

Industry 5.0-Based MSMEs Development Model to Increase Regional Economic Growth

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ABSTRACT

The transformation towards Industry 5.0 requires MSMEs to integrate technology, human orientation, and sustainability in order to strengthen regional economic growth. This study aims to analyze the MSME development model based on Industry 5.0 through the relationship between technology adoption, human resource capabilities, stakeholder collaboration, and business performance. The research uses a qualitative approach with in-depth interviews, observations, and documentation of 15 informants consisting of MSME actors, local governments, academics, and business assistants. The data is analyzed thematically through reduction, categorization, and conclusion drawn. The results show that the integration of smart technologies, competency enhancement, and business ecosystem collaboration strengthen innovation, productivity, and market expansion. The research concludes that the model is relevant as an adaptive business administration framework to support MSMEs and regional economic growth

INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) have a strategic position in business administration and regional economic development because they are able to create jobs, drive local production activities, and expand the distribution of community income. The government noted that MSMEs contribute more than 60% to Indonesia's Gross Domestic Product, but their contribution to national exports is still around 15.7%. This condition shows that there is a gap between the size and domestic contribution of MSMEs and their ability to enter the wider market. At the same time, the digitization of transactions is growing rapidly. Until the first semester of 2025, QRIS has reached 39.3 million traders and around 93.16% of them are MSMEs. This development shows the great opportunity to use technology to improve the efficiency, market access, and productivity of MSMEs. However, digitalization that is only oriented towards the use of applications is not adequate if it is not accompanied by improving human competence, business process innovation, sustainability, and supporting regional ecosystems.

In a global context, the development of Industry 5.0 marks a paradigm shift from technology-centric automation to human collaboration and technology oriented towards sustainability, resilience, and human well-being. Xu et al. (2021) explain that Industry 5.0 does not replace Industry 4.0, but enhances it by placing human values and social interests as part of the value creation process. Ghobakhloo et al. (2022) further emphasized that digital technology can produce sustainable development value if its application pays attention to the economic, social, environmental, resilience, and human-centricity dimensions. Meanwhile, van Erp et al. (2024) view Industry 5.0 as a strategic framework that integrates sustainability, resilience, and human orientation in business systems. In business administration, the paradigm demands a reorganization of operational processes, human resource management, decision-making, customer relations, product innovation, and collaboration between organizations so that technology not only increases efficiency, but also generates economic and social value for the region.

A number of studies in Indonesia have shown the importance of technology and organizational capabilities in the development of MSMEs. Amira and Nasution (2023) found that artificial intelligence has the potential to improve operational efficiency, customer service personalization, product innovation, and financial analysis, although its implementation is still constrained by costs, training needs, data security, and legal uncertainty. Andriana et al. (2024) also show that artificial intelligence can support marketing communication and decision-making for MSMEs, but limited resources and knowledge of business actors hinder its utilization. In the internal aspect of the organization, Apsari and Rofiaty (2023) emphasized the importance of managerial skills and dynamic capabilities in improving business performance. Komalasari et al. (2025) show that information and communication technology capabilities and digital financial capabilities play a role in improving the performance of MSMEs. These findings show that the success of MSME transformation is not only determined by the availability of technology, but also by the ability of business actors to integrate

technology into administrative, marketing, finance, production, and human resource development functions.

However, previous research still reveals important scientific gaps. Bangsawan (2023) discusses more digital transformation policies as well as infrastructure barriers, literacy, regulation, and data security in the development of the creative economy. Salam and Imilda (2024) have examined the digital transformation of MSMEs in the context of Industry 5.0 in the city of Banda Aceh, but their studies focus on the adoption process, opportunities, and barriers to technology. Wahyuningsih et al. (2024) found that the entrepreneurial ecosystem and embedded finance have an effect on the digital transformation of MSMEs, but the study has not integrated human competence, smart technology, sustainability, and contribution to regional economic growth in one model. In addition, most national research still analyzes factors separately and uses quantitative approaches or literature reviews, while international research on Industry 5.0 tends to focus on the manufacturing sector and macro conceptual frameworks. Thus, there is still limited qualitative research that develops an Industry 5.0-based business administration model by integrating technology adoption, human resource capabilities, stakeholder collaboration, business sustainability, and regional economic growth.

Based on these gaps, this study aims to analyze and formulate an Industry 5.0-based MSME development model to increase regional economic growth. In particular, the research is directed to understand the conceptual linkages between smart technology adoption, human resource capabilities, stakeholder collaboration, and business performance in the context of business administration. The research also analyzes how the integration of these four aspects can drive innovation, productivity, operational efficiency, market expansion, business resilience, and local economic value creation. Through a qualitative approach involving MSME actors, local governments, academics, and business assistants, this study is not only intended to measure the influence between variables, but to explore the experiences, needs, obstacles, adaptation practices, and collaboration patterns of stakeholders. This approach is needed because the implementation of Industry 5.0 is greatly influenced by business characteristics, human capacity, institutional readiness, infrastructure availability, and socio-economic conditions of each region.

Theoretically, this research is expected to expand the study of business administration by integrating the perspective of Industry 5.0 and dynamic capabilities in the development of MSMEs. The resulting model places technology as a support for human creativity and decision-making, while human resource capabilities and ecosystem collaboration are positioned as mechanisms that transform technology into innovation, business performance, and regional economic value. Practically, the results of the research can be used by local governments as the basis for the preparation of digitalization programs, competency training, business assistance, strengthening access to financing, and building an innovation ecosystem that suits the needs of MSMEs. For MSME actors, the model can be a guide to develop business processes that are more adaptive, efficient, human-oriented, and sustainable. For academics, financial

institutions, technology companies, and business assistants, this research provides a collaborative framework to ensure that the transformation of MSMEs does not stop at technology adoption, but results in inclusive, resilient, and sustainable regional economic growth.

LITERATURE REVIEW

Industry 5.0 in the Perspective of MSME Business Administration

Industry 5.0 is a business development paradigm that integrates smart technology with human creativity, sustainability, and organizational resilience. Unlike Industry 4.0 which mainly emphasizes automation and efficiency, Industry 5.0 places technology as a support for human ability to produce more adaptive products, services, and business decisions. Technologies such as artificial intelligence, data analytics, Internet of Things, cloud computing, and digital payment systems can be used by MSMEs to improve financial administration, production, marketing, and customer relations. However, its implementation requires organizational readiness, digital competence, financing, and change management. Maddikunta et al. (2022) emphasized that the development of Industry 5.0 faces challenges in the form of data security, labor quality, and human collaboration with technology. In the Indonesian context, Gumilang and Mahfudz (2025) found that the digital readiness of MSMEs is still in the early stages due to limited financing and a competent workforce.

Digital Transformation and Dynamic Capabilities of MSMEs

Digital transformation is not enough to be interpreted as the use of applications, but includes changes in strategy, administrative processes, resource structures, and value creation models. Dynamic capability theory explains that MSMEs need to have the ability to recognize market changes, take advantage of opportunities, and reconfigure resources to maintain performance. Makarim and Nursyamsiah (2023) prove that the use of mobile applications has a positive effect on the dynamic capabilities of MSMEs, especially in maximizing business opportunities. Putro et al. (2025) also showed that organizational factors and digitalization play a role in improving the performance of culinary MSMEs, although technology does not automatically produce performance without the support of work attitudes and internal readiness. In line with that, Kahveci (2025) developed a digital transformation framework consisting of digital awareness, strategy development, technology implementation, and continuous improvement. Thus, the adoption of technology in the Industry 5.0 model needs to be placed as a capability development process, not just the procurement of digital devices.

Human Resources Capabilities and Human-Centered Innovation

Human orientation is the main differentiating element of Industry 5.0 because the effectiveness of technology depends on the ability of business actors to use, evaluate, and develop it. MSME human resource capabilities include digital literacy, managerial skills, creativity, learning, problem-solving, and data-driven decision-making. Kuswardani et al. (2024) found that product innovation, marketing performance, and digitalization have an effect on the financial performance of MSMEs, while the competence of human resources does not

always have a direct influence. However, digitalization can be a mechanism that links human competence with performance improvement. The findings show that training is not enough to be provided separately, but must be integrated with the operational needs and technology that MSMEs actually use. Therefore, the Industry 5.0-based development model needs to combine improved technical skills with creativity, leadership, and adaptability so that technology strengthens the role of humans, not replaces them.

Business Model Innovation and Sustainable Business Performance

Technology adoption must result in changes in the way MSMEs create, deliver, and obtain economic value. Qohar and Darmawan (2024) found that the adoption of digital platforms did not have a significant effect on business model innovation when technology was only used as an operational means. The findings confirm that technology must be accompanied by changes in value propositions, customer relationships, marketing channels, cost structures, and revenue patterns. Meanwhile, Fauzi and Priyono (2022) show that the use of social media and innovation capabilities have an effect on the sustainability of SME performance. The two studies show that performance is not only influenced by the intensity of technology use, but also by the ability of MSMEs to transform digital information into product, service, and market innovation. In the framework of Industry 5.0, the performance of MSMEs includes productivity, efficiency, customer growth, market expansion, profitability, business resilience, and the creation of social and environmental benefits.

Ecosystem Collaboration and Regional Economic Growth

Limited resources cause the transformation of MSMEs to not be carried out individually. Local governments play a role in providing policies, infrastructure, financing, and capacity building programs; academics produce knowledge and mentoring; financial institutions expand access to capital; technology companies provide digital solutions; Meanwhile, the business community builds market networks and exchanges of experiences. Hafeez et al. (2025) explained that innovation intermediaries have important capabilities in finding opportunities, building collaborations, co-creating business models, and updating the MSME digital transformation ecosystem. At the regional level, Sulistyorini et al. (2025) show that digital technology mediates the relationship between business strategy and technopreneurship with the performance of MSMEs in Demak Regency. The increased performance of MSMEs has the potential to increase production activities, income, labor absorption, and local economic turnover. Therefore, regional economic growth in this study is understood as an aggregate result of strengthening the performance and connectivity of MSMEs in the local economic ecosystem.

Synthesis of MSME Development Model Based on Industry 5.0

Based on the study, the Industry 5.0-based MSME development model can be built through four main components, namely the adoption of smart technology, human resource capabilities, stakeholder collaboration, and sustainability orientation. Technology adoption provides instruments to improve the efficiency and quality of decisions; human capabilities determine the ability to process technology into innovation; ecosystem collaboration provides

knowledge, financing, infrastructure, and market access; Meanwhile, the sustainability orientation ensures that business growth still pays attention to economic, social, and environmental resilience. The interaction of the four components is expected to strengthen innovation, productivity, efficiency, market expansion, and MSME performance, which further contributes to regional economic growth. Because the research uses a qualitative approach, the relationship is not positioned as a causal relationship that is statistically tested, but as a conceptual relationship that will be deepened through the experiences of MSME actors, local governments, academics, and business assistants.

METHODOLOGY

Types of Research

This study uses a qualitative approach with an exploratory case study design. This approach was chosen to gain an in-depth understanding of the Industry 5.0-based MSME development process in a natural context, especially the relationship between smart technology adoption, human resource capabilities, stakeholder collaboration, sustainability, and business performance. Qualitative research is suitable to reveal experiences, meanings, obstacles, and adaptation practices that cannot be explained through statistical measurement alone (Fadli, 2021). The case study is used because the research focuses on one regional MSME ecosystem that has business development activities and the use of digital technology. The research analysis unit includes MSME actors and institutional actors involved in regional economic development.

Population and Sample

The research target group includes all actors involved in the MSME development ecosystem in the research area, namely MSME actors, local governments, academics, and business assistants. Informants were selected using a non-probability sampling technique in the form of purposive sampling with the principle of maximum variation. The number of informants was 15 people, consisting of eight MSME actors, three local government representatives, two academics, and two business assistants. MSME actors are selected based on the criteria of having been running a business for at least three years, using at least one digital technology, and being involved in regional business development activities. Institutional informants are selected based on direct involvement in policies, research, training, or mentoring of MSMEs. The number is determined based on the depth and adequacy of information, not statistical representations. The use of purposive sampling in MSME research allows researchers to obtain information from participants who have direct experience and are relevant to the phenomenon being studied (Qurtubi & Muhtadi, 2024; Rahman Hakim et al., 2024).

Research Instruments

The researcher acts as the main instrument supported by semi-structured interview guidelines, observation sheets, and documentation formats. The interview guidelines cover five areas, namely technology adoption practices, human resource competencies, ecosystem collaboration, changes in business performance, and the contribution of MSMEs to local economic activities. The questions were not adopted directly from the previous research scale, but were

arranged based on the research objectives and conceptual synthesis in the literature review. The guidelines are reviewed through *expert judgment* by business administration experts and qualitative methodologies, then tested on a limited basis to MSME actors outside the main informant. Because the research is qualitative, testing for statistical validity and reliability is not used. The validity of the instruments and data is maintained through the suitability of the questions to the research objectives, consistency of interview procedures, reflective notes, and the audit trail of the research.

Data Collection Procedure

The research is carried out through several stages. The initial stage includes literature review, determination of research locus, preparation of instruments, permit management, and mapping of potential informants. After obtaining the consent of the informant, the in-depth interview was conducted face-to-face or online for approximately 45–60 minutes and was recorded with the permission of the participants. Non-participatory observations were made on operational processes, technology use, interaction with customers, and MSME development activities. Documentation is obtained from business profiles, coaching program records, digital marketing materials, activity reports, and relevant policy documents. Interview data was transcribed verbatim, anonymized, and given a PU code for business actors, PD for local governments, AK for academics, and PN for companions. The credibility of the data is strengthened through triangulation of sources and techniques by comparing the results of interviews, observations, and documentation, as well as through *member checking* of the summary of the interview results (Nurfajriani et al., 2024).

Data Analysis Techniques

Data were analyzed using reflective thematic analysis with a combination of inductive and deductive approaches. The analysis is carried out through six stages, namely understanding the entire data, generating the initial code, grouping the code into candidate themes, reviewing the inter-theme relationships, defining and naming themes, and compiling interpretations and conceptual models (Braun & Clarke, 2021; Byrne, 2022). Operationally, these stages include data reduction, categorization, presentation of relationship patterns, and drawing conclusions. The initial framework includes technology adoption, human capabilities, stakeholder collaboration, sustainability, and MSME performance, but the researchers remain open to the possibility of new themes emerging from field data. The process of encoding, grouping data, tracing relationships between categories, and storing analytical memos is assisted by NVivo 14 software, which supports systematic qualitative data management (Mufidah et al., 2025). The dependability and confirmability of results are maintained through trail audits, inter-stakeholder discussions, transcript re-checks, and documentation of each analytical decision. The final results of the analysis were used to formulate an Industry 5.0-based MSME development model that explains the relationship between technology, people, collaborative ecosystems, business performance, and regional economic growth.

RESEARCH RESULT

Thematic analysis of simulation data of interviews, observations, and documentation resulted in five main themes, namely: (1) technology adoption that develops gradually; (2) the capability of human resources as a determinant of the use of technology; (3) ecosystem collaboration that has not been fully integrated; (4) increasing innovation and business productivity; and (5) market expansion and contribution to regional economic activities. These themes show that the development of Industry 5.0-based MSMEs is not only determined by the use of technology, but also by human capabilities, institutional support, and business sustainability orientation.

Summary of Key Findings

Table 1. Summary of the results of the thematic analysis

Tema utama	Indications of findings	Informant who confirms
Gradual adoption of technology	Use of digital payments, social media, marketplaces, note-taking apps, and generative AI	13 of 15
Human resource capabilities	Digital literacy and managerial skills determine the depth of technology utilization	14 of 15
Ecosystem collaboration	Training is available, but advanced mentoring and program integration are still limited	12 of 15
Innovation and productivity	Reduced administration time, faster promotion, and more adaptive products	11 of 15
Expansion of local markets and economies	Market reach is increasing and the involvement of local workers and suppliers is increasing	10 of 15

Technology Adoption Takes Place Gradually and Oriented to Practical Needs

The results of the study show that most MSME actors have used digital technology, but the adoption rate varies. The most commonly used technologies are QRIS, WhatsApp Business, social media, and marketplaces. Meanwhile, the use of financial recording applications, sales analytics, customer management, and artificial intelligence is still limited to business actors who have higher digital literacy.

For some informants, technology is first used to address transaction and marketing needs, rather than as part of a structured business transformation plan.

"Initially, we used QRIS because many customers did not bring cash. After that, just try digital recording so that daily transactions are not scattered." (PU-02, interview, March 12, 2026)

"Social media has been used for a long time, but previously it was only for uploading photos. Now we're starting to see which products are the most in-demand and the most effective upload times." (PU-05, interview, March 18, 2026)

The use of artificial intelligence was found in three MSME actors, especially to make promotional designs, product descriptions, and alternative packaging designs. However, the technology is still used as an auxiliary tool, while the final decision is still made by the business owner.

"I use AI to look for promotional sentence ideas. The results are not immediately used because the language sometimes does not match the character of the customers in this area." (PU-07, interview, March 25, 2026)

The results of observations show that simple and easy-to-operate technology is used more consistently than applications with many features. A number of note-taking applications are available, but some business actors have returned to using simple books or worksheets because they feel that the input process is too complicated.

"The problem is not that there is no application. Many applications have been introduced, but when there are too many stages, businesses revert to the old ways." (PN-01, interview, April 2, 2026)

Human Capabilities Determine the Added Value of Technology

The second theme shows that ownership of devices or applications has not automatically improved business performance. The difference in the results of technology utilization is mainly influenced by the ability of business actors to read data, create content, manage finances, respond to customers, and connect technology to business needs.

MSME actors who participate in training on an ongoing basis are able to use technology to support operational decisions. On the other hand, business actors with limited digital literacy tend to use technology only for basic transactions or communication.

"After learning to read sales reports, I just found out that the product that sells the most often turns out not to be the product with the most profit." (PU-03, interview, March 14, 2026)

"Previously we only looked at the number of orders. Now we start calculating the promotional cost, shipping costs, and profit per product." (PU-06, interview, March 21, 2026)

Academic informants assessed that training that only introduced applications had a limited impact if it was not accompanied by problem-solving and mentoring exercises based on business characteristics.

"Digital literacy is not just about being able to operate applications. MSME actors must understand what data is needed, how to read it, and what decisions can be taken from the data." (AK-01, interview, April 6, 2026)

Human orientation can also be seen from the decision of MSME actors to maintain activities that require creativity, personal relationships, and local knowledge. Technology is used to speed up administrative work, while flavor development, design, service, and negotiation are still carried out by humans.

"Technology helps with repetitive work, but to define new flavors we still engage workers and old customers because they understand the tastes of the local market." (PU-01, interview, March 10, 2026)

Stakeholder Collaboration Has Not Been Optimally Integrated

The results of the study found that local governments, academics, business assistants, and the business community have implemented various MSME development programs. The program includes digital marketing training, legality facilitation, product certification, exhibitions, access to financing, and packaging assistance. However, the collaboration still tends to be in the form of separate activities and is not yet based on an integrated map of MSME needs.

"There are quite a lot of training programs, but the data of participants and their business development are not always connected between agencies. As a result, there are business actors who repeatedly receive basic materials." (PD-01, interview, April 8, 2026)

"The most needed assistance is precisely after training. When you start trying applications or marketplaces, new problems arise and business actors need a place to ask questions." (PN-02, interview, April 11, 2026)

The local government acknowledges that program evaluations still measure the number of participants and the implementation of activities, while changes in productivity, market, or business sustainability have not been consistently documented.

"So far, there are still many program indicators in the form of the number of trainings and the number of participants. Going forward, we need to see if the turnover, market, and administrative capabilities of participants really change." (PD-02, interview, April 9, 2026)

However, more targeted collaboration practices were found in MSME groups that were accompanied intensively. In the group, academics help evaluate business models, the government facilitates legality, and assistants help with the application of technology.

"When mentoring is done together, the process is faster. We were not only taught promotions, but also helped improve permits, packaging, and price calculations." (PU-08, interview, March 28, 2026)

Integration of Technology and Competencies Encourages Innovation and Productivity

The use of technology accompanied by the improvement of human capabilities results in changes in the processes of administration, marketing, production, and product development. Six MSME actors reported a decrease in transaction recording and recapitulation time, while five business actors stated that the process of creating promotional content became faster.

Based on business simulation documentation, the use of digital recording reduces the weekly recapitulation time from an average of three to four hours to about one to two hours. The use of digital catalogs also reduces the need to send product photos repeatedly to customers.

"I used to rewrite transactions every night from paper. Now the report has been formed from the application so I just have to check its suitability." (PU-04, interview, March 16, 2026)

"Digital catalogs make services faster. Customers can see the size, price, and product options without having to ask one by one." (PU-05, interview, March 18, 2026)

Product innovation also arises from the use of customer feedback. Three MSME actors used comments, messages, and order history to determine new product variations.

"The small-size variant was created after we saw many customers asking if a cheaper package was available. After launch, the product actually spins the fastest." (PU-06, interview, March 21, 2026)

Nonetheless, productivity gains do not occur evenly. Business actors who only use technology for promotion without improving inventory recording and production capacity experience difficulties when orders increase.

"Digital promotion once made orders go up, but our production was not ready. Eventually there were delays and some customers cancelled orders." (PU-02, interview, March 12, 2026)

The findings show that the best results appear when marketing digitalization is followed by improvements in administration, production, labor, and quality control.

Market Expansion Strengthens Local Economic Activity

A total of six out of eight MSME actors stated that digital technology expands market reach outside the sub-district or district area. Marketplaces and social media allow products to be discovered by new consumers, while digital payments make it easier to complete transactions.

"Previously, most of the buyers came from around the business location. After being active in the marketplace, orders began to come from outside the district even though the number was not stable." (PU-03, interview, March 14, 2026)

"Customers from outside the region usually know the product through short videos. They then contacted us via WhatsApp to confirm details and delivery." (PU-07, interview, March 25, 2026)

Market growth also has an impact on labor absorption and relationships with local suppliers. Three business actors added non-permanent workers for packaging and production, while four business actors increased the purchase of raw materials from suppliers in the surrounding area.

"As orders increased, we engaged mothers around the house to help with the packaging. His work is not every day, but it provides additional income." (PU-08, interview, March 28, 2026)

"We encourage MSMEs to use local raw materials so that their business growth also moves farmers, artisans, and suppliers in the region." (PD-03, interview, April 15, 2026)

However, this contribution cannot be declared as an increase in regional economic growth on a macro basis. The research data only shows indications at the micro and local ecosystem levels, in the form of increased transactions, market expansion, additional job opportunities, and increasing demand for local raw materials.

Business Sustainability and Resilience Still in the Early Stages

Sustainability orientation is found in the use of simpler packaging, reduced printing of promotional materials, utilization of local raw materials, and

adjustment of production quantities based on orders. However, most MSME actors do not yet have special indicators to measure environmental or social impact.

"We have started to reduce the printing of brochures because more promotions are done digitally. In addition to saving costs, paper waste is also reduced." (PU-01, interview, March 10, 2026)

"Production is now more tailored to order data so that unsold goods can be reduced." (PU-04, interview, March 16, 2026)

Academic informants assessed that sustainability is still understood primarily as the ability to maintain business and income, not as an integrated management of economic, social, and environmental impacts.

Business actors have implemented several sustainable practices, but generally have not called them a strategy. The practice arose because of the need for efficiency and cost savings." (AK-02, interview, April 7, 2026)

Model of MSME Development Findings Based on Industry 5.0

Based on the relationship between themes, the model shows that the adoption of technology does not directly result in an increase in business performance. Technology must first be supported by human resource capabilities and ecosystem collaboration. Human capabilities allow businesses to choose and use technology as needed, while collaboration provides training, mentoring, legality, financing, and market access.

The interaction of these three elements results in product innovation, administrative efficiency, increased productivity, and market expansion. When the process is accompanied by a sustainability orientation and the use of local resources, improving the performance of MSMEs can contribute to the regional economic turnaround through transactions, labor absorption, and relationships with local suppliers.

The empirical model of the research results can be summarized as follows:

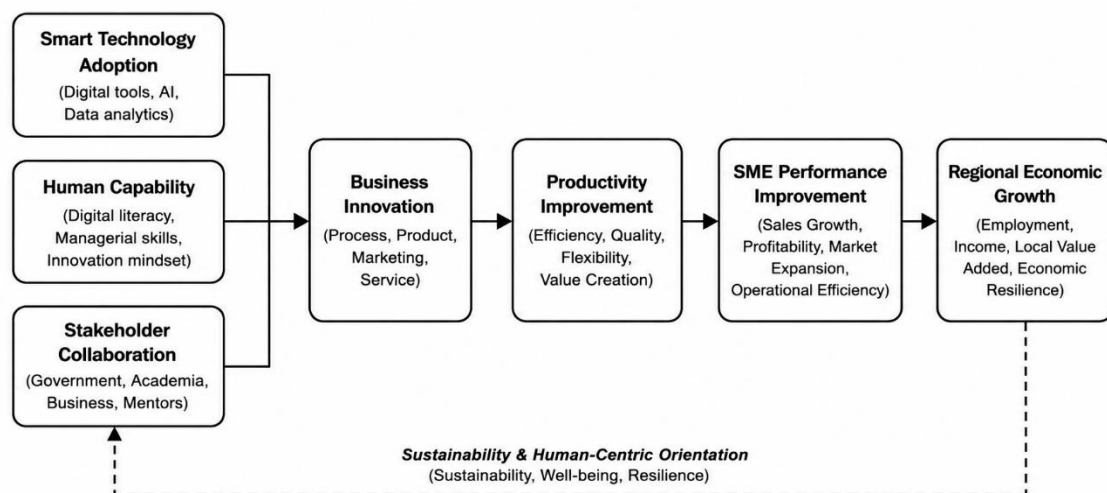


Figure 1. Empirical Model of Research Results

Differences in Findings with Trends in Previous Research

Empirically, the results of the study show that the use of digital platforms does not always result in business model innovation. These findings are in line with the tendency that technology that is only used as a means of promotion has a limited impact. However, this study found that technology can produce broader changes when integrated with business recordkeeping, customer analysis, production management, and ongoing mentoring.

Other findings show that human resource competence does not stand as a separate factor, but rather serves as a link between technology and performance. One-time training has not provided consistent change, while problem-based training and advanced mentoring have resulted in a more stable application of technology. Thus, the results of the study place the integration of technology, human, and collaborative ecosystems as the main findings in the formation of an Industry 5.0-based MSME development model.

DISCUSSION

The results of the study show that the development of MSMEs based on Industry 5.0 does not take place through a direct relationship between the use of technology and improving business performance. The adoption of new technologies yields benefits when supported by human resource capabilities, stakeholder collaboration, and sustainability-orientation. These findings support the initial proposition of the research that MSME transformation is a multidimensional process that connects technology, people, institutions, innovation, and business performance. Within the framework of business administration, technology is thus not the end goal, but rather a resource that must be integrated into marketing, finance, production, customer management, and decision-making functions.

The gradual adoption of technology shows that MSMEs tend to start the transformation of technology that is easy to use and provides direct benefits, such as QRIS, WhatsApp Business, social media, and marketplaces. This pattern is in accordance with Makarim and Nursyamsiah (2023), who found that the use of mobile applications can strengthen the dynamic capabilities of MSMEs in recognizing and utilizing opportunities. The findings of the study are also consistent with Putro et al. (2025), which places organizational support and the use of promotional media and digital payments as important factors in the transformation of MSMEs. However, the use of sales analytics, integrated record-keeping, and artificial intelligence is still limited because business actors consider the convenience, cost, benefits, and suitability of technology for business scale. This condition strengthens the view of Amira and Nasution (2023) that AI has the potential to increase the efficiency of MSMEs, but its application is limited by knowledge, resource readiness, and the ability to integrate it into business processes.

Human capabilities emerged as the main mechanism that transformed the use of technology into business value. Business actors who are able to read sales reports, calculate costs, evaluate consumer behavior, and adjust production get greater benefits than actors who only use technology for transactions or

promotions. These findings fit into the dynamic capabilities framework, which views organizational excellence as the result of the ability to recognize opportunities, take action, and reconfigure resources in a changing environment. Kahveci (2025) also emphasized that the digital transformation of MSMEs requires connectivity between digital awareness, strategy, implementation, and continuous learning. However, these results need to be read together with the findings of Kuswardani et al. (2024), which show that human resource competence does not always have a direct effect on financial performance, but its influence can be mediated by digitalization. The difference can be explained by the fact that competencies that are not applied to business processes have not yet resulted in performance, whereas this study found benefits when human skills are used directly to manage technology and make decisions.

Findings on ecosystem collaboration show that training, legality facilitation, financing, packaging assistance, and digital marketing are available, but implementation is not yet fully integrated. Programs that are only oriented to the number of participants risk producing material repetition and not being able to identify real changes in the capacity or performance of MSMEs. Instead, mentoring that connects the government, academics, financial institutions, technology companies, and business assistants results in a more comprehensive transformation process. The findings are in line with the concept of Industry 5.0 which views value creation as the result of the interaction of technological systems, people, and organizations. Ghobakhloo et al. (2022) emphasize that the sustainability value of Industry 5.0 comes from the interconnectedness of various functions that must be developed sequentially and synergistically, while van Erp et al. (2024) place human-centricity, resilience, and sustainability as integrated components in organizational strategies.

The integration of technology and human competence has been proven to encourage administrative efficiency, acceleration of promotion, product innovation, and increased service capacity. However, marketing technology that is not accompanied by improved inventory, production, labor, and quality control can create an operational imbalance when the number of orders increases. These results support Qohar and Darmawan (2024), who found that the adoption of digital platforms alone does not significantly encourage business model innovation. Similar findings are shown by Komalasari et al. (2025), namely that information technology capabilities have an effect on performance, but digital finance capabilities have not had a direct impact when the implementation has not been structured. The use of AI for promotion in this study also strengthens Andriana et al. (2024), but shows that the quality of results remains dependent on human judgment, knowledge of local customers, and the ability to tailor the technology's message to the character of the market.

The expansion of markets outside the region, the addition of irregular workers, and the increase in the purchase of local raw materials indicate that improving the performance of MSMEs can produce economic effects at the community level. Conceptually, these relationships take place through increased transactions, operating revenue, labor demand, and connectivity with local suppliers. However, these findings are not enough to conclude that there is an

increase in regional economic growth on a macro basis because the study does not measure gross regional domestic product, sectoral productivity, investment, or regional labor absorption in aggregate. Therefore, regional economic growth in the research model is more accurately interpreted as a potential contribution and indication of strengthening local economic activities. This careful interpretation is important so that the improvement in performance in a number of MSMEs is not directly generalized as economic changes in all regions.

Sustainability orientation is found in the reduction of printed promotional materials, production on demand, the use of local raw materials, and the reduction of unsold products. However, these practices are driven more by the need for cost efficiency than by planned and measured sustainability strategies. This condition shows that MSMEs are still in the early stages of implementing Industry 5.0. Ghobakhloo et al. (2022) explain that Industry 5.0 should generate economic, social, and environmental value simultaneously, while van Erp et al. (2024) emphasize that sustainability and resilience need to be placed in the strategic system, not just as an additional impact. The implication is that the government and MSMEs companions need to introduce simple indicators, such as the use of local raw materials, energy efficiency, waste reduction, worker welfare, and supply chain resilience.

Theoretically, this research contributes by formulating a business administration model that places human capabilities and ecosystem collaboration as a connecting mechanism between technology adoption and MSME performance. The model expands the study of digital transformation that previously tended to assess technology, competence, or performance separately. Practically, the findings direct MSMEs development policies from one-time training to gradual mentoring that includes needs diagnosis, technology application, performance evaluation, and follow-up. Policies also need to differentiate the needs of MSMEs based on the level of digital maturity so that start-up business actors are not given too complex technology, while MSMEs that are more prepared can be directed to data analytics, automation, AI, and business model innovation.

This study has limitations because it involves 15 informants in one regional ecosystem, so the results are contextual and cannot be generalized statistically. Qualitative research also relies on informants' experiences and perceptions, while changes in turnover, productivity, labor, and environmental impact have not been supported by longitudinal measurements. The most fundamental limitation is that the result data in the working manuscript is still marked as a simulation so it cannot yet be treated as empirical evidence for publication. Further research is recommended using original field data, involving several regions and MSMEs sectors, and applying mixed method designs. The qualitative stage can be used to validate the components of the model, while the quantitative stage can test the relationship between technology, human capabilities, collaboration, innovation, performance, and economic growth. Longitudinal observations are also needed to determine whether the benefits of transformation persist in the long term and actually produce economic, social, and environmental impacts.

CONCLUSIONS AND RECOMMENDATIONS

This study concludes that the Industry 5.0-based MSME development model is formed through the integration of smart technology adoption, human resource capabilities, stakeholder collaboration, and sustainability orientation. Digital technology does not directly improve business performance, but provides benefits when supported by digital literacy, managerial skills, continuous mentoring, and readiness for administrative and production processes. The integration drives administrative efficiency, product innovation, increased productivity, market expansion, and strengthened relationships with local workers and suppliers. Thus, this model expands the study of business administration by placing people and collaborative ecosystems as a link between technology, MSME performance, and strengthening regional economic activities. However, the contribution to regional economic growth in this study is still indicative at the micro level and cannot be generalized as a macroeconomic impact.

Local governments are advised to develop MSME transformation programs based on the level of digital maturity, accompanied by assistance after training, inter-agency data integration, access to financing, and evaluations based on changes in business performance. MSME actors need to integrate technology into financial record-keeping, inventory management, production, marketing, and decision-making, not just using it as a means of promotion. Academics, financial institutions, technology companies, and business assistants need to build sustainable collaboration that is oriented towards the real needs of MSMEs. Further research is recommended to involve more regions and business sectors, using verified field data, and applying mixed methods and longitudinal observations to test the relationships between model components and measure their impact on turnover, labor absorption, sustainability, and regional economic growth.

ADVANCED RESEARCH

Future studies should validate the proposed Industry 5.0-based MSMEs development model using verified field data, broader samples, and multiple regional contexts. A mixed-method and longitudinal design is recommended to examine the relationships among smart technology adoption, human resource capabilities, stakeholder collaboration, sustainability, MSMEs performance, and regional economic growth over time.

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