

Digital Transformation and Profitability of MSME Manufacturing Sector in Indonesia

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Abstract

Digital transformation by MSMEs in developing countries is not as good as in developed countries. MSMEs in developing countries like Indonesia have many limitations, therefore it is necessary to study the use of digital technology by MSMEs and its impact on company performance. This research aims to analyze the influence of digital transformation on the performance of MSMEs. The sample for this research was MSME companies in the manufacturing sector which were taken using a purposive sampling technique and 305 MSMEs were obtained as samples. The analysis method uses logistic regression analysis. The results of data analysis in this research show that: (a) in micro companies, digitalization of production and logistics and digital value chains, big data has a significant effect on profitability, (b) in small companies, digitalization of production and logistics and digital value chains have a very significant effect on profitability, (c) in medium-sized companies, digitalization of the value chain has a significant effect on profitability. Meanwhile, artificial intelligence does not have a significant effect on micro, small or medium companies. This study contributes to a better understanding of the use of digitalization by MSMEs and its impact on MSME performance in developing countries. Different from previous studies, this study has included artificial intelligence variables in the model and was conducted in Indonesia as a developing country.

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INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are pivotal to the economic growth of numerous nations globally, as they foster job creation (Oduro, 2019), enhance competition, stimulate entrepreneurship, and boost productivity (Jin & Choi, 2019). Furthermore, MSMEs are instrumental in promoting trade sustainability through their innovative contributions to the (Kraft, et al, 2022). Amidst the COVID-19 pandemic, a significant number of MSMEs transitioned to digital platforms and embraced new technologies to remain competitive in the intense business landscape (Tamvada et al., 2022).

The digital shift undertaken by numerous MSMEs has drawn research focus towards the adoption of technology by these enterprises (Radicic & Petković, 2023). Findings from studies indicate that MSMEs employing Information and Communication Technology (ICT) can seize fresh opportunities and acquire enhanced understanding of their clientele, thereby improving their product development process and enhancing their competitiveness in the business arena (Quinton et al., 2018). Furthermore, this digital transformation has a significant impact on the performance of the company, including its financial outcomes (Bangun et al., 2022).

Digital transformation has been a focal point of research in recent years, yet there remains a research gap. For instance, the process and sub-processes involved in technology adoption have not been thoroughly explored (Kraft et al., 2022). The function of digital platforms and architectures, such as Blockchain, big data, and AI, during the technology adoption process is not well-studied. This research deficiency is significant and impacts the performance of MSMEs (Biclesanu et al., 2021). The factors that influence, hinder, and facilitate the adoption of new technology, along with changes in the business environment, underscore the importance of this study in identifying the factors that affect technology adoption on the current performance of MSMEs (Zamani, 2022).

Digital transformation signifies the advent of the fourth industrial revolution (Industry 4.0), ushering in profound shifts in business models and their performance, characterized by the digitization of manufacturing via interconnected production facilities, including machines, products, devices, and online content (Huang et al., 2021). The push for digital transformation is fueled by the conviction that emerging technologies hold immense potential to spur innovation and secure a competitive edge (Vrontis et al., 2022). The digital revolution broadens the scope of enterprises from supply chain systems and value chains to networks of value systems, fostering the emergence of novel network types and forms of digital innovation ecosystems (Xu, 2020). The digital revolution encapsulates the interactions and relationships among organizations and stakeholders leveraging digital technology to launch new products and services that generate value (Trinugroho et al., 2022).

Digitizing production procedures can enhance their productivity and adaptability, and augment the potential for the development of new products. Digital value chains lead to production enhancements by optimizing operations and extending production durations to bolster supply chain collaboration (Lorenz-Meyer & Santos, 2023). The digitalization of production processes and supply chain collaboration are gaining increasing significance in the contemporary global economy (Biclesanu et al., 2021). Anticipated enhancements in big data analytics, production, logistics, and value chains are expected to positively impact a company's innovative performance (Niebel et al., 2019; Radicic & Petković, 2023)

Artificial Intelligence (AI) has brought about transformative changes across diverse sectors, particularly in its uptake by small and medium-sized enterprises (Gyasi, et al, 2019). There is a growing recognition among MSMEs of AI's potential to refine their operations, elevate customer experiences, and propel business expansion (Biclesanu et al., 2021). By harnessing AI, MSMEs can automate mundane tasks, enhance production workflows, and fine-tune supply chain

management, leading to improved efficiency, cost-effectiveness, and superior decision-making (Aydemir & Karagu, 2020).

In 2022, the count of MSMEs in Indonesia hit 64.20 million, with approximately 34% or 21.8 million having transitioned to digital platforms (Mawardi, 2019). This indicates that a substantial number of MSMEs have yet to digitize their operations, necessitating comprehensive research to address these issues effectively. Despite being hampered by scarce human and financial resources, MSMEs benefit from their uncomplicated organizational structure and their capacity to swiftly adapt to market changes (Zamani, 2022). To promptly respond to market fluctuations, MSMEs need to cultivate internal digital competencies, which can enhance their performance and foster innovation growth in an increasingly digital competitive landscape (Scuotto et al., 2021). Nevertheless, MSMEs encounter several obstacles to digitalization, potentially diminishing their efficacy in driving innovation, productivity, and other facets of organizational performance. These hurdles encompass limited financial and human resources, internal opposition to change, and sluggish adoption of digitalization-related business models, particularly in micro and small firms as opposed to medium-sized enterprises (Santamaría et al., 2021). Consequently, this research seeks to investigate the impact of digital transformation on the performance of manufacturing MSMEs in Indonesia.

Literature review and hypothesis development

The advent of the fourth industrial revolution has exerted pressure on MSMEs to enhance their strategic competencies and seek novel business prospects (Rachinger et al., 2019). Start-ups and MSMEs are required to modify their strategies and capabilities to cater to the demands of emerging customers, specifically the millennial and Generation Z cohorts, to maintain connectivity, inclusivity, and customer influence. The formulation of new products, services, and processes is crucial to the establishment, survival, and expansion of businesses (Lina & Suwarni, 2022). Industry 4.0 presents immense opportunities for the inception of new products and services, superior customer service methods, augmented integration across and within value chains, and the execution of business model innovation (Grooss et al., 2022).

The Go Digital MSME initiative in Indonesia offers MSMEs the chance to digitize and aids them in building digital networks. In this research, we examine the impact of digitalization on product and process technological innovation, specifically focusing on digital interconnections in manufacturing and logistics, digital value chains, big data analytics, and AI in Indonesian MSMEs. Digital transformation is a procedure employed to restructure the economy, institutions, and society (Bouwman, et al., 2019). This digital transformation exerts a substantial influence on every industry and company as it necessitates modifications to the company's strategy and business model to integrate digital transformation (Rantala, et al., 2018).

The deployment of digital technology can impact every phase of the innovation cycle, from the inception of innovation to its fruition (Agostini, et al., 2020). It aids in the progression of digitalization and the procurement of new abilities, expertise, and knowledge, which subsequently can yield new products and procedures (Abou-foul, et al., 2021). Innovation is not a terminal objective; firms innovate to enhance profitability, productivity, and competitiveness. Even though digital transformation can result in new products and processes, the primary objective is to cater to emerging demands and probe market opportunities that arise from digital technology (Vrontis et al., 2022).

Firms operating in conventional sectors are investing in a digitally skilled workforce to master new innovation areas and other skills, as well as to devise and execute new business models (Quinton et al., 2018). Numerous recent studies examining the influence of digitalization on MSMEs have pinpointed four reasons elucidating the gradual adoption of digital transformation by MSMEs. Firstly, small firms with a specific focus are less susceptible to the urgency for swift digitalization. Secondly, small firms frequently lack the resources and

managerial foresight to fully comprehend the repercussions of digital transformation on organizational performance. Thirdly, MSMEs typically espouse a phased approach to digitalization, unlike large corporations. Lastly, investments in digitalization are heavily reliant on constrained corporate financial resources, particularly in micro and small enterprises (Gruber, 2019)

The digitization of manufacturing and service procedures results in the amalgamation of vertical and horizontal value chains. Firms are increasingly reliant on their external networks and are participating in co-creation innovation processes grounded in an ecosystem approach (Büyüközkan & Göçer, 2018). By adopting cloud business solutions, MSMEs can enjoy numerous advantages, gaining access to an expansive environment that potentially offers sufficient leverage to compete with larger entities (Coleman et al., 2016). Costa Melo et al. (2023) conducted an analysis of manufacturing MSMEs in the UK and discovered that firms possessed certain product and customer data, which they utilized for various objectives, including the enhancement of products and services. Nevertheless, a significant number of MSMEs do not effectively utilize the data at their disposal. Witkowski (2017) demonstrates that Industry 4.0 plays a pivotal role in advancing logistics and supply chain management. In light of the preceding discussion, we propose the subsequent hypothesis.

H1. : Digitalization of production and logistics has a positive effect on MSME performance.

The emergence of the digital economy can pave the way for small firms to assume a more proactive role in global value chains (Radicic, et al., 2023). Numerous studies furnish empirical proof to depict the positive correlation between the adoption of digital technology and the efficiency of the supply chain (Kache & Seuring, 2017). The digital value chain, particularly interactions with suppliers, enables firms to implement modifications and enhancements in production procedures. Additionally, engagement with customers can yield ideas for new products and services. Supply and value chains are assuming an increasingly pivotal role, with a heightened incidence of product, organizational, or corporate development spanning through open innovation across geographic boundaries (Lee & Schmidt, 2017). Therefore, digital collaboration with customers and suppliers in developing new products and processes, like traditional collaboration, can positively influence the performance of MSMEs, so the following hypothesis is proposed:

H2. : The digital value chain has a positive effect on MSME performance.

Big data analytics is characterized by two key elements: the volume of the data and the analytical instruments employed to scrutinize the data (Liu et al., 2020). processes of data gathering and analytics have facilitated innovation in business models, serving as a competitive factor for corporate profits and will be harnessed as an element engendering additional competitive edges (Duan. et al., 2020). Big data empowers firms across all sectors to devise new products and services, refine existing ones, and formulate novel business models (Chavez, et al., 2017).

The utilization of big data aids in the optimization of processes, enhancement of efficiency, and improvement of customer service (Usai et al., 2021). However, several adverse factors impact the adoption of big data analytics in MSMEs, including a lack of comprehension, cultural obstacles and inherent conservatism, deficiency of internal data analytics expertise, workforce proficiency, scarcity of beneficial and cost-effective business analytics consulting and services, absence of management and organizational models, focus on data security, apprehensions about data protection and privacy, and financial constraints (Côte-Real et al., 2019).

Big Data Analytics denotes the procedure of scrutinizing and deciphering vast quantities of data to glean valuable knowledge and make judicious business decisions (Kache & Seuring, 2017). For small and medium enterprises, the influence of Big Data analysis on performance can be substantial. By capitalizing on Big Data analysis, SMEs can attain a more profound comprehension of their clientele and more accurately direct promotions and advertising (Gyasi, et

al, 2019). Therefore, based on the various potential benefits of big data on innovation, the following hypothesis is proposed:

H3: Big data analysis has a positive effect on MSME performance.

The utilization of AI technology has been acknowledged and embraced by corporations globally. The integration of AI in business functions holds the potential to markedly enhance the performance and competitiveness of MSMEs in developing nations. As per (Kache & Seuring, 2017) dampak the influence of AI adoption is positively correlated with economic metrics such as capital investment, economic yield, return on capital, and wages of existing employees. Moreover, the adoption of AI can act as a catalyst for business model innovation and facilitate industry disruptions. The deployment of AI in MSMEs exerts a positive impact on MSME performance. AI aids in augmenting efficiency and productivity in the manufacturing process by leveraging algorithms and predictive analytics (Suseno, et al, 2018), leading to a surge in sales volume and an improvement in overall business performance. Furthermore, the adoption of AI technologies like Big Data analysis and Machine Learning in supply chain management can mitigate the effects of disruptions and enhance supply chain agility (Gouveia & Costa, 2022). Based on this explanation, the following hypothesis is proposed:

H4: The application of AI has a positive effect on MSME performance.

Drawing from the comprehensive discourse above, Figure 1 presents a theoretical structure concerning the influence of digitalization on the performance of MSMEs. This structure also encapsulates the diversity of firms in terms of firm size and human capital, represented by graduate degrees.

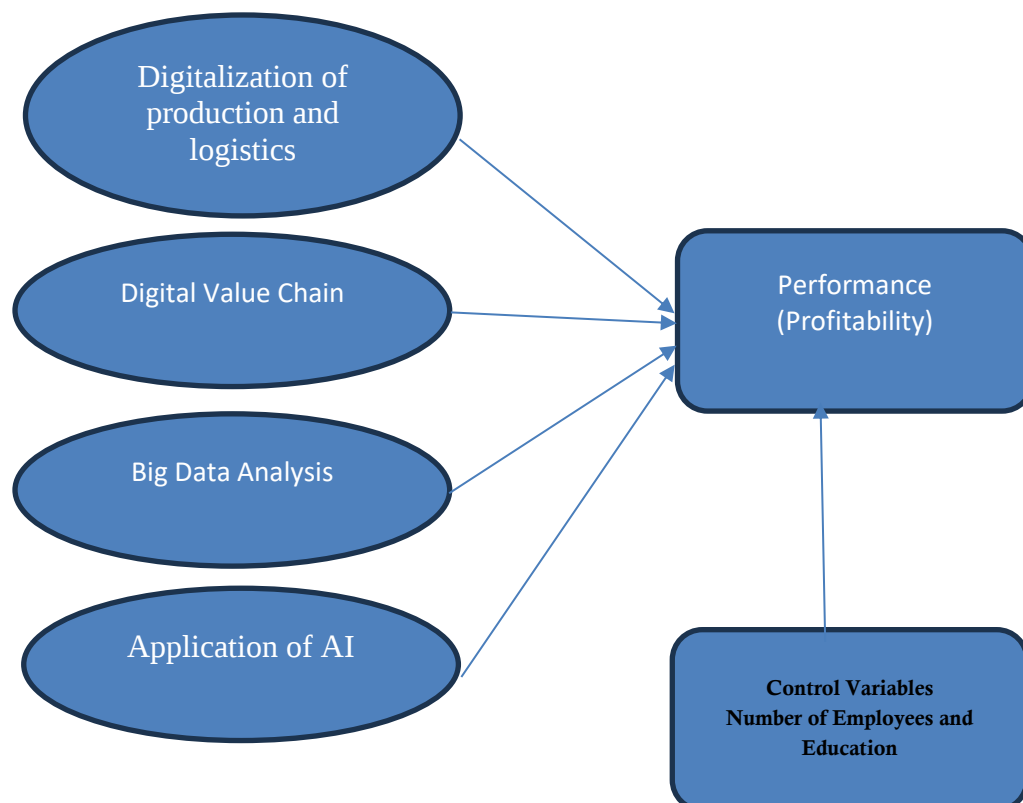


Figure 1. Conceptual Framework

METHODS

Sample

Sample data was taken randomly from MSMEs in the food and beverage manufacturing, textile, wood processing and tobacco industries in Indonesia taken from the Central Statistics Agency. Sample data is grouped by sector, size and region. Our research is aimed at the use of digitalization by MSMEs in the 2017–2022 period. The total sample was 305 MSMEs, consisting of 146 micro businesses, 109 small businesses and 50 medium businesses.

Variable

Dependent variable

The dependent variable in this research is the MSME performance variable. The dependent variable uses a binary indicator, namely 1 if the company makes a profit (profitability) and 0 if the company does not make a profit. Variable measurements can be seen in Table 1.

Independent variable

There are four independent variables in this research that measure a company's use of digitalization, namely: Digitalization of production and logistics, digital value chain, big data analysis, and application of AI. Each variable is measured on a four-item scale that asks companies to evaluate the extent of various digitalization implementations (“no”, “low”, “medium”, high”). The survey question was: “To what extent does your company currently use the following digitalization applications in different business function areas?”. Variable measurements can be seen in Table 1.

Control variables

There are three control variables in the research, namely First, the number of employees which measures the number of employees. Second, the education variable is a dummy variable equal to 1 if the company has employees with a bachelor's degree, and 0 otherwise. This variable is a proxy for human capital, which is considered a significant factor in stimulating innovation activities.

Table 1. Pengukuran Variabel

Variable	Variable Measurement	Source
Performance (Profitability)	Dummy Variable (DV) = 1 if the company makes significant profits and 0 if not	(Niebel et al., 2019; Radicic; 2023)
Digitalization of Production & Logistics	Binary= 1 (“high” or “medium” usage level) if the company uses digital interconnection with production and/or between production and logistics and otherwise “0” (“none” or “low” usage level).	(Niebel et al., 2019; Radicic; 2023).
Value Chain Digitalization	Binary= 1 (“high” or “medium” usage level) if the company uses digital interconnection with customers and/or suppliers and “0” otherwise (“none” or “low” usage level).	(Niebel et al., 2019; Radicic; 2023).
Big Data Analysis	Binary= 1 (usage level “high” or “medium”) if the company uses big data analytics and “0” otherwise (usage level “none” or “low”)	(Niebel et al., 2019; Radicic; 2023).
Application of Artificial	Binary= 1 (“high” or “medium” usage level) if the company uses AI and “0” otherwise (“none” or “low”	(Niebel et al., 2019; Radicic;

Intelligence	usage level)	2023).
Number of employees	Nominal	(Santamaría et al., 2021)
Education	dummy variable = 1 if the company has employees with a bachelor's degree, and 0 otherwise.	(Schneider et al., 2010)

Methodology

The model used to analyze the impact of digitalization on MSME performance is logistic regression (Criscuolo, et.al., 2018) with 1 dependent variable and 4 independent variables.

$$\pi(x) = \frac{\exp(\beta_0 + \beta'x_n)}{1 + \exp(\beta_0 + \beta'x_n)} \quad (1)$$

where y is an independent variable which has a dummy value referring to the performance of MSMEs. β_1 and β_2 are the coefficients on the independent variables x_1 and x_2 (the same in both equations) and ρ is the correlation between the error terms ε_1 and ε_2 (Cardamone, 2010).

$$g(x) = \ln \left\{ \frac{\pi(x)}{1 - \pi(x)} \right\} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p = \sum_{j=1}^p \beta_j x_j \quad (2)$$

So the binary response is expressed, if

$Y = 0$, then $\square = -\pi(x)$ with probability $1 - \pi(x)$,

$Y = 1$, then $\pi = 1 - \pi(x)$ with probability $\pi(x)$.

And it can be stated that $\square$ has $E(\square) = 0$ and $\text{var}(\square) = \pi(x) \cdot [1 - \pi(x)]$ which follows the binomial distribution (Hosmer, 1989).

RESULTS AND DISCUSSION

Sample data was analyzed using SPSS 23 software and the results were obtained in Table 2.

Table 2. Description of Statistics, Mean, and Standard Deviation

Variable	Micro Firms (146)		Small Firms (109)		Medium Firms (50)	
	Mean	SD	Mean	SD	Mean	SD
Profitability	0.520	0.501	0.500	0.502	0.480	0.505
Digitalization of Production & Logistics	0.520	0.501	0.450	0.500	0.540	0.503
Value Chain Digitalization	0.520	0.501	0.500	0.502	0.520	0.505
Big Data Analysis	0.250	0.436	0.360	0.482	0.560	0.501
Application of AI	0.200	0.400	0.280	0.449	0.240	0.431
Number of employees	6.700	1.283	11.210	2.427	25.560	4.730
Education	0.300	0.460	0.390	0.489	0.620	0.490

Based on Table 2, there are 52% of micro companies making a profit, 50% for small companies and 48% for medium companies. These results show that micro companies gain more profits than small and medium companies, this is because small scale businesses are more flexible in carrying out business innovations so they are better able to maintain their income.

The application of digitalization of production and logistics and value chains in MSMEs as shown in Table 2 shows that the use of production digitalization in micro businesses is categorized as high at 52%. In small companies, the use of digitalization of production and logistics is 45%, while the value chain is 50%. In medium-sized companies, the use of digitalization of production and logistics reached 54% and the use of digital value chains reached 52%. Based on this data, it shows that medium-sized companies use digitalization of production and logistics at a higher rate than micro and small companies. The use of the digital value chain

for micro and medium companies is higher than for small companies, although the difference is not significant.

Based on Table 2, it shows that the application of Big Data analysis to micro companies is carried out by 25% of micro companies, 36% of small companies and 56% of medium companies. This shows that the larger the company's scale, the greater its use of Big Data analysis. The larger an MSME is, the more aware it will be of the importance of implementing Big Data analysis for managing company data. The implementation of AI digitalization shows that only 20% of micro companies use AI, while small companies are 28% and medium companies are 24%. This shows that the implementation or use of AI in MSMEs is still low. The reason for this is because there are still many MSME players who do not know the use of AI to support their business operational activities. Human resources data held by MSMEs shows that micro businesses have 30% of employees with bachelor's degrees, while for small and medium companies it is 39% and 62 people respectively. Table 2 also shows that the average number of employees in micro companies is 7 people, and in small companies it is 11 people and 26 people in medium scale companies..

Table 3. Logistic Regression Analysis Results

Variable	Micro Firms		Small Firms		Medium Firms	
	B	Sign	B	Sign	B	Sign
Digitalization of Production & Logistics	1.320	0.042	5.285	0.000	1.642	0.314
Value Chain Digitalization	1.427	0.037	4.827	0.000	3.802	0.038
Big Data	2.322	0.046	-0.572	0.815	0.652	0.719
Artificial Intelligence	-1.709	0.164	-2.719	0.314	0.031	0.984
Employee	0.310	0.124	-0.419	0.123	0.353	0.100
Education	1.049	0.052	0.329	0.748	-0.981	0.585
Constant	-3.954	0.008	1.075	0.682	-12.152	0.031

The results of the logistic regression analysis in Table 4 show that in micro companies, digitalization of production and logistics, value chains and big data have a significant effect on profitability. In small companies, digitalization of production and logistics and digital value chains have a significant impact on profitability. In medium-sized companies, only the digital value chain has a significant effect on profitability. For the control variables, only education has a significant effect on the profitability of micro companies.

Actors in the MSME sector are executing digital transformations in their business functions to surmount social limitations that affect their performance. Insufficient knowledge, financial resources, and human capital pose challenges for MSMEs in hastening the process of digitalization (Adi, 2023). The digital technology metamorphosis undertaken by MSMEs in their offerings is intended to sustain their performance and augment efficiency in manufacturing and services (Oduro, 2019). The outcomes of this research concerning the influence of the digital transformation implemented by MSMEs will be elucidated subsequently.

Initially, the digitalization of manufacturing and logistics processes exerts a positive and significant impact on the profitability of micro and small-scale enterprises, whereas for medium-scale firms, the effect is not significant. This positive influence indicates that the digitalization of production and logistics undertaken by micro and small-scale businesses can enhance their business performance, as reflected in profitability. The outcomes of this study align with prior research (Costa Melo et al., 2023). that explored the influence of digital transformation on MSME performance. Specifically, this study corroborates the research conducted by Radicic & Petković (2023), which discovered that digitalization in production and logistics positively impacts company performance. These findings demonstrate that digitalization in production and logistics can boost efficiency and product innovation in MSMEs, thereby necessitating MSMEs to implement digital transformation in their production and logistics.

Secondly, the digitalization of the value chain has been demonstrated to exert a positive and significant impact on the performance of micro, small, and medium enterprises. This positive influence indicates that the more MSMEs digitize their value chain, the greater their profitability becomes. This finding is corroborated by several studies that provide empirical evidence to depict the positive correlation between the adoption of digital technology and supply chain efficiency (Kache & Seuring, 2017). Digital value chains, especially interactions with suppliers, enable firms to implement changes and enhancements in production processes, thereby stimulating innovation processes. Moreover, engagement with customers can yield ideas for new products and services (Lee & Schmidt, 2017; Radicic & Petković, 2023). Digitalization in the supply chain encompasses digital products and services as well as the management of supply chain processes in firms undergoing a rapid transformation process (Büyükoğkan & Göçer, 2018). Supply and value chains are assuming an increasingly pivotal role, with a heightened incidence of product, organizational, or corporate development spanning through open innovation across geographic boundaries (Lee & Schmidt, 2017). Consequently, digital collaboration with customers and suppliers in the creation of new products and processes, akin to conventional collaboration, can exert a positive impact on MSME performance.

Thirdly, the study examines the influence of big data analysis on the performance of MSMEs. Big data is perceived as a competitive factor for corporate earnings and is anticipated to be leveraged in the future. This implies that its importance should be investigated, particularly its association with innovation, as another factor contributing to competitive advantage (Duan et al., 2020). However, only a handful of MSMEs possess the capability to employ customer online insights in the creation of new products, which can significantly contribute to their performance growth (Liu et al., 2020). The findings of this research indicate that big data analysis solely impacts product performance in micro enterprises. Conversely, in small and medium enterprises, it does not have a significant effect. This is plausible for micro enterprises, as the utilization of big data is simpler and its application is more dynamic, enabling the swift innovation of products and services, which subsequently influences company profits.

Fourthly, the examination of the impact of Artificial Intelligence on the performance of MSMEs has not been substantiated across all business scales, be it micro, small, or medium. This could be attributed to the possibility that MSMEs do not fully comprehend the application of AI in their operations, as evidenced by data indicating that only approximately 20-28% of MSMEs utilize AI. Some data reveals that AI is currently gaining momentum in both domestic and international markets, with 70 percent of experts asserting that SMEs need to incorporate AI technology to maintain competitiveness in the long run (Zirar et al., 2023). AI presents opportunities particularly in the realms of supply chain optimization, enhanced process efficiency, and improved customer service (Suseno, et al., 2018). This finding is also corroborated by a study conducted by Saarland University, which indicates that in Europe, SMEs have minimal engagement with AI, with 43 percent of respondents having not yet interacted with AI, and the majority of SMEs not offering additional training on opportunities in this domain (Gouveia & Costa, 2022).

Upon examining the control variables, it is found that company size does not exert a significant influence across various company scales. This implies that an increase in the employee count does not impact the performance of MSMEs. Lastly, human capital, represented by companies that employ individuals with bachelor's degrees, has a positive and significant effect on the performance of MSMEs, but this is only observed in micro companies. This can be attributed to the fact that in micro companies, which have fewer employees with bachelor's degrees compared to small and medium companies, this scenario offers an advantage or flexibility in innovation due to their knowledge and skills, which subsequently influences the company's profitability.

CONCLUSIONS

The findings of this research provide the conclusion that in order for MSMEs to improve their performance, they need to digitize production and logistics, digitize the value chain, and apply Big Data, apart from that they must improve the quality of their human resources. If this is done it will have a positive impact on the performance of MSMEs. These findings also show that the application of digitalization in MSMEs is still low, this is shown by the highest application of digitalization in production and logistics at 54% in medium companies, digitalization in the value chain is highest at 52% in micro and medium companies, the use of big data is highest at 56% in medium companies, and the highest use of AI at 28% in small companies. Therefore, training is needed for MSMEs regarding digital transformation so that they can improve their performance in this 4.0 revolution era. Apart from that, factors inhibiting the implementation of digitalization, such as a lack of strategy towards digitalization, organizational culture that is reluctant to accept change, and business models that are very irrelevant (Rahman et al., 2023) need to immediately find the right solution.

REFERENCES

- Abou-foul, M., Ruiz-Alba, J. L., & Soares, A. (2021). The impact of digitalization and servitization on the financial performance of a firm: an empirical analysis. *Production Planning and Control*, 32(12), 975–989. <https://doi.org/10.1080/09537287.2020.1780508>
- Adi, A. S. (2023). The effect of digital transformation and innovation on SMEs ' performance in times of COVID-19. *Problems and Perspectives in Management*, 21(4), 84–100. [https://doi.org/10.21511/ppm.21\(4\).2023.07](https://doi.org/10.21511/ppm.21(4).2023.07)
- Agostini, L., Galati, F., & Gastaldi, L. (2020). The digitalization of the innovation process: Challenges and opportunities from a management perspective. *European Journal of Innovation Management*, 23(1), 1–12. <https://doi.org/10.1108/EJIM-11-2019-0330>
- Aydemir, E., & Karagu, K. (2020). Solving a Periodic Capacitated Vehicle Routing Problem Using Simulated Annealing Algorithm for a Manufacturing Company. *Brazilian Journal of Operations and Production Management*, 17(1), 1–13. <https://doi.org/10.14488/BJOPM.2020.011>
- Bangun, N., Kusuma, C., & Winarto, D. (2022). Transformasi Digital Fungsi Penjualan Pada Umkm Kuliner Di Kelapa Dua Tangerang. *Serina Iv Untar 2022*, 20(April), 1717–1722.
- Biclesanu, I., Anagnoste, S., Branga, O., & Savastano, M. (2021). Digital entrepreneurship: Public perception of barriers, drivers, and future. *Administrative Sciences*, 11(4). <https://doi.org/10.3390/admsci11040125>
- Bouwman, H., Nikou, S., & de Reuver, M. (2019). Digitalization, business models, and SMEs: How do business model innovation practices improve performance of digitalizing SMEs? *Telecommunications Policy*, 43(9), 101828. <https://doi.org/10.1016/j.telpol.2019.101828>
- Büyüközkan, G., & Göçer, F. (2018). Digital Supply Chain: Literature review and a proposed framework for future research. *Computers in Industry*, 97, 157–177. <https://doi.org/10.1016/j.compind.2018.02.010>
- Chavez, R., Yu, W., Jacobs, M. A., & Feng, M. (2017). Data-driven supply chains, manufacturing capability and customer satisfaction. *Production Planning and Control*, 28(11–12), 906–918. <https://doi.org/10.1080/09537287.2017.1336788>
- Coleman, S., Göb, R., Manco, G., Pievatolo, A., Tort-Martorell, X., & Reis, M. S. (2016). How Can SMEs Benefit from Big Data? Challenges and a Path Forward. *Quality and Reliability Engineering International*, 32(6), 2151–2164. <https://doi.org/10.1002/qre.2008>
- Côrte-Real, N., Ruivo, P., Oliveira, T., & Popovič, A. (2019). Unlocking the drivers of big data analytics value in firms. *Journal of Business Research*, 97(June 2018), 160–173. <https://doi.org/10.1016/j.jbusres.2018.12.072>
- Costa Melo, D. I., Queiroz, G. A., Alves Junior, P. N., Sousa, T. B. de, Yushimito, W. F., & Pereira, J. (2023). Sustainable digital transformation in small and medium enterprises (SMEs): A review on performance. *Heliyon*, 9(3), e13908. <https://doi.org/10.1016/j.heliyon.2023.e13908>

- Criscuolo, P., Laursen, K., Reichstein, T., & Salter, A. (2018). Winning combinations : search strategies and innovativeness in the UK. *Industry and Innovation*, 25(2), 0. <https://doi.org/10.1080/13662716.2017.1286462>
- Duan, Y., Cao, G., & Edwards, J. S. (2020). Understanding the impact of business analytics on innovation. In *European Journal of Operational Research* (Vol. 281, Issue 3). Elsevier B.V. <https://doi.org/10.1016/j.ejor.2018.06.021>
- Gouveia, B., & Costa, O. (2022). Industry 4.0: Predicting lead conversion opportunities with machine learning in small and medium sized enterprises. *Procedia Computer Science*, 204, 54–64. <https://doi.org/10.1016/j.procs.2022.08.007>
- Grooss, O. F., Presser, M., & Tambo, T. (2022). Surround yourself with your betters: Recommendations for adopting Industry 4.0 technologies in SMEs. *Digital Business*, 2(2), 100046. <https://doi.org/10.1016/j.digbus.2022.100046>
- Gruber, H. (2019). Proposals for a digital industrial policy for Europe. *Telecommunications Policy*, 43(2), 116–127. <https://doi.org/10.1016/j.telpol.2018.06.003>
- Gyasi, E. A., Handroos, H., & Kah, P. (2019). Survey on artificial intelligence (AI) applied in welding: A future scenario of the influence of AI on technological, economic, educational and social changes. *Procedia Manufacturing*, 38(2019), 702–714. <https://doi.org/10.1016/j.promfg.2020.01.095>
- Huang, C. C., Wu, J. H., Wu, J. H., & Liu, W. C. (2021). Digital transformation of SMEs during COVID-19. *Digital Transformation of SMEs during COVID-19: A Systematic Review. Journal of Business Research*.
- Jin, S. H., & Choi, S. O. (2019). The effect of innovation capability on business performance: A focus on it and business service companies. *Sustainability (Switzerland)*, 11(19), 1–15. <https://doi.org/10.3390/su11195246>
- Kache, F., & Seuring, S. (2017). Challenges and opportunities of digital information at the intersection of Big Data Analytics and supply chain management. *International Journal of Operations and Production Management*, 37(1), 10–36. <https://doi.org/10.1108/IJOPM-02-2015-0078>
- Kraft, C., Lindeque, J. P., & Peter, M. K. (2022). The digital transformation of Swiss small and medium-sized enterprises: insights from digital tool adoption. *Journal of Strategy and Management*, 15(3), 468–494. <https://doi.org/10.1108/JSMA-02-2021-0063>
- Lee, H. L., & Schmidt, G. (2017). Using Value Chains to Enhance Innovation. *Production and Operations Management*, 26(4), 617–632. <https://doi.org/10.1111/poms.12665>
- Lina, L. F., & Suwarni, E. (2022). Social Commerce Adoption to Enhance SMEs Performance: Technology, Organization and Environment (TOE) Perspectives. *Jurnal Aplikasi Bisnis Dan Manajemen*, 8(3), 689–696. <https://doi.org/10.17358/jabm.8.3.689>
- Liu, Y., Soroka, A., Han, L., Jian, J., & Tang, M. (2020). Cloud-based big data analytics for customer insight-driven design innovation in SMEs. *International Journal of Information Management*, 51(April), 0–1. <https://doi.org/10.1016/j.ijinfomgt.2019.11.002>
- Lorenz-Meyer, F., & Santos, V. (2023). Blockchain in the shipping industry: A proposal for the use of blockchain for SMEs in the maritime industry. *Procedia Computer Science*, 219(2021), 807–814. <https://doi.org/10.1016/j.procs.2023.01.354>
- Mawardi, A. I. (2019). An Opportunity: Growing of Financial Technology to Stimulate Sharing Economy in East Java. *Journal of Economics, Business, and Government Challenges*, 1(2), 54–64. <https://doi.org/10.33005/ebgc.v1i2.22>
- Niebel, T., Rasel, F., & Viete, S. (2019). BIG data–BIG gains? Understanding the link between big data analytics and innovation. *Economics of Innovation and New Technology*, 28(3), 296–316. <https://doi.org/10.1080/10438599.2018.1493075>
- Odoro, S. (2019). Examining open innovation practices in low-tech SMEs: insights from an emerging market. *Journal of Science and Technology Policy Management*, 10(3), 509–532. <https://doi.org/10.1108/JSTPM-03-2019-0036>
- Quinton, S., Canhoto, A., Molinillo, S., Pera, R., & Budhathoki, T. (2018). Conceptualising a digital orientation: antecedents of supporting SME performance in the digital economy. *Journal of Strategic Marketing*, 26(5), 427–439. <https://doi.org/10.1080/0965254X.2016.1258004>
- Rachinger, M., Rauter, R., Müller, C., Vorraber, W., & Schirgi, E. (2019). Digitalization and its influence on business model innovation. *Journal of Manufacturing Technology Management*, 30(8), 1143–1160. <https://doi.org/10.1108/JMTM-01-2018-0020>

- Radicic, D., & Petković, S. (2023). Impact of digitalization on technological innovations in small and medium-sized enterprises (SMEs). *Technological Forecasting and Social Change*, 191(January). <https://doi.org/10.1016/j.techfore.2023.122474>
- Rahman, N. A., Ahmad, A. H., Ani, N. S., Kadir, A. R., Reni, A., & Gjorevska, E. (2023). Exploring the Impact of Entrepreneurial Orientation, Competitive Advantage, and Technological Factors on SMEs Digital Performance: A Comprehensive Analysis. *International Journal of Business and Quality Research*, 01(March), 75–87.
- Rantala, T., Ukko, J., Saunila, M., & Havukainen, J. (2018). The effect of sustainability in the adoption of technological, service, and business model innovations. *Journal of Cleaner Production*, 172, 46–55. <https://doi.org/10.1016/j.jclepro.2017.10.009>
- Santamaria, L., Nieto, M. J., & Rodríguez, A. (2021). Failed and successful innovations: The role of geographic proximity and international diversity of partners in technological collaboration. *Technological Forecasting and Social Change*, 166(January). <https://doi.org/10.1016/j.techfore.2021.120575>
- Scuotto, V., Nicotra, M., Del Giudice, M., Krueger, N., & Gregori, G. L. (2021). A microfoundational perspective on SMEs' growth in the digital transformation era. *Journal of Business Research*, 129(January), 382–392. <https://doi.org/10.1016/j.jbusres.2021.01.045>
- Suseno, Y., Laurell, C., & Sick, N. (2018). Assessing value creation in digital innovation ecosystems: A Social Media Analytics approach. *Journal of Strategic Information Systems*, 27(4), 335–349. <https://doi.org/10.1016/j.jsis.2018.09.004>
- Tamvada, J. P., Narula, S., Audretsch, D., Puppala, H., & Kumar, A. (2022). Adopting new technology is a distant dream? The risks of implementing Industry 4.0 in emerging economy SMEs. *Technological Forecasting and Social Change*, 185(September), 122088. <https://doi.org/10.1016/j.techfore.2022.122088>
- Trinugroho, I., Pamungkas, P., Wiwoho, J., Damayanti, S. M., & Pramono, T. (2022). Adoption of digital technologies for micro and small business in Indonesia. *Finance Research Letters*, 45(April), 102156. <https://doi.org/10.1016/j.frl.2021.102156>
- Usai, A., Fiano, F., Messeni Petruzzelli, A., Paoloni, P., Farina Briamonte, M., & Orlando, B. (2021). Unveiling the impact of the adoption of digital technologies on firms' innovation performance. *Journal of Business Research*, 133(March 2020), 327–336. <https://doi.org/10.1016/j.jbusres.2021.04.035>
- Vrontis, D., Chaudhuri, R., & Chatterjee, S. (2022). Adoption of Digital Technologies by SMEs for Sustainability and Value Creation: Moderating Role of Entrepreneurial Orientation. *Sustainability (Switzerland)*, 14(13). <https://doi.org/10.3390/su14137949>
- Witkowski, K. (2017). Internet of Things, Big Data, Industry 4.0 - Innovative Solutions in Logistics and Supply Chains Management. *Procedia Engineering*, 182, 763–769. <https://doi.org/10.1016/j.proeng.2017.03.197>
- Xu, Y. (2020). Digital Innovation Ecosystem: Research Context, Research Hotspot and Research Trends -- Knowledge Mapping Analysis Using Citespace. *Journal of Electronics and Information Science*, 5, 72–80. <https://doi.org/10.23977/jeis.2020.51011>
- Zamani, S. Z. (2022). Small and Medium Enterprises (SMEs) facing an evolving technological era: a systematic literature review on the adoption of technologies in SMEs. *European Journal of Innovation Management*, 25(6), 735–757. <https://doi.org/10.1108/EJIM-07-2021-0360>
- Zirar, A., Ali, S. I., & Islam, N. (2023). Worker and workplace Artificial Intelligence (AI) coexistence: Emerging themes and research agenda. *Technovation*, 124(February), 102747. <https://doi.org/10.1016/j.technovation.2023.102747>