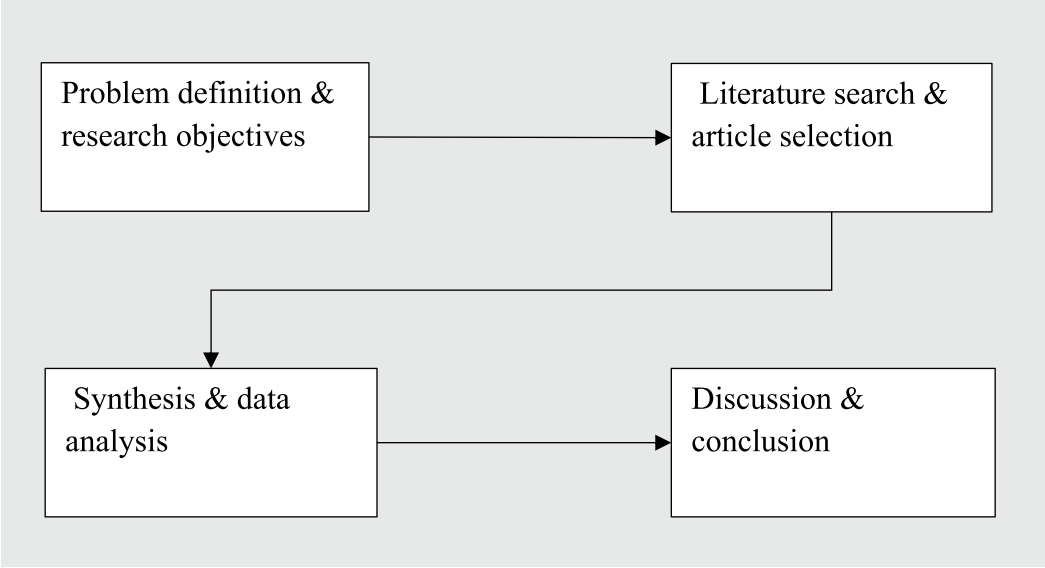

Fig. 2. The review processes.

The study was limited to papers published after 2015 because of the quick development of AI technologies and their substantial influence on business at this period (Mai et al., 2024, Babina et al., 2024). Over the past 10 years, businesses have increasingly used AI technologies such as machine learning, deep learning, and predictive analytics (Shao et al., 2022). This period has also witnessed a rise in research into the use of AI by businesses of all sizes, from startups to global conglomerates, in addition to the development of regulations and ethical standards for AI in business (Tominc et al., 2024).

Data cleaning and coding

Given the goal of our review and the need to present results based on a systematic and unbiased analysis of the literature (Tranfield et al., 2003), in the third step, each of the 78 papers was assigned a unique ID number after extraction to facilitate smooth identification among the articles. ID numbers remained constant throughout the review process. The following validation columns were then used to arrange the data: *ID number, authors, title, publication year, keywords, abstract, and journal name.*

Results and discussion

Distribution of studies based on level of analysis

Fig. 4 illustrates the proportion of AI adoption studies across different firm sizes, categorized as *SMEs, large firms, both* (SMEs and large), and *unidentified*. Based on these results, we can determine which firm sizes are most represented among the 78 records analyzed in the current systematic review. Accordingly, a significant portion of AI adoption studies focuses on the *SMEs* category (44%), indicating a growing interest in understanding how AI is being utilized within these firms. This trend is likely driven by the unique challenges SMEs face compared with larger enterprises. Studies that do not specify a particular firm size (labelled as *not identified*) account for 32% of the total. *Large* firms constitute 15% of the records, and studies examining both SMEs and large enterprises represent 9%. Therefore, the distribution of these studies across different firm sizes is relevant for the current systematic literature review objective of understanding the dynamics of AI adoption in SMEs and large firms (see full list records with the corresponding level of analysis in Appendix B).

Year of publication of selected studies

No publications were recorded from the selected studies in this review, no publications were recorded from 2015 to 2018. However, a significant acceleration in research activities over the last few years has been observed, peaking in 2024 (Fig. 5).

Publication distribution based on the theories used

The theoretical models employed by the authors in the selected records were reviewed to obtain a thorough understanding of the underlying theoretical models used in the studies. As indicated in Fig 6, those studies counted as *not applicable* were those in which the authors did not explicitly indicate the theories used in their study. However, the *TOE framework* is the most commonly used theoretical model, followed by the *technology acceptance model (TAM)*.

Bibliometric analysis

A bibliometric analysis, a popular quantitative technique in systematic literature review research, was conducted. Previous studies, such as Linnenluecke et al. (2020), suggest that this method is effective in mapping the theme of interest to see its intellectual roots and the structure of the literature over time, helping researchers identify key themes and relevant keywords for analysis. The bibliometric approach also facilitates network analysis and visualization.

Keywords network analysis

A keyword co-occurrence analysis was conducted using a full-counting approach to explore the most prevalent themes and keywords in AI adoption. To avoid bias during the keyword selection process, not only the abstracts and keywords of the selected records but also the entire text were carefully examined. Fig. 7 presents the most frequently used keywords from both the WOS and Scopus in the study from 2015 to 2024. Among the keywords, *artificial intelligence* is the most mentioned, with 51 occurrences, followed by *technology adoption* and *SMEs*, with 14 occurrences each.

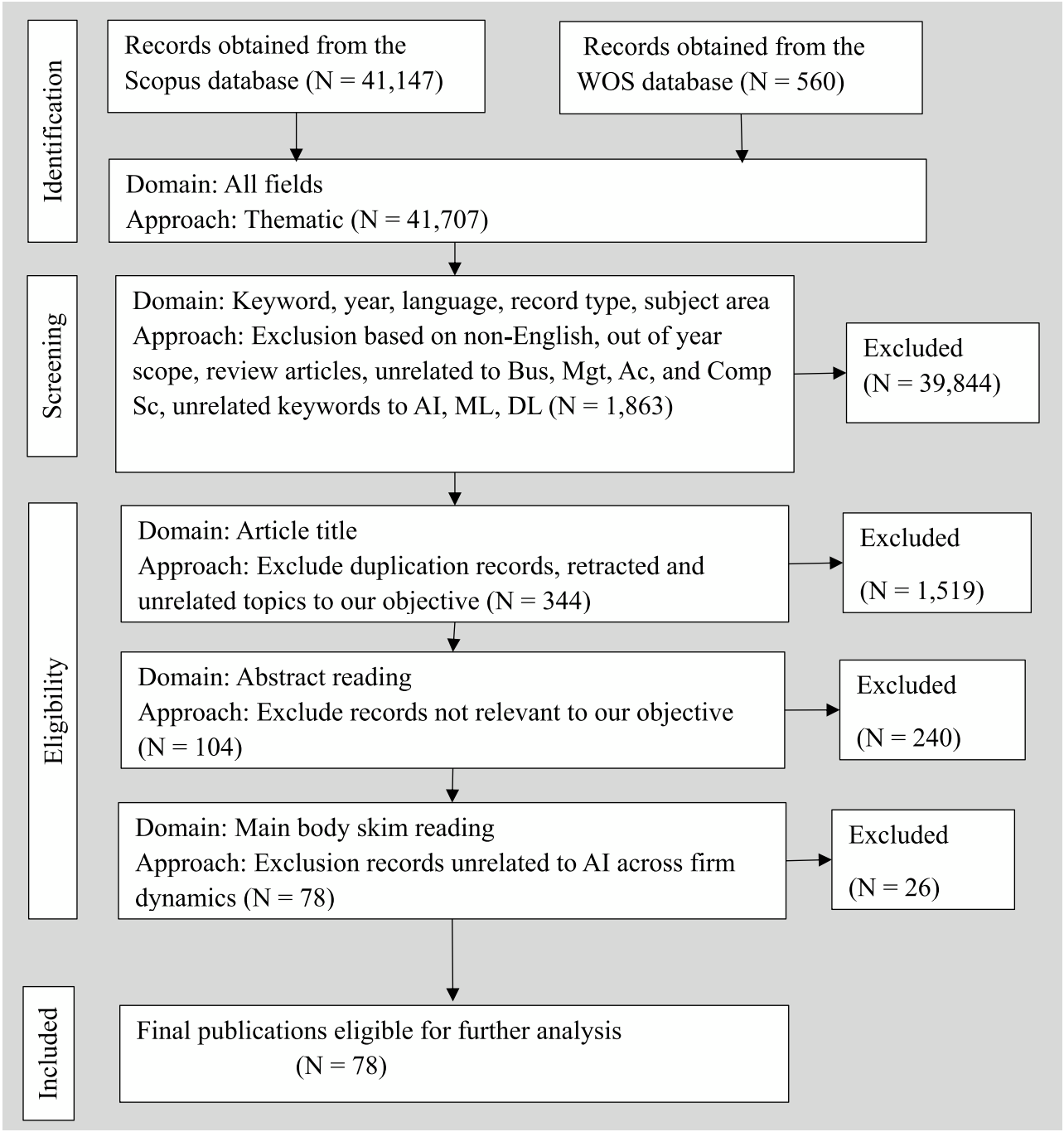

Fig. 3. Study selection process (PRISMA flow diagram).

Analysis of the clusters according to TOE model

Technological factors

Technology readiness. Technology readiness is directly linked to IT infrastructure. Several studies have emphasized the importance of the digital maturity level (Brătucu et al., 2024) and advanced digital infrastructure to enable technological readiness in the adoption of AI across various sectors (Agarwal, 2022; Baabdullah et al., 2021; Das & Bala, 2024; Dora et al., 2022; Issa et al., 2022; Kovič et al., 2024; Merhi & Harfouche, 2024; Tominc et al., 2024). SMEs and large firms have different infrastructure requirements for successfully implementing AI (Badghish & Soomro, 2024). Large enterprises typically possess the necessary technological infrastructure to support extensive AI systems. Aghimien et al. (2024), Gupta et al. (2022), Mantri & Mishra (2023), Solaimani & Swaak (2023), and Tominc et al. (2024) agree that the substantial financial resources available to large firms enable them to leverage advanced AI technologies that require significant computational power and data for training and deployment. This capability allows large organizations to imbibe AI into their systems, raising efficiency and innovation.

SMEs usually face high barriers to accessing the necessary infrastructural facilities for AI adoption (Kapoor, 2024; Schlegel et al., 2023; Tawil et al., 2024). According to Jalil et al. (2024), AI readiness is found complementary to technological orientation in SMEs, among other factors (Polisetty et al., 2024).

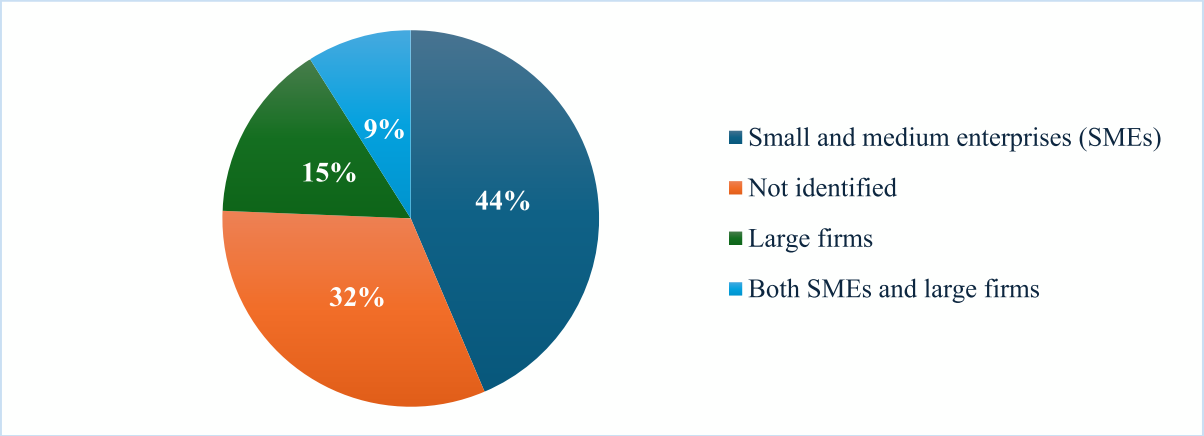

Fig. 4. Proportion of the studies based on firm size analysis.
NB: Not identified refers to those studies in which the authors did not explicitly specify the particular firm size such as *small* or *large* firms in the paper.

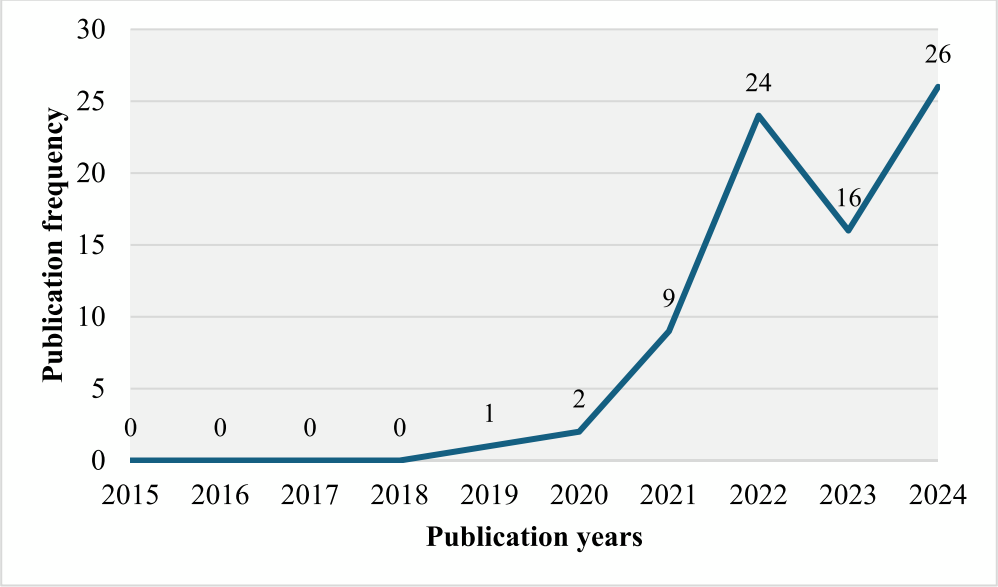

Fig. 5. Distribution of publication over 2015–2024.
Source: Compiled by authors, 2024

System customization (flexibility)

Many SMEs see ease of use as a key criterion in choosing AI tools to simplify their adoption (Hamdan et al., 2022b; Vedapradha et al., 2024). The reason is that SMEs need AI tools that require little training or specialized skills given their limited talent resources. Sharma et al. (2022) found that the biggest enabler or deterrent to SMEs' intention to adopt AI is the system characteristics or technical context, further supported by Barata et al. (2023), Handoko (2021), and Maroufkhani et al. (2023). Hansen and Bøgh (2021) noted that the reason behind the most successful implementation of AI in SMEs is its greater simplicity. They usually choose *plug-and-play* AI tools, such as chatbots (Sharma et al., 2022) and they will become hesitant if they believe that the system is complicated and challenging to use and apply. User-friendly AI tools with less complex interfaces allow SMEs to adopt AI through basic training (Chatterjee et al., 2022; Chatterjee et al., 2021b; Hamdan et al., 2022a; Ho et al., 2022). Therefore, the degree of flexibility and compatibility with existing systems are strong predictors of AI adoption in SMEs (Kaymakci et al., 2022; Rawashdeh et al., 2023).

AI tools and needs

Looking at the core objectives and scope of AI adoption between SMEs and large firms is another important factor. Analyzing the rationale and purpose of AI adoption in terms of the core goals and extent of coverage of SMEs and large firms is another relevant consideration. As reported in prior studies, there are statistically significant differences in the AI needs/usage requirements between large firms in terms of firm size and SMEs (Tominc et al., 2024). Large enterprises mainly implement AI when handling big data, interacting with customers from around the world and implementing logistics on a large scale. These goals frequently relate to managing affordances for operation and optimizing the efficiency that arises from higher degrees and breadths of application (Yang et al., 2024).

SMEs, despite acknowledging AI's benefits, prioritize immediate practical concerns (Tominc et al., 2024). For instance, they require AI for specific purposes and consider time as a cost (Rawashdeh et al., 2023), such as chatbots to enhance customer satisfaction, manage inventory, or automate clerical tasks. Their goals are frequently more particular and temporary owing to the marketing affordances that influence less depth and width of use (Yang et al., 2024).

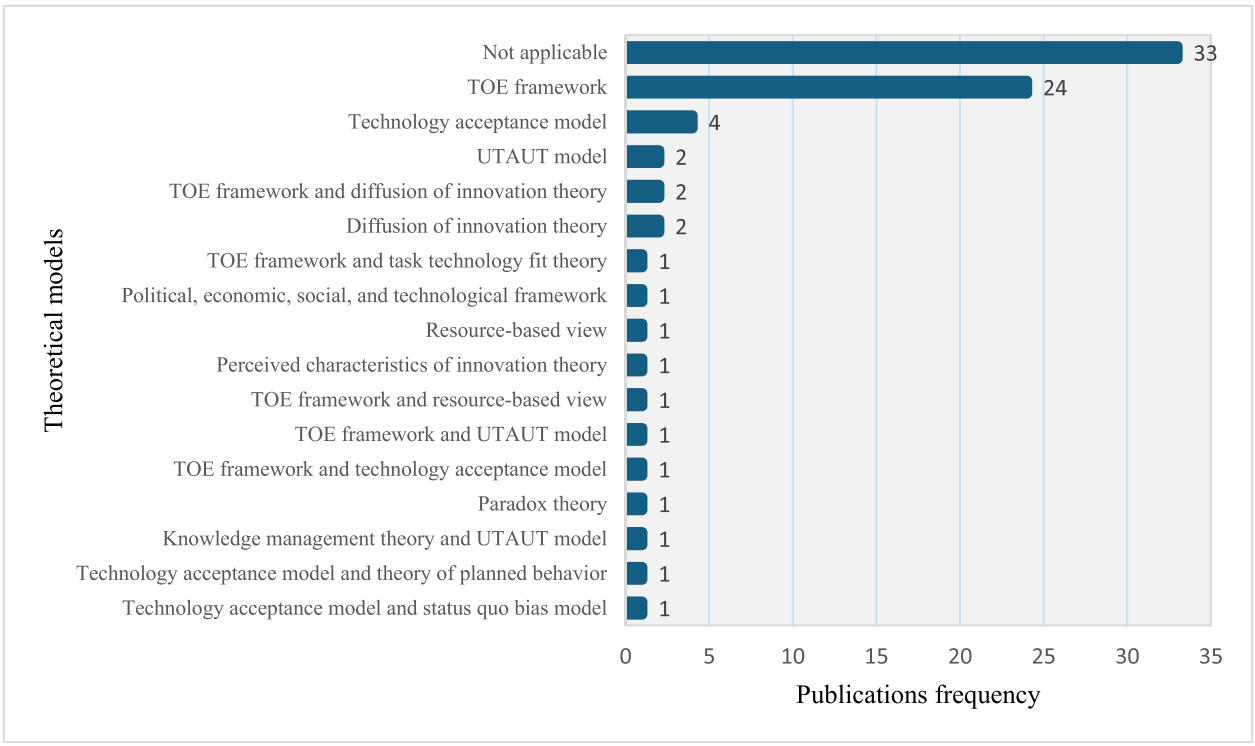

Fig. 6. Publication distribution based on the theories used.
Source: Compiled by authors, 2024

Data requirements

AI integration calls for the accumulation of huge data sets that can be used to run predictive analytics (Fu et al., 2023). Big firms often accumulate substantial data, which helps put AI's data processing and analytical prospects for better use than SMEs. This access to large data volumes results in improved decision-making options and better-informed decisions (Tominc et al., 2024). AI can also be customized according to the needs of large enterprises as well as the way these companies work to meet their needs, thus increasing its value.

In contrast, Peretz-Andersson et al. (2024) found that SMEs encounter difficulties in obtaining and managing the vast volumes of data needed for AI applications. Similarly, problems with access to a big data set for AI deployment in manufacturing firms have been brought to light (Kovič et al., 2024), and SMEs may encounter data availability concerns in some situations.

Organizational contexts

Skills and competencies

Skills and competencies play an important role in AI technology adoption. Functional and operational knowledge creates differences between SMEs and large firms (Grashof & Kopka, 2023; Wei & Pardo, 2022). For instance, Huseyn et al. (2024) highlighted the positive outcomes of training programs aimed at upgrading actors' skill to effectively utilize AI in SME operations. Studies have consistently shown that tangible resources and workforce skills positively influence AI implementation (Chen et al., 2024). Knowledge embodiment affects people's intentions to adopt technology (Pee et al., 2019). In fact, small firms often lack such expertise (Hansen & Bøgh, 2021), as they might not be able to provide competitive salaries and career growth as large firms do, which can hinder their ability to implement AI solutions effectively (Peretz-Andersson et al., 2024). Reliance on outside consultants or partnerships may result from this lack of technical expertise, which is not always practical for smaller businesses because of their financial constraints.

Conversely, larger firms typically find it easier to incorporate AI into their business, as they have the financial means to retain specialized personnel (Tominc et al., 2024). Blomster and Koivumäki (2022) conceptualized the skills and competencies required for successful AI adoption. As a result, personnel competencies in the properties of the data and their ability to manage successful machine learning projects. Therefore, hiring qualified data scientists to enhance employees' IT awareness and the right set of skills positively influences their attitudes toward AI adoption (Almashawreh et al., 2024; Khaliq et al., 2022; Rahman et al., 2023; Solaimani & Swaak, 2023). Tawil et al. (2024) suggested that SMEs need the right skills to produce useful insights from data-driven decision-making using AI.

Resources and financial readiness

Resources are the nerve centers of every organization. Research in finance has shown a strong correlation between firm size and financial availability. Integrating AI requires both internal and external investments, and financial resources are critical determinants. Scholars have noted that the capital element plays a critical role in the value-enhancement mechanism of AI tools (Luo & Yu, 2022). According to Tominc et al. (2024), large firms have the funds and human capital to invest in sophisticated AI technologies. They may also develop in-house AI tools adapted to their needs.

In most cases, such investments are beyond the scope of SMEs because of their limited resources and restricted access to financing (Bąk et al., 2024; Tominc et al., 2024). They are hesitant to invest in software and hardware if they cannot expect quick positive results and revenue (Tawil et al., 2024). Budget constraints (Wong et al., 2020) and the perceived cost of AI (Mousa et al., 2024; Sharma et al., 2022) are acute for SMEs, and they rarely have in-house AI solutions, leading them to find more affordable, basic AI solutions. Due to their inherent structure, SMEs face difficulties in accessing financial resources as they lack collateral to secure loans (Nagy et al., 2023; Wang & Pan, 2022). A study

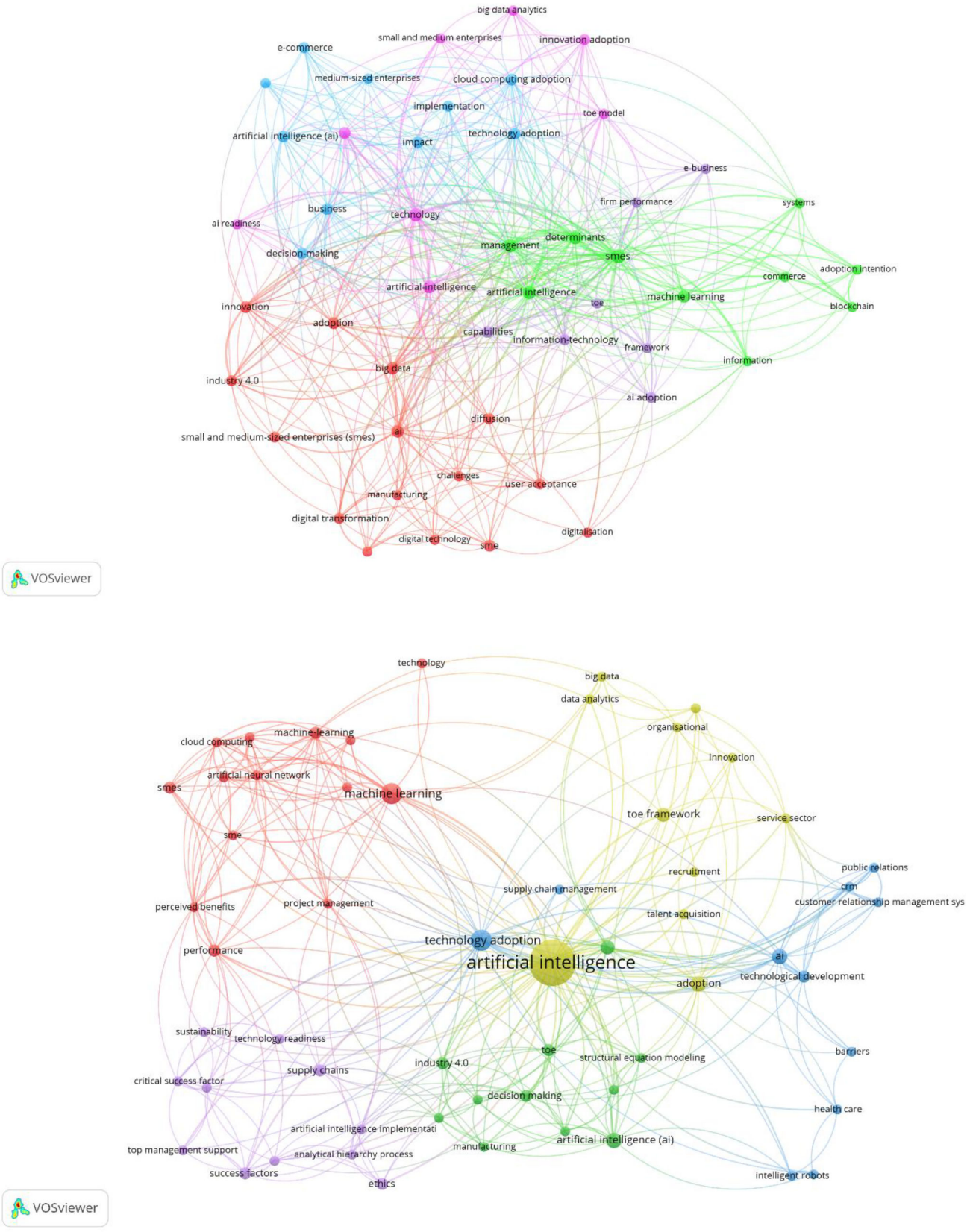

Fig. 7. Co-occurrence of keywords based on full-counting method.
Source: VOS viewers' result compiled by authors, 2024

by Dvoráková et al. (2021) on SMEs confirmed that perceived financial costs were the primary problem for the adaptation of the latest technologies, as AI forced them largely to depend on outsourcing. Peretz-Andersson et al. (2024) underscored structuring AI resources as a necessary precondition for SMEs to adopt and develop AI capabilities successfully.

Management commitment and support

Management commitment and support are crucial for the successful adoption of AI in both SMEs and large firms (Maroufkhani et al., 2023). Management commitment can directly impact the formulation of business direction, staff involvement, provision of training, and resource allocation among others (Sharma et al., 2022). The degree to which management awareness of the benefits and support can influence the willingness to change to AI adoption (Agarwal, 2022; Chatterjee et al., 2021a; Das & Bala, 2024; Fetais et al., 2022).

Previous studies show that large firms benefit from their strong management support because of greater financial resources that enable them to invest in talent, structured change management, and formalized structures compared to their SME counterparts. Badghish and Soomro (2024) indicated that management within SMEs is not encouraging, mainly due to high follow-up costs during the implementation process. Their strategic framework of AI utilization (Kim & Seo, 2023) suggests that SMEs need to have a management-enhancing strategy to achieve better management principles and practices, such as productivity or efficiency, to overcome this problem. Similarly, Hossain et al. (2024) found that leadership readiness and decision-making style affect the level of organizational readiness for AI implementation.

External environmental factors

Market dynamics and competitive pressure

Competitive pressure impacts the adoption of AI solutions more swiftly by organizations seeking to gain a competitive edge (Merhi & Harfouche, 2024). Specifically, the entry of new firms may force new competitive dynamics (Costa et al., 2022), which, in fact, leads firms to find more innovative ways of tackling. According to Yang et al. (2024), larger companies are forced to use AI to preserve their market position because they frequently operate in fiercely competitive conditions fueled by AI breakthroughs. On the other hand, SMEs might not be subject to competitive pressures or might not have the infrastructure and resources needed to adopt AI on the same scale. If we look at firm dynamics, Bąk et al. (2024) reported that larger firms are more equipped to use AI more quickly and efficiently since they have more resources, wider perspectives, and superior capabilities than SMEs.

Partnership and collaboration

Another important factor that facilitates the use of AI is partner collaboration. Collaboration is a relationship in which businesses share resources, information, and risks to maximize the benefits of working together, rather than acting alone. Partner collaboration is a positive driver of the adoption of artificial intelligence technology (Pai & Chandra, 2022; Wang & Pan, 2022). Usually, firms that do not have all the expertise and experts such as SMEs, vendors, or external consultants play a critical role in providing adequate technical support (Chen et al., 2021; Daoud & Kammoun, 2024). According to Mousa et al. (2024) and Hasani et al. (2024), AI vendor support directly and positively affects SMEs, particularly for several reasons, including a lack of funding, technology, and qualified people.

Regulatory and ethical compliance

Regulatory environments, such as laws, ethical regulations, and standards, are the most important factors for AI adoption (Merhi, 2023; Singh et al., 2024). The deployment of AI in firms must consider data privacy and security from the political, economic, social, and technological dimensions (Akinsolu, 2022). Privacy and security have a direct impact on trust in the intention to adopt AI (Ahmad, 2024; Chatterjee et al., 2021a; Dora et al., 2022; Hasani et al., 2024; Polisetty et al., 2024). Organizations must comply with the legal and regulatory frameworks in place (Ahmad, 2024). Managers must be aware of the security and privacy of AI implementation to meet regulatory compliance (Al Badi et al., 2022; Pillai & Sivathanu, 2020) and to ensure transparency and accountability (Volkmar et al., 2022).

The absence of AI guidelines, data protection, and lack of transparency in AI systems are some of the critical factors for AI deployment (Bansal et al., 2024; Singh et al., 2023). The issue of data management and protection may encourage or inhibit the readiness for AI adoption in the organization (Hangl et al., 2023; Hradecky et al., 2022). In this regard, large firms are more concerned with compliance with auditing requirements when implementing AI tools; therefore, they frequently have well-established strategic frameworks for tackling ethical AI practices compared to SMEs (Ahmad, 2024; Yang et al., 2024). The lack of knowledge and awareness of intelligent software (Rawindaran et al., 2022), data security and privacy (Khayer et al., 2021), lack of solid business strategy (Wang, 2024), and lack of a practical framework among SMEs, as stated in (Faqihi & Miah, 2023), can hinder their willingness to adopt these technologies. Similarly, security and trust are critical factors in stakeholder interactions with AI systems (Aghimien et al., 2024). Therefore, the effective integration of AI in SMEs depends on creating an atmosphere of trust and ethical responsibility concerning regulations.

The results of the review are summarized into 10 thematic clusters, organized within the three broad dimensions of the TOE model, as shown in Fig. 8.

Discussion of the results

This study evaluates whether small and large firms' efforts toward implementing AI differ significantly by using bibliometric analysis and a systematic literature review from reputable sources such as the Web of Science and Scopus. A total of 78 peer-reviewed articles were analyzed and categorized the states and trends using the TOE theoretical model. Methodologically, the review incorporates AI adoption studies across different firm sizes focusing on both SMEs and large firms to have a balanced understanding of the subject.

AI adoption is significantly influenced by the technology readiness of the firm, which is closely related to IT infrastructure and digital maturity level. In support of Tominc et al. (2024), large firms benefit from advanced infrastructure and access to financial resources, enabling them to leverage sophisticated AI applications. However, SMEs typically encounter significant barriers in accessing the necessary infrastructural facilities for AI adoption (Kapoor, 2024; Schlegel et al., 2023; Tawil et al., 2024). Similarly, the issue of ease of use and simplicity in AI tools is very important to SMEs (Sharma et al., 2022), as user-friendly *plug-and-play* reduces the need for training and resource constraints, and they will become hesitant if they believe that the system is complicated and challenging to use and apply (Hansen & Bøgh, 2021).

The rationale and purpose of AI use also differ between SMEs and their counterparts. While large enterprises mainly focus on AI for handling big data, optimizing operations, and managing logistics on a large scale (Yang et al., 2024), SMEs prioritize AI for immediate practical concerns such as interacting with customers through chatbots, managing inventory, or automating routine tasks (Rawashdeh et al., 2023; Yang et al., 2024). Furthermore, from the point of view of data requirements, large firms have access to huge data sets, which help them to employ AI for predictive analysis whereas SMEs frequently find it difficult to handle the large volumes of data necessary for successful AI deployment (Kovič et al., 2024; Peretz-Andersson et al., 2024).

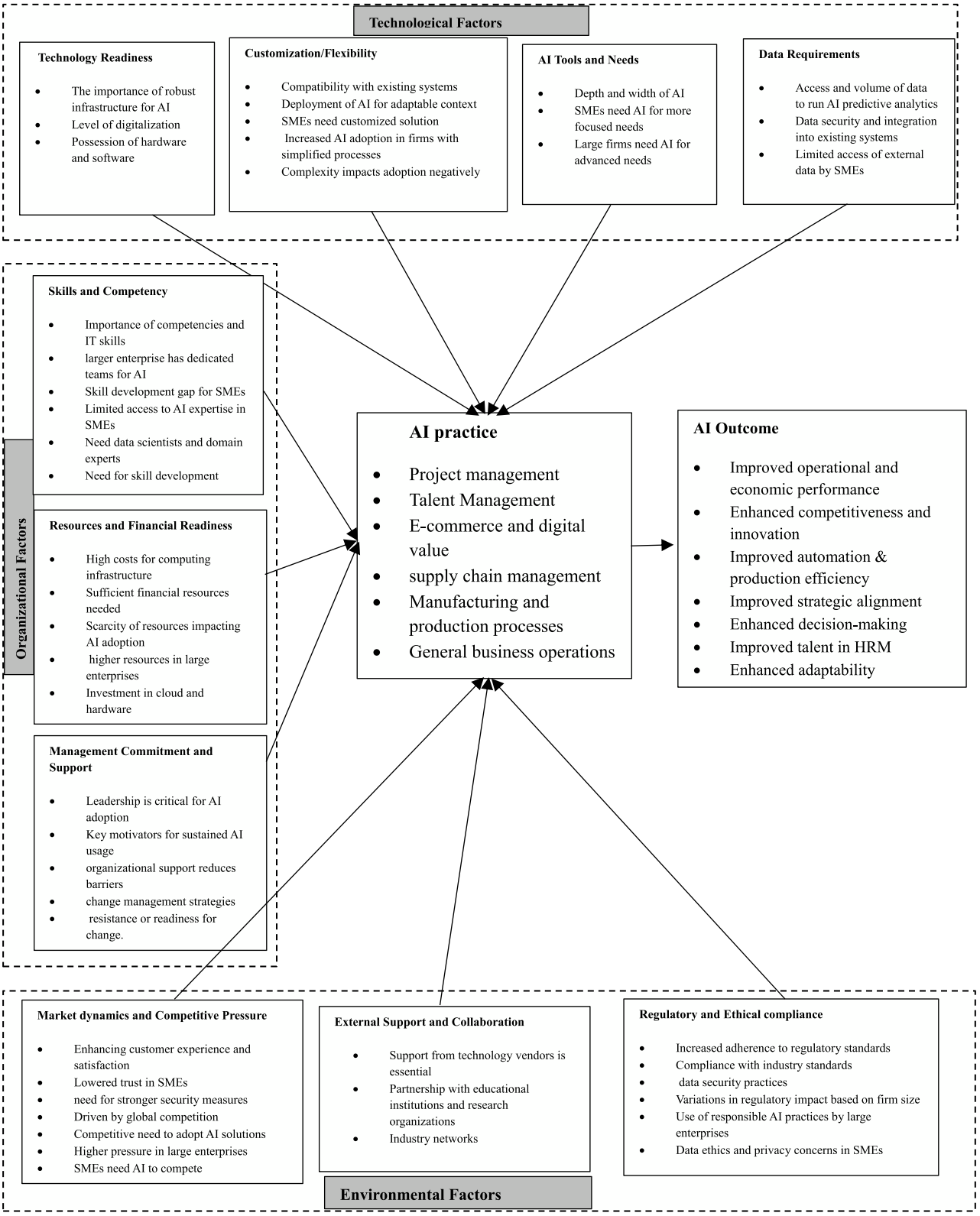

Fig. 8. Clustered findings using the TOE model.
Source: Compiled by authors, 2024

Skills and competencies shape the adoption of AI. Functional and operational knowledge creates differences between SMEs and large firms (Grashof & Kopka, 2023; Wei & Pardo, 2022). This study is consistent with the findings of Chen et al. (2024), which underscore that tangible resources and workforce skills tend to have a positive association with AI implementation. By contrast, large firms can build in-house AI solutions, while SMEs frequently view AI as expensive, limiting them to simple, low-cost solutions or depending on outside consultants, which can be costly. Financial readiness exacerbates this discrepancy. Large firms, as noted by Tominc et al. (2024), have the

capital to invest in sophisticated AI technologies. Conversely, SMEs often lack the resources and face limited access to financing, making such investments unfeasible (Bąk et al., 2024; Tominc et al., 2024).

Management support is another significant factor, as leadership often instills structured adoption with resource allocation and training (Agarwal, 2022; Chatterjee et al., 2021c; Das & Bala, 2024; Fetais et al., 2022; Hossain et al., 2024). SMEs may struggle due to limited managerial awareness or perceived costs. Moreover, competitive pressures drive firms to implement AI rapidly, which the larger ones can easily leverage using their resources and stay ahead (Merhi & Harfouche, 2024).

Partnerships and collaborations provide crucial support, especially to SMEs, in the form of access to technical expertise and resources from vendors or consultants (Chen et al., 2021; Daoud & Kammoun, 2024; Hasani et al., 2024; Mousa et al., 2024; Pai & Chandra, 2022; Wang & Pan, 2022). Finally, regulatory and ethical compliance influences AI adoption. While larger firms are better positioned to meet data security and privacy standards, SMEs often lack the necessary mechanisms and require external guidance to align with regulations and ethical practices (Aghimien et al., 2024; Bansal et al., 2024; Faqihi & Miah, 2023; Singh et al., 2023).

This systematic review delves into a deeper comprehension of AI adoption in SMEs by highlighting the necessity of interdisciplinary strategies and focused approaches to optimize its potential advantages while reducing related obstacles. The outcome of our systematic review demonstrates that organizational size plays a crucial role in shaping how AI technologies are adopted and the outcomes they yield. Larger companies typically have the financial capacity and infrastructure to support extensive AI initiatives that promote innovation and operational improvements (Ebuka et al., 2023). These organizations can integrate AI across numerous departments, fostering productivity and competitive advantage. However, they also face unique challenges such as organizational inertia and complex decision-making processes, which can slow the pace of adoption and affect alignment with broader strategic goals (Kim & Seo, 2023).

Limitations and avenues for future research

This study, like many other studies, had the following limitations. First, although the systematic review was comprehensive, the scope of the database was limited to Scopus and WOS from 2015 to 2024. Consequently, some potentially relevant studies may have been excluded because of the chosen database and filtering process. Second, only journal articles were considered, while conference papers, review articles, case reports, book chapters, and other gray literature documents were removed. Third, the keywords used in the search strategy may impact on the number of sample records used in the review. Fourth, future research should use R-software and other text-mining tools to provide nuanced insights into the literature. Finally, the present research utilized the TOE framework. Future research should consider more holistic frameworks that integrate sociocultural dynamics and qualitative perspectives to better capture the nuanced processes of AI adoption across diverse sectors. Despite these limitations, this study addressed important research gaps in the literature.

Conclusions

Over the past 10 years, AI has quickly emerged as a top technological priority for organizations to facilitate data-driven decisions, streamline operational efficiency, and drive overall productivity (Damioli et al., 2021; Hwang & Kim, 2021; Kumar et al., 2024). The objective of this study is to examine and compare the nature of AI applications and antecedents in two unique business contexts (SMEs and large firms) using the TOE framework. This includes, but is not limited to: technological readiness, resource availability, functionality, and AI needs. Although both SMEs and well-established firms recognize the transformative role of AI, their implementation experience is markedly different and shaped by unique organizational needs and size. Larger well-established firms generally implement AI more efficiently because they have greater resource possession and established practices. On the other hand, SMEs encounter unique obstacles inherent to their nature that necessitate tailored solutions and support systems to enable them to integrate AI technologies. Therefore, this study identifies the technological, organizational, and environmental factors that influence AI adoption, and serves as a practical guideline for businesses and policymakers to align strategies with the specific needs of SMEs and large enterprises for equitable AI-driven growth across firm sizes. This review shows that SMEs may continue to fall behind in the AI adoption race without the provision of tailored support schemes. In fact, future research studies are encouraged to develop frameworks that can facilitate the design of AI solutions, especially for SMEs.

Theoretical implications

This systematic review is an important study in so far as it enriches the existing literature on AI across various firms by identifying how SMEs and large enterprises adopt and use AI differently. It offers insights into the unique hurdles and deterrents faced by SMEs in AI adoption, enhancing the understanding of how AI impacts businesses of different sizes. It also offers pragmatic insights into the literature on AI adoption between SMEs and larger, established firms, adding a new dimension to the understanding of technological integration in various business contexts.

Practical implications

This systematic review has practical implications for enterprises, especially SMEs, in effectively adopting AI by considering different organizational contexts and studying how to maximize the benefits. Generally, SMEs often present difficulties commonly cited in the literature: lack of resources or technological readiness. Thus, targeted support from frameworks and policies is necessary to facilitate smoother and more effective integration. These are the barriers that SMEs need to overcome by looking for funding mechanisms to access affordable AI tools.

In the case of larger firms, this study underlines the need to optimize existing resources and enhance strategic AI adoption as a means to sustain competitive advantages. The results of this systematic review and bibliometric analysis therefore highlight practical interventions aimed at the main areas where SMEs need additional help to be able to use AI effectively.

Data availability statement

The data supporting this study's findings are included in the manuscript and are available from author upon request.

Declaration of generative AI

No AI-assisted tool was used for content generation; all ideas and conclusions are the author's work.

About the author

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Samuel Godadaw Ayinaddis: Writing – original draft, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The author declares no conflict of interest.

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Appendix A. Keywords and syntax used for extraction of the records

Data collection process
- Database sources – Web of Science (WOS) and Scopus
- Time span – 2015 – 2024
- Total records retrieved – WOS = 560 records & Scopus = 41,147 records

Search methodology and query design
- AI terms – artificial intelligence, AI, machine learning, and deep learning.
- Adoption – terms: adoption, implementation, usage, utilization.
- Firm size terms – *SMEs*: small and medium enterprises, small and medium-sized enterprises, SMEs, SME, small and medium businesses; *large enterprises*: large enterprises, large firms, large businesses, multinational companies, global companies, large organizations.
- Boolean search syntax – ("artificial intelligence" OR "AI" OR "machine learning" OR "deep learning") AND ("adoption" OR "implementation" OR "usage" OR "utilization") AND (("small and medium enterprises" OR "small and medium-sized enterprises" OR "SMEs" OR "SME" OR "small and medium businesses") OR ("large enterprises" OR "large firms" OR "large businesses" OR "multinational companies" OR "global companies" OR "large organizations")).

Analytical approach and reporting
- Method – thematic and bibliometric technique using PRISMA framework and Vosviewer
- Final report – figures, tables, diagrams, and frameworks

Appendix B. Articles by the level of analysis

SMEs level
- Badghish and Soomro (2024), Peretz-Andersson et al. (2024), Hasani et al. (2024), Jalil et al. (2024), Almashawreh et al. (2024), Tawil et al. (2024), Huseyn et al. (2024), Daoud and Kammoun (2024), Faqihi and Miah (2023), Rawindaran et al. (2022), Nagy et al. (2023), Kim and Seo (2023), Fu et al. (2023), Bąk et al. (2024), Polisetty et al. (2024), Wang (2024), Khayer et al. (2021), Wong et al. (2020), Chatterjee et al. (2022), Dvoráková et al. (2021), Baabdullah et al. (2021), Hamdan et al. (2022a), Kaymakci et al. (2022), Hamdan et al. (2022b), Maroufkhani et al. (2023), Sharma et al. (2022), Mantri and Mishra (2023), Rawashdeh et al. (2023), Mousa et al. (2024), Khan et al. (2024), Wei and Pardo (2022), Wang et al. (2022), Hansen and Bøgh (2021), Kapoor (2024).

Large firm level
- Hossain et al. (2024), Agarwal (2022), Ahmad (2024), Rahman et al. (2023), Bansal et al. (2024), Gupta et al. (2022), Costa et al. (2022), Luo and Yu (2022), Chen et al. (2021), Pee et al. (2019), Fetais et al. (2022), Vedapradha et al. (2024).

Both SMEs and large firm level
- Tominc et al. (2024), Chatterjee et al. (2021c), Yang et al. (2024), Kovič et al. (2024), Grashof and Kopka (2023), Hradecky et al. (2022), Handoko (2021).

Not specified
- Barata et al. (2023), Das and Bala (2024), Aghimien et al. (2024), Brătucu et al. (2024), Chen et al. (2024), Singh et al. (2023), Singh et al. (2024), Ho et al. (2022), Chatterjee et al. (2021b), Wang and Pan (2022), Akinsolu (2022), Schlegel et al. (2023), Merhi (2023), Solaimani and Swaak (2023), Hangl et al. (2023), Khaliq et al. (2022), Blomster and Koivumäki (2022), Al Badi et al. (2022), Volkmar et al. (2022), Issa et al. (2022), Pai and Chandra (2022), Chatterjee et al. (2021a), Pillai and Sivathanu (2020), Merhi and Harfouche (2024), Dora et al. (2022).

References

Abrokwah-Larbi, K., & Awuku-Larbi, Y. (2024). The impact of artificial intelligence in marketing on the performance of business organizations: evidence from SMEs in an emerging economy. *Journal of Entrepreneurship in Emerging Economies, 16*(4), 1090–1117. https://doi.org/10.1108/JEEE-07-2022-0207

Agarwal, A. (2022). AI adoption by human resource management: a study of its antecedents and impact on HR system effectiveness. *Foresight, 25*(1), 67–81. https://doi.org/10.1108/FS-10-2021-0199

Aghimien, D., Aigbavboa, C. O., Chan, D. W., & Aghimien, E. I. (2024). Determinants of cloud computing deployment in South African construction organisations using structural equation modelling and machine learning technique. *Engineering, Construction and Architectural Management, 31*(3), 1037–1060. https://doi.org/10.1108/ECAM-05-2022-0464

Ahmad, A. (2024). Ethical implications of artificial intelligence in accounting: A framework for responsible ai adoption in multinational corporations in Jordan. *International Journal of Data and Network Science, 8*(1), 401–414. https://doi.org/10.5267/j.ijdns.2023.9.014

Akinsolu, M. O. (2022). Applied artificial intelligence in manufacturing and industrial production systems: PEST considerations for engineering managers. *IEEE Engineering Management Review, 51*(1), 52–62. https://doi.org/10.1109/EMR.2022.3209891

Al Badi, F. K., Alhosani, K. A., Jabeen, F., Stachowicz-Stanusch, A., Shehzad, N., & Amann, W. (2022). Challenges of AI Adoption in the UAE Healthcare. *Vision: The*

Journal of Business Perspective, 26(2), 193–207. https://doi.org/10.1177/0972262920988398

Almashawreh, R.e., Talukder, M., Charath, S. K., & Khan, M. I. (2024). AI adoption in Jordanian SMEs: The Influence of technological and organizational orientations. *Global Business Review*. , Article 09721509241250273. https://doi.org/10.3390/bdcc8070079

Arakpogun, E. O., Elsahn, Z., Olan, F., & Elsahn, F. (2021). Artificial intelligence in Africa: Challenges and opportunities. *The fourth industrial revolution: Implementation of artificial intelligence for growing business success*, 375–388. https://doi.org/10.1007/978-3-030-62796-6_22

Arkorful, V., Barfi, K. A., & Aboagye, I. K. (2021). Integration of information and communication technology in teaching: Initial perspectives of senior high school teachers in Ghana. *Education and Information Technologies, 26*(4), 3771–3787. https://doi.org/10.1007/s10639-020-10426-7

Baabdullah, A. M., Alalwan, A. A., Slade, E. L., Raman, R., & Khatatneh, K. F. (2021). SMEs and artificial intelligence (AI): Antecedents and consequences of AI-based B2B practices. *Industrial Marketing Management, 98*, 255–270. https://doi.org/10.1016/j.indmarman.2021.09.003

Babina, T., Fedyk, A., He, A., & Hodson, J. (2024). Artificial intelligence, firm growth, and product innovation. *Journal of Financial Economics, 151*, Article 103745. https://doi.org/10.1016/j.jfineco.2023.103745

Badghish, S., & Soomro, Y. A. (2024). Artificial intelligence adoption by SMEs to achieve sustainable business performance: application of technology–organization–environment framework. *Sustainability, 16*(5), 1864. https://doi.org/10.3390/su16051864

Bąk, S., Jedynak, P., & Kaczmaryk, P. (2024). Adaptation determinants of artificial intelligence in small and medium enterprises. https://doi.org/10.7172/2956-7602.103.4.

Baker, J. (2012). The technology–organization–environment framework. *Information Systems Theory: Explaining and Predicting Our Digital Society, 1*, 231–245.

Bansal, C., Pandey, K. K., Goel, R., & Sharma, A. (2024). Analysis of barriers to AI banking chatbot adoption in India: An ISM and MICMAC approach. *Issues In Information Systems, 25*(4), 417–441. https://doi.org/10.48009/4_iis_2024_133

Barata, S. F., Ferreira, F. A., Carayannis, E. G., & Ferreira, J. J. (2023). Determinants of E-commerce, artificial intelligence, and agile methods in small-and medium-sized enterprises. *IEEE Transactions on Engineering Management*. https://doi.org/10.1109/TEM.2023.3269601

Blomster, M., & Koivumäki, T. (2022). Exploring the resources, competencies, and capabilities needed for successful machine learning projects in digital marketing. *Information systems and e-business management, 20*(1), 123–169. https://doi.org/10.1007/s10257-021-00547-y

Brătucu, G., Ciobanu, E., Chițu, I. B., Litră, A. V., Zamfirache, A., & Bălășescu, M. (2024). The use of technology assisted by artificial intelligence depending on the companies' digital maturity level. *Electronics, 13*(9), 1687. https://doi.org/10.3390/electronics13091687

Chatterjee, S., Ghosh, S. K., Chaudhuri, R., & Chaudhuri, S. (2021a). Adoption of AI-integrated CRM system by Indian industry: from security and privacy perspective. *Information & Computer Security, 29*(1), 1–24. https://doi.org/10.1108/ICS-02-2019-0029

Chatterjee, S., Chaudhuri, R., Vrontis, D., Thrassou, A., & Ghosh, S. K. (2021b). Adoption of artificial intelligence-integrated CRM systems in agile organizations in India. *Technological Forecasting and Social Change, 168*, Article 120783. https://doi.org/10.1016/j.techfore.2021.120783

Chatterjee, S., Rana, N. P., Dwivedi, Y. K., & Baabdullah, A. M. (2021c). Understanding AI adoption in manufacturing and production firms using an integrated TAM-TOE model. *Technological Forecasting and Social Change, 170*, Article 120880. https://doi.org/10.1016/j.techfore.2021.120880

Chatterjee, S., Chaudhuri, R., Vrontis, D., & Basile, G. (2022). Digital transformation and entrepreneurship process in SMEs of India: a moderating role of adoption of AI-CRM capability and strategic planning. *Journal of Strategy and Management, 15*(3), 416–433. https://doi.org/10.1108/JSMA-02-2021-0049

Chen, C.-T., Chen, S.-C., Khan, A., Lim, M. K., & Tseng, M.-L. (2024). Antecedents of big data analytics and artificial intelligence adoption on operational performance: the ChatGPT platform. *Industrial Management & Data Systems, 124*(7), 2388–2413. https://doi.org/10.1108/IMDS-10-2023-0778

Chen, H., Li, L., & Chen, Y. (2021). Explore success factors that impact artificial intelligence adoption on telecom industry in China. *Journal of Management Analytics, 8*(1), 36–68. https://doi.org/10.1080/23270012.2020.1852895

Costa, R. L. D., Cruz, M., Gonçalves, R., Dias, Á., Silva, R. V. D., & Pereira, L. (2022). Artificial intelligence and its adoption in financial services. *International Journal of Services Operations and Informatics, 12*(1), 70–86. https://doi.org/10.1504/IJSOI.2022.123569

Crockett, K., Colyer, E., Gerber, L., & Latham, A. (2021). Building trustworthy AI solutions: A case for practical solutions for small businesses. *IEEE Transactions on Artificial Intelligence, 4*(4), 778–791. https://doi.org/10.1109/TAI.2021.3137091

Czarnitzki, D., Fernández, G. P., & Rammer, C. (2023). Artificial intelligence and firm-level productivity. *Journal of Economic Behavior & Organization, 211*, 188–205. https://doi.org/10.1016/j.jebo.2023.05.008

Damioli, G., Van Roy, V., & Vertesy, D. (2021). The impact of artificial intelligence on labor productivity. *Eurasian Business Review, 11*, 1–25. https://doi.org/10.1007/s40821-020-00172-8

Daoud, Y., & Kammoun, A. (2024). Analyzing and forecasting e-commerce adoption drivers among SMEs: A machine learning approach. *Human Behavior and Emerging Technologies, 2024*(1), Article 7747136. https://doi.org/10.1155/2024/7747136

Das, S. D., & Bala, P. K. (2024). What drives MLOps adoption? An analysis using the TOE framework. *Journal of Decision Systems, 33*(3), 376–412. https://doi.org/10.1080/12460125.2023.2214306

Davis, F. D., Bagozzi, R., & Warshaw, P. (1989). Technology acceptance model. *Journal of Manag Science, 35*(8), 982–1003.

Dora, M., Kumar, A., Mangla, S. K., Pant, A., & Kamal, M. M. (2022). Critical success factors influencing artificial intelligence adoption in food supply chains. *International Journal of Production Research, 60*(14), 4621–4640. https://doi.org/10.1080/00207543.2021.1959665

Dvoráková, L., Horák, J., Caha, Z., Machová, V., Hašková, S., Rowland, Z., & Krulicky, T. (2021). Adaptation of small and medium-sized enterprises in the service sector to the conditions of Industry 4.0 and Society 4.0: evidence from the Czech Republic. *Economic Annals-XXI/Ekonomìčnij Časopis-XXI, 191*. https://doi.org/10.21003/ea.V191-06

Ebuka, A. A., Emmanuel, D., & Idigo, P. (2023). Artificial Intelligence as a catalyst for the Sustainability of Small and Medium Scale Businesses (SMEs) in Nigeria. *Annals of Management and Organization Research, 5*(1), 1–11. https://doi.org/10.35912/amor.v5i1.1719

Faiz, F., Le, V., & Masli, E. K. (2024). Determinants of digital technology adoption in innovative SMEs. *Journal of Innovation & Knowledge, 9*(4), Article 100610. https://doi.org/10.1016/j.jik.2024.100610

Faqihi, A., & Miah, S. J. (2023). Artificial intelligence-driven talent management system: Exploring the risks and options for constructing a theoretical foundation. *Journal of Risk and Financial Management, 16*(1), 31. https://doi.org/10.3390/jrfm16010031

Fares, O. H., Butt, I., & Lee, S. H. M. (2023). Utilization of artificial intelligence in the banking sector: A systematic literature review. *Journal of Financial Services Marketing, 28*(4), 835–852. https://doi.org/10.1057/s41264-022-00176-7

Feng, F., Li, J., Zhang, F., & Sun, J. (2024). The impact of artificial intelligence on green innovation efficiency: Moderating role of dynamic capability. *International Review of Economics & Finance, 96*, Article 103649. https://doi.org/10.1016/j.iref.2024.103649

Fetais, A. H., Faisal, M. N., Sabir, L. B., & Al Esmael, B. (2022). Artificial intelligence adoption for E-government: Analysis of enablers in an emerging economy. *International Journal of Electronic Government Research (IJEGR), 18*(1), 1–21. https://doi.org/10.4018/IJEGR.300773

Fu, H.-P., Chang, T.-H., Lin, S.-W., Teng, Y.-H., & Huang, Y.-Z. (2023). Evaluation and adoption of artificial intelligence in the retail industry. *International Journal of Retail & Distribution Management, 51*(6), 773–790. https://doi.org/10.1108/IJRDM-12-2021-0610

Ganguly, K. K. (2024). Understanding the challenges of the adoption of blockchain technology in the logistics sector: the TOE framework. *Technology Analysis & Strategic Management, 36*(3), 457–471. https://doi.org/10.1080/09537325.2022.2036333

Garg, S., Ahmad, A., & Madsen, D.Ø. (2024). Academic writing in the age of AI: Comparing the reliability of ChatGPT and Bard with Scopus and Web of Science. *Journal of Innovation & Knowledge, 9*(4), Article 100563. https://doi.org/10.1016/j.jik.2024.100563

Ghosh, A., Chakraborty, D., & Law, A. (2018). Artificial intelligence in Internet of things. *CAAI Transactions on Intelligence Technology, 3*(4), 208–218. https://doi.org/10.1049/trit.2018.1008

Grashof, N., & Kopka, A. (2023). Artificial intelligence and radical innovation: an opportunity for all companies? *Small Business Economics, 61*(2), 771–797. https://doi.org/10.1007/s11187-022-00698-3

Gupta, S., Ghardallou, W., Pandey, D. K., & Sahu, G. P. (2022). Artificial intelligence adoption in the insurance industry: Evidence using the technology–organization–environment framework. *Research in International Business and Finance, 63*, Article 101757. https://doi.org/10.1016/j.ribaf.2022.101757

Gwaka, L., Haseki, M., & Yoo, C. S. (2023). Community networks as models to address connectivity gaps in underserved communities. *Information Development, 39*(3), 524–538. https://doi.org/10.1177/02666669221089658

Haenlein, M., & Kaplan, A. (2019). A brief history of artificial intelligence: On the past, present, and future of artificial intelligence. *California Management Review, 61*(4), 5–14. https://doi.org/10.1177/0008125619864925

Hamdan, I. K., Sumarliah, E., & Fauziyah, F. (2022a). A machine learning method to predict the technology adoption of blockchain in Palestinian firms. *International Journal of Emerging Markets, 17*(4), 1008–1029. https://doi.org/10.1108/IJOEM-05-2021-0769

Hamdan, I. K., Aziguli, W., Zhang, D., Sumarliah, E., & Usmanova, K. (2022b). Forecasting blockchain adoption in supply chains based on machine learning: evidence from Palestinian food SMEs. *British Food Journal, 124*(12), 4592–4609. https://doi.org/10.1108/BFJ-05-2021-0535

Handoko, B. L. (2021). How audit firm size moderate effect of toe context toward auditor adoption of machine learning. *Journal of Theoretical and Applied Information Technology, 99*(24), 5972–5980.

Hangl, J., Krause, S., & Behrens, V. J. (2023). Drivers, barriers and social considerations for AI adoption in SCM. *Technology in Society, 74*, Article 102299. https://doi.org/10.1016/j.techsoc.2023.102299

Hansen, E. B., & Bøgh, S. (2021). Artificial intelligence and internet of things in small and medium-sized enterprises: A survey. *Journal of Manufacturing Systems, 58*, 362–372. https://doi.org/10.1016/j.jmsy.2020.08.009

Harzing, A.-W., & Alakangas, S. (2016). Google Scholar, Scopus and the Web of Science: a longitudinal and cross-disciplinary comparison. *Scientometrics, 106*, 787–804. https://doi.org/10.1007/s11192-015-1798-9

Hasani, T., Rezania, D., & Mohammadi, M. (2024). Towards a framework for successful metaverse adoption in Small and Medium-sized Enterprises: An exploratory study.

International Journal of Engineering Business Management, 16, Article 18479790241257118. https://doi.org/10.1177/18479790241257118

Ho, Y.-H., Alam, S. S., Masukujjaman, M., Lin, C.-Y., Susmit, S., & Susmit, S. (2022). Intention to adopt AI-powered online service among tourism and hospitality companies. *International Journal of Technology and Human Interaction (IJTHI), 18*(1), 1–19. https://doi.org/10.4018/IJTHI.299357

Hossain, M. K., Srivastava, A., Oliver, G. C., Islam, M. E., Jahan, N. A., Karim, R., Kanij, T., & Mahdi, T. H. (2024). Adoption of artificial intelligence and big data analytics: an organizational readiness perspective of the textile and garment industry in Bangladesh. *Business process management journal*. https://doi.org/10.1108/BPMJ-11-2023-0914

Hradecky, D., Kennell, J., Cai, W., & Davidson, R. (2022). Organizational readiness to adopt artificial intelligence in the exhibition sector in Western Europe. *International Journal of Information Management, 65*, Article 102497. https://doi.org/10.1016/j.ijinfomgt.2022.102497

Huseyn, M., Ruiz-Gándara, Á., González-Abril, L., & Romero, I. (2024). Adoption of artificial intelligence in small and medium-sized enterprises in Spain: The role of competences and skills. *Amfiteatru Economic, 26*(67), 848–866. https://doi.org/10.24818/EA/2024/67/848

Hwang, W.-S., & Kim, H.-S. (2021). Does the adoption of emerging technologies improve technical efficiency? Evidence from Korean manufacturing SMEs. *Small Business Economics*, 1–17. https://doi.org/10.1007/s11187-021-00554-w

Issa, H., Jabbouri, R., & Palmer, M. (2022). An artificial intelligence (AI)-readiness and adoption framework for AgriTech firms. *Technological Forecasting and Social Change, 182*, Article 121874. https://doi.org/10.1016/j.techfore.2022.121874

Jalil, M. F., Lynch, P., Marikan, D. A. B. A., & Isa, A. H. B. M. (2024). The influential role of artificial intelligence (AI) adoption in digital value creation for small and medium enterprises (SMEs): does technological orientation mediate this relationship? *AI & Society*, 1–22. https://doi.org/10.1007/s00146-024-01969-1

Kapoor, V. (2024). Exploring the Indian MSME perspective on integrating AI-enabled solutions in the recruitment process: an analytical hierarchy (AHP) approach. *International Journal of Globalisation and Small Business, 14*(1), 1–17. https://doi.org/10.1504/IJGSB.2024.138672

Kaymakci, C., Wenninger, S., Pelger, P., & Sauer, A. (2022). A systematic selection process of machine learning cloud services for manufacturing SMEs. *Computers, 11*(1), 14. https://doi.org/10.3390/computers11010014

Khaliq, A., Waqas, A., Nisar, Q. A., Haider, S., & Asghar, Z. (2022). Application of AI and robotics in hospitality sector: A resource gain and resource loss perspective. *Technology in Society, 68*, Article 101807. https://doi.org/10.1016/j.techsoc.2021.101807

Khayer, A., Jahan, N., Hossain, M. N., & Hossain, M. Y. (2021). The adoption of cloud computing in small and medium enterprises: A developing country perspective. *VINE Journal of Information and Knowledge Management Systems, 51*(1), 64–91. https://doi.org/10.1108/VJIKMS-05-2019-0064

Kim, J.-S., & Seo, D. (2023). Foresight and strategic decision-making framework from artificial intelligence technology development to utilization activities in small-and-medium-sized enterprises. *Foresight, 25*(6), 769–787. https://doi.org/10.1108/FS-06-2022-0069

Kopka, A., & Fornahl, D. (2024). Artificial intelligence and firm growth—catch-up processes of SMEs through integrating AI into their knowledge bases. *Small Business Economics, 62*(1), 63–85. https://doi.org/10.1007/s11187-023-00754-6

Kovič, K., Tominc, P., Prester, J., & Palčič, I. (2024). Artificial intelligence software adoption in manufacturing companies. *Applied Sciences, 14*(16), 6959. https://doi.org/10.3390/app14166959

Kraus, S., Mahto, R. V., & Walsh, S. T. (2023). *The importance of literature reviews in small business and entrepreneurship research, 61* pp. 1095–1106). Taylor & Francis.

Kulkarni, A. V., Joseph, S., & Patil, K. P. (2024). Artificial intelligence technology readiness for social sustainability and business ethics: Evidence from MSMEs in developing nations. *International Journal of Information Management Data Insights, 4*(2), Article 100250. https://doi.org/10.1016/j.jjimei.2024.100250

Kumar, V., Ashraf, A. R., & Nadeem, W. (2024). AI-powered marketing: What, where, and how? *International Journal of Information Management, 77*, Article 102783. https://doi.org/10.1016/j.ijinfomgt.2024.102783

Lee, Y. S., Kim, T., Choi, S., & Kim, W. (2022). When does AI pay off? AI-adoption intensity, complementary investments, and R&D strategy. *Technovation, 118*, Article 102590. https://doi.org/10.1016/j.technovation.2022.102590

Lemos, S. I., Ferreira, F. A., Zopounidis, C., Galariotis, E., & Ferreira, N. C. (2022). Artificial intelligence and change management in small and medium-sized enterprises: an analysis of dynamics within adaptation initiatives. *Annals of Operations Research*, 1–27. https://doi.org/10.1007/s10479-022-05159-4

Li, P., Bastone, A., Mohamad, T. A., & Schiavone, F. (2023). How does artificial intelligence impact human resources performance. evidence from a healthcare institution in the United Arab Emirates. *Journal of Innovation & Knowledge, 8*(2), Article 100340. https://doi.org/10.1016/j.jik.2023.100340

Lin, C.-H., & Chen, W.-H. (2023). A technology-organization-environment (TOE) framework based on scientometry for understanding the risk factors in sustainable water resources management. *Water Resources Management, 37*(15), 5849–5869. https://doi.org/10.1007/s11269-023-03634-6

Linnenluecke, M. K., Marrone, M., & Singh, A. K. (2020). Conducting systematic literature reviews and bibliometric analyses. *Australian Journal of Management, 45*(2), 175–194. https://doi.org/10.1177/0312896219877678

Luo, Y., & Yu, L. (2022). Capital or Technology? Which is better at promoting the value of AI companies—Theoretical Analysis and Empirical Test. *Systems, 10*(5), 152. https://doi.org/10.3390/systems10050152

Mai, T. G., Nguyen, M., Ghobakhlou, A., Yan, W. Q., Chhun, B., & Nguyen, H. (2024). Decoding a decade: The evolution of artificial intelligence in security, communication, and maintenance within the construction industry. *Automation in Construction, 165*, Article 105522. https://doi.org/10.1016/j.autcon.2024.105522

Makridakis, S. (2017). The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms. *Futures, 90*, 46–60. https://doi.org/10.1016/j.futures.2017.03.006

Manser Payne, E. H., Peltier, J., & Barger, V. A. (2021). Enhancing the value co-creation process: Artificial intelligence and mobile banking service platforms. *Journal of Research in Interactive Marketing, 15*(1), 68–85. https://doi.org/10.1108/JRIM-10-2020-0214

Mantri, A., & Mishra, R. (2023). Empowering small businesses with the force of big data analytics and AI: A technological integration for enhanced business management. *The Journal of High Technology Management Research, 34*(2), Article 100476. https://doi.org/10.1016/j.hitech.2023.100476

Maroufkhani, P., Iranmanesh, M., & Ghobakhloo, M. (2023). Determinants of big data analytics adoption in small and medium-sized enterprises (SMEs). *Industrial Management & Data Systems, 123*(1), 278–301. https://doi.org/10.1108/IMDS-11-2021-0695

Merhi, M. I. (2023). An evaluation of the critical success factors impacting artificial intelligence implementation. *International Journal of Information Management, 69*, Article 102545. https://doi.org/10.1016/j.ijinfomgt.2022.102545

Merhi, M. I., & Harfouche, A. (2024). Enablers of artificial intelligence adoption and implementation in production systems. *International Journal of Production Research, 62*(15), 5457–5471. https://doi.org/10.1080/00207543.2023.2167014

Mikalef, P., & Gupta, M. (2021). Artificial intelligence capability: Conceptualization, measurement calibration, and empirical study on its impact on organizational creativity and firm performance. *Information & management, 58*(3), Article 103434. https://doi.org/10.1016/j.im.2021.103434

Mishra, A. A., & Pathak, D. K. (2024). Industry 4.0 technologies adoption and sustainability integration in human resource management: An analysis using extended TOE framework and TISM. *IEEE Transactions on Engineering Management*. https://doi.org/10.1109/TEM.2024.3456604

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L. A., & Group, P.-P. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews, 4*, 1–9. https://doi.org/10.1186/2046-4053-4-1

Mousa, K., Zhang, Z., Sumarliah, E., & Hamdan, I. K. (2024). The impact of cloud computing adoption on firm performance among SMEs in Palestine: A machine learning approach. *International Journal of Intelligent Information Technologies (IJIIT), 20*(1), 1–24. https://doi.org/10.4018/IJIIT.338715

Nagy, M., Lăzăroiu, G., & Valaskova, K. (2023). Machine intelligence and autonomous robotic technologies in the corporate context of SMEs: Deep learning and virtual simulation algorithms, cyber-physical production networks, and Industry 4.0-based manufacturing systems. *Applied Sciences, 13*(3), 1681. https://doi.org/10.3390/app13031681

Nguyen, T. H., Le, X. C., & Vu, T. H. L. (2022). An extended technology-organization-environment (TOE) framework for online retailing utilization in digital transformation: Empirical evidence from Vietnam. *Journal of Open Innovation: Technology, Market, and Complexity, 8*(4), 200. https://doi.org/10.3390/joitmc8040200

Omoge, A. P., Gala, P., & Horky, A. (2022). Disruptive technology and AI in the banking industry of an emerging market. *International Journal of Bank Marketing, 40*(6), 1217–1247. https://doi.org/10.1108/IJBM-09-2021-0403

Pai, V., & Chandra, S. (2022). Exploring factors influencing organizational adoption of artificial intelligence (AI) in corporate social responsibility (CSR) initiatives. *Pacific Asia Journal of the Association for Information Systems, 14*(5), 4. https://doi.org/10.17705/1pais.14504

Pee, L. G., Pan, S. L., & Cui, L. (2019). Artificial intelligence in healthcare robots: A social informatics study of knowledge embodiment. *Journal of the Association for Information Science and Technology, 70*(4), 351–369. https://doi.org/10.1002/asi.24145

Peretz-Andersson, E., Tabares, S., Mikalef, P., & Parida, V. (2024). Artificial intelligence implementation in manufacturing SMEs: A resource orchestration approach. *International Journal of Information Management, 77*, Article 102781. https://doi.org/10.1016/j.ijinfomgt.2024.102781

Pillai, R., & Sivathanu, B. (2020). Adoption of artificial intelligence (AI) for talent acquisition in IT/ITeS organizations. *Benchmarking: An International Journal, 27*(9), 2599–2629. https://doi.org/10.1108/BIJ-04-2020-0186

Polisetty, A., Chakraborty, D., Kar, A. K., & Pahari, S. (2024). What determines AI adoption in companies? Mixed-method evidence. *Journal of Computer Information Systems, 64*(3), 370–387. https://doi.org/10.1080/08874417.2023.2219668

Rahman, M., Ming, T. H., Baigh, T. A., & Sarker, M. (2023). Adoption of artificial intelligence in banking services: an empirical analysis. *International Journal of Emerging Markets, 18*(10), 4270–4300. https://doi.org/10.1108/IJOEM-06-2020-0724

Raman, R., Pattnaik, D., Hughes, L., & Nedungadi, P. (2024). Unveiling the dynamics of AI applications: A review of reviews using scientometrics and BERTopic modeling. *Journal of Innovation & Knowledge, 9*(3), Article 100517. https://doi.org/10.1016/j.jik.2024.100517

Rammer, C., Fernández, G. P., & Czarnitzki, D. (2022). Artificial intelligence and industrial innovation: Evidence from German firm-level data. *Research Policy, 51*(7), Article 104555. https://doi.org/10.1016/j.respol.2022.104555

Rana, M. M., Siddiqee, M. S., Sakib, M. N., & Ahamed, M. R. (2024). Assessing AI adoption in developing country academia: A trust and privacy-augmented UTAUT framework. *Heliyon*, (18), 10. https://doi.org/10.1016/j.heliyon.2024.e37569

Rawashdeh, A., Bakhit, M., & Abaalkhail, L. (2023). Determinants of artificial intelligence adoption in SMEs: The mediating role of accounting automation.

International Journal of Data and Network Science, 7(1), 25–34. https://doi.org/10.5267/j.ijdns.2022.12.010

Rawindaran, N., Jayal, A., & Prakash, E. (2022). Exploration of the impact of cybersecurity awareness on small and medium enterprises (SMEs) in Wales using intelligent software to combat cybercrime. *Computers, 11*(12), 174. https://doi.org/10.3390/computers11120174

Schlegel, D., Schuler, K., & Westenberger, J. (2023). Failure factors of AI projects: results from expert interviews. *International Journal Of Information Systems And Project Management: IJISPM, 11*(3), 25–40. https://doi.org/10.12821/ijispm110302

Schwaeke, J., Peters, A., Kanbach, D. K., Kraus, S., & Jones, P. (2024). The new normal: The status quo of AI adoption in SMEs. *Journal of small business management*, 1–35. https://doi.org/10.1080/00472778.2024.2379999

Shao, Z., Zhao, R., Yuan, S., Ding, M., & Wang, Y. (2022). Tracing the evolution of AI in the past decade and forecasting the emerging trends. *Expert Systems with Applications, 209*, Article 118221. https://doi.org/10.1016/j.eswa.2022.118221

Sharma, S., Singh, G., Islam, N., & Dhir, A. (2022). Why do SMEs adopt artificial intelligence-based chatbots? *IEEE Transactions on Engineering Management, 71*, 1773–1786. https://doi.org/10.1109/TEM.2022.3203469

Singh, A., Dwivedi, A., Agrawal, D., & Singh, D. (2023). Identifying issues in adoption of AI practices in construction supply chains: towards managing sustainability. *Operations Management Research, 16*(4), 1667–1683. https://doi.org/10.1007/s12063-022-00344-x

Singh, N., Jain, M., Kamal, M. M., Bodhi, R., & Gupta, B. (2024). Technological paradoxes and artificial intelligence implementation in healthcare. An application of paradox theory. *Technological Forecasting and Social Change, 198*, Article 122967. https://doi.org/10.1016/j.techfore.2023.122967

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of business research, 104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Solaimani, S., & Swaak, L. (2023). Critical success factors in a multi-stage adoption of artificial intelligence: A necessary condition analysis. *Journal of Engineering and Technology Management, 69*, Article 101760. https://doi.org/10.1016/j.jengtecman.2023.101760

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*(7), 79. https://doi.org/10.3390/bdcc8070079

Tominc, P., Oreški, D., Čančer, V., & Rožman, M. (2024). Statistically significant differences in AI support levels for project management between SMEs and large enterprises. *AI, 5*(1), 136–157. https://doi.org/10.3390/ai5010008

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management, 14*(3), 207–222. https://doi.org/10.1111/1467-8551.00375

Varma, A., Pereira, V., & Patel, P. (2024). Artificial intelligence and performance management. *Organizational Dynamics, 53*, Article 101037. https://doi.org/10.1016/j.orgdyn.2024.101037

Vedapradha, R., Hariharan, R., Sudha, E., & Divyashree, V. (2024). Artificial intelligence–Talent acquisition in HEIs recruitments. *The International Journal of Information and Learning Technology(ahead-of-print)*. https://doi.org/10.1108/IJILT-09-2023-0176

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences, 39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425–478. https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 157–178. https://doi.org/10.2307/41410412

Volkmar, G., Fischer, P. M., & Reinecke, S. (2022). Artificial intelligence and machine learning: Exploring drivers, barriers, and future developments in marketing management. *Journal of business research, 149*, 599–614. https://doi.org/10.1016/j.jbusres.2022.04.007

Wamba-Taguimdje, S.-L., Wamba, S. F., Kamdjoug, J. R. K., & Wanko, C. E. T. (2020). Influence of artificial intelligence (AI) on firm performance: the business value of AI-based transformation projects. *Business process management journal, 26*(7), 1893–1924. https://doi.org/10.1108/BPMJ-10-2019-0411

Wang, J. (2024). Using artificial intelligence to analyze SME e-commerce utilization and growth strategies. *Journal of Computational Methods in Sciences and Engineering, 24*(1), 611–621. https://doi.org/10.3233/JCM-226933

Wang, M., & Pan, X. (2022). Drivers of artificial intelligence and their effects on supply chain resilience and performance: an empirical analysis on an emerging market. *Sustainability, 14*(24), 16836. https://doi.org/10.3390/su142416836

Wei, R., & Pardo, C. (2022). Artificial intelligence and SMEs: How can B2B SMEs leverage AI platforms to integrate AI technologies? *Industrial Marketing Management, 107*, 466–483. https://doi.org/10.1016/j.indmarman.2022.10.008

Wong, L.-W., Leong, L.-Y., Hew, J.-J., Tan, G. W.-H., & Ooi, K.-B. (2020). Time to seize the digital evolution: Adoption of blockchain in operations and supply chain management among Malaysian SMEs. *International Journal of Information Management, 52*, Article 101997. https://doi.org/10.1016/j.ijinfomgt.2019.08.005

Yang, J., Blount, Y., & Amrollahi, A. (2024). Artificial intelligence adoption in a professional service industry: A multiple case study. *Technological Forecasting and Social Change, 201*, Article 123251. https://doi.org/10.1016/j.techfore.2024.123251