JURNAL PENELITIAN MULTIDISIPLIN BANGSA
e-ISSN : 3048-4251
Volume 1, No. 7, Tahun 2024
https://ejournal.amirulbangunbangsapublishing.com/index.php/jpnmb/index

Implementation of Digital Transformation and Artificial Intelligence as Innovation for MSMEs in the Era of Industrial Revolution 4.0

Sri Hutami Adiningsih[1], Is Arianto Pratama[2]
[1]*Pendidikan Ekonomi, Universitas Negeri Makassar, Indonesia*
[2]*Institut Teknologi Bisnis dan Maritim Balik Diwa Makassar, Indonesia*

Corresponding Author
Nama Penulis: Sri Hutami Adiningsih
E-mail: sri.hutami@unm.ac.id

Abstract

Technology plays an important role in economic development. Covid-19 has changed people's lifestyles and the behavioral patterns of business actors have transformed from traditional to digital. Even though Covid-19 has had a significant impact in the form of a decline in the global economy, including on Micro, Small and Medium Enterprises (MSMEs), it has also provided lessons in the form of adaptation to innovation and digital transformation in the form of the application of the latest technology and artificial intelligence. This research uses a qualitative descriptive method and research data is collected through articles, journals, books, and official sources that are reliable and accurate. This research aims to describe phenomena or events from the development of the Industrial Revolution 4.0 era which supports the growth of MSMEs to change or transform digitally with the help of artificial intelligence so that they can grow and compete globally. The results of this research show that the Industrial Revolution 4.0 and digital transformation can provide opportunities and strengths to build sustainable businesses. Along with changes in people's consumption patterns, MSMEs have also implemented digital adoption in the form of switching to e-commerce platform sites, food delivery applications, and online business models. However, the adoption of artificial intelligence is still not widely used by MSMEs. However, several MSMEs have adopted artificial intelligence technology such as chatbot applications for automatic customer communication services. Apart from that, support and providing programs from the government and the private sector are needed for MSMEs so that they can develop and adapt their business models to the latest technological adaptations so that MSMEs are also able to survive and even grow rapidly in the future.
Keywords *- artificial intelligence, digital transformation, MSMEs*

Abstrak

Teknologi memegang peranan penting dalam perkembangan ekonomi. Covid-19 telah mengubah gaya hidup masyarakat dan pola perilaku pelaku usaha yang bertransformasi dari tradisional menjadi digital. Meskipun Covid-19 memberikan dampak yang signifikan berupa penurunan ekonomi global, termasuk terhadap Usaha Mikro, Kecil, dan Menengah (UMKM), namun juga memberikan pelajaran berupa adaptasi terhadap inovasi dan transformasi digital berupa penerapan teknologi terkini dan kecerdasan buatan. Penelitian ini menggunakan metode deskriptif kualitatif dan data penelitian dikumpulkan melalui artikel, jurnal, buku, dan sumber-sumber resmi yang dapat dipercaya dan akurat. Penelitian ini bertujuan untuk mendeskripsikan fenomena atau kejadian dari perkembangan era Revolusi Industri 4.0 yang mendukung pertumbuhan UMKM untuk berubah atau bertransformasi secara digital dengan bantuan kecerdasan buatan sehingga dapat tumbuh dan bersaing secara global. Hasil penelitian ini menunjukkan bahwa Revolusi Industri 4.0 dan transformasi digital dapat memberikan peluang dan kekuatan untuk membangun bisnis yang berkelanjutan. Seiring dengan perubahan pola konsumsi masyarakat, UMKM juga telah menerapkan adopsi digital dalam bentuk peralihan ke situs platform e-commerce, aplikasi pesan-antar makanan, dan model bisnis online. Namun, adopsi kecerdasan buatan masih belum banyak digunakan oleh UMKM. Namun, beberapa UMKM telah mengadopsi teknologi kecerdasan buatan seperti

aplikasi chatbot untuk layanan komunikasi pelanggan secara otomatis. Selain itu, dukungan dan penyediaan program dari pemerintah dan pihak swasta sangat dibutuhkan bagi UMKM agar dapat mengembangkan dan menyesuaikan model bisnisnya dengan adaptasi teknologi terkini sehingga UMKM juga mampu bertahan bahkan berkembang pesat di masa depan.
***Kata kunci** - kecerdasan buatan, transformasi digital, UMKM*

INTRODUCTION

Covid-19, which occurred at the end of 2019, has changed the social and economic order in the form of psychology and weakened the global economy. However, on the other hand, Covid-19 has provided a significant increase in the application of technology. The existence of large-scale social restrictions and the WFH (work from home) policy indirectly means that people must be able to adapt to using additional technology in working and carrying out daily activities. These changes also encourage digital transformation which is disrupting various fields, especially in the economic sector. Along with digital disruption which is in line with the increasing adoption of digital technology to accelerate the transformation of the industrial revolution 4.0.

The industrial revolution has had a major influence on the order of life and increased the rate of business growth globally. Changes brought about by the industrial revolution in economic concepts have made it easier to cut costs, time and energy to become more efficient and effective. In the development of the industrial revolution, there have been four stages starting from industrial revolution 1.0, industrial revolution 2.0, industrial revolution 3.0, and now industrial revolution 4.0. Industrial revolution 4.0 is a transformation from the use of industrial equipment to cyber-physical system technology which focuses on automation. The difference between the industrial revolution 4.0 and revolutions 1.0 to 3.0 is clearly seen to have changed lifestyles and fundamental human tasks, where revolution 4.0 has a wider scale, scope and complexity and can influence scientific, economic, political and industrial disciplines (Schwab, 2017).

In the industrial revolution 4.0 technology, there are technologies that play an important role, such as the internet of things (IoT), artificial intelligence, big data, cloud computing, augmented reality, cyber security, additive manufacturing, system integration, and simulation (simulation). Some of this technology has been used for industry, such as big data which has been used by business people to analyze business data. Apart from that, 3D printer technology (including the additive manufacturing part) has been used by several factories to make products quickly. Currently, some business people have also adopted artificial intelligence technology. A study conducted by Menendez et al (2020) explained that the survey they conducted in several industries was interpreted as a trend driven by the increasing availability of data (big data) globally spurring the growth of artificial intelligence (AI) such as ChatGPT. The AI-based chatbot, which was launched in November 2022, quickly attracted global attention as a technological system that improves learning and strengthens techniques in industry and academia, although currently ChatGPT still has several shortcomings in terms of differences in language delivery (Chakraborty, 2023).

Compared with the previous industrial revolution, there are technological differences based on improvements in speed, specifications and system transformation that drive demand for goods and services. Currently, more and more business people are using the on-demand economy and the human cloud (Schwab, 2017). In essence, the human cloud turns professional activities into project-based assignments collected from virtual workers located anywhere in the world. An on-demand economy where labor providers are no longer employees in the traditional sense but are independent workers who perform specific tasks. Thus, the industrial revolution 4.0 has had a huge impact on the development of the economy and business globally.

Artificial Intelligence has become a major driver of change in various sectors bringing tremendous innovation and efficiency. In an era where technology plays an increasingly central role,

artificial intelligence is emerging as a revolutionary force that promises to have a significant impact. Artificial intelligence (AI) is related to the process of thinking and reasoning, and also discusses behavior that measures success in relation to human performance that is rational, ideal, and based on what they know, where a system is said to be rational if it does the "right thing". (Russell & Norvig, 2010). Apart from that, AI can also be interpreted as a technological system that imitates behavior (human behavior) with thinking procedures that are similar to humans (Supriyadi & Asih, 2020). Artificial intelligence refers to the development and implementation of computer systems that have the ability to perform tasks that normally require human intelligence. These tasks include learning from experience, thinking through complex problems, understanding natural language, and adapting to new situations. There are several approaches to AI in the form of a human-centered approach which must be part of empirical science, which is involves observations and hypotheses about human behavior, in addition, the rationalist approach involves a combination of mathematics and engineering (Russell & Norvig, 2010).

AI systems can be designed to mimic cognitive functions such as perception, problem solving, and decision making. Machine learning, which is a subset of AI, allows systems to improve their performance over time by learning from data patterns. Artificial intelligence has diverse technologies, ranging from rule-based expert systems to advanced neural networks. The main goal of artificial intelligence is to create machines that can perform tasks efficiently and autonomously, ultimately improving efficiency, accuracy, and problem-solving capabilities in various domains such as in healthcare, finance, and robotics. As AI advances, its impact on society, the economy, and technology is enormous. In addition, the continued application of AI must be able to provide ethical considerations and responsible AI development.

The internet and digitalization have changed business models from traditional to new service models in the industry. Currently, several traditional business models have not yet integrated and penetrated (used) the Internet. Traditional companies are faced with high development costs, difficulties in managing inventory, lack of user engagement, and lack of understanding of user positions and user needs which have a serious impact on the development of micro, small and medium enterprises (MSMEs). Reporting from Republika.co.id (2023) by the Coordinating Minister for Maritime Affairs and Investment, Luhut Binsar Pandjaitan stated that Micro, Small and Medium Enterprises have a very important role for the national economy and in June 2023 as many as 22.68 million MSME units have carried out onboarding. to the digital ecosystem. Apart from that, UNCTAD (United Conference on Trade and Development) wrote that the contribution of Small and Medium Enterprises has reached 60.3% to GDP (Gross Domestic Product) and can absorb 97% of Indonesia's workforce by 2022 (Repbublika.co.id, 2023).

The large scale and number of MSMEs in Indonesia support the national economy. Improvement of the national economy will occur if sustainable development continues to be developed for the economic sector and social stability in the context of the welfare of society and the country. The current dilemma is that transformation is an important step for the sustainable development of MSMEs, and if this step is not taken in the long term, MSMEs will experience setbacks and even bankruptcy (Yi He, 2023). On the other hand, transformation requires a lot of resources, management changes and updating operating models are the biggest challenges for business actors. In the era of increasingly high Internet usage, companies must implement new innovative, operating and sales models to replace inefficient traditional bureaucratic management methods (Yi He, 2023).

LITERATURE REVIEW

I. Industrial Revolution 4.0

The industrial revolution 4.0 is an era of digitalization where all systems are interconnected (collaborate) anywhere in real time using information technology and integration of the Cyber Physical

System (CPS) along with the Internet of Things (IoT) and Internet of Services (IoS) so that it can providing innovation and business optimization that is more efficient and effective (Kagermann, 2011). Germany is the first country to talk about industry 4.0 because it is related to their country's development plan policy or what is called High-Tech Strategy 2020 (Heng, 2013). Then several other countries began to develop the concept of industry 4.0 with the terms Smart Industry, Smart Factory, Advanced Manufacturing, and so on which aims to increase competitiveness and face global competition (Prasetyo & Sutopo, 2018).

There is evidence that the technology underlying the industrial revolution 4.0 will naturally influence all corporate organizations on the way leaders do business, labor market conditions and resources. One specific symptom of this phenomenon is the historical decline in the average age of companies listed in the S&P 500 which recorded a decline in company age down from around 60 years to around 18 years (Schwab, 2017). Another symptom is the shift in the time it takes for new entrants to dominate the market and achieve significant revenues, such as Facebook taking six years and Google only taking five years to reach revenues of $1 billion per year driven by new technology (Schwab, 2017). This provides evidence that businesses supported by technology and digital capabilities can increase the speed and scale of change for the business world.

Kagermann (2013) states that industrial revolution 4.0 provides benefits such as meeting customer needs personally, providing new business models, optimal decision making, providing added value, and dynamic engineering and business processes. Apart from that, Schwab (2017) explains that the industrial revolution 4.0 has four main impacts on cross-industry businesses, such as:

- Customer expectations change.
- Products are improved with data, thereby increasing asset productivity.
- New partnerships are being formed as companies realize the importance of newer forms of collaboration,
- Changed operating model to a new digital model.

Apart from the benefits, industry 4.0 also has challenges such as resistance to changes in social aspects, unstable political conditions, demographic changes, the application of sustainable technology, the risk of natural disasters, and limited resources (Drath and Horch, 2014). Therefore, the application of industry 4.0 must be adapted to the conditions of the user and based on the ability to use the latest technology and resources.

II. Artificial Intelligence (AI) and Digital Transformation

The recent history of artificial intelligence dates back to World War II and the advent of computers. Many advances in computer science and proficiency in programming techniques have been achieved through the challenges of trying to enable computers to have game features and master complex board games (Lucci & Kopec, 2016). Some examples of games played with computers that have utilized the application of artificial intelligence insights and methodologies are the computer games Chess and Othello.

Artificial intelligence (AI) and digital transformation are fundamentally interrelated and are changing the world of work and life. Digital transformation, also known as “business transformation” is a response to the rapid adoption of digital technology supported by the internet by humans (customers) so that the success of the transformation depends on humans (employees) working effectively with digital technology to provide a better customer experience for other humans (Laurens, 2019). Digital transformation creates new ways of working and creates value (innovation) rather than traditional methods which can free humans to be more creative, while machines can do the heavy work replacing humans. Businesses that adopt digital transformation collaborate between humans (workers) and machines (technology) and become more productive, stronger and faster in their development.

Although digital transformation and AI have good potential for business growth for companies that are able to adopt them appropriately. Digital transformation and AI will not be successful without building a competency base in the six capabilities, namely a digital roadmap led by business, talent,

operating model, technology, data, adoption and scaling (Lamarre et al, 2023). Then, these elements are interconnected and need to be managed in a way that is similar to a good operating model competency, for example, a company will not be able to run without the right talent (Lamarre et al, 2023). Likewise, great technology will not have a big impact if users cannot adopt it.

Digital transformation has developed rapidly in Indonesia since the existence of the internet in line with the growth of technology, information and communication. Liu et al (2019) stated that in order to increase the productivity and efficiency of companies in the field of digital transformation, it is necessary to use digital technology including the internet of things (IoT), cloud computing and big data.

III. Artificial Intelligence (AI) and MSMEs

Kanovska (2020) explains that smart technology in terms of artificial intelligence (AI) has significant potential for business actors to develop their business even though the development of AI for Micro, Small and Medium Enterprises (MSMEs) is still in its infancy. Based on information from Aaja Baruwal, the Driven Transformation for Businesses Rosebay Group said that MSMEs in Indonesia consider that AI and Big Data are not yet relevant for MSMEs because the businesses they have formed are still new and have no or very little data about consumers (CNN Indonesia.com, 2020). Apart from that, the use of AI and Big data will be very useful for MSMEs to predict and provide recommendations about consumer behavior, although integrated management and systems are needed to be able to adopt big data and machine learning technology which can help business actors to get recommendations, predictions and deep data analysis making decisions that affect the quantity or quality of products/services produced (Fathoni & Bhrata, 2022).

The CEO of ICS Compute, Budhi Wibawa, explained that MSMEs in Indonesia can utilize AI tools from Amazon Web Services (AWS) to save costs and simplify business activities such as generative AI which can create content, provide new ideas, images, videos, stories and music, while a machine learning tool called Amazon Sage Maker can observe customer shopping patterns, examine sales data and estimate consumer shopping tendencies (trends) in the future (Kompas.com, 2023). Furthermore, Budhi added that if AI is used thoroughly then MSME players will benefit in their business because AI democratizes technology for all parties and the AI tools on AWS can be used for free within a certain period of time (Kompas.com, 2023).

METHOD

This research uses a method with a qualitative descriptive approach. Method The qualitative descriptive approach is a research method that aims to describe in depth a phenomenon or event and focuses on understanding meaning and context, without using quantitative measurements. This research collects data through observation, content analysis originating from literature studies in the form of articles, journals, official sources and books (Winartha, 2006). Next, this method applies qualitative analysis to identify emerging patterns, themes, or characteristics. The results of research using this method are in the form of narrative descriptions that provide an in-depth understanding of the phenomenon being studied. A qualitative descriptive approach is suitable for use in this research because the researcher aims to explore insight, contextual understanding, or complexity of the topic of implementation of digital transformation and artificial intelligence as an innovation for the development of micro, small and medium enterprises (MSMEs). Apart from that, the relationship with the industrial revolution 4.0 era is also discussed, where the 4.0 revolution era is closely related to digital transformation. The initial stage of this research is to collect data from trusted literature and books related to the industrial revolution 4.0 era which is related to digital transformation so as to encourage the development of intelligence. creation and implementation in the realm of development economics, especially for micro, small and medium enterprises (MSMEs). After that, researchers looked

for viewpoints from the literature in a broad and in-depth manner regarding the existing technology in the application of artificial intelligence in Indonesia for MSMEs and analyzed the data to come to a conclusion about the implementation, potential and challenges that exist for the application of artificial intelligence technology and digital transformation. The results of this research use data analysis techniques in the form of data reduction, namely data obtained from trusted sources, websites, and based on the author's observations to be able to obtain conclusions that do not eliminate the value of the data. The author also presents the data narratively so that the data that has been processed is easy for readers to understand. Furthermore, this research provides recommendations that can be carried out by micro, small and medium enterprises (MSMEs) along with the private sector and government to work together and increase or make maximum use of the productivity and management of business actors from the use of digital transformation and artificial intelligence in Indonesia.

RESULTS AND DISCUSSION

I. Results

Overall, the impact of the industrial revolution 4.0 on business is a change that cannot be separated from the simple digitalization that characterized the industrial revolution 3.0 to a much more complex form of innovation based on a combination of various technologies with the latest methods. This forces all business actors to review the way they run their business and take a different form (Schwab, 2017). The industrial revolution 4.0 encourages business people to create innovations from traditional forms of business that have a disruptive impact and direct consumers into cyberspace using the Internet and the latest technology in the form of artificial intelligence. A change is disrupting the transportation sector in Indonesia, such as the development of online transportation on the Go-Jek, Grab and Maxim applications.

The Covid-19 pandemic has also made a big contribution to creating a new ecosystem in the context of the Indonesian economy in the form of digital entrepreneurship, thereby indirectly encouraging MSMEs to adapt towards digital. Several factors that must be taken into account in developing digital MSMEs include considerations of quality and production capacity, and human resource factors to understand digital literacy (Arianto, 2020). Apart from that, other factors are not Another important aspect in developing digital MSMEs is alignment with consumer behavior in the digital era and infrastructure issues (Hanim et al, 2021).

Digital transformation and the use of artificial intelligence (AI) technology in Indonesia have become an integral part of economic and social development. Along with the development of information and communication technology, many sectors in Indonesia have adopted digital transformation to increase operational efficiency and competitiveness. Large companies and MSMEs are starting to utilize various digital solutions, ranging from changes to e-commerce, digital financial services, to implementing AI systems to increase productivity and innovation. Large companies such as e-commerce Shopee, Tokopedia, Lazada and so on have utilized AI technology in the form of chatbots, recommendation engines, big data and so on. This shift in adoption of the latest technology is clearly visible in the financial sector, where digital banking services are increasingly dominating, using AI technology to analyze credit risk, detect fraud, manage portfolios, and change the way financial institutions operate. Additionally, in the manufacturing industry, companies are starting to apply automation and IoT supported by AI to improve production efficiency and product quality.

Based on Accenture research entitled Realizing a Cloud-Enabled Economy: How Cloud Drives Economic and Societal Impact Through Micro, Small, and Medium-Sized Businesses, it is said that one of the AI tools called Generative AI recorded significant high growth among cloud technology in the long term. In the next 10 years, Generative AI tools will grow 27% every year. Apart from that, Accenture research explains that 75% of Indonesian MSMEs from socially diverse industrial backgrounds by 2030 will adopt AI such as machine learning, natural language processing and generative AI (Kompas.com, 2023).

II. Discussion

Implementation of Artificial Intelligence (AI) in digital transformation for MSMEs

Digital transformation in Indonesia is becoming more prominent through the implementation of artificial intelligence and is specifically having a positive impact on Micro, Small and Medium Enterprises (MSMEs). The application of AI in the context of Indonesian MSMEs has provided innovative solutions to increase operational efficiency, competitiveness and ability to adapt to market changes. One of the most important aspects of AI integration is its ability to analyze big data and provide valuable insights to MSMEs. The rapid development of the digital economy today together with the industrial revolution 4.0 opens up opportunities for business actors to adopt the latest technology along with artificial intelligence. The adoption of artificial intelligence for small and medium businesses in Indonesia is still relatively low. However, several MSMEs have adopted AI, such as the Sri Ratu Loundry business which uses the no-code chatbot platform from WhatsApp Business as an efficient communication, recording and scheduling system for order pick-up and delivery services (Ardiansyah, 2023). In the world of e-commerce, it is hoped that MSMEs in Indonesia will also adopt artificial intelligence technology to improve the online shopping experience. AI-based product recommendation systems in e-commerce will help MSMEs to understand customer preferences, increase sales and build long-term relationships. Furthermore, AI can help MSMEs in supply chain management, predicting demand, optimizing stock, reducing the risk of overstock or understock which can be detrimental to the business. Benefits and Risks of Using AI and Digital Transformation for MSMEs.

The application of artificial intelligence (AI) and digital transformation provides various significant benefits for MSMEs in Indonesia. One of the main benefits is increased operational efficiency. AI can help MSMEs automate various tasks, from inventory management, customer data analysis, to automated customer service. This not only increases productivity, but also allows for greater focus on innovation and product development. Apart from that, digital transformation expands market access for MSMEs. Through e-commerce and digital marketing platforms, MSMEs can reach a wider range of consumers or can also reach consumers throughout the country and even globally. Sophisticated data analysis also helps MSMEs to understand market trends, customer preferences and compete more effectively. The adoption of AI technology also simplifies financial and payment processes, strengthening the competitiveness of MSMEs in the digital economy era.

One important aspect of artificial intelligence is its ability to analyze big data. With this ability, artificial intelligence can identify patterns that are difficult for humans to recognize. In a business context, this means companies can make more informed and timely decisions, opens up new opportunities and increases operational efficiency. Machine learning technology which is the core of artificial intelligence

allows systems to learn from data and existing experiences (historical past), adapting without the need for extensive programming. Although generally speaking, not many MSMEs in Indonesia have applied AI technology, several MSMEs have utilized platforms that utilize AI features, such as Warung Pintar, which is a startup to help warung (small shop) businesses to be able to work directly with suppliers and distributors and improve management performance. stall business becomes more effective.

Even though digital technology and AI have various benefits, there are also risks that need to be aware of when using these technological tools for MSMEs. One of the main risks is the cost of implementing technology which is sometimes relatively expensive for the MSME category, especially small-scale (home-based) businesses which may face financial challenges in adopting this advanced technology. Apart from that, the risk of personal data security (privacy) must also be considered. The use of digital technology increases the potential risk of customer data leaks or cyberattacks that could harm a business's reputation. Apart from that, the digital literacy aspect is also a challenge in itself. MSMEs that do not have sufficient technological knowledge may have difficulty integrating and understanding the benefits of adopting AI technology. Therefore, training and assistance in implementing this technology needs to be an integral part of the digital transformation strategy for MSMEs. By understanding and managing these risks, MSMEs can maximize the benefits of using AI and digital transformation to increase their competitiveness and business growth.

CONCLUSION

The Industrial Revolution 4.0 opens up great opportunities for small and medium enterprises (SMEs) to change their operational paradigm. By adopting advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and additive manufacturing, SMEs can optimize their business processes. Digitalization provides a platform for MSMEs to increase production efficiency, manage supply chains more effectively, and reduce operational costs. In addition, big data analysis allows small and medium businesses to gain in-depth insight into market trends, customer behavior, and show more effective and efficient business strategies. Collaboration through digital networks also expands business partnership opportunities, while the use of technology to improve customer experience can help MSMEs excel in their business. However, challenges such as personal data (privacy), digital security, and the need for employee involvement in learning and developing new skills also need to be addressed alongside AI adoption. With the right awareness and adaptation, SMEs can gain major benefits from the Industrial Revolution 4.0 and can strengthen their competitiveness in an increasingly connected global economy.

It is also hoped that the Indonesian government will support the implementation of AI in MSMEs through various initiatives and regular training programs, especially in areas outside Java. Training and mentoring programs along with accessibility to AI technology are the focus to ensure that MSMEs can take full advantage of the digital revolution. Moreover, AI innovation opens the door for MSMEs to get involved in a wider range of sectors, such as smart manufacturing, digital agriculture and innovative financial services. Through AI integration, MSMEs in Indonesia can play a greater role in the digital economy, creating jobs and creating opportunities for sustainable national economic growth.

REFERENCES

Ardiansyah, Hilman, Ginanjar. (2023). Implementation of Chatbot Auto Reply on WhatsApp Using Artificial Intelligence (Case Study of Sri Ratu Laundry). *Sti&K National Seminar on Information and Communication Technology, Volume 7 Number 1,1*

Arianto, B. (2020). Development of Digital MSMEs during the Covid-19 Pandemic. ATRABIS: Journal of Business Administration (e-Journal), 6(2), 233-247

Chakraborty, Sourojeet, et al. (2023). Insights on mapping indusrty 4.0 and Education 4.0. *Front. Educ.* 8:1150190. https://doi: 10.3389/feduc.2023.1150190

CNN Indonesia.com. (2020). Expert Says Big Data and AI Must Start to Be Used by Indonesian MSMEs. Accessed from https://www.cnnindonesia.com/technology/20201126201456-185-575093/pakar-besar-big data-dan-ai-besar-mulai-dipakai-umkm-ri on 2 October 2023

Drath, R., & Horch, A. (2014). Industrie 4.0: Hit or hype? [industry forum]. IEEE industrial electronics magazine, 8(2), pp. 56-58.

Fathoni, M, Alif., & Bhrata, A, Arta. (2022). Smart Manufacturing Management System Utilizing Big Data and Machine Learning Algorithms for MSME Production. Journal of Science Innovation and Technology (SINTECH), *Volume 3, Number 1 November 2022: 36-47*.

Hanim, L., Soponyono, E., & Maryanto. (2021). Development of Digital MSMEs during the Covid 19 Pandemic. *National Seminar on Research and Community Service*

Heng, S. (2014). Industry 4.0: Upgrading of Germany's Industrial Capabilities on the Horizon. https://ssrn.com/abstract=2656608

Hernandez-de-Menendez, et al. (2020). Competencies for industry 4.0. Int. J. Interact. Design Manuf 4, 1511–1524. https://doi: 10.1007/s12008-020-00716-2.

Kagermann, H., Lukas, W.D., & Wahlster, W. (2011). Industry 4.0: With the Internet of Things on the way to the 4th industrial revolution. http://www.vdinachrichten.com/Technik Gesellschaft/Industrie-40- Mit-Internet-Dinge-Weg-4-industriellen-Revolution.

Kanovska, L. (2020). Are smart service manufacturing providers different in cooperation and innovation flexibility, in innovation performance and business performance from non- smart service manufacturing providers? *12*(4), 105–116. Retrieved from https://doi.org/10.2478/emj-2020-0031.

Kompas.com. (2023). Benefits of AI for MSMEs, Facilitate Business and Save Costs. Accessed from https://tekno.kompas.com/read/2023/09/27/11550087/besar-ai-untuk-umkm simplify-usaha-dan-menghemat-bayar?page=all on 12 October 2023

Lamarre et al. (2023). *The McKinsey Guide to Outcompeting in the Age of Digital and AI. Wiley.*

Laurens, Rob. (2019). Digital Transformation. Routledge: Tayloy & Francis Group. https://www.routledge.com/rsc/downloads/Digital_Transformation_v2.pdf

Liu, C. H., Lin, Q., & Wen, S. (2019). Blockchain-Enabled Data Collection and Sharing for Industrial IoT with Deep Reinforcement Learning. IEEE Transactions on Industrial Informatics, 15(6). https://doi.org/10.1109/TII.2018.2890203

Lucci, Stephen., & Kopec, Danny. (2016). Artificial Intelligence in the 21st Century: Second Edition. Mercury Learning and Information: Dulles, Virginia.

Prasetyo, Hoedi., & Sutopo, Wahyudi. (2018). Industry 4.0: Study of Aspect Classification and Research Development Directions. Journal of Industrial Engineering, Vol. 13, no. 1.

Repbulika.co.id. Noor, Ahmad Fikri. (2023). Luhut: 22.68 million Digital Onboarding MSMEs as of June 2023. Accessed from https:// Ekonomi.republika.co.id/berita/rzom48490/luhut-2268-juta-umkm onboarding-digital-per-juni-2023.

Russell, S. J., & Norvig, P. (2010). *Artificial intelligence: a modern approach.* 3rd ed. Upper Saddle River, NJ, Prentice Hall.

Schwab, Klaus. (2017). The fourth Industrial Revolution. Portfolio.

https://law.unimelb.edu.au/__data/assets/pdf_file/0005/3385454/SchwabThe_Fourth_Industrial_Revolution_Klaus_S.pdf

Supriyadi, E. I., & Asih, D. B. (2020). Implementation of Artificial Intelligence (AI) in the Field of Public Administration in the Era of Industrial Revolution 4.0, *RASI Journal, Volume 2, No.2*.

Wirartha, I, Made. (2006). Research Methodology: Socioeconomic. Andi: Bulungan Regency Library and Archives Office

Yi He. (2023). Path and Mechanism of Industrial Internet Industry Promoting the Transformation and Upgrading of Small and Medium-sized Enterprises with Artificial Intelligence. *Hindawi Mobile Information System*. https://doi.org/10.1155/2023/3620662