



Artificial Intelligence-Based Digital Transformation for MSMEs in Bandung City: An Informatics Framework for Business Intelligence and Sustainable Competitiveness

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Abstract: Micro, Small, and Medium Enterprises (MSMEs) play an important role in supporting local economic development, employment, entrepreneurship, and community welfare. However, the rapid development of digital technology has created new challenges for MSMEs, particularly in terms of digital capability, data management, artificial intelligence adoption, cybersecurity, and the integration of digital platforms into business processes. This study aims to develop an informatics-based framework for implementing contemporary digital technologies among MSMEs in Bandung City. The study employs a qualitative conceptual approach through a literature review and contextual analysis of digital transformation in MSMEs. The analysis integrates artificial intelligence, machine learning, big data analytics, cloud computing, digital payment, e-commerce, business intelligence, and cybersecurity into an integrated digital transformation framework. The findings indicate that MSME digital transformation should develop progressively from basic digital infrastructure and digital transactions toward data integration, intelligent analytics, and strategic decision support. Bandung City provides an important context for this transformation because of its dynamic economic structure and strong development of trade, manufacturing, creative industries, and information and communication activities. The study argues that artificial intelligence should not be adopted independently from organizational capabilities. Effective implementation requires adequate digital literacy, data quality, technological infrastructure, managerial readiness, and cybersecurity. The proposed framework contributes to the information technology literature by connecting contemporary informatics technologies with practical MSME transformation in an urban Indonesian context. The framework also provides a conceptual foundation for future empirical research examining the relationship between digital capability, artificial intelligence adoption, business intelligence, and MSME performance.

Keywords: Artificial Intelligence; Digital Transformation; Information Technology; MSMEs; Bandung City; Machine Learning; Big Data; Business Intelligence; Cybersecurity

I. Introduction

Micro, Small, and Medium Enterprises (MSMEs) represent an important component of economic development because they contribute to employment creation, entrepreneurship, innovation, and income generation. Their contribution becomes particularly significant in developing economies where small businesses provide opportunities for communities to participate in productive economic activities and generate local economic value (Beck et al., 2005; Ayyagari et al., 2007). The increasing integration of information technology into business activities has subsequently transformed the competitive environment in which MSMEs operate. Digital technologies provide opportunities for businesses to expand market access, improve operational efficiency, strengthen customer relationships, and support managerial decision making (Bharadwaj et al., 2013; Vial, 2019).

The transformation of business through digital technology, however, cannot be understood simply as the adoption of social media, e-commerce, or digital payment applications. Digital transformation represents a broader organizational process through which digital technologies influence business processes, organizational capabilities, customer relationships, and value creation (Verhoef et al., 2021; Warner & Wäger, 2019). An MSME that creates an online store but continues to manage inventory manually, stores customer information separately, and makes business decisions without analyzing available data has only achieved a limited form of digitalization. The greater opportunity lies in integrating different technologies so that business information can flow across organizational processes and subsequently support intelligent decision making.

This issue is increasingly relevant in Indonesia because MSMEs are operating within a rapidly developing digital economy. The adoption of e-commerce, social media marketing, digital financial services, and digital payment systems has created new opportunities for small businesses to reach customers and improve transaction efficiency. Nevertheless, digital transformation among MSMEs remains uneven because many businesses continue to face limitations related to financial resources, digital literacy, technological infrastructure, human resources, and organizational readiness (Rahayu & Day, 2015; OECD, 2021). Consequently, the success of digital transformation depends not only on technology availability but also on the ability of entrepreneurs to integrate technology into business processes.

The development of Artificial Intelligence (AI) creates an additional dimension in this transformation. AI has become one of the most important contemporary technologies because it enables organizations to perform prediction, classification, recommendation, natural language processing, and automated decision support (Russell & Norvig, 2021). In the context of MSMEs, AI can potentially be used to predict product demand, classify customers, analyze consumer sentiment, recommend products, automate customer service, and optimize digital marketing activities. Davenport and Ronanki (2018) argue that AI can generate business value when it is connected to practical organizational problems, while Oldemeyer et al. (2024) emphasize that SMEs continue to experience barriers related to knowledge, infrastructure, cost, and data availability when implementing AI.

Bandung City provides an interesting context for examining this transformation. The city has a dynamic economic structure characterized by trade, manufacturing, creative industries, services, and information and communication activities. According to the Bandung City Statistics Agency, the city's economy reached approximately IDR 403.97 trillion at current prices in 2025 and recorded economic growth of 5.29 percent. The information and communication sector has also become an important component of the city's economic structure, creating a favorable environment for the development of technology-oriented businesses and digital entrepreneurship.

The combination of Bandung's entrepreneurial environment and technological development creates an opportunity to position information technology as a strategic instrument for MSME competitiveness. The role of informatics in this context extends beyond software development. Informatics can support the collection, integration, processing, analysis, and interpretation of business data, enabling MSMEs to transform operational information into knowledge and managerial decisions.

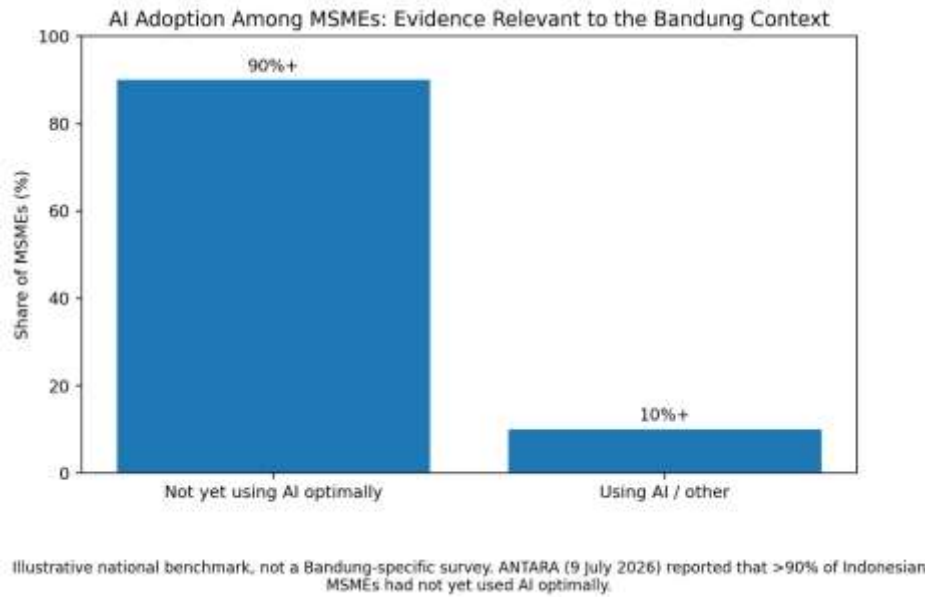


Figure 1. AI Adoption Gap among Indonesian MSMEs: Implications for Bandung City

Source: Author's elaboration based on the statement of the Indonesian Minister of MSMEs reported by ANTARA (2026).

Figure 1 illustrates the substantial gap in artificial intelligence (AI) adoption among Indonesian MSMEs and its implications for the digital transformation of MSMEs in Bandung City. More than 90% of Indonesian MSMEs were reported to have not yet utilized AI optimally, indicating that AI adoption remains at an early stage despite the increasing availability of digital technologies. The figure is presented as a national benchmark rather than a direct measurement of AI adoption among Bandung MSMEs. Nevertheless, the national condition provides an important contextual basis for examining the opportunities and challenges of AI implementation among MSMEs in Bandung City. The relatively low level of AI utilization indicates considerable potential for introducing AI-based applications, particularly in customer management, digital marketing, sales forecasting, inventory management, financial analysis, and business decision-making. Therefore, Bandung's MSME digital transformation agenda should move beyond basic digitalization toward the development of data-driven and AI-supported business capabilities.

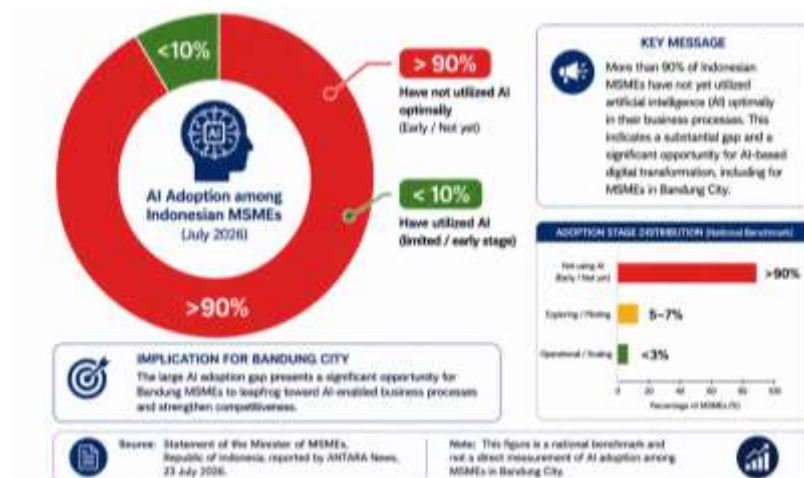


Figure 2. AI Adoption Gap among Indonesian MSMEs: National Benchmark Relevant to the Bandung City Context

Source: Statement of the Minister of Micro, Small, and Medium Enterprises of the Republic of Indonesia, reported by ANTARA News, July 9, 2026.

Figure 2 illustrates the substantial gap in artificial intelligence (AI) utilization among Indonesian MSMEs and its relevance to the digital transformation of MSMEs in Bandung City. The Minister of MSMEs reported that more than 90% of Indonesian MSMEs had not yet utilized AI optimally in their business processes, indicating that AI adoption among MSMEs remains significantly below its potential. This condition demonstrates a substantial opportunity for MSMEs to improve productivity, efficiency, customer engagement, and business decision-making through AI-based technologies. Although the figure uses national-level evidence and therefore should not be interpreted as a direct measurement of AI adoption among Bandung MSMEs, it provides an important benchmark for understanding the broader adoption gap. The relevance to Bandung is reinforced by local digital transformation initiatives, including the introduction of the AI-based Kabayanku application at the 2025 Sajajar MSME culinary festival in Bandung, which was designed to facilitate MSME access to government services, certification, and business assistance.

Recent literature indicates that successful SME digital transformation requires an interaction between technological capabilities and organizational capabilities. Sagala and Őri (2024) demonstrate that digital transformation success is associated with organizational learning, IT alignment, leadership, digital marketing, collaboration, and competitive conditions. This suggests that technology adoption should be accompanied by capability development. The present study therefore proposes an informatics-based framework that connects digital infrastructure, digital transactions, data management, artificial intelligence, business intelligence, and strategic decision making in the context of Bandung MSMEs.

Based on this background, the study seeks to examine how contemporary information technologies can be integrated into MSME business processes and how such integration can support the development of intelligent, data-driven, and sustainable businesses in Bandung City. The study particularly emphasizes the transition from basic digitalization toward intelligent digital transformation in which data and computational technologies become integral components of managerial decision making.

II. Review of Literatures

Digital transformation has emerged as an important research topic in information systems, business management, and entrepreneurship. Vial (2019) defines digital transformation as a process through which digital technologies cause changes in organizational structures, processes, and value creation mechanisms. Verhoef et al. (2021) further explain that digital transformation involves multiple stages and requires changes in organizational capabilities, business models, and customer interaction. This perspective is particularly relevant to MSMEs because limited resources require businesses to adopt technologies strategically rather than simply following technological trends.

Information system adoption in small businesses has traditionally been influenced by technological, organizational, and environmental factors. Thong (1999) emphasizes the importance of organizational characteristics, technological factors, and external conditions in determining information system adoption. Rahayu and Day (2015) similarly demonstrate that Indonesian SME adoption of e-commerce is influenced by perceived benefits, organizational readiness, technological readiness, and environmental conditions. These findings indicate that

technology adoption cannot be separated from the capabilities and circumstances of individual businesses.

Digital transformation therefore requires the development of organizational capabilities. Warner and Wäger (2019) explain that organizations need dynamic capabilities related to digital sensing, digital seizing, and digital transformation. In the context of MSMEs, these capabilities can involve the ability of entrepreneurs to recognize digital opportunities, select appropriate technologies, and modify business processes accordingly. Sagala and Óri (2024) further demonstrate that SME digital transformation is influenced by organizational learning, leadership, IT alignment, digital marketing, collaboration, and competitive conditions. These findings reinforce the importance of integrating technological and organizational perspectives.

Artificial intelligence represents a particularly significant development within the contemporary digital transformation landscape. Russell and Norvig (2021) describe AI as a field concerned with the development of systems capable of performing tasks associated with intelligent behavior. In business environments, AI can support prediction, classification, automation, natural language processing, recommendation, and decision support. Davenport and Ronanki (2018) demonstrate that AI applications can generate business value through process automation, cognitive insight, and customer engagement.

The potential of AI for MSMEs is substantial because many small businesses already generate digital data through transactions, social media, e-commerce platforms, and digital payment systems. Machine learning algorithms can analyze historical sales data to predict future demand, while natural language processing can analyze customer reviews to identify perceptions and concerns. Customer analytics can also enable MSMEs to identify purchasing patterns and develop more personalized marketing strategies.

Nevertheless, AI adoption requires an adequate technological and organizational foundation. Oldemeyer et al. (2024) identify several challenges associated with AI implementation in SMEs, including limited knowledge, financial constraints, insufficient infrastructure, and difficulties related to data. This finding suggests that MSMEs should not immediately implement complex AI systems without first establishing appropriate data management capabilities.

Big data and business intelligence are therefore important components of AI-enabled digital transformation. Chen et al. (2012) explain that business intelligence and analytics transform organizational data into insights that can support decision making. Although individual MSMEs may not possess the enormous datasets associated with multinational corporations, digital platforms enable them to collect increasingly diverse information from transactions, customers, marketing activities, inventory systems, and digital payments.

The development of cloud computing further facilitates this process. Mell and Grance (2011) define cloud computing as a model that provides convenient and on-demand access to shared computing resources. For MSMEs, cloud technology reduces the need for substantial investment in physical infrastructure and allows businesses to access accounting, storage, database, analytics, and AI services through flexible subscription models. Cloud computing therefore provides an important technological foundation for scalable digital transformation. Digital payment systems also play an increasingly important role. Digital payments improve transaction efficiency while simultaneously generating structured transaction records. From an

informatics perspective, these records represent valuable data that can be integrated with accounting, inventory, and customer information. Consequently, digital payment adoption can contribute not only to financial efficiency but also to the development of data-driven business management.

E-commerce similarly contributes to digital transformation by enabling MSMEs to reach customers beyond geographical boundaries. However, the value of e-commerce increases significantly when marketplace data are integrated with inventory, accounting, customer relationship management, and business intelligence systems. Such integration allows MSMEs to identify product performance, customer preferences, sales trends, and marketing effectiveness.

Cybersecurity must also be considered an integral component of digital transformation. Increased dependence on digital systems exposes MSMEs to risks including phishing, malware, unauthorized access, account takeover, and data theft. Therefore, cybersecurity practices such as strong authentication, multi-factor authentication, secure backups, access control, and employee awareness should be integrated into MSME digital transformation strategies from the beginning.

III. Research Methods

This study employs a qualitative conceptual research approach based on literature review and contextual analysis. The objective of the approach is to synthesize existing knowledge concerning digital transformation, artificial intelligence, business intelligence, cloud computing, digital platforms, cybersecurity, and MSME development and subsequently apply the synthesis to the context of Bandung City.

The literature was selected based on its relevance to digital transformation, information technology, artificial intelligence, data analytics, organizational readiness, and MSME development. Both foundational literature and recent academic publications were considered to establish theoretical continuity while reflecting contemporary technological developments. Official information concerning the economic condition of Bandung City was also considered to contextualize the proposed framework.

The analysis was conducted by identifying major technologies relevant to MSME transformation, mapping these technologies to business processes, and synthesizing the relationships between technology adoption, data capability, intelligent analytics, and business decision making. The resulting framework is conceptual rather than statistically validated and therefore should be considered a foundation for subsequent empirical research.

IV. Result and Discussion

The analysis produces the Bandung Intelligent MSME Sustainable Digital Transformation Framework, which conceptualizes digital transformation not merely as a technological upgrading process but as a strategic transformation toward long-term economic, social, and environmental value creation. The framework is grounded in the premise that information technology creates sustainable value only when digital capabilities are embedded within organizational processes, stakeholder relationships, and sustainability objectives. This perspective is consistent with the sustainable development principle that current economic development should not undermine the ability of future generations to meet their needs

(WCED, 1987). It also corresponds with the Triple Bottom Line perspective, which argues that organizational performance should be considered through the interrelated dimensions of economic prosperity, social well-being, and environmental responsibility (Elkington, 1997). Recent studies further demonstrate that sustainability should be integrated into digital transformation rather than treated as a separate organizational agenda, particularly in SMEs where resource constraints make strategic integration essential (Ciarli et al., 2023; Sagala & Őri, 2024; Sánchez et al., 2024).

From this perspective, the proposed framework represents a transition from technology adoption to sustainable digital capability. The fundamental assumption is that technologies such as cloud computing, artificial intelligence, machine learning, data analytics, digital payment, and e-commerce should not operate as isolated applications. Instead, they should form an interconnected information environment in which transaction data are converted into organizational knowledge and subsequently into decisions that improve economic efficiency while generating social and environmental value. This interpretation is important because digital transformation can create both positive and negative sustainability consequences. Digitalization may reduce material consumption, improve resource efficiency, and support smarter decision making, but it can also generate energy consumption, electronic waste, privacy risks, digital exclusion, and new forms of organizational dependency. Sustainable digital transformation therefore requires an explicit alignment between technological innovation and sustainability objectives (George et al., 2021; Singh et al., 2023).

The first stage of the framework involves the establishment of digital infrastructure. At this stage, MSMEs require access to smartphones or computers, reliable internet connectivity, cloud services, digital point-of-sale systems, and basic cybersecurity mechanisms. Infrastructure represents the technological foundation of transformation because advanced applications cannot generate value when businesses lack reliable access to digital systems. However, from a sustainability perspective, infrastructure should not be evaluated solely according to availability. The sustainability of digital infrastructure should also consider affordability, energy efficiency, accessibility, security, and long-term maintainability. For MSMEs with limited financial resources, cloud-based services may provide a more sustainable economic alternative to extensive investment in physical IT infrastructure because computing and storage capacity can be scaled according to business needs. This interpretation is consistent with the Resource-Based View, which emphasizes the importance of valuable and difficult-to-replicate organizational resources in creating competitive advantage (Barney, 1991), while more recent research demonstrates that digital technologies can strengthen organizational sustainability when supported by appropriate capabilities and platforms.

The infrastructure stage also has an important social dimension. Digital access determines whether MSMEs can participate equally in emerging digital markets. Consequently, digital literacy and affordable technology should be considered components of sustainable infrastructure rather than merely supporting variables. An MSME owner who possesses technology without the skills to use it effectively remains digitally disadvantaged. This condition highlights the relationship between technological sustainability and social sustainability because inclusive digital transformation requires the development of human capabilities alongside technological infrastructure. Recent research on MSME sustainable performance identifies organizational learning, managerial expertise, resource bases, and external environmental management as important antecedents of dynamic capabilities and sustainable entrepreneurial outcomes.

The second stage involves digital transaction integration. MSMEs increasingly interact with customers through e-commerce platforms, social media, digital payment systems, QRIS, online delivery services, and digital communication platforms. Each interaction produces information that can potentially be integrated into a broader business information system. The transition from isolated digital activities to integrated digital transactions represents an important step because it allows entrepreneurs to develop a more comprehensive understanding of their customers, revenues, costs, and operational activities.

From the Triple Bottom Line perspective, digital transaction integration can contribute to economic sustainability through lower transaction costs, broader market access, faster payment settlement, and improved financial visibility. The social dimension emerges through improved customer accessibility, greater financial inclusion, and opportunities for small businesses to participate in markets beyond their immediate geographical locations. The environmental dimension can potentially emerge through more efficient transaction processes, reduced reliance on physical documentation, and improved coordination of supply and delivery activities. However, these benefits should not be assumed automatically. Digitalization only contributes to sustainability when efficiency gains are translated into measurable reductions in resource use or improvements in stakeholder welfare.

The third stage involves data management and integration. At this stage, businesses organize information generated through sales, customers, inventory, accounting, marketing, and digital payments. Data cleaning, database development, cloud storage, data standardization, and data governance become critical capabilities. The objective is not simply to accumulate more information but to establish reliable and meaningful organizational knowledge.

This stage represents a critical connection between information technology and sustainability. High-quality data allow MSMEs to measure resource consumption, identify operational inefficiencies, monitor customer behavior, evaluate financial performance, and detect unnecessary activities. Data therefore function as an organizational resource that enables evidence-based sustainability management. For example, a culinary MSME can use transaction and inventory data to identify products that frequently remain unsold, thereby reducing food waste. A fashion MSME can analyze purchasing patterns to avoid excessive inventory accumulation. A retail business can use sales data to optimize replenishment and reduce unnecessary transportation. Thus, data management creates a mechanism through which digitalization can produce environmental and economic benefits simultaneously.

Data governance also introduces an important social and ethical dimension. Customer information collected through digital transactions must be managed responsibly. Privacy, consent, access control, cybersecurity, and transparency become part of sustainable digital transformation because the misuse of customer data can damage trust and create social harm. Stakeholder Theory provides a useful explanation for this relationship because business value should be understood as being created for multiple stakeholders rather than for owners alone (Freeman, 1984). Customers, employees, suppliers, government institutions, financial institutions, technology providers, and communities are all affected by the way MSMEs collect and use digital information.

The fourth stage involves intelligent analytics. Once sufficient and reliable data have been established, MSMEs can begin using machine learning, predictive analytics, customer segmentation, sentiment analysis, and recommendation systems. The main transformation at

this stage is the movement from descriptive information toward predictive and prescriptive intelligence. Instead of merely asking what happened in the past, MSMEs can begin asking what is likely to happen and what actions should be taken.

This transition can be interpreted through the Dynamic Capabilities Theory proposed by Teece et al. (1997), particularly the capabilities of sensing, seizing, and transforming. Digital analytics strengthens the sensing capability of MSMEs by allowing them to identify changes in customer behavior, market demand, and operational conditions. Artificial intelligence strengthens the seizing capability by enabling businesses to evaluate alternatives and identify appropriate responses. The transforming capability emerges when organizations modify their processes, products, or business models based on analytical insights. Recent empirical research supports this connection, showing that digital capabilities and innovation capabilities are important drivers of AI adoption among SMEs, while dynamic capabilities and digitalization are associated with innovation and sustainable performance.

Artificial intelligence therefore should not be treated merely as a technological tool for automation. Within a sustainability framework, AI can function as an intelligence mechanism for resource optimization. Demand forecasting can reduce overproduction, inventory prediction can reduce stock losses, customer analytics can improve marketing efficiency, and anomaly detection can identify unusual financial or operational activities. The environmental contribution of AI emerges when improved prediction reduces unnecessary resource consumption, while the economic contribution emerges through lower costs and improved productivity. The social contribution can emerge through better customer service, improved accessibility, and more responsive business processes.

Nevertheless, AI can also create sustainability risks. AI systems require computational resources, data infrastructure, and technical expertise. Poorly governed AI may generate biased recommendations, compromise privacy, or replace tasks without adequate attention to employee adaptation. Therefore, sustainable AI adoption requires a balance between efficiency, human oversight, transparency, and accountability. Recent research increasingly conceptualizes AI-driven digital ecosystems as mechanisms that can strengthen organizational resilience and sustainable value co-creation, particularly when supported by sufficient digital maturity.

The fifth stage involves strategic decision support. Analytical results can be transformed into dashboards, automated alerts, sales forecasts, inventory recommendations, customer insights, and financial indicators. At this stage, information technology is no longer limited to administrative support but becomes an important component of managerial decision making. The central sustainability implication is that decision making can become more forward-looking. Instead of responding only to immediate financial outcomes, MSME owners can evaluate how decisions affect profitability, customers, employees, suppliers, and environmental resources.

This is where the Triple Bottom Line becomes particularly relevant. A conventional business intelligence dashboard may focus primarily on sales, revenue, and profit. A sustainable business intelligence dashboard should extend this perspective by incorporating indicators related to resource efficiency, customer satisfaction, employee development, digital inclusion, waste reduction, and responsible data management. Consequently, the proposed framework suggests a transition from Business Intelligence toward Sustainable Business Intelligence. The objective is not to eliminate the economic dimension but to integrate

economic, social, and environmental information into strategic decision making. Literature on SME digital transformation has shown that economic performance is often emphasized while social and environmental dimensions remain comparatively neglected, indicating an important gap that sustainable digital transformation frameworks should address.

The conceptual relationship can therefore be understood as a continuous process from digital infrastructure to digital transactions, from transactions to integrated data, from data to intelligent analytics, and from analytics to strategic decisions. However, sustainability should not be positioned only as an outcome at the end of this process. Instead, sustainability should operate as a cross-cutting principle throughout all transformation stages. This means that digital infrastructure should be accessible and efficient, transactions should be inclusive and secure, data should be governed responsibly, analytics should support resource efficiency and stakeholder value, and strategic decisions should balance economic, social, and environmental consequences.

One of the most relevant applications of this framework is AI-supported demand forecasting. A Bandung culinary MSME may possess historical information concerning sales volume, product categories, promotional activities, purchasing times, holidays, and seasonal conditions. Machine learning can analyze these variables to estimate future demand. The sustainability value of the system lies not primarily in the complexity of the algorithm but in its ability to reduce overproduction, minimize food waste, improve inventory planning, and increase profitability. Thus, one technological capability can simultaneously contribute to the Profit and Planet dimensions of the Triple Bottom Line.

The same principle applies to customer management. Customer data generated through e-commerce transactions, digital payments, social media interactions, and online reviews can be analyzed to identify purchasing patterns and customer segments. High-frequency customers can be offered appropriate loyalty programs, while customers showing declining engagement can receive relevant rather than indiscriminate promotional communication. Natural language processing can analyze customer reviews to identify recurring complaints and positive perceptions. This can strengthen economic sustainability through improved customer retention while supporting social sustainability through more responsive customer relationships.

The integration of business intelligence further improves managerial visibility. Instead of reviewing individual transaction records, MSME owners can monitor sales trends, product performance, customer behavior, cash flow, and resource utilization through integrated dashboards. The transformation from intuition-based management to evidence-based management can increase organizational resilience because decisions become more closely connected to actual business conditions. Research on digital transformation and SME resilience indicates that digital capabilities can support organizations in responding to environmental turbulence and uncertainty, particularly when combined with dynamic capabilities.

However, the framework demonstrates that technology adoption should remain proportional to organizational readiness. An MSME with limited digital literacy may obtain greater value from cloud accounting, digital payment, and basic business intelligence than from immediately implementing sophisticated machine learning systems. Similarly, an MSME with limited data availability should prioritize data collection, standardization, and integration before adopting advanced AI. This staged approach is consistent with recent sustainable

digital transformation roadmaps for SMEs, which emphasize digital maturity, strategic alignment, organizational governance, people, and sustainability as interconnected dimensions of transformation.

Digital literacy therefore represents a fundamental component of sustainable digital transformation. Entrepreneurs need to understand how digital tools operate, how data should be interpreted, how AI-generated outputs should be evaluated, and how cybersecurity risks should be managed. Digital literacy also has an intergenerational and organizational dimension because the sustainability of transformation depends on whether knowledge remains within the organization when individual employees or technology providers change. Developing internal digital capabilities can therefore reduce technological dependency and strengthen the long-term resilience of MSMEs.

Data quality is equally important. Artificial intelligence depends on reliable and representative data. Inaccurate transaction records, incomplete customer information, duplicate records, inconsistent product classifications, and biased datasets can reduce the quality of analytical outcomes. From a sustainability perspective, poor data quality can also produce inefficient decisions that increase waste, costs, and stakeholder dissatisfaction. The appropriate sequence should therefore begin with data collection and governance, followed by data integration, analysis, prediction, and action. This logic reinforces the argument that data governance is not merely an IT function but a sustainability capability.

The Bandung context strengthens the relevance of the proposed framework. Bandung's economy reached approximately IDR 403.97 trillion at current prices in 2025 and grew by 5.29 percent, demonstrating the continuing dynamism of the local economy. Earlier BPS data showed that trade, manufacturing, and information and communication were among the dominant economic activities in Bandung, with contributions of 26.32 percent, 18.29 percent, and 14.09 percent respectively in 2024. This economic structure provides a relevant environment for sustainable digital transformation because MSMEs operating in trade, manufacturing, services, and creative industries can apply digital technologies to improve productivity while simultaneously addressing resource efficiency, market accessibility, and stakeholder needs.

The Bandung context also demonstrates why sustainable digital transformation should be approached as an ecosystem rather than an individual firm-level initiative. Universities, local government, technology providers, financial institutions, communities, and MSMEs possess complementary resources and capabilities. Stakeholder Theory suggests that sustainable value creation requires attention to the interests of multiple stakeholders rather than focusing exclusively on firm-level financial outcomes (Freeman, 1984). In this context, universities can contribute knowledge, research, student projects, AI prototyping, data analytics, and cybersecurity expertise; local government can provide policy support, training, infrastructure, and incentives; financial institutions can facilitate digital financial services; technology providers can provide scalable platforms; and MSMEs can provide real-world business problems and implementation environments.

Universities in Bandung can consequently contribute to sustainable digital transformation through MSME digital transformation clinics. Informatics departments can work directly with MSMEs to develop lightweight information systems, cloud-based accounting, inventory applications, customer dashboards, AI-based recommendation systems, and cybersecurity mechanisms. Such collaboration can generate social sustainability by

increasing digital inclusion and entrepreneurial capabilities while also creating educational value for students. The university therefore becomes not merely an educational institution but an intermediary within the local digital innovation ecosystem.

The role of local government is equally important. MSME digitalization policies should gradually move beyond introductory training in social media and e-commerce toward AI literacy, data analytics, cybersecurity, cloud computing, business intelligence, and sustainability measurement. Government intervention can also encourage responsible technology adoption by providing incentives for resource-efficient digital systems, cybersecurity compliance, digital skills development, and collaborative innovation. Such policies are consistent with the view that sustainable digital transformation requires both internal organizational capabilities and an enabling external environment. Recent research on SMEs indicates that technological readiness, organizational capabilities, and environmental support jointly influence AI and sustainability transitions.

The proposed framework therefore extends the conventional digital transformation model by introducing sustainability as a cross-cutting strategic logic. The framework can be interpreted through four complementary theoretical perspectives. The Resource-Based View explains why digital infrastructure, data, knowledge, and technological capabilities can become strategic resources when they are valuable and difficult to replicate. Dynamic Capabilities Theory explains how MSMEs sense technological and market changes, seize digital opportunities, and transform their business processes. Stakeholder Theory explains why digital transformation should create value for customers, employees, suppliers, government, communities, and other stakeholders rather than focusing exclusively on owners. Finally, the Triple Bottom Line provides the sustainability logic through which economic, social, and environmental outcomes can be evaluated simultaneously.

This theoretical integration produces a more comprehensive understanding of MSME digital transformation. Technology adoption alone does not guarantee sustainability. Rather, sustainable performance emerges when digital resources are converted into organizational capabilities, capabilities are translated into stakeholder value, and stakeholder value is aligned with economic, social, and environmental objectives. Recent empirical evidence supports this integrated perspective by showing that AI-driven digital ecosystems can strengthen resilience and sustainable value co-creation, while dynamic capabilities and digitalization can contribute to sustainable performance among SMEs.

Accordingly, the ultimate objective of the Bandung Intelligent MSME Sustainable Digital Transformation Framework is not simply to create technologically advanced businesses. Its objective is to develop MSMEs that are economically viable, socially inclusive, environmentally responsible, and digitally resilient. The transformation can therefore be represented conceptually as:

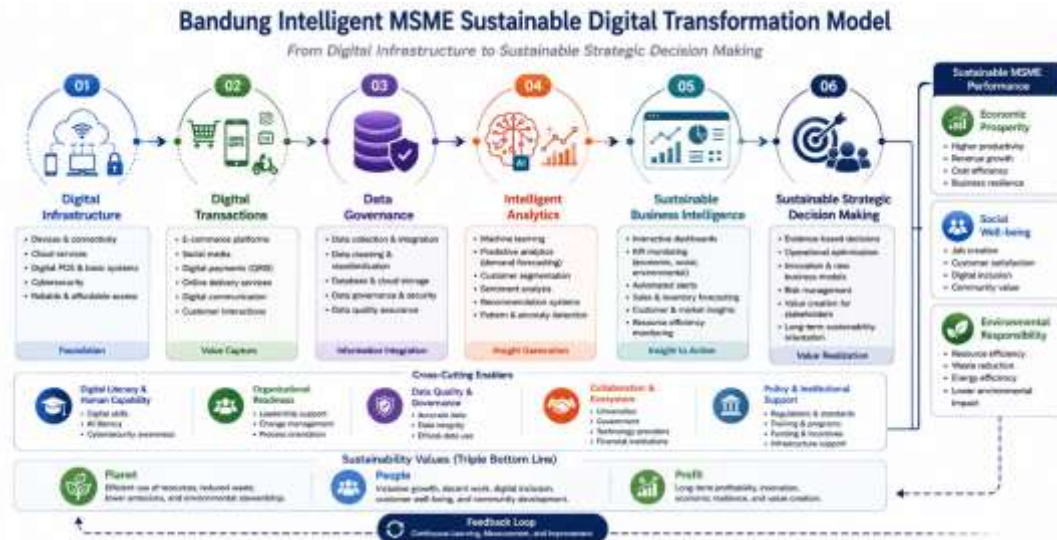


Figure 3. Bandung Intelligent MSME Sustainable Digital Transformation Model

Source: Author's elaboration based on the Resource-Based View (Barney, 1991), Dynamic Capabilities Theory (Teece et al., 1997), Stakeholder Theory (Freeman, 1984), Triple Bottom Line framework (Elkington, 1997), and sustainable development perspective (WCED, 1987).

Figure 3 presents the proposed Bandung Intelligent MSME Sustainable Digital Transformation Model, which illustrates how information technology can be progressively transformed into sustainable business value for MSMEs in Bandung City. The model consists of six interconnected stages, beginning with digital infrastructure and continuing through digital transactions, data governance, intelligent analytics, sustainable business intelligence, and sustainable strategic decision making. Rather than treating digital technologies as independent applications, the model conceptualizes them as an integrated information ecosystem in which data generated from digital transactions are governed, analyzed through artificial intelligence and machine learning, and subsequently transformed into actionable business intelligence.

The model is supported by several cross-cutting capabilities, including digital literacy and human capability, organizational readiness, data quality and governance, collaboration and ecosystem development, and policy and institutional support. These capabilities are positioned as enabling conditions because technology adoption alone cannot guarantee sustainable transformation. The model further incorporates the Triple Bottom Line perspective, represented by Planet, People, and Profit, to emphasize that MSME digital transformation should generate not only economic benefits but also social and environmental value. Economic outcomes include productivity, revenue growth, cost efficiency, and business resilience, while social outcomes include employment, customer satisfaction, digital inclusion, and community value. Environmental outcomes include resource efficiency, waste reduction, energy efficiency, and reduced environmental impact.

The model therefore proposes a transition from technology adoption toward sustainable digital intelligence. Digital infrastructure provides the foundation for participation in the digital economy, while digital transactions generate business data. Data governance ensures that information is accurate, secure, and usable. Intelligent analytics subsequently transform data into predictive insights, while sustainable business intelligence integrates economic, social, and environmental indicators into managerial dashboards and performance monitoring. These

insights support sustainable strategic decision making involving operational optimization, innovation, risk management, stakeholder value creation, and long-term business resilience. The feedback loop at the bottom of the model emphasizes continuous learning, measurement, and improvement, indicating that sustainable digital transformation is not a one-time technological intervention but an ongoing organizational process.

Within this model, digital transformation becomes the mechanism, organizational capability becomes the enabling condition, stakeholder value becomes the relational foundation, and sustainability becomes the long-term outcome. Such a perspective is particularly relevant for Bandung because the city's dynamic economic environment provides substantial opportunities for MSMEs to use information technology not merely to increase sales but to develop more resilient, efficient, inclusive, and environmentally responsible business models.

The deeper implication is that the success of Bandung MSME digitalization should not be evaluated solely through the number of businesses that enter e-commerce platforms, adopt digital payment systems, or use AI applications. A more meaningful evaluation should examine whether digital transformation improves economic resilience, strengthens human and organizational capabilities, increases stakeholder value, reduces resource inefficiency, enhances responsible data management, and contributes to long-term environmental and social sustainability. This interpretation shifts the research agenda from “How many MSMEs have adopted technology?” toward “How effectively does technology create sustainable value for MSMEs and their stakeholders?” Such a shift provides a stronger theoretical foundation for future empirical studies of AI-enabled sustainable digital transformation among MSMEs in Bandung City.

V. Conclusion

The rapid development of information technology has created significant opportunities for MSMEs to improve their competitiveness, but the transformation process needs to move beyond basic digital presence. MSMEs require an integrated approach that connects digital infrastructure, digital transactions, data management, artificial intelligence, business intelligence, and strategic decision making.

This study proposes the Bandung Intelligent MSME Digital Transformation Framework as an informatics-based approach for supporting this transition. The framework conceptualizes digital transformation as a progressive process beginning with digital infrastructure, continuing through digital transaction integration and data management, and subsequently advancing toward intelligent analytics and strategic decision support. Artificial intelligence represents an important opportunity for Bandung MSMEs because it can support demand forecasting, customer segmentation, sentiment analysis, recommendation systems, automation, and managerial decision making. Nevertheless, AI adoption cannot be separated from digital literacy, data quality, organizational readiness, technological infrastructure, and cybersecurity.

Bandung's dynamic economic environment provides a relevant setting for implementing this framework. Collaboration among MSMEs, government, universities, technology providers, and financial institutions can strengthen the local digital ecosystem and accelerate technology adoption.

The fundamental transformation is therefore not simply from offline to online business, but from digital presence to digital intelligence. The competitiveness of Bandung MSMEs in the future will increasingly depend on their ability to collect, integrate, analyze, and transform digital information into intelligent business decisions.

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