Electronic Journal of Education, Social Economics and Technology
Vol. 6, No. 1, (2025), pp. 589-600
ISSN 2723-6250 (online)
DOI: https://doi.org/10.33122/ejeset.v6i1.451

SAINTIS publishing

Research Article

The Role of Technology in Increasing the Competitiveness of SMEs in the Digital Era

Eva Anzani Siregar[1]*, Yunia Wardi[2] & Marwan[3]

[1] Master of Economics Education, Universitas Negeri Padang, Padang, Indonesia, 25171
[2] Department of Management, Universitas Negeri Padang, Padang, Indonesia, 25171
[3] Department of Economics Education, Universitas Negeri Padang, Padang, Indonesia, 25171
*Corresponding Author: evaanzani@student.unp.ac.id

ABSTRACT

This study examines the role of digital technologies in enhancing the competitiveness of small and medium enterprises (SMEs) in the digital era using a Systematic Literature Review (SLR) approach. The findings highlight that digital transformation enables SMEs to accelerate innovation, expand collaboration networks, and improve operational efficiency. The adoption of technologies such as blockchain, e-commerce, and digital payment systems have positively impacted SMEs by increasing transparency, expanding market reach, and optimizing supply chains. However, challenges such as limited financial resources, lack of digital skills, and weak corporate governance hinder effective technology adoption. Government policies, collaboration with research institutions, and tailored digital strategies are essential to overcome these barriers. The study emphasizes the need for adaptive strategies to integrate Industry 4.0 technologies and sustain SME growth.

Keywords: Digital Technology; SMEs; Competitiveness; Digital Transformation; Systematic Literature Review

1. INTRODUCTION

In the business world, SMEs, or small and medium-sized enterprises, are essential to the generation of jobs, progress, and financial development (Al-Azzam & Charfeddine, 2022; Charfeddine & Zaouali, 2022). SMEs contributes significantly with relation to GDP (gross domestic product) and is a major source of job creation in many countries. In many emerging economies, SMEs is essential for promoting economic growth, innovation, and social inclusion. They reflect economic diversity and resilience through their flexibility and ability to adapt to changing markets. Boosting SMEs's adaptability to market changes is important through technological innovation. Innovation in technology will boost economic productivity activities and improve the level of well-being of people in general (Surya et al. 2021). For example, the World Bank estimates that 600 million jobs would be required by 2030 to meet the world's fast expanding labor demand, which SMEs are projected to fill (Bank Dunia 2021). However, in order to fulfill this mission and remain competitive in an increasingly global and digital market, SMEs needs to adopt and utilize technology effectively. It's important to enhance their capacity for performance and innovation in order to bolster their competitive advantage (Farida and Setiawan 2022).

Digital technology, ranging from e-commerce (payment options, augmented reality, and contactless delivery), social media, EdTech, FinTech, and cyber security, offers great opportunities to improve operational efficiency, expand market access, and drive product innovation (Modgil et al., 2022; Latifah et al., 2022). Yet the potential of technology is enormous; they are faced with some limitations on access to funding, knowledge, and resources for absorbing industry 4.0 and open innovation, as well as financial management, marketing, logistics, and management of human resources (Telukdarie, Philbin, et al., 2022; Madhavan et al., 2022; Kumar et al., 2024). Some components inhibit SMEs's capacity to adopt digital technology, such as restricted access to expensive external consultants, difficulties attracting and retaining a skilled workforce, and a lack of knowledge and awareness of the benefits of digital technology (Telukdarie, Dube, et al. 2022).

Based on studies carried out by Nithyanandam et al., (2022), it is important to integrate digital technology into education as well as provide real-life experiences to students in an industry environment. De Simone et al., (2022) The SMEs industry plays an important role in the economy, but it is often difficult for them to access and implement technology. In this literature review, several problems that can be solved through the implementation of AI/ML in manufacturing SMEs have been identified, including supply chain management, upkeep, quality, production planning, and production control, and more. Then, research Altes et al., (2024) revealed that technological progress was a profitable and beneficial thing for the company. So based on the description above, there is no specific picture of the role of technology in improving SMEs's competitiveness in the digital age.

The importance of discussing the role of technology in improving SMEs's competitiveness in the digital age is that it has a significant impact on both economic expansion and the welfare of the community (Aditya et al. 2023). With the right

adoption of technology, SMEs can expand market reach, increase operational efficiency, reduce production costs, increase productivity, connect with vendors and customers, and create added value to the goods or services provided (Martini et al., 2023;Kumar et al., 2024). Moreover, his study advances more than just academic literature but is also important to provide guidance to stakeholders, such as governments and financial institutions, in designing policies and support programs for SMEs to make optimal use of technology.

The integration of technology by micro, small, and medium-sized enterprises (SMEs) has become an important element in improving efficiency and competitiveness in an increasingly competitive market. Based on various research studies, many SMEs have started utilizing modern tools like social media and e-commerce platforms, and financial management applications to support their business operations. For example, the use of social media serves not only as a marketing tool but also as a direct communication channel with customers. E-commerce allows SMEs to significantly expand their market reach, reaching customers beyond local geographical boundaries. Although the uptake of this technology indicates a promising pattern., the degree of integration still varies depending on various factors, such as the size of the enterprise, the level of education of the owner or manager, in addition to having access to technological and monetary assets.

The current research is aimed at exploring opportunities for SMEs to adopt technology. In addition to identifying barriers, this research will look for possible solutions to overcome these challenges. Thus, the research not only provides insights into the role of technology but also offers practical guidance for the SMEs on their journey towards digitalization, but it still leaves a number of important gaps that have not been fully addressed by previous research.

2. RESEARCH METHOD

This study is a literature review study using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method. This method can ensure the transparency of the literature search process and ensure all steps in the review process, from identification to data synthesis (Vu-Ngoc et al., 2018). This process is illustrated through a flowchart that shows the number of articles identified, filtered, and finally included in the analysis. The systematic screening in this PRISMA method is: identification, screening, feasibility testing and inclusion (Rethlefsen & Page, 2021). The Research Question (RQ) of this paper is: How can the implementation of digital technology improve SMEs's competitiveness in the digital age?.

Identification Stage

The first stage in the screening process is to identify all relevant research through searches in various databases using keywords relevant to technology and SME competitiveness. The search stage was carried out on search engines in the Scopus and Science direct databases and has produced 25 articles. The keywords used for the initial search were by using a boolean search as shown in Table 1 which shows the search strategy used in the identification process:

Table 1. Keywords and Information Search Strategies

Basis Data	Keywords Used
Science direct Scopus Proquest	("role of technology" OR "impact of technology" OR "technology adoption") AND ("competitiveness" OR "competitive advantage") AND ("SMEs" OR "small and medium enterprises" OR "small businesses") AND ("digital era" OR "digital transformation" OR "Industry 4.0")

Screening stage

The article screening steps are based on predetermined inclusion and exclusion criteria. The stages of this screening are based on the criteria in the **Table 2**.

Table 2. Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Keyword Relevance	All articles that appear according to the keyword	All articles that appear that don't match the keyword
Time Range	2020 – 2024	< 2020
Language	English	Non-English
Open Access	Open Access Articles	Articles that are not Open Access

Eligibility Level

Articles that pass the initial screening stage are then evaluated in more depth. At this stage, the researcher reads the abstract and conclusion of the article to ensure that the literature meets all the criteria that have been set. Only articles that meet all the criteria will be included in the final analysis.

Inclusion Stage

At the inclusion stage, it is carried out with the following steps: each author reads the article independently. Next, the two authors discussed to evaluate the quality of the content of the article. In the evaluation, emphasis is placed on the substance and methodology of the article to assess its quality rating. To include an article in a review, the author must reach an agreement regarding the quality of the article. The abstraction in the data analysis of this literature study can be seen in the following figure 1:

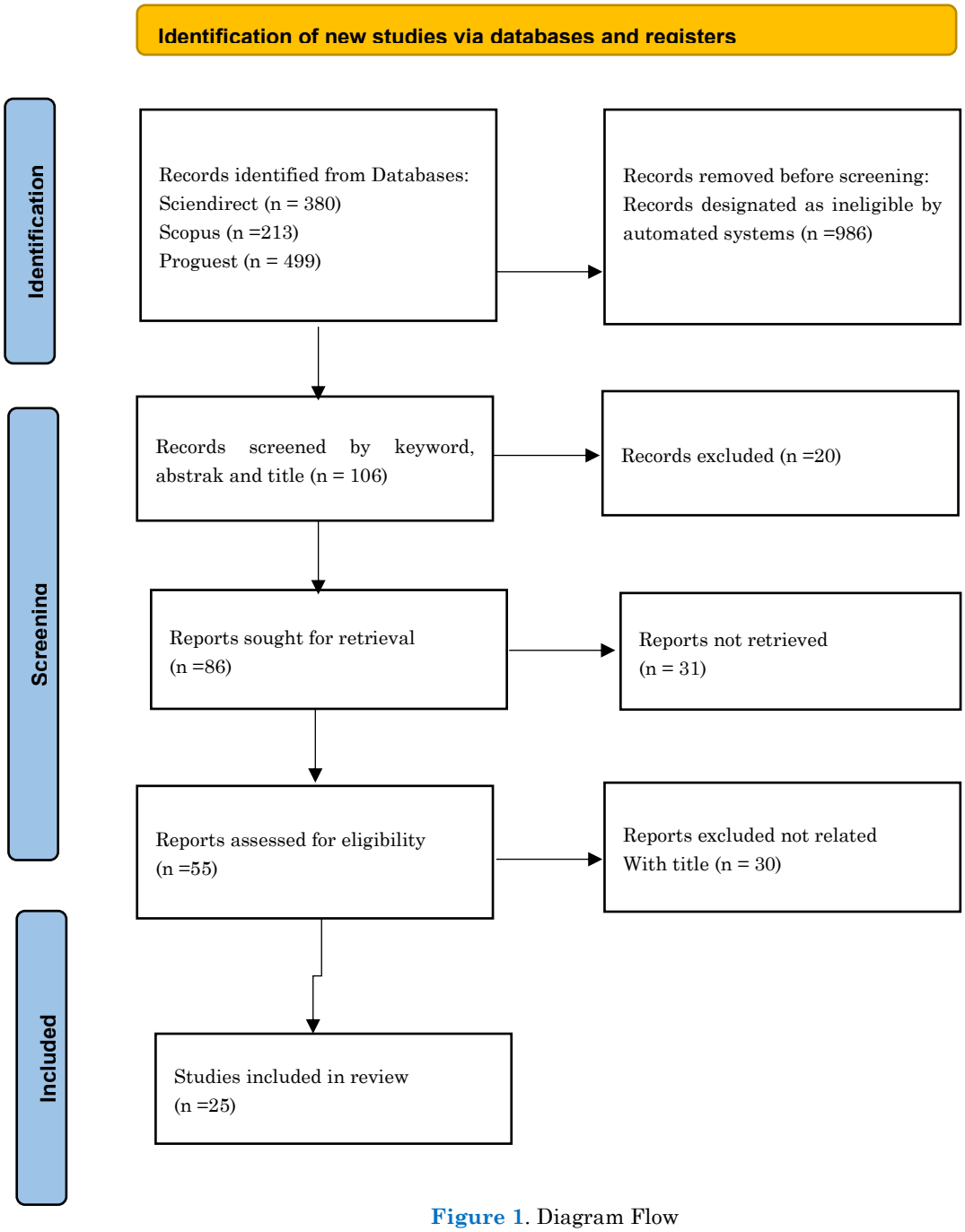

Figure 1. Diagram Flow

3. RESULTS AND DISCUSSION

3.1 Results

Research articles on the role of technology in improving the competitiveness of SMEs from the ScienceDirect, Scopus and Proquest databases. After obtaining a number of samples that meet the specified criteria, an examination of each abstract and conclusion of each research article was carried out to extract various information that cannot be obtained by simply looking at the title. Publication in the form of articles discussing the role of technology in SMEs has relatively increased every year from 2020 to 2023 but in 2024 it has decreased, as presented in Figure 1. There are 25 articles that have been successfully collected and selected. The most published articles were in 2023 with 10 articles, followed by 2024 with 5 articles and 2022 with 8 articles.

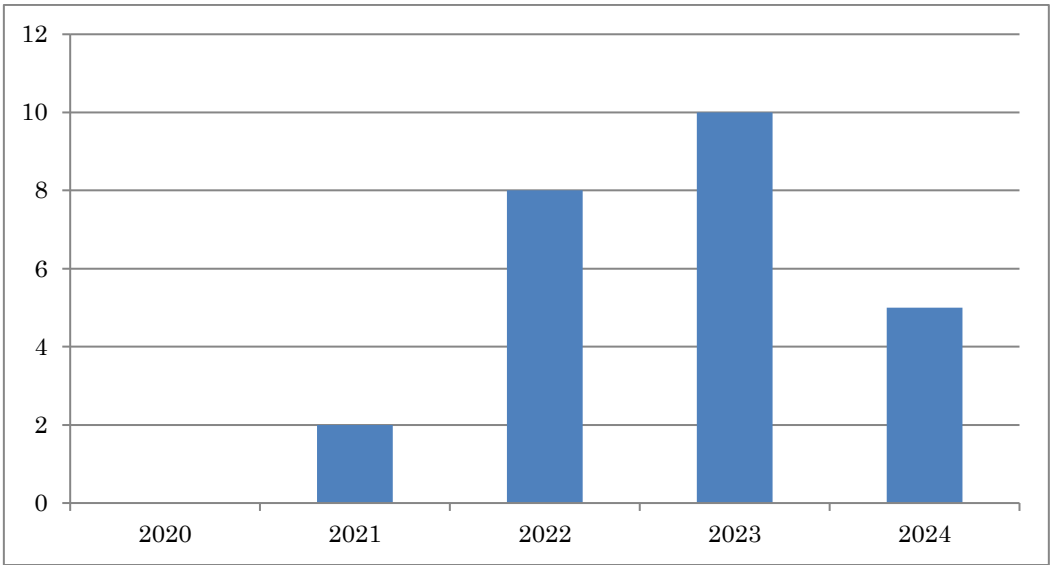

Figure 2. Research Progress.
Source: Processed data (2024)

The increasing number of articles published each year indicates an increase in interest and research activity along with the development and increasing popularity of technological developments and the decline in 2024 is an opportunity to conduct further studies on the role of technology in increasing the competitiveness of SMEs. Based on the literature review that has been conducted (see in **Table 3**).

Table 3. Result of Article Selection

No	Author/ Year	Key Findings	Summary
1.	(Srisathan, Ketkaew, and Naruetharadhol 2023)	Open Innovation	This study highlights the important role of technology in supporting open innovation to enhance ambidextrous innovation in Thai SMEs. Technology enables SMEs to access global network collaboration, accelerate innovation, and enhance competitiveness through commercialization. In addition, government support and strategic policies play a role in facilitating technology adoption to strengthen SMEs' position in the international market.
2.	(Rakshit et al. 2022)	Use of blockchain technology	Blockchain technology plays a significant role in supporting the internationalization of SMEs, especially high-tech SMEs in India. The study highlights how Amazon's platform facilitates global partnerships through blockchain, enabling Indian SMEs to operate in international markets.
3.	(Kilay, Simamora, and Putra 2022)	Positive Impact of Digitalization	Technology plays a vital role in enhancing the competitiveness of SMEs through online shopping and electronic payments, which drive labor efficiency, business growth, and access to wider markets. However, technology adoption is still limited due to various challenges, such as lack of awareness, resources, and governance. Therefore, an open innovation approach and collaborative solutions are needed to accelerate the digitalization of SMEs.
4.	(Rojas-García et al. 2024)	Increasing SME Competitiveness, Role of E-Commerce & Logistics Optimization and Barriers to Technology Adoption	Digitalization and digital transformation enhance the competitiveness of SMEs, especially in the logistics sector, by increasing profitability, operational efficiency, customer satisfaction, and market access through e-commerce and logistics optimization such as "The Last Mile". However, technology adoption still faces challenges, including resource constraints and a lack of understanding of effective strategies.
5.	(Tortora et al. 2021)	The lack of technology adoption	Industry 4.0 (I4.0) technologies have the potential to improve the competitiveness of SMEs in Italy, but adoption is still low due to lack of understanding, financial constraints and lack of skills. To overcome these barriers, collaboration between companies, universities, research institutions and consultants is needed to support the implementation of I4.0 and encourage innovation in the SME sector.
6.	(Mishra and Kushwaha 2023)	SME Litigation Risks and Resource Constraints	Technology can improve the competitiveness of SMEs by supporting the implementation of Business Legal Expense Insurance (BLEI) to manage litigation risks. However, limited resources and weak risk management make SMEs vulnerable to legal issues. The development of BLEI

No	Author/ Year	Key Findings	Summary
			supported by efficient regulations and legal systems can help SMEs reduce legal barriers and improve their business sustainability.
7.	(Telukdarie, Dube, et al. 2022)	Digitalization Increases Competitiveness	Digitalization and the application of Industry 4.0 technology can improve the efficiency, innovation, and competitiveness of SMEs in the global market. However, many SMEs still do not understand the benefits of digital technology and face challenges in its adoption. Therefore, increased awareness and solutions are needed to overcome technological barriers, such as lack of system integration and resource constraints.
8.	(Mulchandani, Jasrotia, and Mulchandani 2023)	The Role of Digital Technology	Adoption of Supply Chain Finance (SCF) can improve supply chain efficiency and reduce liquidity risk in SMEs. The use of digital technology in e-commerce plays a significant role in accelerating the adoption of SCF. In addition, supply chain effectiveness can be improved through collaboration, negotiation, and trade digitization, thereby helping SMEs manage finances and operations more efficiently.
9.	(Lin and Xu 2024)	Positive Impact of Digital Inclusive Finance (DIF)	Digital Inclusive Finance (DIF) plays a key role in improving the performance of SMEs in China's manufacturing sector, both in terms of energy efficiency and environmental sustainability. DIF helps SMEs reduce energy consumption and coal use, while addressing financing constraints, encouraging investment in green technologies, and improving corporate environmental performance.
10.	(Ragoobur et al. 2023)	The Role of E-Commerce	SMEs in Mauritius are facing significant challenges due to COVID-19, especially smaller and male-led businesses. The most effective recovery strategies include market diversification, reduced working hours, and price adjustments. In addition, the adoption of e-commerce has proven to be an efficient tool to aid business recovery.
11.	(Charfeddine, Umlai, and El-Masri 2024)	The Role of Digitalization	SME credit access in Qatar is influenced by financial literacy, perception of financial access, and digitalization. To increase credit access, it is necessary to develop FinTech, crowdfunding, and improve SME financial literacy and competence. With the flexibility of financial institutions and optimization of technology, SME funding access can be increased.
12.	(Endris and Kassegn 2022)	The Role of SMEs in Sustainable Development	SMEs play a vital role in sustainable development in Sub-Saharan Africa and Ethiopia. However, their development is hampered by market, financial and technological constraints. Therefore, strategic steps are needed to overcome these challenges so that SMEs can have a greater impact on the economy and employment in the region.
13	(Amadasun and Mutezo 2022)	The Role of Technology in Innovation	This article shows that market competition, market orientation and technological dynamics can enhance the competitiveness and growth of SMEs in Lesotho. The use of appropriate technology will increase innovation and productivity, so managers and entrepreneurs need to implement market-based strategies and adopt technological advances to increase their business value.
14.	(Rizi et al. 2023)	Technology Acceptance Model	This article highlights the role of trust as a key factor in driving SMEs in Indonesia to move to online business. The study also links the technology acceptance model to e-business transactions, suggesting that understanding technology and trust factors can improve SME competitiveness in the digital economy.
15	(Prasad, Rao, and Lanka 2022)	Integration of blockchain technology	Research results show that the integration of blockchain technology can help improve transparency, reliability, data security, feedback, and information accessibility in a sustainable supply chain led by Lean.
16	(Martínez-Peláez et al. 2023)	the importance of sustainable digital transformation	Continuous digital transformation is essential for SMEs to achieve competitiveness and business sustainability. Corporate culture changes that support innovation, productivity, and sustainability are key to this process.
17	(Kawane et al. 2024)	Digitalisasi dan transformasi digital	Digitalization and digital transformation play a significant role in increasing the competitiveness of SMEs, especially during times of crisis. This study shows how digital platforms help restaurants adapt to new business models that meet health guidelines. Despite challenges in implementing the platforms, digitalization has proven to be a key factor for the sustainability of SMEs in the food industry. Local government support is also needed to help SMEs cope with difficult conditions.
18	(Susanti, Mulyanti, and Wati 2023)	Transformasi digital	Digital transformation enhances innovation and competitive advantage in women-managed SMEs. Competitive advantage contributes positively to SME performance, while innovation has mixed effects. These findings underscore the importance of digital transformation and innovation in enhancing SME competitiveness.
19	(Machado et al. 2024)	Sustainability & Industry 4.0	Integration of sustainability and Industry 4.0 improves the competitiveness of SMEs by identifying 32 key indicators, barriers and

No	Author/ Year	Key Findings	Summary
			facilitators in the supply chain.
20.	(Supriyati, Suharman, and Supriadi 2023)	Utilization of IT	Utilization of IT and business strategies increases the effectiveness and competitiveness of SMEs in ASEAN.
21.	(Pellegrino and Abe 2023)	Benefits of social media for SMEs.	The results provide insightful information for practitioners and scholars who want to comprehend the current state of knowledge and guide future study regarding social media's beneficial use in small and medium-sized businesses.
22.	(Sastararuji et al. 2022)	Cloud accounting increases the competitiveness of SMEs.	This study highlights the importance of cloud-based accounting technology in improving the competitiveness of SMEs post-pandemic. Service providers need to tailor solutions to SME needs, while SMEs must establish organizational guidelines and integrate cloud accounting with other aspects of the business to optimize performance.
23.	(Müller-Pérez et al. 2022)	The adoption of inbound marketing technology by SMEs is influenced by benefits, WOM, attitudes, and beliefs.	The adoption of inbound marketing technology by SMEs is influenced by perceived benefits, word-of-mouth (WOM), attitude, and trust, while perceived convenience and risk are less influential. The integration of new variables in the TAM model improves the prediction of technology adoption, helping SMEs survive and thrive despite the impact of the COVID-19 pandemic.
24.	(Loo, Ramachandran, and Raja Yusof 2023)	Adoption of technology and innovation	The conclusion of this article is that technology adoption and innovation are key factors in improving SMEs's competitiveness in Malaysia. SMEs in Malaysia has several challenges in adopting technology, such as lack of technical expertise, misperception of expenses, and challenges posed by social mobility constraints.
25.	(Valdez-Juárez and Castillo-Vergara 2021)	Technology skills	Technological skills have a significant impact on open innovation and eco-innovation, which indirectly improves SME performance. Eco-friendly and open innovation contribute positively to SME competitiveness, providing insights for businesses and policy makers.

Source: Scopus Database, Science Direct and Proquest (Processed)

Based on the **Table 3**, it provides an explanation of the role of technology and innovation in SMEs. Where this literature review was published from 2021 to 2024 with the most discussion in 2023.

3.1.1 The Role Of Digital Technology In Increasing The Competitiveness Of Smes

Digital technology plays a crucial role in enhancing the competitiveness of small and medium enterprises (SMEs) through open innovation and digital transformation. In an increasingly competitive era of globalization, SMEs are required to utilize technology to accelerate innovation, expand collaboration networks, and improve operational efficiency. For example, SMEs in Thailand have successfully adopted digital technology to accelerate innovation and expand global collaboration networks. This success cannot be separated from government support and strategic policies that encourage the adoption of technology to strengthen the position of SMEs in the international market. The use of digital technology allows SMEs to commercialize their products and services more effectively, thereby significantly increasing their competitiveness.

In various countries, the integration of technologies such as blockchain has had a positive impact on SMEs, especially in increasing transparency and security of transactions. For example, SMEs in India, especially in the high-tech sector, have succeeded in expanding their markets globally with the help of blockchain technology. In addition, digitalization also drives labor efficiency, accelerates business growth, and opens access to wider markets through e-commerce platforms and electronic payment systems. However, the adoption of technology by SMEs does not always run smoothly, because there are still various challenges such as lack of awareness of the benefits of technology, limited resources, and weak corporate governance. Therefore, an open and collaborative innovation approach is a solution that can accelerate the digitalization process in the SME sector.

Optimizing logistics is also an important aspect in increasing the competitiveness of SMEs in the digital era. One example is the "The Last Mile" strategy in e-commerce, which aims to improve operational efficiency, customer satisfaction, and company profitability. However, the implementation of effective digital strategies still faces obstacles, such as limited infrastructure and lack of workforce skills in adopting new technologies. In some countries such as Italy, the adoption of Industry 4.0 technology is still relatively low due to financial constraints, lack of understanding of the benefits of technology, and minimal digital skills among the workforce. Therefore, collaboration between companies, universities, research institutions, and consultants is needed to support the implementation of technology and encourage innovation in the SME sector.

In addition, the implementation of digital-based Supply Chain Finance (SCF) can play an important role in improving the efficiency of the SME supply chain. Through SCF, SMEs can reduce liquidity risks, better manage finances, and improve the operational efficiency of their businesses. In China, digital inclusive finance (DIF) has been shown to improve the

performance of SMEs, especially in the manufacturing sector. DIF not only helps overcome financing constraints but also encourages investment in environmentally friendly technologies and improves energy efficiency and corporate sustainability. Another advantage of digital transformation is the use of cloud accounting technology that allows SMEs to manage their finances in a more flexible and integrated manner. This technology has become increasingly important after the pandemic, where many SMEs have had to adapt to changes in the global economy.

Market-based strategies and the application of information technology have also been shown to improve the performance of SMEs in countries such as Lesotho, ASEAN, and Malaysia. The success of SMEs in these countries shows that developing optimal business strategies and efficient use of information technology can help SMEs compete in the international market. However, challenges in implementing digital technology remain major obstacles, including limited resources, lack of technical skills, and high-cost perceptions. Many SMEs are still not ready to adopt the Industry 4.0 paradigm, as seen in Italy, where the level of understanding and readiness of SMEs towards technology is still low. Therefore, a strategy is needed that adapts to the size and characteristics of each SME to integrate sustainability technology and Industry 4.0 into their supply chains.

Digitalization also plays an important role in maintaining the sustainability of SMEs, especially in the face of economic crises. For example, the Gotanda Eats platform in Japan shows that digitalization can help SMEs survive during difficult times, despite challenges in terms of platform-based service delivery. In addition, trust and ease of use of technology are also key factors in the adoption of digital technology by SMEs. Therefore, a collaborative approach and appropriate policy support are needed to accelerate technology adoption and improve the competitiveness of SMEs in the digital era. Supportive regulatory interventions, increased financial literacy, and the use of information technology are essential to increase SME access to credit and support their sustainable growth. In conclusion, synergy between the government, business actors, and educational institutions is needed to ensure that SMEs can continue to grow and compete in the increasingly complex digital era.

4. CONCLUSION

Digital technology significantly enhances SME competitiveness through innovation, efficiency, and market expansion. Despite its benefits, challenges such as resource limitations, lack of awareness, and regulatory barriers hinder adoption. Collaboration between governments, businesses, and academia is essential to support digital transformation. Future research should explore tailored strategies for SME digitalization, the impact of emerging technologies like AI and IoT, and policy frameworks that facilitate sustainable SME growth in the digital era.

RECOMMENDATIONS

Digital transformation has become a key factor in increasing the competitiveness of MSMEs in the era of globalization. Therefore, research can be focused on analyzing the influence of digital transformation on the competitiveness of MSMEs, by examining how the adoption of technologies such as e-commerce, cloud computing, and blockchain can improve operational efficiency and expand market access. In addition, considering the importance of collaboration in the digital era, a study on the role of open innovation in improving MSME performance through digitalization can also be conducted. This research can explore how partnerships with the government, universities, and technology startups can accelerate the digitalization of MSMEs. In the supply chain sector, the impact of blockchain on the transparency and efficiency of MSMEs is an interesting topic, considering that this technology can increase trust and security of transactions. Case studies on MSMEs that have adopted blockchain can provide insights into the effectiveness of this technology in increasing business competitiveness. In addition, the implementation of Digital Supply Chain Finance (SCF) to increase MSME liquidity can also be a focus of research, especially in understanding how digital-based financial technology can help MSMEs overcome obstacles to accessing financing and improve their operational efficiency.

In the e-commerce sector, digital-based logistics optimization strategies for MSMEs can be an interesting research topic. This study can examine the effectiveness of the "The Last Mile" strategy in increasing customer satisfaction and profitability of MSMEs. Furthermore, research on factors influencing the adoption of Industry 4.0 technology by MSMEs is very relevant to understanding the obstacles and strategies that can be applied to improve MSME readiness in utilizing advanced technology. On the financial side, the role of inclusive digital finance in improving the sustainability of MSMEs can be an important study, especially in the context of how digital financial inclusion (DIF) can help MSMEs overcome financial constraints, encourage investment in environmentally friendly technologies, and improve energy efficiency and sustainability of their businesses. With the right approach, these studies can contribute to the development of more effective digitalization policies and strategies for MSMEs.

ACKNOWLEDGEMENTS

I am grateful to God Almighty for all the grace, guidance, and strength given so that this research can be completed properly. I would like to express my deepest gratitude to my academic advisors and mentors for their guidance, insights, and valuable inputs that have helped in the preparation of this research. Their support and guidance were instrumental in improving

this work. I would also like to thank my peers and fellow researchers for their support, discussions and cooperation that have enriched my understanding. Their motivation and encouragement have been invaluable in this research journey. I would also like to thank my family and friends for their continued support, patience and encouragement. Their belief in my abilities has been a source of encouragement in completing this research. Finally, I would like to thank the various institutions and organizations that have provided support, whether in the form of resources, funding, or other assistance. Their contributions have been invaluable in the success of this research. This research would not have been realized without the help and contributions of many parties. Therefore, I would like to express my deepest gratitude to all those who have been involved.

AUTHOR'S CONTRIBUTIONS

Eva Anzani Siregar (Corresponding Author) contributed to concept formulation, research design, data collection, analysis, and drafting and revising the manuscript. Yunia Wardi and Marwan provided guidance on the research, including determining points that needed to be improved, strengthening the analysis, and refining the discussion and conclusions. They also provided input in improving the structure and quality of the manuscript.
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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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