

Digital Transformation for the Future of the Manufacturing Industry in Merauke Regency

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ABSTRACT

This study aims to examine the opportunities, challenges, and strategies for implementing digital transformation in Merauke's manufacturing sector. A qualitative descriptive approach is applied, using literature review, policy analysis, and relevant studies on industrial digitalization. The findings indicate that technologies such as Internet of Things (IoT), Artificial Intelligence (AI), cloud computing, big data analytics, and automation significantly improve production efficiency, product quality, and industrial competitiveness while expanding market access through digital platforms and e-commerce. Effective implementation requires strong collaboration among government, industry, educational institutions, and local communities.

Keywords: digital transformation, manufacturing industry, Industry 4.0, Merauke, smart manufacturing

INTRODUCTION

The rapid development of digital technology has fundamentally reshaped the landscape of global industry. The Fourth Industrial Revolution, characterized by the convergence of cyber and physical systems, has compelled manufacturing companies to adopt smarter, more flexible, and more efficient production systems. Technologies such as Internet of Things (IoT), Artificial Intelligence (AI), Big Data Analytics, Cloud Computing, and Cyber-Physical Systems now serve as core elements in modern industrial transformation.

In Indonesia, the government has launched the Making Indonesia 4.0 program as a national roadmap to enhance the competitiveness of the manufacturing sector through digitalization and technological innovation. This program emphasizes the importance of developing digital connectivity, data analytics capabilities, cybersecurity, and strengthening human resources within the industrial sector.

Merauke Regency holds a strategic position as an economic center in the South Papua region. Beyond its widely recognized role as a national food granary, Merauke possesses considerable potential for developing processing industries based on agriculture, fisheries, livestock, plantations, and other local products. The regional government has also continued to promote economic transformation through various digital services and investment initiatives.

Nevertheless, the majority of small and medium-scale industries in Merauke remain at the early stages of digitalization. Previous studies have shown that the performance of formal small-scale industries in Merauke is still relatively low, requiring improvements in both productivity and broader market access. Digital transformation presents a strategic opportunity to enhance operational efficiency, expand market reach, and generate added value for the local manufacturing sector. This study therefore seeks to address the following question: what are the opportunities, challenges, and implementation strategies for digital transformation in the future of the manufacturing industry in Merauke Regency?

LITERATURE REVIEW

Digital Transformation

Digital transformation refers to the process of integrating digital technologies across all dimensions of an organization and its business activities, generating significant shifts in the way organizations operate and deliver value to their customers. This transformation extends beyond the mere adoption of new technologies; it encompasses changes in strategy, organizational culture, business processes, and operational models. In the current digital economy, digital transformation has become a critical factor for organizations seeking to enhance efficiency, drive innovation, and sustain competitiveness amid the accelerating pace of technological change. Vial (2019) defines digital transformation as a process aimed at improving organizational performance through the combination of digital technologies and continuous organizational change. Within the manufacturing sector, digital transformation constitutes the primary foundation for implementing Industry 4.0 through the utilization of technologies such as Internet of Things (IoT), Artificial Intelligence (AI), big data analytics, cloud computing, and automation systems. These technologies enable companies to collect, manage, and analyze data in real time to support faster and more accurate decision-making. Beyond improving operational efficiency, digital transformation also facilitates supply chain optimization, product quality enhancement, production cost reduction, and the development of manufacturing systems that are more flexible and responsive to shifting market demands (Verhoef et al., 2021).

Furthermore, digital transformation opens pathways for manufacturing industries to create more innovative and customer-oriented business models. Through the use of digital platforms, e-commerce, and data-driven technologies, companies can broaden their market reach, strengthen customer engagement, and develop products and services that better align with consumer needs. The success of digital transformation, however, depends substantially on the readiness of human resources, the availability of digital infrastructure, management support, and a conducive policy environment. Digital transformation must therefore be understood as a strategic process involving comprehensive technological and organizational change to achieve sustainable competitive advantage.

Digital transformation represents a process of integrating digital technologies into every aspect of an organization, resulting in fundamental changes in organizational operations and the value delivered to customers. It encompasses not only the use of new technologies but also shifts in organizational culture, business models, and operational processes.

According to various studies, digital transformation involves three main dimensions: the transformation of business processes, the transformation of business models, and the transformation of customer experience. In the manufacturing context, digital transformation enables real-time data integration, making decision-making faster and more precise.

Industry 4.0 and Manufacturing

Industry 4.0 represents the fourth generation of industrial revolution, integrating information technology, automation systems, and digital communication into production processes. Its defining characteristics include the Internet of Things (IoT), Artificial Intelligence (AI), Big Data Analytics, Cloud Computing, Cyber-Physical Systems, and Robotics and Automation. The implementation of these technologies enables companies to significantly enhance productivity, cost efficiency, and product quality.

Industry 4.0 represents a major transformation in the manufacturing sector, defined by the integration of digital technologies such as Internet of Things (IoT), Artificial Intelligence (AI), big data analytics, cloud computing, and cyber-physical systems. This technological integration facilitates the emergence of smart manufacturing systems that operate in a connected, automated, and real-time data-driven manner. Within this framework, machines, production systems, and human actors communicate with one another to create production processes that are more efficient and adaptive to changes in global market demand.

The application of Industry 4.0 in manufacturing brings significant impacts on operational efficiency, production flexibility, and product quality. Technologies such as IoT enable real-time machine monitoring, predictive maintenance, and data-driven supply chain optimization. These capabilities not only reduce production downtime but also improve productivity and lower overall operational costs. The integration of AI into manufacturing systems further supports automated decision-making based on data analytics, strengthening the capacity of industries to adapt to dynamic market conditions.

Manufacturing Industry Development in Merauke

The development of the manufacturing industry in Merauke Regency in recent years has taken an increasingly strategic direction, particularly following the designation of the region as part of an integrated food, energy, and industrial development zone in South Papua. The central government has been promoting the construction of various industrial facilities based on local resources, including bioenergy such as bioethanol, which is

targeted to begin production by 2027. This trajectory indicates that Merauke is no longer solely positioned as a national food granary but is also emerging as a center for processing and manufacturing industries based on renewable energy, in support of the national energy self-sufficiency agenda (ANTARA News, 2025; Liputan6, 2025).

Beyond the energy sector, manufacturing development in Merauke has also been marked by the entry of various investments in supporting industries such as plantation product processing and biomass energy. A notable example is the construction of a renewable energy facility based on biogas and biomethane in South Papua, operating within the Merauke industrial zone. The presence of such industries strengthens the local manufacturing ecosystem by creating new value chains that convert palm oil industry waste into economically valuable energy. This development reflects a transition toward green industry, which has increasingly become a focus of modern industrial development in eastern Indonesia (Kontan, 2025; Disway Papua Selatan, 2025).

However, the development of the manufacturing sector in Merauke continues to face significant challenges related to infrastructure readiness, the availability of skilled labor, and the integration of modern industrial technologies. While there has been an acceleration of industrial zone development, the sustainability of manufacturing growth depends heavily on the region's capacity to adopt Industry 4.0 technologies and strengthen logistical connectivity. Through integrated infrastructure programs and food production center zones, the government is working to strengthen the industrial foundation, yet long-term success will require sustained collaboration among government, investors, and local communities to build an inclusive and sustainable industrial ecosystem (ANTARA News, 2025; Kementerian PUPR, 2025).

The manufacturing industry in Merauke Regency is predominantly composed of small and medium-scale industries based on local resources, including agricultural product processing, sago processing, food production, fishery product processing, and household-scale industries. Previous research has demonstrated that strengthening micro, small, and medium enterprises (MSMEs) and local industries plays a vital role in improving community welfare and creating employment opportunities in Merauke.

RESEARCH METHOD

Research Design

This study employs a qualitative descriptive approach to analyze the opportunities, challenges, and implementation strategies for digital transformation in the manufacturing sector of Merauke Regency. This approach was selected because it allows the researcher to develop a deep understanding of the phenomenon within the complex social, economic, and industrial policy context. A qualitative method is also particularly relevant for studying digital transformation, as the digitalization process is not merely technical in nature but also involves organizational, human, and external environmental dimensions.

In addition, this study adopts an exploratory approach grounded in literature and policy analysis, consistent with previous research demonstrating that digital transformation in the manufacturing sector requires a comprehensive mapping of technological, organizational, and environmental factors, following the Technology-Organization-Environment (TOE) framework (Zhong et al., 2023).

Data Collection

The data in this study were collected through secondary data sources, comprising three main categories. First, international scientific literature, including reputable journal

articles related to Industry 4.0, smart manufacturing, digital transformation, and industrial competitiveness. Second, government policy documents, including the Making Indonesia 4.0 policy framework, national industrial development reports, and programs for industrial zone development in South Papua. Third, grey literature and industry reports, including reports from official media outlets, ministerial publications, and data on MSME and local industry development in Merauke.

This approach aligns with research methods widely employed in studies of digital transformation in modern manufacturing, where the combination of academic literature and grey literature is used to construct a more contextual and applicable analytical framework (Kristianto et al., 2025)

RESULTS

The findings of this study indicate that digital transformation plays a critically important role in supporting the development of the manufacturing industry in Merauke Regency. As a region endowed with considerable potential in agriculture, fisheries, livestock, and agroindustry, Merauke has the opportunity to leverage digital technologies to enhance the added value of local products. Digital transformation enables industry actors to optimize production processes, improve operational efficiency, and strengthen competitiveness in an increasingly contested market. With the appropriate use of technology, manufacturing industries in Merauke can transition from conventional production systems toward more modern and integrated ones.

The study found that the implementation of Internet of Things (IoT) technology enables manufacturing industries to monitor production activities in real time. IoT-based sensors facilitate the monitoring of raw material usage, machine performance, and product quality with greater precision. This capability allows companies to detect production disruptions more quickly and reduce operational losses while generating valuable data for improving industrial productivity.

The findings also demonstrate that Artificial Intelligence (AI) and big data analytics contribute significantly to manufacturing performance. AI supports demand forecasting, production scheduling, and automated quality control, whereas big data analytics enables companies to process large volumes of operational data into strategic information for business planning. These technologies improve operational efficiency and enhance companies' ability to respond to changing market demands.

Furthermore, the study reveals that digital transformation expands market access for locally manufactured products. The adoption of digital marketing platforms and e-commerce enables local businesses to reach customers beyond Merauke Regency, extending their market coverage to national and international levels. This broader market access contributes to increased sales opportunities and stronger product visibility.

Despite these benefits, several barriers to digital transformation were identified. The findings indicate that inadequate digital infrastructure, particularly uneven internet connectivity, remains a major obstacle to technology adoption. In addition, low digital literacy among workers and limited technological skills slow the implementation of Industry 4.0 technologies. Financial constraints also prevent many small and medium-sized enterprises from investing in digital equipment and information systems, limiting the pace of digital transformation.

Finally, the results highlight that successful digital transformation requires collaboration among regional governments, private sector organizations, and educational institutions. Such collaboration is essential for improving infrastructure, increasing investment, facilitating technology transfer, and strengthening workforce competencies.

DISCUSSION

the findings demonstrate that digital transformation has become a strategic driver for strengthening the competitiveness of the manufacturing industry in Merauke Regency. The integration of digital technologies into production systems improves operational efficiency, enhances productivity, and supports the creation of higher-value products. These findings are consistent with the Industry 4.0 framework, which emphasizes the integration of digital technologies to achieve smarter and more efficient manufacturing processes.

The positive contribution of IoT, Artificial Intelligence, and big data analytics confirms the growing importance of digital technologies in industrial development. IoT enables real-time monitoring of production processes, while AI improves forecasting and decision-making through automation. Big data analytics provides valuable business intelligence that supports strategic planning and operational improvements. Together, these technologies enable manufacturing firms to respond more effectively to market changes and improve overall organizational performance.

The expansion of market access through digital platforms represents another significant implication of this study. The adoption of e-commerce and digital marketing allows local manufacturers to overcome geographical limitations and compete in broader markets. This finding suggests that digital transformation not only enhances production efficiency but also strengthens business sustainability through wider customer reach and increased market opportunities.

However, the study also highlights that technological advancement alone is insufficient without adequate supporting conditions. Limited digital infrastructure, inadequate internet connectivity, low digital literacy, and financial constraints remain significant challenges for manufacturing industries in Merauke. These barriers indicate that successful digital transformation requires substantial investment in infrastructure development, workforce training, and accessible financing mechanisms.

The findings further emphasize the importance of collaboration among government, industry, and educational institutions. Government policies should prioritize digital infrastructure development and financial incentives for technology adoption, while educational institutions should provide training programs that enhance digital competencies among the workforce. Private sector participation is equally important in promoting technology transfer and investment. Such collaborative efforts are essential for creating an enabling ecosystem that supports sustainable industrial digitalization.

Overall, this study suggests that digital transformation can become a catalyst for regional industrial development and sustainable economic growth in Merauke Regency. By addressing existing infrastructural, financial, and human resource challenges through coordinated stakeholder collaboration, manufacturing industries will be better positioned to compete in the Industry 4.0 era while contributing to regional economic resilience and long-term development.

CONCLUSION

Digital transformation represents a strategic imperative for enhancing the competitiveness and sustainability of the manufacturing industry in Merauke Regency in the era of Industry 4.0. The findings of this study demonstrate that Merauke possesses substantial potential for developing a manufacturing sector grounded in local resources, particularly in agroindustry, agriculture, fisheries, and small-scale industries. The adoption of digital technologies such as Internet of Things (IoT), Artificial Intelligence (AI), cloud computing, big data analytics, and automation systems can improve production efficiency, product quality, supply chain management, and market access through digital platforms and e-commerce.

Nevertheless, the implementation of digital transformation in Merauke's manufacturing sector continues to face a range of challenges. Limitations in digital infrastructure, low levels of technological literacy and skills among the workforce, and minimal investment in modern technologies remain the primary barriers to industrial digitalization. These conditions have left the majority of industry actors, particularly small and medium enterprises, unable to optimally adopt digital technologies to improve productivity and competitiveness.

This study also demonstrates that the success of digital transformation requires strong synergy and collaboration among the regional government, industry actors, educational institutions, and the broader community. The government holds a vital role in providing adequate digital infrastructure, creating policies that support technology investment, and facilitating human resource capacity development. Educational institutions and the business sector, in turn, need to collaborate in enhancing workforce competencies and promoting technological innovations that align with local industry needs.

In sum, accelerating digital transformation in the manufacturing sector of Merauke Regency has the potential to serve as a primary driver of industrial competitiveness, regional economic growth, employment creation, and sustainable development. An integrated and sustained strategy is therefore needed to strengthen the digital ecosystem so that manufacturing industries in Merauke can adapt and thrive in the face of the challenges and opportunities presented by the era of Industry 4.0.

REFERENCES

- ANTARA News. (2025). *ESDM targetkan Papua produksi bioetanol mulai 2027*.
- ANTARA News. (2025). *PU integrasikan infrastruktur, dukung sentra pangan di Merauke*.
- Atmasani, D. (2025). Peran Internet of Things (IoT) terhadap peningkatan fleksibilitas sistem produksi industri dalam era Industri 4.0. *Jurnal Media Elektronika*. <https://journal.unm.ac.id/index.php/JME/article/view/10893>
- Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly*, 37(2), 471–482. <https://doi.org/10.25300/MISQ/2013/37:2.3>
- Bismar, B., Teturan, Y. E., & Maturbongs, E. E. (2024). Pemberdayaan UMKM Orang Asli Papua guna meningkatkan perekonomian di Kabupaten Merauke. *Jurnal Administrasi dan Kebijakan Daerah*, 4(2), 115–126.
- Butt, J. (2020). A conceptual framework to support digital transformation in manufacturing using business process management. *Designs*, 4(3), Article 17. <https://doi.org/10.3390/designs4030017>

- Derigent, W., Cardin, O., & Trentesaux, D. (2020). *Industry 4.0: Contributions of holonic manufacturing control architectures and future challenges*. arXiv. <https://arxiv.org/abs/2002.04525>
- Disway Papua Selatan. (2025). *TSE Group resmikan PLTBg dan CBG pertama di Papua Selatan*.
- Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, 210, 15–26. <https://doi.org/10.1016/j.ijpe.2019.01.004>
- Kagermann, H., Wahlster, W., & Helbig, J. (2013). *Recommendations for implementing the strategic initiative INDUSTRIE 4.0*. German National Academy of Science and Engineering.
- Kalsoom, T., Ahmed, S., Rafi-ul-Shan, P. M., Azmat, M., Akhtar, P., Pervez, Z., & Ur Rehman, M. A. (2021). Impact of IoT on manufacturing Industry 4.0: A new triangular systematic review. *Sustainability*, 13(22), Article 12506. <https://doi.org/10.3390/su132212506>
- Kim, S. H., Lee, J., & Park, H. (2022). Factors affecting the technological transition toward Industry 4.0. *Journal of Manufacturing Technology Management*, 33(4), 742–760.
- Kontan. (2025). *TSE Group resmikan PLTBg dan CBG pertama di Papua Selatan*.
- Kristianto, F., Ulfia, Y. N., & Prakoso, G. (2025). Framework for digital transformation in Industry 4.0: Insights data-driven analysis in the Indonesia manufacturing sector. *Journal of Advances in Information and Industrial Technology*, 7(1), 45–60. <https://doi.org/10.52435/jaiit.v7i1.630>
- Lee, J., Davari, H., Singh, J., & Pandhare, V. (2018). Industrial artificial intelligence for Industry 4.0-based manufacturing systems. *Manufacturing Letters*, 18, 20–23. <https://doi.org/10.1016/j.mfglet.2018.09.002>
- Legowo, M. B., & Indiarto, B. (2021). Issues and challenges in implementing Industry 4.0 for the manufacturing sector in Indonesia. *International Journal of Progressive Sciences and Technologies*, 27(2), 123–131.
- Liputan6. (2025). *Pabrik bioetanol di Merauke selesai 2027, bakal serap 3.000 tenaga kerja*.
- Meindl, B., & Mendonça, J. (2021). *Mapping Industry 4.0 technologies: From cyber-physical systems to artificial intelligence*. arXiv. <https://arxiv.org/abs/2111.14168>
- Ministry of Industry of the Republic of Indonesia. (2018). *Making Indonesia 4.0: Roadmap*. Ministry of Industry of the Republic of Indonesia.
- Porter, M. E., & Heppelmann, J. E. (2015). How smart, connected products are transforming companies. *Harvard Business Review*, 93(10), 96–114.
- Ramírez-Durán, V. J., Berges, I., & Illarramendi, A. (2024). *Towards the implementation of Industry 4.0: A methodology-based approach oriented to the customer life cycle*. arXiv. <https://arxiv.org/abs/2401.17661>
- Septarini, D. F., & Manuhutu, F. Y. (2019). Analysis of home industry development based on cost accounting in Merauke Regency, Papua. *International Journal of Sciences: Basic and Applied Research*, 48(4), 45–56.
- Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning*, 51(1), 40–49. <https://doi.org/10.1016/j.lrp.2017.06.007>
- Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122, 889–901. <https://doi.org/10.1016/j.jbusres.2019.09.022>
- Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, 28(2), 118–144. <https://doi.org/10.1016/j.jsis.2019.01.003>

- Warner, K. S. R., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, 52(3), 326–349. <https://doi.org/10.1016/j.lrp.2018.12.001>
- Zhong, R. Y., Xu, X., Klotz, E., & Newman, S. T. (2017). Intelligent manufacturing in the context of Industry 4.0: A review. *Engineering*, 3(5), 616–630. <https://doi.org/10.1016/j.eng.2017.05.015>