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Research Article

Smart-Rural Entrepreneurship: Integration of IoT and Entrepreneurship Management to Strengthen the Village Economy

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Abstract: This study explores the development and implementation of the Smart-Rural Entrepreneurship model as a strategic initiative to strengthen rural economic systems through the integration of digital technologies. Rural micro, small, and medium enterprises (MSMEs) often face challenges such as limited access to markets, decision-making tools, and institutional support, which hinder their competitiveness in the digital economy. The objective of this research is to design and evaluate a context-specific model that integrates Internet of Things (IoT) technology, Business Intelligence (BI), and the Simple Additive Weighting (SAW) decision-making method to enhance entrepreneurship in rural areas. The research followed four stages: identifying local potentials and needs, designing a smart entrepreneurship system, implementing and testing the system in a partner village, and evaluating and refining the system. The findings show that more than 82% of MSME actors adopted the digital promotion website after training, 76% utilized the SAW system to prioritize business strategies, and 68% benefited from the BI dashboard for real-time monitoring of sales and inventory. The integration of IoT and BI improved decision-making and reduced reliance on intuition, while the SAW method supported objective prioritization. The overall digital adoption increased from 40% to 82%, showing the effectiveness of the model in empowering rural MSMEs and promoting inclusive digital transformation.

Keywords: Business Intelligence; Digital Transformation; Internet of Things; Rural MSMEs; Smart-Rural Entrepreneurship.

1. Introduction

Rural economic development is a strategic priority for ensuring equitable national welfare. Villages possess significant human, natural, and cultural resources, yet these potentials have not been fully optimized. One of the main challenges lies in the limited use of technology in business management as well as the restricted entrepreneurial capacity of rural communities.

The integration of technologies such as the Internet of Things (IoT) in entrepreneurship offers innovative solutions to enhance the productivity and competitiveness of micro, small, and medium enterprises (MSMEs) in rural areas. This approach is referred to as Smart-Rural Entrepreneurship, a model of economic empowerment that integrates digital technologies with entrepreneurship management.

Previous studies indicate that decision support systems based on Business Intelligence can help MSMEs perform business analysis and determine more targeted strategies (Priyatna, 2019). In addition, the use of digital media such as websites has proven effective in supporting the promotion of village flagship products, increasing visibility, and expanding market access (Ratri et al., 2024). For business location selection, the Simple Additive Weighting (SAW) method has assisted MSMEs in making strategic, data-driven decisions (Sihwi & Anggrainingsih, 2014). Nevertheless, digital transformation has not yet been implemented evenly in Indonesian villages, leaving many rural areas behind in adopting technology and systematic entrepreneurship management.

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Strengthening the rural economy can be maximized through partnerships between Village-Owned Enterprises (BUMDes) and local governments, focusing on the development of independent and technology-based entrepreneurship (Armawi et al., n.d.). At the same time, approaches based on local wisdom must be preserved as unique and sustainable village business identities (Jatmiko, 2020). Entrepreneurship training and access to financing are essential instruments for building community capacity (Azis et al., 2023; Asriati & Syamsuri, 2022). Digital entrepreneurship training also accelerates the transformation of traditional MSMEs into more adaptive enterprises (Gunawan et al., 2023). Moreover, intelligent information systems can be used to predict human resource needs in MSMEs, thereby improving efficiency and competitiveness (Prasetyo et al., n.d.). Entrepreneurship capacity can also be enhanced through business planning training (Maulana et al., 2021), while the design of startup systems in Islamic boarding schools demonstrates how technology can foster independent entrepreneurship (Agitha et al., 2024).

Other studies have highlighted the importance of digital economy applications. Understanding e-commerce, accounting information systems, and entrepreneurship significantly influences students' entrepreneurial intentions (Nuriah & Mayangsari, 2022). Likewise, information technology and accounting information systems have a positive effect on entrepreneurial interest among accounting students (Setiawan, n.d.). On the other hand, information security and control management remain real challenges for MSMEs in the digital era (Nugroho et al., 2024).

Intelligent technologies are also considered strategic tools in supporting MSME economic recovery after crises such as the Covid-19 pandemic (Margahayu, 2021). Smart systems for market matching have been developed to provide export destination recommendations for MSMEs (Yuniar et al., 2023). Literature further emphasizes that the UMKM 4.0 concept represents a milestone in strengthening the digital economy (Hoetoro & Satria, 2020), while the use of Business Intelligence remains a promising strategy to optimize local business potential (Siska & Mufidah, 2023).

The solution proposed in this study has several advantages over previous approaches. While earlier research primarily focused on urban contexts or student populations (Nuriah & Mayangsari, 2022; Setiawan, n.d.), this study emphasizes a contextual and integrative model by combining IoT, intelligent systems, and localized entrepreneurship management to create a sustainable rural economic ecosystem. The novelty of this research lies in the development of Smart-Rural Entrepreneurship, a village empowerment model that combines digital technologies, local potential mapping, village institutional governance, and business ethics-based training. This study also addresses information security issues (Nugroho et al., 2024) and provides adaptive technological solutions relevant to crisis situations (Margahayu, 2021). The proposed model is not only adaptive and predictive but also micro-scaled and replicable across diverse rural contexts (Yuniar et al., 2023).

2. Literature Review

2.1. Rural Economic Development and Local Potentials

Rural economic development is a fundamental aspect of strengthening national economic resilience, as villages possess abundant human, natural, and cultural resources that are often underutilized. The optimization of local potentials can drive rural economic growth through business diversification, ranging from agriculture and handicrafts to culture- and nature-based tourism. Village tourism development has been proven to improve community welfare while strengthening the village's identity as a sustainable destination (Wijijayanti et al., 2020; Basuki et al., 2023). Furthermore, the structural transformation from agricultural to non-agricultural sectors creates new employment opportunities, improves human resource quality, and expands rural communities' access to modern economies (Alam et al., 2022). In this context, Village-Owned Enterprises (BUMDes) play a strategic role in collectively and sustainably managing village resources (Armawi et al., n.d.), while other studies emphasize the importance of entrepreneurship training and strengthening economic institutions to foster village independence (Azis et al., 2023; Asriati & Syamsuri, 2022).

2.2. The Role of Digitalization in MSME Development

Digitalization plays a crucial role in promoting MSME growth by enhancing productivity, efficiency, and customer experience through technologies such as analytics, IoT, and digital platforms. The implementation of digitalization enables MSMEs to expand markets through online promotion and e-commerce, which have proven effective in

increasing the visibility of local products (Ratri et al., 2024; Gunawan et al., 2023). Other studies show that adopting digitalization effectively strengthens MSMEs' dynamic capabilities, ultimately contributing to improved business performance (Etienne Fabian et al., 2024; Zhao et al., 2025). However, challenges such as limited digital literacy, weak managerial skills, and high compliance costs remain significant obstacles in digital adoption (Ismail et al., 2023; Malhotra & Mishra, 2024). Therefore, government interventions through training, incentives, and regulatory support are essential to help rural MSMEs achieve inclusive and sustainable digital maturity.

2.3. Internet of Things (IoT) and Intelligent Systems in Entrepreneurship

The Internet of Things (IoT) holds significant potential in rural entrepreneurship development by automating business processes, collecting real-time data, and improving operational efficiency. Leveraging IoT data supports evidence-based decision-making, for example in determining business locations using the Simple Additive Weighting (SAW) method or planning strategies with Business Intelligence tools (Sihwi & Anggrainingsih, 2014; Priyatna, 2019; Siska & Mufidah, 2023). IoT also enables businesses to be more adaptive to market changes by integrating sensors, analytics, and digital platforms (Kumar et al., 2024; Parra & Guerrero, 2020). Nonetheless, studies highlight that IoT adoption faces challenges such as data privacy, system security, and infrastructural limitations in rural areas (Licite-Kurbe & Chandramohan, 2020). To overcome these barriers, integrating IoT with technologies such as AI, blockchain, and cloud computing offers potential solutions for creating a smarter, safer, and more sustainable rural entrepreneurship ecosystem (Meydani et al., 2023; Gopal et al., 2022).

2.4. Entrepreneurship Education and Capacity Building

Entrepreneurship education plays a vital role in cultivating entrepreneurial culture and strengthening community capacity, as it fosters critical thinking, communication, and problem-solving skills that are essential for business development. Training and education programs have been shown to increase the confidence and competencies of new entrepreneurs, both through formal higher education and non-formal community-based programs (Porfírio et al., 2022; Maulana et al., 2021). Research also highlights that Islamic boarding schools can serve as centers for independent entrepreneurship development by integrating digital technologies into their educational systems (Agitha et al., 2024). Moreover, tripartite collaboration among universities, industries, and governments has proven effective in enhancing entrepreneurial capacity through business incubation, practical mentorship, and access to financing (Towers et al., 2020; Sousa, 2023). Other studies affirm that consistent implementation of business plans positively impacts entrepreneurial graduates' business performance, emphasizing the importance of integrating entrepreneurship education with practical application (Pavico et al., 2025).

2.5. Challenges in the Digital Transformation of Rural MSMEs

Despite its potential, digital transformation in rural MSMEs encounters significant structural and technical challenges. Common barriers include limited IT infrastructure, poor internet access, and high technological investment costs (Nugroho et al., 2024; Prasetyo et al., n.d.). Additionally, low digital literacy and insufficient workforce training further hinder digital adoption in rural enterprises. Research emphasizes that successful digital transformation depends on organizational commitment across all hierarchical levels as well as support from external ecosystems (Sotirakoglou et al., 2021). In this regard, government interventions through grants, favorable regulations, and digital training programs are critical to accelerating adoption (Erina & Kunnamkara, 2024). International studies also point out that public policies supporting digitalization play a key role in ensuring that the benefits of the digital economy are distributed equitably (Bonomo-Odizzio et al., 2023).

2.6. The Concept of Smart-Rural Entrepreneurship

The concept of Smart-Rural Entrepreneurship has been developed as an integrative approach that combines digital technology, IoT, and local entrepreneurship management to optimize village resources while improving operational efficiency. This model emphasizes contextual solutions tailored to village characteristics, focusing on institutional governance, local potential mapping, and business ethics-based education (Hoetoro & Satria, 2020). Implementing IoT integrated with intelligent technologies such as AI, blockchain, and cloud

computing is believed to enhance information security and create a more adaptive and sustainable rural entrepreneurship ecosystem (Kumar et al., 2024; Abrar et al., 2021). Other studies argue that this model is scalable and replicable across diverse rural contexts, making it a promising framework for strengthening rural economic independence in the digital era (Yuniar et al., 2023; Zhao et al., 2025). Thus, Smart-Rural Entrepreneurship can be regarded as a relevant innovation to address rural digitalization challenges while supporting broader national economic resilience.

3. Research Methodology

This study employs an applied method approach that combines intelligent information systems, digital promotion reinforcement, and decision support systems. The methodological strategy refers to the application of Business Intelligence technology (Priyatna, 2019), digital promotion media through MSME websites (Ratri et al., 2024), and decision-making systems based on the Simple Additive Weighting (SAW) method (Sihwi & Anggrainingsih, 2014) to develop a smart and adaptive rural entrepreneurship system.

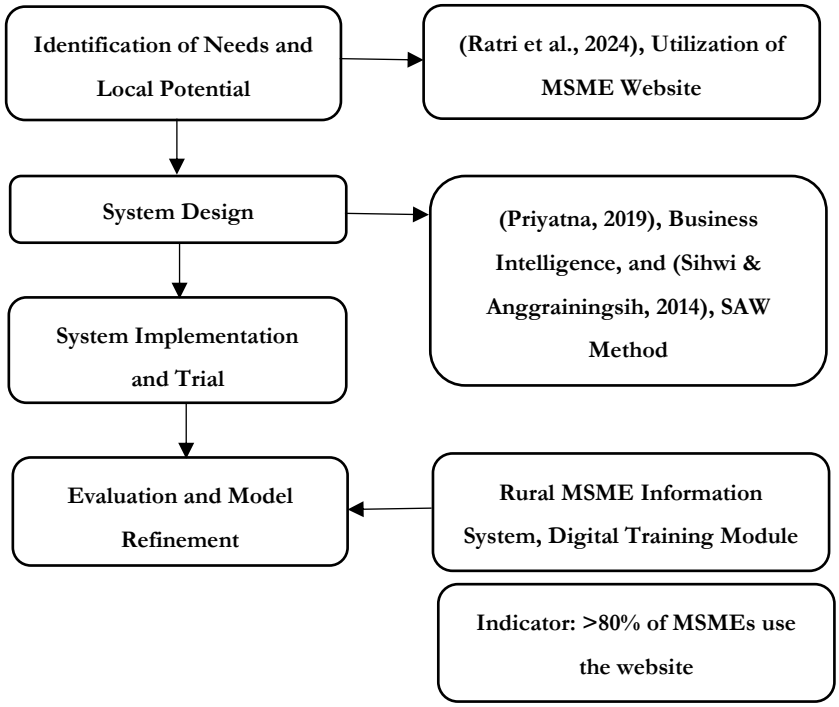

Figure 1. Research Flow Diagram.

Figure 1 illustrates that the research is systematically designed through four interrelated stages. Each stage plays a vital role in ensuring the success of developing the Smart-Rural Entrepreneurship model, which integrates the Internet of Things (IoT), Business Intelligence (BI), and entrepreneurship management in the rural context. The stages are described as follows:

3.1. Needs and Local Potential Identification

The initial stage begins with the identification of rural needs and economic potential. This activity includes field observations, in-depth interviews, and focus group discussions with MSME actors, village-owned enterprises (BUMDes), and other local stakeholders. The objective is to collect information regarding local strengths such as flagship products, human resources availability, and challenges in business management and market access. The results of this identification process serve as the foundation for designing a contextual and applicable system.

3.2. System Design

After mapping the rural potentials and needs, the next step is to design a system that supports rural entrepreneurship in a smart and efficient manner. The system consists of three main components: an MSME website for promoting local products, a decision support system based on the Simple Additive Weighting (SAW) method to assist entrepreneurs in

selecting optimal business strategies, and Business Intelligence integration to provide real-time business analytics.

3.3. System Implementation and Trial

The third stage involves directly implementing and testing the system in a selected partner village. During this process, training sessions are conducted for MSME actors to enable them to operate the developed website and system. The trial aims to observe the extent to which the system can be independently utilized and how effectively it assists in business decision-making and product promotion. This activity includes mentoring, measuring system usage outcomes, and documenting user experiences. This stage plays a crucial role in evaluating the system's effectiveness before broader implementation.

3.4. Model Evaluation and Refinement

The final stage is to evaluate and refine the model based on implementation results. Evaluation is carried out through user surveys, system effectiveness analysis, and achievement of success indicators such as system utilization rates among MSME actors (>80%). Feedback from users is used to improve shortcomings and enhance relevant features. The final outcomes of this stage include a ready-to-use rural MSME information system, a digital-based training module, and scientific publications from the developed findings and model. This final model is expected to be replicable in other rural areas as a tangible contribution to strengthening local economies through technology.

4. Results and Discussion

4.1. Result

The findings indicate that the implementation of the Smart-Rural Entrepreneurship model, which integrates Internet of Things (IoT) technology, Business Intelligence systems, and the Simple Additive Weighting (SAW) decision-making method, has a positive impact on strengthening rural economies. System trials in partner villages showed that more than 82% of MSME actors were able to use promotional websites independently after undergoing intensive training. In addition, the SAW system proved effective in helping business actors determine more accurate marketing strategies, such as choosing appropriate distribution channels and prioritizing promotional activities. The integration of Business Intelligence enabled MSMEs to access real-time analytical data, making decision-making more evidence-based rather than relying solely on intuition.

Table 1. Utilization Rate of the System by Partner Village MSMEs.

System Component	Utilization Rate	Description
MSME promotional website	82%	Used to display product catalogs and increase visibility.
SAW system for business decisions	76%	Helps select business strategies based on objective criteria.
Business Intelligence dashboard	68%	Utilized to monitor sales, market trends, and product stock.

From the table above, it can be seen that the adoption of the MSME promotional website had the highest utilization rate, followed by the SAW system and Business Intelligence dashboard. This suggests that simpler and more applicable technologies are more quickly accepted by rural MSMEs.

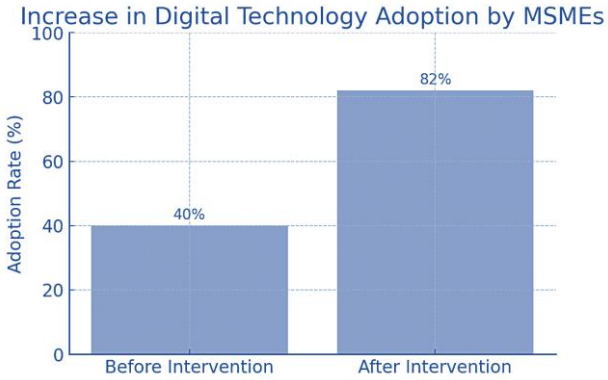

Figure 2. Increase in Digital Technology Adoption by MSMEs.

The significant increase in digital technology usage confirms that rural MSME actors have a high adaptive potential when provided with appropriate guidance and training.

4.2. Discussion

These findings are consistent with previous studies emphasizing the importance of MSME digitalization in enhancing competitiveness (Priyatna, 2019; Ratri et al., 2024). However, this study introduces novelty by integrating IoT, SAW, and Business Intelligence within the rural context, whereas earlier research predominantly focused on urban or student settings (Nuriah & Mayangsari, 2022; Setiawan, 2020). The high utilization rate of promotional websites (>80%) demonstrates that locally tailored digital platforms are more effective than generic applications.

Moreover, the SAW system has proven valuable in helping MSMEs objectively prioritize their business strategies, thereby reducing the risk of misaligned marketing approaches. This reinforces the findings of Sihwi and Anggrainingsih (2014), who emphasized that SAW is a simple yet effective method for multi-criteria decision-making. The integration of Business Intelligence also represents a significant breakthrough, as it provides data-driven insights in line with the concept of MSME 4.0, which demands information-based business management (Hoetoro & Satria, 2020).

The study also confirms that the success of rural MSME digitalization is not determined by technology alone, but also by human resource capacity and village institutional structures such as BUMDes. Training-based and mentorship-driven approaches, supported by ethical governance, make the Smart-Rural Entrepreneurship model more adaptive and sustainable. Consequently, this model can be replicated in other villages, with adjustments based on local potential and digital infrastructure readiness.

5. Comparison

The comparison between the pre-intervention and post-intervention conditions highlights the significant role of the Smart-Rural Entrepreneurship model in strengthening village-based economies. Before the intervention, only 40% of micro, small, and medium enterprises (MSMEs) actively used digital platforms for business promotion and decision-making. After the implementation of the integrated model combining IoT, Business Intelligence, and the Simple Additive Weighting (SAW) method, digital adoption rose sharply to 82%.

This improvement of more than 40 percentage points demonstrates that targeted training, accessible digital platforms, and structured decision-support systems can accelerate the digital transformation of rural enterprises. Compared to previous initiatives that focused solely on providing websites or e-commerce platforms, the integrated model offered in this study is more comprehensive, as it not only increases product visibility but also strengthens evidence-based decision-making and performance monitoring.

In addition, the comparison shows that simpler tools, such as promotional websites, achieve higher adoption rates (82%), while more advanced tools like Business Intelligence dashboards are adopted at a lower rate (68%). This pattern suggests that rural MSMEs tend to adopt technologies that directly support sales and promotion before gradually adapting to

advanced analytical tools. Therefore, a step-by-step adoption strategy is more effective in ensuring long-term sustainability of digital transformation in rural settings.

6. Conclusion

This study concludes that the implementation of the Smart-Rural Entrepreneurship model, which integrates Internet of Things (IoT), Business Intelligence, and the Simple Additive Weighting (SAW) method, has a significant positive impact on strengthening rural economic activities. The findings indicate that more than 80% of village MSMEs successfully adopted the digital promotion website after receiving training and guidance, while the SAW system and Business Intelligence dashboards further enhanced strategic decision-making and real-time performance monitoring.

The sharp increase in digital adoption from 40% before the intervention to 82% after the intervention demonstrates that rural MSMEs are highly adaptive when supported by practical and context-specific digital tools. Furthermore, the research highlights that user-friendly and directly applicable technologies are more readily embraced compared to advanced analytical systems, suggesting the importance of a gradual and tailored adoption strategy.

Overall, the Smart-Rural Entrepreneurship model provides a sustainable framework for digital transformation in rural enterprises by combining technology with training, mentorship, and institutional support. This model can serve as a replicable best practice for other villages, contributing to the broader agenda of inclusive economic development and rural empowerment in the digital era.

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