An Integrative Model of Digital Entrepreneurship for Enhancing MSME Sustainability in Bogor Regency

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ABSTRACT

This study develops and empirically tests an integrative model examining how digital literacy, digital entrepreneurship, and digital innovation jointly influence the sustainability of micro, small, and medium enterprises (MSMEs) in Bogor Regency, Indonesia. Addressing the limited empirical evidence from semi-urban MSME contexts, this research adopts a quantitative cross-sectional approach using survey data collected from 180 MSME owners. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to evaluate both the measurement and structural models. The results demonstrate that digital literacy has a strong and significant effect on digital entrepreneurship (β = 0.694), indicating that foundational digital skills are essential for fostering entrepreneurial orientation in digital environments. Furthermore, digital entrepreneurship significantly influences digital innovation (β = 0.726), highlighting its role as a key driver of innovation adoption and value creation. Digital innovation is found to have a substantial impact on MSME sustainability (β = 0.542), while digital entrepreneurship also exerts a direct positive effect on sustainability (β = 0.384). The proposed model explains 64.5% of the variance in MSME sustainability, indicating strong explanatory power. The findings contribute theoretically by positioning digital entrepreneurship as a central mechanism linking digital literacy and innovation to sustainable business outcomes, and practically by offering insights for policymakers and development agencies in designing integrated digital capability and entrepreneurship programs to support MSME sustainability in semi-urban regions.

Keywords: Digital literacy; Digital entrepreneurship; Digital innovation; MSME sustainability; PLS-SEM; Digital transformation

ABSTRAK

Penelitian ini bertujuan untuk mengembangkan dan menguji secara empiris model integratif yang menjelaskan pengaruh literasi digital, kewirausahaan digital, dan inovasi digital terhadap keberlanjutan usaha mikro, kecil, dan menengah (UMKM) di Kabupaten Bogor, Indonesia. Penelitian ini menjawab keterbatasan bukti empiris pada konteks

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UMKM di wilayah semi-perkotaan yang masih relatif jarang dikaji dalam literatur kewirausahaan digital. Pendekatan kuantitatif dengan desain survei potong lintang digunakan dengan melibatkan 180 pelaku UMKM sebagai responden. Data dianalisis menggunakan Partial Least Squares Structural Equation Modeling (PLS-SEM) untuk menguji model pengukuran dan model struktural. Hasil penelitian menunjukkan bahwa literasi digital berpengaruh positif dan signifikan terhadap kewirausahaan digital (β = 0,694), yang mengindikasikan bahwa penguasaan keterampilan digital dasar berperan penting dalam membentuk orientasi kewirausahaan di era digital. Selanjutnya, kewirausahaan digital terbukti berpengaruh signifikan terhadap inovasi digital (β = 0,726), yang menegaskan perannya sebagai penggerak utama dalam adopsi inovasi dan penciptaan nilai berbasis digital. Inovasi digital juga berpengaruh signifikan terhadap keberlanjutan UMKM (β = 0,542), sementara kewirausahaan digital memiliki pengaruh langsung yang positif terhadap keberlanjutan usaha (β = 0,384). Model integratif yang diusulkan mampu menjelaskan 64,5% variasi keberlanjutan UMKM, yang menunjukkan daya jelas model yang kuat. Secara teoretis, temuan ini menempatkan kewirausahaan digital sebagai mekanisme kunci yang menghubungkan literasi digital dan inovasi digital dengan keberlanjutan usaha. Secara praktis, hasil penelitian memberikan implikasi bagi perancang kebijakan dan lembaga pendamping UMKM dalam merumuskan program penguatan kapabilitas digital dan kewirausahaan yang terintegrasi untuk mendukung keberlanjutan UMKM di wilayah semi-perkotaan.

Kata Kunci: Literasi Digital; Kewirausahaan Digital; Inovasi Digital; Keberlanjutan UMKM; PLS-SEM; Transformasi Digital.

INTRODUCTION

The rapid development of the global economy over the past decade has brought a fundamental transformation in the way micro, small, and medium enterprises (MSMEs) operate, interact with markets, and maintain business continuity in an increasingly uncertain environment. This transformation is driven mainly by the expanding penetration of digital technologies and the accelerating pace of socio-economic disruptions occurring worldwide, including in Indonesia. As one of the backbone sectors of the national economy, MSMEs are confronted with escalating demands to strengthen their digital capabilities, adopt technology-based business practices, and develop entrepreneurial orientations that align with the dynamics of the digital era. In this context, Bogor Regency—characterized by a large and diverse MSME population—represents a strategic yet challenging environment to observe how digital entrepreneurship shapes business sustainability. The region's economic vibrancy coexists with structural barriers that hinder the optimal absorption of digital innovation among local enterprises, making it a particularly relevant setting for empirical investigation.

Although digital transformation is often promoted as a promising pathway to enhance MSME competitiveness, the implementation of digital tools frequently fails to yield meaningful benefits when not supported by adequate entrepreneurial capacity. Recent studies show that MSMEs' ability to understand, adopt, and leverage digital technologies is largely determined by their level of digital literacy and entrepreneurial orientation (Kraus et al., 2021). Digital transformation is not merely a mechanical shift involving the use of social media, online marketplaces, or digital payment services. Instead, it entails the creation of new value through digital creativity, innovation, and opportunity recognition (Nambisan, 2020). In practice, many MSMEs in regions such as Bogor Regency adopt digital tools at a basic, technical level without integrating them into long-term business strategies. As a result, digital activities often fail to contribute significantly to business sustainability. The distinction between mere technological usage and strategic digital entrepreneurship is therefore central to understanding why some MSMEs are able to sustain and grow, while others stagnate.

Bogor Regency illustrates this complexity clearly. On one hand, it benefits from proximity to major economic hubs, such as Jakarta and Bogor City, which creates opportunities for access to wider markets and business networks. On the other hand, disparities in digital capability remain evident across MSME groups. While some enterprises have begun to creatively leverage digital platforms to enhance sales performance, others continue to face difficulties in understanding even the basic digital functions relevant to their businesses. Uneven access to digital training, mentorship, and infrastructure reinforces gaps in technological readiness. These conditions indicate that the digitalization of MSMEs in Bogor Regency is not merely a matter of technology availability but is dependent largely on the strength of digital entrepreneurial capacity among business owners.

Despite the growing international literature on digital entrepreneurship from 2020 to 2021, several theoretical gaps remain. First, most studies focus on technology-based firms, start-ups, or MSMEs in large urban centers with advanced digital ecosystems, while empirical attention to MSMEs in semi-urban or rural regency contexts is still limited (Ritter & Pedersen, 2020). Second, many studies address digitalization from a technical standpoint—such as platform use, e-commerce, or online marketing—without examining the deeper aspects of digital entrepreneurial orientation, including creativity, risk-taking, and opportunity recognition. Yet, recent works emphasize that these entrepreneurial attributes are essential for successful digital transformation (Kraus et al., 2020). Third, research on MSME sustainability often treats economic, social, or environmental dimensions separately, whereas the digital era requires an integrated perspective that connects innovation, digital capability, and long-term sustainability.

In addition to these theoretical gaps, there is a clear empirical gap concerning MSMEs in Bogor Regency. Local studies over the past three years have mostly focused on digital marketing practices, consumer behavior, or training effectiveness, with very few applying structural models capable of examining complex relationships among key variables. Empirical studies that test integrative models linking digital literacy, digital entrepreneurship, digital innovation, and MSME sustainability are still scarce. Moreover, the measurement of digital entrepreneurship in many previous studies is often partial and does not capture critical dimensions such as digital creativity, technological adaptability, and value creation. A more robust empirical approach is needed to uncover the causal mechanisms shaping MSME sustainability in the digital age.

Despite the growing body of literature on digital entrepreneurship and MSME digital transformation, several critical gaps remain unaddressed. From an empirical perspective, existing studies predominantly focus on MSMEs operating in large urban centers or digitally advanced ecosystems, leaving limited empirical evidence from semi-urban regions in Indonesia, such as Bogor Regency, where digital readiness and entrepreneurial capabilities remain uneven. This lack of empirical investigation restricts the generalizability of current findings and limits the understanding of how digital entrepreneurship operates in less mature digital environments. From a theoretical standpoint, much of the prior research treats digital entrepreneurship as a direct antecedent of performance or sustainability outcomes, without adequately conceptualizing its role as a causal mechanism that translates digital literacy into innovation-driven value creation. Consequently, the mediating and enabling function of digital entrepreneurship within an integrated digital capability framework remains underexplored. Methodologically, previous studies often rely on descriptive or single-equation analytical approaches, which are insufficient for capturing the complex and layered relationships among digital literacy, digital entrepreneurship, digital innovation, and sustainability. To address these gaps, this study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to test a multi-layered integrative model, allowing for simultaneous examination of direct and indirect effects within a predictive-oriented framework. By doing so, this research provides a more comprehensive explanation of how digital capabilities contribute to MSME sustainability in semi-urban contexts.

METHOD

This study proposes a novel integrative model of digital entrepreneurship that connects four key constructs—digital literacy, digital entrepreneurship, digital innovation, and MSME sustainability—within a unified theoretical and empirical framework. Rather than examining each variable in isolation, this model explains how these constructs interact to influence the sustainability of MSMEs in Bogor Regency. Employing Structural Equation Modeling–Partial Least Squares (SEM-PLS), the study offers methodological contributions by providing stronger causal inferences compared to conventional quantitative approaches. The focus on MSMEs in Bogor Regency also adds contextual depth to the literature, offering insights into digital transformation in semi-urban localities that are often overlooked.

The study also has practical implications for policymakers, MSME development agencies, and business practitioners. Understanding how digital literacy shapes digital entrepreneurial orientation can guide local governments in designing training programs that not only develop technical skills but also foster innovative mindsets among MSME owners. Furthermore, identifying the influence of digital entrepreneurship and innovation on business sustainability offers evidence for developing policies that strengthen the adaptive and innovative capacity of MSMEs. These findings are especially relevant in the "new digital normal" following the COVID-19 pandemic, where consumer behavior and business interactions have shifted rapidly toward digital channels, requiring MSMEs to adapt more quickly. Enterprises with stronger digital entrepreneurial orientation are better positioned to navigate these changes, while those without such competencies risk falling behind (Zaheer et al., 2021).

Overall, this introduction emphasizes that MSME digitalization should not be understood merely as technology adoption but as a broader transformation of entrepreneurial capacity. Digital entrepreneurship serves as a key mechanism linking digital literacy and innovation to sustainable business performance. By addressing both theoretical and empirical gaps, this study contributes to advancing digital entrepreneurship theory and offers actionable insights for promoting sustainable MSMEs, particularly within the unique socio-economic context of Bogor Regency.

This study employed a quantitative research design with a cross-sectional survey approach to examine the relationships among digital literacy, digital entrepreneurship, digital innovation, and MSME sustainability in Bogor Regency. The use of a quantitative approach was considered appropriate because the primary objective of the study was to validate a structural model and test the causal pathways among latent variables. Similar methodological choices have been widely adopted in recent studies on digital transformation and entrepreneurship, especially those focusing on micro and small enterprises in emerging economies (Kraus et al., 2020; Nambisan, 2020; Zaheer et al., 2021). By drawing on this methodological foundation, the present study aimed to produce empirical evidence that can strengthen the understanding of how digital capabilities shape MSME sustainability at the regional level.

The population of this study consisted of micro, small, and medium enterprises operating in Bogor Regency, a district known for its diverse economic activities and rapidly growing entrepreneurial ecosystem. Because no comprehensive list of digitally engaged MSMEs was available, the sampling frame was developed based on data from local government units, MSME associations, and digital business communities in the region. A purposive sampling technique was used to recruit respondents who met the following criteria: (1) the enterprise had been operating for at least two years, (2) the business owner or manager actively participated in digital marketing, administration, or communication activities, and (3) the enterprise was registered or informally recognized within the local MSME network. These criteria ensured that respondents were sufficiently exposed to digital technologies, allowing them to provide accurate assessments of their digital literacy and digital entrepreneurial orientation. A total of 180 MSME owners or managers participated in the survey, a sample size considered adequate for Partial Least

Squares Structural Equation Modeling (PLS-SEM) as recommended by Hair et al., particularly when the model contains multiple latent constructs with several indicators.

Data were collected using a structured questionnaire distributed both online and offline. The online version was disseminated through WhatsApp groups of local MSME communities, while the offline version was administered through field visits to traditional markets, home industries, and small business clusters across several subdistricts in Bogor Regency. This combined distribution method was chosen to ensure inclusivity, considering that not all MSME owners possess the same level of digital convenience. Before full deployment, the questionnaire was pilot-tested with 20 MSME owners to examine clarity, readability, and relevance. Minor revisions were made based on respondent feedback, particularly relating to simplifying certain items and aligning terminology with common digital practices used by local business actors.

The measurement instrument consisted of four latent constructs: digital literacy, digital entrepreneurship, digital innovation, and MSME sustainability. Items for each construct were adapted from established scales previously validated in studies on digital capability and entrepreneurial orientation. Digital literacy items drew on indicators developed by Park (2020) and Lim (2021), focusing on digital operational skills, information management, and awareness of digital security. Digital entrepreneurship items were adapted from the digital entrepreneurial orientation scale used by Kraus et al. (2020), emphasizing creativity, proactive behavior, opportunity recognition, and digital risk-taking. Digital innovation items followed the framework used by Nambisan (2020), capturing product, process, and marketing innovations enabled by digital tools. MSME sustainability was measured using a combination of indicators referencing economic resilience, adaptability, and long-term viability, incorporating insights from Zaheer et al. (2021). All items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

To ensure the reliability and validity of the instrument, several procedures were applied. Content validity was examined through expert judgment involving two academics specializing in entrepreneurship and digital business, as well as one practitioner from a local MSME development agency. Construct validity and reliability were assessed through outer model testing using PLS-SEM, which included evaluations of factor loadings, Average Variance Extracted (AVE), Cronbach's alpha, and composite reliability. Consistent with best practices in SEM-PLS studies, factor loadings above 0.70, AVE above 0.50, and reliability coefficients above 0.70 were considered acceptable thresholds. These analytical procedures followed the guidelines outlined in contemporary SEM literature, particularly Hair et al. (2021). To assess common method bias, a full collinearity VIF test was conducted, and all VIF values were below 3.3, indicating no serious common method bias.

The decision to use PLS-SEM for data analysis was driven by several considerations. First, PLS-SEM is well-suited for exploratory research models and predictive-oriented analyses, especially when dealing with relatively small sample sizes and non-normal data distributions. Second, the method allows for simultaneous examination of complex relationships among multiple latent constructs, making it particularly relevant for integrative models such as the one proposed in this study. Third, PLS-SEM has been widely employed in recent research on digital transformation, digital innovation, and entrepreneurial orientation, demonstrating its methodological suitability for analyzing technology-driven behavioral constructs (Kraus et al., 2020; Nambisan, 2020). The analysis was conducted using SmartPLS version 4.0, enabling comprehensive testing of both the measurement model and the structural model.

Bootstrapping with 5,000 resamples was applied to assess the significance of path coefficients and evaluate the robustness of the structural model. Coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and overall model fit were examined to determine the explanatory power and predictive strength of the proposed integrative model. The chosen analytical framework ensured that the study's findings

would be interpretable not only from a statistical standpoint but also from a practical perspective relevant to MSME development in Bogor Regency.

Altogether, the methodological approach adopted in this study integrates rigorous quantitative procedures with contextual sensitivity to the characteristics of MSMEs in a semi-urban district. By grounding the empirical strategy in established digital entrepreneurship research and adapting it to local conditions, the method provides a strong foundation for generating valid and meaningful insights into how digital capabilities contribute to MSME sustainability.

RESULTS

The data analysis was conducted using the PLS-SEM technique to evaluate both the measurement and structural components of the proposed integrative model. Before analyzing the structural relationships among variables, assessments of indicator reliability, construct reliability, and validity were performed. The initial inspection of the measurement model showed that all items loaded satisfactorily on their respective constructs. As illustrated in Table 1, the outer loadings ranged from 0.712 to 0.891, exceeding the recommended threshold of 0.70. This indicates that each indicator demonstrated a strong contribution in measuring its corresponding latent construct. In addition to the outer loading assessment, the Average Variance Extracted (AVE) values for all constructs were above 0.50, suggesting that convergent validity was achieved. Digital literacy exhibited an AVE of 0.617, digital entrepreneurship 0.653, digital innovation 0.682, and MSME sustainability 0.701. These results reflect the internal consistency of the measurement model and affirm that the constructs were conceptually sound and statistically robust.

Table 1. Outer Loadings and AVE of Latent Constructs

Construct	Item Code	Loading	AVE
Digital Literacy	DL1	0.732	0.617
	DL2	0.781	
	DL3	0.842	
Digital Entrepreneurship	DE1	0.764	0.653
	DE2	0.821	
	DE3	0.879	
Digital Innovation	DI1	0.799	0.682
	DI2	0.846	
	DI3	0.891	
MSME Sustainability	MS1	0.752	0.701
	MS2	0.828	
	MS3	0.874	

Reliability testing further demonstrated the robustness of the measurement model. Composite reliability values for digital literacy, digital entrepreneurship, digital innovation, and MSME sustainability ranged from 0.866 to 0.914, surpassing the commonly accepted threshold of 0.70. Cronbach's alpha values also confirmed the internal reliability of each construct, with all values exceeding 0.80. The satisfactory outcomes of both convergent validity and reliability tests provided the foundation for advancing to the structural model evaluation. All HTMT values were below 0.85, confirming discriminant validity.

The structural model was examined to determine the magnitude and significance of relationships among the latent constructs. The coefficient of determination (R^2) indicated that digital literacy explained 48.2% of the variance in digital entrepreneurship, while digital entrepreneurship accounted for 52.7% of the variance in digital innovation. Furthermore, the combined effect of digital entrepreneurship and digital innovation explained 64.5% of the variance in MSME sustainability. These R^2 values demonstrate moderate to substantial explanatory power, indicating that the proposed model effectively

captures the underlying dynamics of digital capability development and sustainable business performance among MSMEs.

Bootstrapping with 5,000 resamples was applied to assess the significance of path coefficients. As summarized in Table 2, all hypothesized relationships were statistically significant at $p < 0.05$, confirming that digital literacy has a strong and positive effect on digital entrepreneurship ($\beta = 0.694$, $p < 0.001$). The path from digital entrepreneurship to digital innovation also exhibited a strong relationship ($\beta = 0.726$, $p < 0.001$), supporting the idea that entrepreneurial capability is closely tied to the ways MSMEs utilize digital tools for innovation. Digital innovation demonstrated a direct and significant effect on MSME sustainability ($\beta = 0.542$, $p = 0.003$), indicating that enterprises capable of integrating digital innovation into their operational and marketing activities are more likely to sustain long-term business performance. The direct effect of digital entrepreneurship on MSME sustainability was also significant ($\beta = 0.384$, $p = 0.011$), reinforcing its role as both a predictor of innovation and a determinant of sustainability.

Table 2. Path Coefficients and Significance Levels

Path	Coefficient (β)	p-value	Result
Digital Literacy → Digital Entrepreneurship	0.694	<0.001	Supported
Digital Entrepreneurship → Digital Innovation	0.726	<0.001	Supported
Digital Innovation → MSME Sustainability	0.542	0.003	Supported
Digital Entrepreneurship → MSME Sustainability	0.384	0.011	Supported

The statistical findings suggest that digital literacy plays a fundamental role in shaping the entrepreneurial mindset necessary for adopting and leveraging digital tools. MSMEs with higher digital literacy are more capable of recognizing digital opportunities and converting them into entrepreneurial activities. This aligns with previous research emphasizing the role of digital skills as a precursor to digital opportunity recognition and strategic digital behavior among small business owners (Kraus et al., 2020). Furthermore, the strong relationship between digital entrepreneurship and digital innovation confirms that entrepreneurial orientation is a critical driver of innovation, particularly in contexts where MSMEs must adapt quickly to evolving market conditions.

The significant effects of both digital innovation and digital entrepreneurship on MSME sustainability reveal the layered nature of sustainability in the digital era. MSMEs that actively innovate through digital means—such as adopting digital marketing systems, improving production processes, or developing digitally enhanced products—tend to experience more stable market performance and long-term resilience. The dual pathway through which digital entrepreneurship influences sustainability, both directly and through innovation, underscores its centrality in the integrative model. These findings resonate with emerging literature suggesting that sustainability in the digital age cannot be separated from the capacity to innovate and adapt using digital tools (Zaheer et al., 2021).

Overall, the results of the model affirm the theoretical assumptions underlying digital capability frameworks and provide empirical evidence supporting the integrative role of digital entrepreneurship in strengthening MSME sustainability. The significance of each pathway demonstrates that enhancing digital literacy and digital entrepreneurial capacity can create a cumulative impact on innovation and long-term business sustainability—an insight particularly relevant for MSME development strategies in Bogor Regency.

DISCUSSION

The results of this study provide empirical confirmation of the proposed integrative model, revealing that digital literacy, digital entrepreneurship, and digital innovation play crucial roles in shaping MSME sustainability in Bogor Regency. The statistical findings demonstrated that digital literacy has a strong and significant effect on digital entrepreneurship ($\beta = 0.694$), digital entrepreneurship significantly influences digital innovation ($\beta = 0.726$), digital innovation contributes meaningfully to MSME

sustainability (β = 0.542), and digital entrepreneurship also shows a direct effect on MSME sustainability (β = 0.384). Collectively, these pathways explain 64.5% of the variance in sustainability, indicating that the model has substantial explanatory power. This section discusses the implications of these relationships, relates them to previous studies, and provides contextual interpretation within the dynamics of MSMEs in Bogor Regency.

The first key finding—the strong effect of digital literacy on digital entrepreneurship—highlights the foundational role of digital capabilities in shaping entrepreneurial orientation. Digital literacy equips MSME owners with the skills necessary to operate digital tools, manage online information, and navigate emerging technological platforms. These skills appear to enhance their confidence in engaging in digital entrepreneurial activities, including identifying online opportunities, adopting digital marketing strategies, and experimenting with digital-based innovation. The finding aligns with the growing body of literature asserting that digital literacy is a prerequisite for digital entrepreneurial behavior (Kraus et al., 2021; Park, 2020). These studies emphasize that digital entrepreneurship requires more than basic technological ability; it demands the cognitive capacity to understand digital landscapes, evaluate risks, and anticipate potential gains from digital ventures. In the context of Bogor Regency, where MSME digital adoption varies considerably, higher digital literacy directly supports entrepreneurial adaptability and openness to technological change.

The second finding, digital entrepreneurship significantly influencing digital innovation (β = 0.726), reinforces the role of entrepreneurial orientation as a critical driver of innovation. This relationship suggests that MSME owners who possess a strong digital entrepreneurial mindset are more likely to leverage digital tools creatively to develop new products, improve processes, or revise their marketing strategies. This aligns with Nambisan's (2020) perspective that digital entrepreneurship fosters innovation through proactive opportunity-seeking and experimentation with digital solutions. The strong coefficient in this pathway also suggests that innovation is not merely a result of technological availability but rather of entrepreneurial capability and intention. This is particularly relevant in semi-urban regions like Bogor, where exposure to competitive markets compels MSMEs to innovate continuously to maintain relevance. MSME owners who actively engage in digital entrepreneurship, by exploring new digital platforms, testing digital strategies, and interacting with digital communities, are better positioned to convert technological opportunities into meaningful innovations.

The third pathway—digital innovation significantly affecting MSME sustainability, confirms the central role of innovation in sustaining business performance. The positive coefficient (β = 0.542) indicates that enterprises capable of integrating digital innovation into their operations demonstrate greater long-term resilience and adaptability. This finding corroborates earlier studies, such as Zaheer et al. (2021), which suggested that digital innovation enhances business efficiency, expands market reach, and strengthens the capacity to respond to market disruptions. Innovation also serves as a mechanism for differentiation, enabling MSMEs to stand out in highly competitive sectors such as food processing, handicrafts, and local services. In Bogor Regency, where consumer preferences are shifting rapidly toward digital service delivery and online transactions, digital innovation becomes indispensable for maintaining customer loyalty and increasing the visibility of local products.

The final significant relationship, digital entrepreneurship directly influencing MSME sustainability—underscores that entrepreneurial orientation remains a central determinant of long-term business viability. Although the coefficient (β = 0.384) is smaller than that of digital innovation, its significance indicates that entrepreneurial behavior contributes to sustainability independently of innovation. This supports the idea that entrepreneurs who leverage digital platforms strategically are better able to navigate uncertainties, diversify revenue streams, and build networks that enhance business stability. Kraus et al. (2020) also highlighted that digital entrepreneurial orientation fosters the ability to reconfigure resources, adjust to market fluctuations, and maintain

competitiveness. Within the context of Bogor Regency's evolving economic landscape, digital entrepreneurial behavior functions as a protective mechanism, enabling businesses to withstand competition from urban markets while exploiting niche local opportunities.

The combination of direct and indirect effects emphasizes the layered nature of sustainability in the digital era. Digital entrepreneurship not only contributes directly to sustainability but also indirectly through its influence on digital innovation. This dual pathway illustrates that digital entrepreneurship serves as both a behavioral driver and a strategic enabler of innovation. The cumulative effect reinforces the theoretical argument that digital entrepreneurship acts as a central construct linking digital skills to long-term business outcomes. The sizable R^2 values in digital innovation (52.7%) and sustainability (64.5%) also suggest that the model captures significant aspects of MSME performance dynamics.

When examining these findings in the specific context of Bogor Regency, several socio-economic characteristics emerge as relevant. The region's proximity to Jakarta and Bogor City exposes local MSMEs to competitive pressures and consumer markets that increasingly favor digitalized business interactions. At the same time, disparities in digital infrastructure and digital inclusion create uneven patterns of adoption among MSMEs. Businesses operating in more urbanized districts such as Cibinong or Parung tend to adopt digital tools more rapidly, while enterprises located in rural areas face limitations in access, skills, and technological exposure. The strong influence of digital literacy in the model indicates that addressing this digital divide is essential for enhancing entrepreneurial participation and sustainability across the region. The findings also highlight that innovation-driven MSMEs are more capable of exploiting Bogor's growing digital ecosystem, including local marketplaces, tourism platforms, and community-based digital networks.

Although digital entrepreneurship exerts a significant direct effect on MSME sustainability, its magnitude ($\beta = 0.384$) is relatively smaller compared to the effect of digital innovation ($\beta = 0.542$). This finding suggests that entrepreneurial orientation in the digital context primarily contributes to sustainability through its ability to stimulate innovation rather than acting as a dominant standalone driver of long-term performance. Digital entrepreneurship reflects behavioral and strategic readiness—such as opportunity recognition, proactiveness, and digital risk-taking—yet these attributes generate sustainable outcomes only when translated into concrete innovative practices, including digital process improvements, product differentiation, and market expansion. Consequently, digital innovation represents a more proximal and operational mechanism through which value creation and sustainability are realized. This result reinforces the argument that digital entrepreneurship is a necessary but not sufficient condition for MSME sustainability. Sustainable business performance is influenced by a broader set of factors beyond entrepreneurial behavior, including market dynamics, access to financial resources, competitive intensity, and the strength of business networks. These contextual and structural elements may either amplify or constrain the effectiveness of digital entrepreneurship in generating sustainable outcomes. Therefore, future research is encouraged to incorporate external and resource-based variables—such as financial capability, institutional support, and network embeddedness—to develop a more comprehensive understanding of MSME sustainability in digitally transforming environments.

The theoretical contributions of this study lie in its integrative approach, demonstrating that digital literacy, digital entrepreneurship, and digital innovation function interdependently in shaping sustainability. Unlike previous studies that examined these constructs in isolation, this model provides a holistic explanation of how digital capability translates into sustained performance. The findings extend digital entrepreneurship theory by illustrating that MSMEs in semi-urban contexts require foundational digital skills, entrepreneurial orientation, and innovative practices to achieve sustainable growth. The results further enrich the literature by offering empirical evidence from a regional setting that has been underrepresented in digital entrepreneurship research.

From a practical standpoint, the study offers several implications for policymakers, MSME support institutions, and digital ecosystem stakeholders. First, programs aimed at strengthening MSME sustainability should prioritize digital literacy training, ensuring that small business owners possess not only technical skills but also a deeper understanding of how digital tools can enhance entrepreneurial strategy. Second, entrepreneurship development programs must emphasize digital opportunity recognition, risk-taking, creativity, and business model experimentation. Third, MSME facilitation programs should encourage innovation by providing access to digital infrastructure, marketplaces, and collaborative platforms. The strong effect of innovation on sustainability implies that enhancing MSME innovative capacity will yield significant gains in long-term performance.

For MSME practitioners, the findings imply that cultivating a digital entrepreneurial mindset is as important as acquiring digital tools. Business owners must continuously explore digital opportunities, adapt quickly to digital trends, and incorporate innovation into everyday operations. In the long run, digital entrepreneurship provides a path toward resilience, helping enterprises survive market disruptions and capitalize on digital-era opportunities.

Despite its contributions, this study has limitations. The cross-sectional design restricts the ability to capture changes in digital behavior over time. Future research should employ longitudinal designs to explore dynamic shifts in digital entrepreneurship and innovation. Additionally, qualitative approaches could enrich the understanding of contextual factors influencing digital adoption, particularly among rural MSMEs.

Overall, the findings affirm that strengthening MSME sustainability in Bogor Regency requires an integrated approach: enhancing digital literacy, fostering digital entrepreneurial orientation, and deepening digital innovation. These components collectively construct a pathway toward resilient and sustainable MSMEs in the digital economy era.

CONCLUSION

The findings of this study provide a comprehensive understanding of how digital literacy, digital entrepreneurship, and digital innovation interact to enhance MSME sustainability in Bogor Regency. The integrative model developed and tested in this research demonstrates that digital capabilities and entrepreneurial behaviors are mutually reinforcing components that shape the long-term viability of small businesses in the digital economy. With significant path relationships across all proposed hypotheses and substantial explanatory power reflected in the R^2 values, the study confirms that improving MSME sustainability requires more than merely introducing technological tools; it requires cultivating the human, cognitive, and behavioral capacity to use these tools strategically.

One of the key conclusions drawn from this study is that digital literacy forms the foundational pillar of digital entrepreneurship. The strong effect of digital literacy on entrepreneurial orientation indicates that MSME owners who possess higher digital skills are better equipped to recognize digital opportunities, navigate online environments, and manage digital risks. This relationship underscores the critical importance of building digital literacy not only as a technical competency but also as a cognitive resource that shapes the entrepreneur's ability to engage in meaningful digital business activities. In semi-urban contexts such as Bogor Regency, where disparities in digital readiness remain evident, developing digital literacy can directly influence the entrepreneurial mindset needed to respond to evolving market conditions.

Furthermore, the study confirms that digital entrepreneurship significantly drives digital innovation. MSME owners who adopt a proactive, opportunity-seeking, and creative approach to digital tools are more likely to generate innovative ideas, implement digital solutions, and experiment with new forms of value creation. This link suggests that innovation does not emerge automatically from technological access but is instead propelled by entrepreneurial intention and behavior. The importance of this pathway

highlights that policymakers and support institutions should prioritize strengthening entrepreneurial orientation alongside providing access to digital technologies.

The research also reinforces the essential role of digital innovation in shaping MSME sustainability. The significant contribution of digital innovation to sustainability shows that MSMEs able to redesign processes, introduce digital products or services, or adopt digital marketing approaches tend to achieve better long-term performance. Innovation becomes a mechanism through which businesses enhance operational efficiency, respond to customer needs more dynamically, and maintain competitiveness amid shifting digital consumer behaviors. In the context of Bogor Regency's growing digital economy, the ability to innovate is pivotal to ensuring that local MSMEs remain relevant and resilient.

Additionally, the study establishes that digital entrepreneurship has a direct effect on sustainability, independent of innovation. This finding indicates that entrepreneurial behaviors—such as willingness to take risks, ability to utilize digital channels for strategic purposes, and capacity to build digital networks—contribute meaningfully to long-term business stability. The dual impact of digital entrepreneurship, both directly and through innovation, reinforces its central role within the integrative model.

Taken together, the results provide strong theoretical implications. The model validates the notion that digital literacy acts as a precursor to entrepreneurial orientation, which in turn drives innovation and sustainability. It extends digital entrepreneurship theory by demonstrating how digital capabilities translate into sustainable business outcomes within a semi-urban Indonesian context. Additionally, it contributes to the growing literature on digital transformation by offering empirical evidence from MSMEs, a sector often underrepresented in digital capability research.

From a practical standpoint, the findings offer clear directions for MSME development strategies. Government programs should move beyond basic training modules and focus on strengthening digital literacy, entrepreneurial orientation, and creative use of digital tools. MSME support institutions—such as cooperatives, community learning centers, and digital business hubs—must design initiatives that encourage experimentation, innovation, and digital business model development. Moreover, MSME owners should continuously build their digital competencies and cultivate an entrepreneurial mindset that allows them to adapt to technological changes and market shifts.

Despite its contributions, the research has limitations. Its cross-sectional design does not capture long-term behavioral changes in digital adoption. Future studies may use longitudinal or mixed-method designs to gain deeper insights into the dynamic evolution of digital entrepreneurship. Expanding the sample across additional districts or provinces may also enhance generalizability.

In conclusion, the integrative model presented in this study demonstrates that MSME sustainability in Bogor Regency is strengthened when digital literacy, digital entrepreneurship, and digital innovation are developed concurrently. These three elements form an interconnected pathway that supports resilience, adaptability, and competitive advantage in the digital era. As the economic landscape becomes increasingly shaped by digital forces, MSMEs that embrace this integrative approach will be better positioned to achieve sustainable and inclusive growth.

Theoretical Implications

The findings of this study offer several significant theoretical contributions to the literature on digital entrepreneurship, innovation, and MSME sustainability. First, the study confirms that digital literacy serves as a foundational antecedent of digital entrepreneurship, providing empirical evidence for the argument that digital skills enable entrepreneurs to recognize, evaluate, and respond to opportunities in digital environments. While previous research has often discussed digital literacy as a technical capability, this study extends its conceptualization by demonstrating its strategic importance in shaping entrepreneurial behavior. This reinforces theoretical propositions by Kraus et al. (2021), who emphasized the cognitive role of digital capability in entrepreneurial decision-making.

Second, the study advances the understanding of digital entrepreneurship as a central mediating construct linking digital literacy to both innovation and sustainability. In many earlier studies, digital entrepreneurship has been treated as an outcome or as a parallel construct to innovation. By demonstrating its dual role—both as a direct predictor of sustainability and an indirect driver through digital innovation—this study contributes to a more nuanced theoretical model of how digital capability is transformed into long-term business advantage. This strengthens the conceptual argument that digital entrepreneurship is not merely behavioral but also a mechanism that enables resource orchestration within MSMEs.

Third, the results provide empirical support for the argument that digital innovation is a key determinant of sustainability, validating insights from Nambisan (2020) and Zaheer et al. (2021). By situating digital innovation within an integrative model, the study demonstrates that innovation functions as a bridge between entrepreneurial orientation and long-term resilience. The significant contribution of digital innovation to sustainability adds depth to existing models of innovation capability by showing that innovation is not simply a product of technological access, but the result of entrepreneurial intention and literacy-based cognitive readiness.

Fourth, the model contributes to the broader theoretical conversation on MSME sustainability in developing economies by illustrating how capability-based and opportunity-based constructs interact. The study aligns with resource-based and dynamic capability perspectives, suggesting that MSMEs develop sustainability not only by possessing digital resources but by dynamically leveraging them through entrepreneurial and innovative processes. This expands the theoretical understanding of how resource orchestration occurs among small enterprises operating in semi-urban and digitally uneven areas such as Bogor Regency.

Overall, the theoretical implications of this study extend existing knowledge by presenting a coherent, empirically validated model that integrates digital literacy, entrepreneurship, innovation, and sustainability into a single explanatory framework. This strengthens the foundation for future theoretical exploration and offers a replicable model for studies in similar socio-economic contexts.

Practical Implications

Beyond theoretical contributions, the study provides several practical insights for policymakers, MSME support institutions, and business practitioners. The strong effect of digital literacy on digital entrepreneurship highlights the urgent need for targeted digital literacy programs that go beyond teaching basic skills. Government agencies and MSME development centers should design training initiatives that incorporate advanced competencies such as digital opportunity recognition, online risk management, data-driven decision-making, and digital content strategy. Such programs should be contextualized to local MSME conditions and delivered through hybrid formats to ensure inclusivity.

Second, the finding that digital entrepreneurship drives innovation underscores the need for entrepreneurship development programs that emphasize mindset transformation, creativity, digital business modeling, and experimentation. Local governments and entrepreneurial hubs in Bogor Regency should promote environments that encourage MSMEs to explore new digital platforms, test prototypes, and engage with digital communities. Entrepreneurship incubators, co-working spaces, and digital marketplaces can act as catalysts for accelerating MSME digital transformation.

Third, the significant link between digital innovation and sustainability provides important guidance for MSME support institutions. There is a need to facilitate access to digital infrastructure, tools, and innovation ecosystems. This includes providing subsidized access to e-commerce platforms, digital payment systems, logistic partners, and cloud-based business tools. Support institutions can also create innovation clinics or digital mentorship schemes where MSME owners receive hands-on assistance in implementing digital solutions tailored to their business models.

Fourth, the direct effect of digital entrepreneurship on sustainability indicates that MSMEs should be encouraged to adopt a strategic approach to digitalization, not merely a functional one. Business owners need to be exposed to case studies, success stories, and peer-to-peer learning networks where they can observe how digital tools lead to long-term competitive benefits. This strategic orientation will enable MSMEs to diversify markets, build digital customer relationships, and strengthen crisis resilience—especially important given the region's exposure to competitive pressure from urban centers.

Finally, the study's implications highlight the importance of collaboration among stakeholders. Sustainable MSME development in the digital era requires synergy among government agencies, educational institutions, private sector digital platforms, and MSME associations. Collaborative programs can accelerate capacity building, reduce digital gaps, and foster a culture of digital innovation throughout Bogor Regency.

Taken together, these practical implications underscore that strengthening MSME sustainability requires a holistic approach: improving digital literacy, cultivating digital entrepreneurship, enabling innovation ecosystems, and fostering cross-sector collaboration. By implementing these recommendations, policymakers and practitioners can create a more inclusive and resilient digital economy that empowers MSMEs to thrive sustainably.

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