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Moderating Role of MSME Collaboration on Digital Innovation Toward Adaptive Capability and MSME Performance in Indonesia

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A B S T R A C T
This study investigates the effect of digital innovation on MSME performance in Indonesia, focusing on the mediating role of digital adaptive capability and the moderating effect of MSME collaboration. Drawing on the Dynamic Capabilities Theory, a structural equation model was developed and tested using data from 100 MSMEs across various sectors. The results indicate that digital innovation has a significant direct effect on performance and also enhances adaptive capability. However, adaptive capability itself does not significantly influence performance, suggesting it may require complementary factors to be effective. Contrary to expectations, MSME collaboration did not moderate the effects of innovation or adaptive capability on performance, implying that collaboration must be strategically aligned to be beneficial. The findings highlight the need for MSMEs to focus on internal digital readiness while being cautious about over-relying on external partnerships. The study contributes to the digital transformation literature in emerging economies and provides practical guidance for MSME policy and strategy. Future research is recommended to use longitudinal data and explore additional moderators or mediators in the innovation–performance relationship.

INTRODUCTION

In recent years, digital innovation has emerged as a vital force driving business transformation across various sectors, including Micro, Small, and Medium Enterprises (MSMEs) in Indonesia (Bogers et al., 2018). Despite the widespread availability of digital technologies, many Indonesian MSMEs continue to struggle with effective adoption and integration into their business models. According to the Ministry of Cooperatives and SMEs, as of 2023, only around 27% of Indonesia's 64 million MSMEs had adopted digital platforms, reflecting a large digital gap between potential and practice. This difficulty is often rooted in limited digital literacy, insufficient technological infrastructure, and a lack of strategic orientation toward innovation (Cenamor et al., 2019). Consequently, the gap between the promise of digital transformation and its actual implementation has widened, contributing to stagnant or inconsistent business performance across the MSME sector (Baral et al., 2023).

The Indonesian government has launched various digital empowerment programs, yet empirical evidence suggests that digital innovation alone is insufficient to drive sustainable MSME performance (Charband & Jafari Navimipour, 2016). Field observations reveal that while some MSMEs have adopted digital tools such as e-commerce platforms or social media marketing, the outcomes remain inconsistent across sectors and regions (Dwivedi et al., 2021). These inconsistencies point to deeper organizational and environmental factors that influence digital adaptation (Emory University et al., 2013). Furthermore, collaboration among MSMEs—through networks, partnerships, and shared learning—has emerged as a potential lever to amplify the impact of digital innovation (Al Issa & Omar, 2024). Yet, the strategic role of collaboration in shaping adaptive digital capability remains underexplored, particularly in the Indonesian MSME context (Collazos et al., 2025).

Although MSMEs in Indonesia contribute more than 60% of the national Gross Domestic Product (GDP) and absorb around 97% of the workforce (Kemenkop UKM, 2023), most of them still face serious challenges in daily business practices. The main issues include limited access to digital technology, weak managerial capabilities, and underdeveloped marketing strategies, which hinder their ability to compete in domestic and global markets. Data from BPS (2022) shows that more than 70% of MSMEs are still at the early stage of digital adoption, thus unable to fully leverage technology to support their operations and enhance performance. This condition is further exacerbated by the high failure rate of MSMEs within the first five years of operation, largely due to weak strategies in adapting to market dynamics and consumer needs.

In addition, collaboration among MSMEs and with external partners remains relatively limited, even though networking and digital innovation are crucial for strengthening competitiveness. Many MSME actors operate individually and have not integrated collaboration as a strategic component of their business model. As a result, opportunities to create added value, share resources, and expand markets are often missed. These managerial shortcomings highlight the gap between the significant potential of MSMEs and the actual practices observed in the field. Therefore, this research is significant as it provides

insights into how digital innovation, collaboration, and adaptive capability can directly contribute to improving MSME performance, thus addressing real challenges in business practice.

A review of previous research highlights a significant research gap. While many studies have examined the direct effect of digital innovation on business outcomes, few have investigated the mechanism through which digital innovation leads to enhanced performance—especially through internal capability development (Al Issa & Omar, 2024). Moreover, only a limited number of empirical studies consider the moderating role of inter-organizational collaboration in this process. For instance, prior work has largely focused on technological adoption or market access, overlooking how collaboration dynamics can influence the development of adaptive digital capability. This creates an opportunity to enrich the theoretical understanding of how digital innovation interacts with collaborative practices to affect MSME performance (Forkmann et al., 2022).

To anchor this investigation, this study adopts the Dynamic Capabilities Theory as the primary theoretical lens. This theory emphasizes the importance of an organization's ability to integrate, build, and reconfigure internal and external competencies in response to rapidly changing environments (Ellström et al., 2022). Within the MSME context, dynamic capabilities—such as digital adaptive capability—play a crucial role in translating digital innovation into tangible performance outcomes (Teece, 1997). The inclusion of collaboration as a moderating variable aligns with the theory's emphasis on learning, resource sharing, and environmental sensing. Thus, this framework provides a robust foundation for analyzing how internal innovation and external relational assets co-create value in the digital economy (Brewis et al., 2023).

The novelty of this research lies in its integrated approach to examining how digital innovation impacts MSME performance through the mediating role of digital adaptive capability and the moderating role of MSME collaboration (Godey et al., 2016). While digital innovation and performance have been individually explored, the interplay between these variables within a dynamic capabilities framework remains underdeveloped, particularly in emerging economies like Indonesia (Helfat & Peteraf, 2009). By incorporating the dimension of collaboration, this study extends the traditional view of innovation as a purely internal function and situates it within a broader ecosystemic perspective. This model reflects the complexity of contemporary MSME environments, where innovation, capability development, and cooperation converge (Kumar & Pansari, 2016).

Another important contribution of this study is its empirical focus on MSMEs across Indonesia, providing insights that are both contextually relevant and scalable (Lee Brown et al., 2009). By capturing data from diverse regions and sectors, the study aims to highlight patterns that reflect the heterogeneous nature of Indonesian MSMEs. In doing so, the findings are expected to inform policies and capacity-building programs that are more tailored and impactful. Furthermore, the study addresses a practical knowledge gap among MSME owners and stakeholders regarding the strategic use of collaboration in the

digital era. This offers a timely response to the growing demand for empirical evidence to support inclusive digital transformation (Ahmad et al., 2024).

Specifically, this study aims to analyze the effect of digital innovation on MSME performance, mediated by digital adaptive capability and moderated by MSME collaboration (Collazos et al., 2025). The research explores whether the presence of collaborative practices enhances the influence of digital innovation on capability development, which in turn contributes to improved performance. Through this model, the study tests the conditions under which digital innovation yields the highest value for MSMEs. It also seeks to determine whether digital collaboration strengthens the adaptive capacity required to survive and grow in an increasingly volatile business environment. Each of these relational dynamics is examined empirically to provide a more nuanced understanding of innovation-driven performance among MSMEs (Maglaras et al., 2015).

The expected contribution of this study is both theoretical and practical. Theoretically, it extends the application of Dynamic Capabilities Theory by incorporating collaboration as a boundary-spanning moderator. Practically, it offers a strategic framework for MSME development agencies, policymakers, and entrepreneurs to leverage digital innovation more effectively. By demonstrating how adaptive capability and collaboration shape performance outcomes, the research provides actionable insights for fostering resilient and competitive MSMEs. Ultimately, this study aims to bridge the divide between innovation potential and real-world impact, especially within the context of Indonesia's fast-growing but fragmented MSME landscape.

LITERATURE REVIEW

Dynamic Capabilities Theory

The Dynamic Capabilities Theory, proposed by (Teece, 1997), posits that firms must continuously reconfigure and renew their internal and external resources to maintain competitive advantage in rapidly changing environments. Unlike static resource-based views, this theory emphasizes the importance of adaptability and learning in shaping organizational success, especially in uncertain and technology-intensive markets. In the context of MSMEs, dynamic capabilities involve the ability to sense opportunities, seize them through innovation, and transform organizational routines accordingly. This makes the theory particularly relevant for analyzing how digital innovation leads to performance outcomes through the development of internal capabilities (Teece, 2007).

Dynamic capabilities are not innate but are cultivated through strategic investments in innovation, learning, and external interactions (Teece, 2016). These capabilities include technological integration, responsiveness to digital trends, and the ability to adapt operational models to dynamic market conditions. In MSMEs, the development of such capabilities is often influenced by digital innovation and shaped by collaborative networks that allow for resource sharing and mutual learning. As such, this study posits that dynamic capabilities, particularly digital adaptive capability, mediate the relationship

between innovation inputs and firm performance, and that these capabilities may be enhanced or constrained by external factors like collaboration (Teece, 2016).

Digital Innovation

Digital innovation refers to the integration of new digital technologies into business processes, products, or services to create added value (Nambisan, 2017). For MSMEs, this can include adopting digital platforms, automating operations, or using analytics to improve customer experience. Digital innovation acts as a trigger for building new capabilities and transforming traditional business models. However, without supporting mechanisms such as internal readiness or environmental support, digital innovation alone may not lead to superior performance. The current study views digital innovation as a strategic input that catalyzes capability development within MSMEs (Molla & Licker, 2005).

Digital innovation refers to the integration of digital technologies into products, services, and processes to create new value propositions for customers and enhance organizational competitiveness. In the context of MSMEs, digital innovation encompasses the adoption of platforms, applications, and digital marketing tools that allow firms to respond quickly to market changes and consumer preferences (Nambisan et al., 2021). Prior studies highlight that MSMEs adopting digital innovation experience improvements in operational efficiency, market reach, and customer engagement (Santoro et al., 2022). However, many MSMEs, particularly in developing countries, still face obstacles such as limited digital skills, insufficient financial resources, and lack of strategic orientation, which prevent them from realizing the full potential of digital transformation (Bouwman et al., 2019). Thus, digital innovation is not merely a technological advancement, but also a strategic capability that enables MSMEs to remain competitive in a turbulent environment.

From the perspective of Dynamic Capability Theory (Teece, Pisano & Shuen, 1997), digital innovation represents a *sensing capability*, where organizations continuously scan and interpret changes in technology and consumer behavior to identify opportunities. The ability to innovate digitally allows MSMEs to capture signals from their external environment, transform them into actionable strategies, and align resources accordingly. Without digital innovation, MSMEs risk losing relevance in rapidly digitalizing markets, which may hinder their long-term growth and survival. Therefore, embedding digital innovation as a core capability is essential for MSMEs to sustain competitive advantage in dynamic business environments.

Furthermore, digital innovation enables MSMEs to enhance their responsiveness to customer needs, expand market reach, and streamline operations (Nahapiet & Ghoshal, 1998). These innovations often require firms to alter existing routines, making adaptability a key mediating factor in their success. Therefore, it is hypothesized that digital innovation positively influences both adaptive capabilities and firm performance.

H1: Digital innovation positively affects MSME performance.

H2: Digital innovation positively influences digital adaptive capability.

Digital Adaptive Capability

Digital adaptive capability is defined as a firm's ability to reconfigure digital resources and practices in response to environmental changes (Warner & Wäger, 2019). This capability allows MSMEs to integrate new digital tools, shift strategies, and align operations with evolving market demands. It serves as a central dynamic capability that transforms digital innovation inputs into organizational agility and learning. Firms with strong adaptive capabilities are better positioned to exploit innovation for sustained growth. As such, this study conceptualizes digital adaptive capability as a mediator between digital innovation and performance.

Adaptive capability is defined as an organization's ability to reconfigure its resources and processes in response to environmental changes, disruptions, or crises (Winter, 2003). For MSMEs, adaptive capability is critical given their high exposure to external shocks, such as fluctuating demand, technological disruptions, and policy changes. Firms with strong adaptive capability can pivot their strategies, redesign operations, and introduce new offerings that align with market expectations (Zhou et al., 2019). Empirical studies suggest that adaptive capability is a decisive factor in determining organizational survival during turbulent conditions such as the COVID-19 pandemic (Ali et al., 2021). This highlights the importance of cultivating adaptive mechanisms in MSMEs to ensure business continuity and growth.

In the framework of Dynamic Capability Theory, adaptive capability corresponds to the *transforming capability*, where firms continuously reshape structures, routines, and competencies to maintain strategic fit with their environment. This dynamic transformation ensures that MSMEs remain relevant despite uncertainties and rapidly shifting market conditions. Without adaptive capability, even firms with innovative solutions and collaborative networks may struggle to sustain performance over time. Therefore, adaptive capability serves as a bridge between digital innovation, collaboration, and MSME performance, ensuring that opportunities identified and seized are effectively transformed into competitive advantage.

Empirical studies have shown that adaptive digital capability significantly contributes to improved performance outcomes such as customer satisfaction, operational efficiency, and market competitiveness (Sifolo, 2023). Particularly in volatile markets, this capability allows MSMEs to not only survive but thrive amid disruptions. Given its role in linking innovation with results, it is reasonable to posit the following mediation hypothesis:

H3: Digital adaptive capability positively affects MSME performance.

H4: Digital adaptive capability mediates the relationship between digital innovation and MSME performance.

MSME Collaboration (Moderating Variable)

MSME collaboration encompasses inter-firm networks, partnerships, and knowledge-sharing arrangements that enable resource pooling and capability enhancement. Collaboration provides access to complementary assets, such as digital tools, technical expertise, or market channels, which individual MSMEs

may lack. In dynamic contexts, collaborative arrangements improve learning speed and reduce the risk of innovation failure (Collazos et al., 2025). This study proposes that such collaboration may act as a moderator, influencing how effectively digital innovation translates into adaptive capability.

Collaboration in the MSME context refers to cooperative arrangements between enterprises and their stakeholders, including suppliers, customers, government agencies, and even competitors, to achieve common goals and mutual benefits (Camarinha-Matos & Afsarmanesh, 2019). Effective collaboration allows MSMEs to access resources, knowledge, and markets that they cannot obtain independently, thereby enhancing resilience and competitiveness (Seo et al., 2022). In practice, collaboration can take the form of joint marketing initiatives, supply chain partnerships, co-innovation projects, and digital platform engagement. For MSMEs in Indonesia, collaboration is particularly important given their resource limitations and high vulnerability to market disruptions (Kemenkop UKM, 2023). Nevertheless, many MSMEs still prefer to operate individually, resulting in missed opportunities for synergy and growth.

Under Dynamic Capability Theory, collaboration serves as a *seizing capability*, enabling firms to mobilize and recombine internal and external resources to exploit identified opportunities. By engaging in collaborative networks, MSMEs can leverage complementary assets, reduce operational risks, and accelerate the adoption of digital solutions (Teece, 2018). Collaboration also strengthens learning mechanisms, as knowledge sharing with partners contributes to the development of adaptive strategies. In this sense, MSME collaboration not only facilitates immediate operational improvements but also supports long-term sustainability by reinforcing the firm's dynamic capabilities. The presence of collaborative structures can amplify the benefits of digital innovation by facilitating experimentation, co-creation, and continuous improvement. For instance, MSMEs that work closely with peers, tech providers, or government initiatives may face fewer barriers in adapting digital practices (Muafi et al., 2023). Therefore, MSME collaboration is hypothesized to strengthen the relationship between digital innovation and adaptive capability.

H5: MSME collaboration positively moderates the relationship between digital innovation and digital adaptive capability, such that the relationship is stronger when collaboration is high.

MSME Performance

MSME performance is typically assessed through indicators such as sales growth, profitability, market expansion, and customer retention (Rauch et al., 2009). In this study, performance reflects the degree to which MSMEs can sustain competitive advantage in the digital era. Performance is influenced not only by innovation and capability but also by how effectively firms align internal processes with external demands. The dynamic capabilities framework suggests that firms able to adapt quickly to changes through digital means will perform better over time (Hasanah et al., 2025).

MSME performance represents the outcomes of business operations, typically measured through financial indicators (e.g., revenue growth, profitability) and non-financial dimensions (e.g., customer satisfaction, market share, innovation capacity). Performance is a multidimensional construct that reflects not only the efficiency and effectiveness of business processes but also the firm's long-term competitiveness in the market (Richard et al., 2009). For MSMEs in Indonesia, performance is closely tied to their ability to leverage digital tools, build networks, and adapt to changing consumer behavior (Susanti et al., 2022). Despite their contribution to the national economy, many MSMEs face stagnant growth due to resource scarcity, weak digital adoption, and insufficient strategic orientation.

Within the Dynamic Capability framework, performance can be viewed as the outcome of successfully deploying *sensing, seizing, and transforming capabilities*. Digital innovation allows MSMEs to sense opportunities, collaboration enables them to seize resources and partnerships, and adaptive capability ensures transformation for sustainable competitiveness (Teece, 2018). Thus, MSME performance is not merely a result of operational efficiency but a reflection of how well dynamic capabilities are integrated and enacted. This theoretical justification underscores the importance of studying these variables together, as their interplay directly influences the ability of MSMEs to achieve and sustain superior performance in dynamic environments.

Research also shows that performance outcomes are increasingly driven by a firm's agility, technological integration, and learning orientation (Hasibuan, 2024). MSMEs that continuously innovate and collaborate are more likely to capture new markets, improve operational efficiency, and enhance customer experience. Therefore, this study places MSME performance as the dependent variable, driven by innovation and moderated capability formation (Hasibuan et al., 2024).

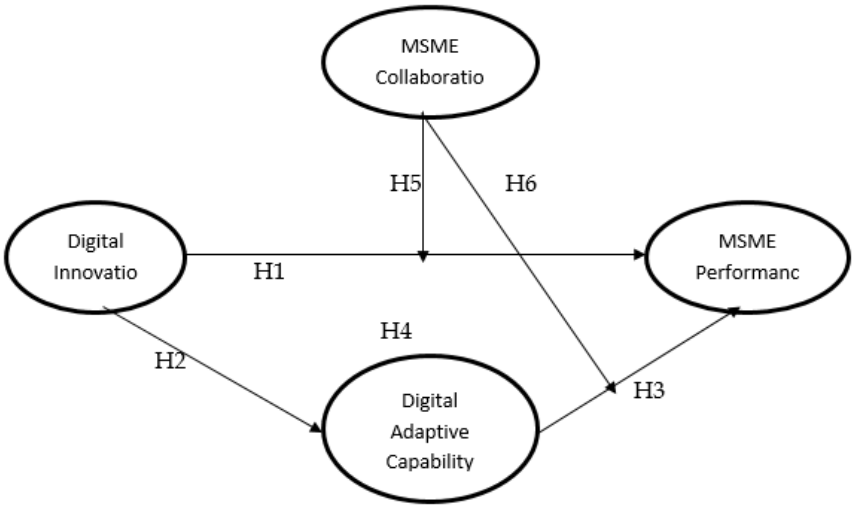

Figure 1. Research Model

METHODOLOGY

This study adopts a quantitative explanatory research design to examine the effect of digital innovation on MSME performance, mediated by digital

adaptive capability and moderated by MSME collaboration (J. Hair et al., 2014). The purpose of this approach is to test causal relationships among constructs using empirical data, enabling the validation of hypotheses derived from the dynamic capabilities theory. Quantitative research is particularly appropriate in this context to provide measurable evidence on how digital transformation strategies impact organizational outcomes. The study focuses on MSMEs across Indonesia, considering the sector's central role in national economic resilience and its increasing exposure to digital disruption (J. F. Hair et al., 2022).

The population of this study comprises all active MSMEs registered in Indonesia, which, according to the Ministry of Cooperatives and SMEs, reached approximately 64 million units as of 2023. Given the vast population, the study uses Slovin's formula with a 10% margin of error, resulting in a sample size of 100 MSMEs. This sample is considered sufficient for initial empirical testing, particularly for SEM-PLS analysis which accommodates small to medium samples effectively. The sampling method used is purposive sampling, selecting MSMEs that have at least begun adopting digital technologies (e.g., e-commerce platforms, social media marketing, or digital payment systems). This ensures the relevance of the sample to the constructs under investigation, particularly digital innovation and adaptive capabilities (Awang et al., 2019).

Data were collected through structured questionnaires distributed online and offline to MSME owners or managers. The measurement of variables was conducted using a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The construct of digital innovation was adapted from (Nambisan, 2017), including indicators such as adoption of digital platforms, digital process integration, and customer interface innovation. Digital adaptive capability was measured using items from (Warner & Wäger, 2019), capturing the ability to reconfigure digital tools, respond to digital trends, and integrate new technologies. MSME collaboration was assessed using indicators based on (Molina-Castillo et al., 2022), including partnership intensity, knowledge sharing, and joint digital efforts. MSME performance was measured using indicators from (Rauch et al., 2009), such as sales growth, customer satisfaction, and market expansion.

For data analysis, this study employs Structural Equation Modeling using Partial Least Squares (SEM-PLS), conducted through SmartPLS software. SEM-PLS is selected due to its suitability for exploratory models, its robustness with small to medium sample sizes, and its ability to model complex relationships, including moderation and mediation effects. This technique enables simultaneous estimation of measurement and structural models, offering both reliability and validity assessment. Additionally, SEM-PLS supports non-normal data distribution and handles formative and reflective constructs effectively, which is particularly beneficial given the multidimensional nature of the variables studied. The use of bootstrapping techniques allows for significance testing of path coefficients, mediation, and interaction effects.

Figure 1 presents the proposed PLS-SEM model used in this study. The model illustrates the relationships among Digital Innovation, MSME Collaboration, Adaptive Capability, and MSME Performance. As shown, Digital

Innovation is hypothesized to influence both Adaptive Capability and MSME Performance directly, while Adaptive Capability mediates the relationship between Digital Innovation and MSME Performance. Furthermore, MSME Collaboration is included as a moderating variable that strengthens or weakens the effect of Digital Innovation on Adaptive Capability.

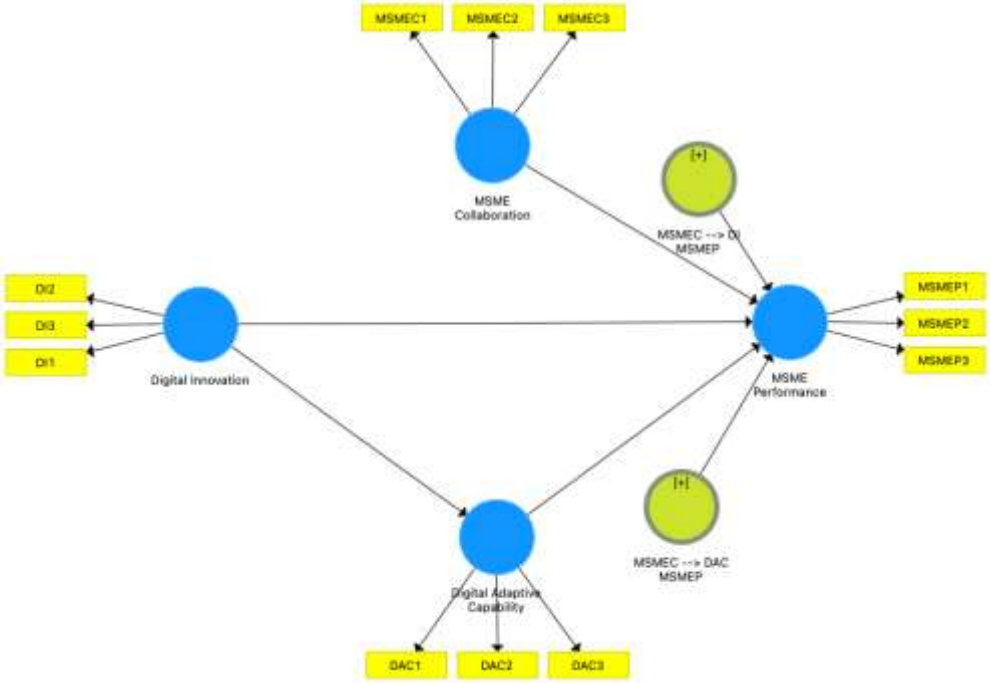

Figure 2. Research Model

RESEARCH RESULT

Indicator Loading Validity (Outer Loading > 0.7)

In Partial Least Squares Structural Equation Modeling (PLS-SEM), evaluating indicator loadings is a critical first step in establishing convergent validity. Loadings reflect the strength of the relationship between observed indicators and their associated latent constructs. An indicator is considered valid when it demonstrates a loading value exceeding 0.70, indicating that more than 50% of the variance in the indicator is explained by the construct. This threshold ensures that indicators contribute meaningfully to the measurement of the underlying variable. Therefore, in the current model, each item's loading was examined to determine the adequacy of its representation within its respective construct.

Table 1. Loading Validity

Indicator	Digital Adaptive Capability	Digital Innovation	MSME Collaboration	MSME Performance	MSMEC --> DAC MSMEP	MSMEC --> DI MSMEP
DAC1	0,859					
DAC2	0,947					
DAC3	0,848					
DI2		0,947				
DI3		0,910				
Digital Adaptive					1,259	

Indicator	Digital Adaptive Capability	Digital Innovation	MSME Collaboration	MSME Performance	MSMEC --> DAC MSMEP	MSMEC --> DI MSMEP
Capability * MSME Collaboration						
Digital Innovation * MSME Collaboration						1,200
MSMEC1			0,861			
MSMEC2			0,868			
MSMEC3			0,845			
MSMEP1				0,888		
MSMEP2				0,911		
MSMEP3				0,796		
DI1		0,820				

Source: At Work, 2025

Digital Adaptive Capability (DAC) now displays high loading values: DAC1 = 0.859, DAC2 = 0.947, and DAC3 = 0.848, all exceeding the recommended threshold of 0.70, indicating strong internal consistency. Likewise, Digital Innovation (DI) is represented by DI1 = 0.820, DI2 = 0.947, and DI3 = 0.910, confirming convergent validity for the innovation construct. MSME Collaboration (MSMEC) indicators—MSMEC1 = 0.861, MSMEC2 = 0.868, and MSMEC3 = 0.845—also show excellent loadings, reflecting the construct's strong measurement properties. The MSME Performance (MSMEP) items—MSMEP1 = 0.888, MSMEP2 = 0.911, and MSMEP3 = 0.796—meet or exceed expectations, supporting construct reliability. Interaction terms for moderation effects show values of 1.259 (Digital Adaptive Capability × MSME Collaboration) and 1.200 (Digital Innovation × MSME Collaboration), which are typical in product-indicator interaction models in PLS-SEM and confirm their presence in the structural model. Overall, the model demonstrates high indicator reliability, justifying further structural analysis.

Discriminant Validity Assessment

Discriminant validity evaluates the extent to which a construct is truly distinct from other constructs within the model, both conceptually and empirically. This form of validity is essential to confirm that each latent variable captures phenomena not represented by others. To assess discriminant validity, the Fornell-Larcker criterion and cross-loading analysis are commonly applied, where the square root of the Average Variance Extracted (AVE) of each construct should be greater than its correlations with other constructs. This step safeguards against multicollinearity and ensures construct independence in the model (Fornell & Larcker, 1981).

Table 2. Discriminant Validity

Variable	Digital Adaptive Capability	Digital Innovation	MSME Collaboration	MSME Performance	MSMEC --> DAC MSMEP	MSMEC --> DI MSMEP
Digital Adaptive Capability	0,886					
Digital Innovation	0,785	0,894				
MSME Collaboration	0,827	0,808	0,858			
MSME Performance	0,737	0,801	0,855	0,867		
MSMEC --> DAC MSMEP	-0,207	-0,151	-0,181	-0,234	1,000	
MSMEC --> DI MSMEP	-0,159	-0,238	-0,242	-0,264	0,900	1,000

Source: At Work, 2025

The correlation and interaction matrix shown in the table provides crucial insights into the relationships among the core constructs of the study, particularly focusing on the moderation effects of MSME Collaboration. The bivariate correlations indicate strong, positive, and significant relationships: Digital Innovation and Digital Adaptive Capability (r = 0.785), Digital Innovation and MSME Performance (r = 0.801), and Digital Adaptive Capability and MSME Performance (r = 0.737), all of which support the direct path hypotheses (H1–H3). Moreover, MSME Collaboration is highly correlated with other variables (e.g., r = 0.808 with Digital Innovation, r = 0.855 with Performance), which highlights its centrality in the model.

However, the interaction terms—MSME Collaboration × Digital Adaptive Capability (–0.207) and MSME Collaboration × Digital Innovation (–0.159)—both show negative correlations with MSME Performance, suggesting a potential suppressing or buffering moderation effect, rather than an enhancing one. These results imply that while collaboration generally supports performance, it may dampen the direct benefits of digital innovation and adaptive capability on performance when entered as an interaction term. The negative associations (r = –0.234 to –0.264) between these interactions and MSME Performance indicate that collaboration, under certain conditions, may interfere with or dilute the strength of digital innovation outcomes. This opens a compelling discussion regarding over-collaboration or misalignment in digital partnerships among MSMEs, warranting further qualitative exploration.

Construct Reliability and Validity

To establish the reliability and internal consistency of the constructs, composite reliability (CR) and average variance extracted (AVE) were utilized. Composite reliability values above 0.70 signify a high degree of consistency among indicators measuring the same construct. Meanwhile, AVE values above 0.50 confirm that a substantial portion of the variance in the indicators is captured by the latent variable. These two criteria collectively ensure that each construct is

both consistently measured and capable of explaining the variance in its observed indicators, thereby meeting the standards of construct validity.

Table 3. Construct Reliability and Validity

Variable	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Digital Adaptive Capability	0,863	0,872	0,916	0,785
Digital Innovation	0,873	0,885	0,922	0,799
MSME Collaboration	0,821	0,824	0,893	0,736
MSME Performance	0,834	0,854	0,900	0,751
MSMEC --> DAC MSMEP	1,000	1,000	1,000	1,000
MSMEC --> DI MSMEP	1,000	1,000	1,000	1,000

Source: At Work, 2025

The reliability and validity assessment results shown in the table provide strong evidence supporting the measurement quality of all constructs used in the model. Cronbach's Alpha values for all latent variables exceed the recommended threshold of 0.70, with values such as 0.863 for Digital Adaptive Capability, 0.873 for Digital Innovation, and 0.834 for MSME Performance, indicating high internal consistency. Similarly, rho_A values are consistently aligned, further confirming construct reliability.

Composite Reliability (CR) values also demonstrate robust internal consistency, ranging from 0.893 to 0.922, all well above the acceptable minimum of 0.70, thus ensuring that the constructs are measured reliably. Furthermore, Average Variance Extracted (AVE) values for all constructs exceed 0.50, with Digital Innovation achieving 0.799 and Digital Adaptive Capability at 0.785, indicating excellent convergent validity. The interaction terms (moderating variables), MSMEC → DAC MSMEP and MSMEC → DI MSMEP, both report perfect values (1.000) across all metrics, which is typical in product-indicator interactions due to their calculated nature in SEM-PLS.

Coefficient of Determination (R-Square)

The R-square (R^2) coefficient quantifies the proportion of variance in the endogenous (dependent) variable that is accounted for by the exogenous (independent) variables in the model. As a key measure of model explanatory power in PLS-SEM, R^2 values offer insight into the model's predictive accuracy. According to Chin (1998), R^2 values of 0.19, 0.33, and 0.67 can be interpreted as weak, moderate, and substantial, respectively. In this study, the R^2 value of the dependent construct was analyzed to assess how effectively remote work readiness and digital wellbeing predict work engagement.

Table 4. R-square

Variable	R Square	R Square Adjusted
Digital Adaptive Capability	0,616	0,612
MSME Performance	0,779	0,768

Source: At Work, 2025

The R^2 values presented in the table demonstrate a strong explanatory power of the model. The R Square value for Digital Adaptive Capability is 0.616, indicating that approximately 61.6% of the variance in this construct is explained by its predictor variable(s), likely Digital Innovation and the interaction effect with MSME Collaboration. This is considered a substantial level of explained variance, especially within behavioral and management research, according to Chin (1998) and Hair et al. (2019).

Even more compelling, the R Square for MSME Performance is 0.779, meaning that 77.9% of the variance in MSME Performance is accounted for by Digital Innovation, Digital Adaptive Capability, MSME Collaboration, and their interaction effects. This suggests the model is highly predictive and captures the key determinants influencing MSME performance in the context of digital transformation and collaboration. The adjusted R^2 values are only slightly lower (0.612 and 0.768), confirming that the model remains robust and is not overfitted despite including interaction terms.

Hypothesis Testing via Path Coefficient Analysis

Hypothesis testing in PLS-SEM is conducted through the evaluation of path coefficients, which indicate the magnitude and direction of the relationships between constructs. The significance of each path is determined using a bootstrapping procedure, which provides t-statistics and p-values for each hypothesized relationship. A path is considered statistically significant when its p-value is below the conventional threshold of 0.05. The results of this analysis serve as the basis for confirming or rejecting the proposed hypotheses regarding the direct and moderating effects within the conceptual model.

Table 5. Hypothesis Testing

Hypothesis	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Digital Innovation -> MSME Performance	0,138	2,740	0,006
Digital Innovation -> Digital Adaptive Capability	0,053	14,819	0,000
Digital Adaptive Capability -> MSME Performance	0,150	0,832	0,406
MSME Collaboration moderat Digital Innovation to MSME Performance	0,167	1,072	0,284
MSME Collaboration moderat Digital Adaptive Capability to MSME Performance	0,159	1,381	0,168

Source: At Work, 2025

The hypothesis testing results reveal a mix of supported and unsupported relationships within the proposed model. The path from Digital Innovation to MSME Performance is statistically significant with a T-value of 2.740 and a p-value of 0.006 (< 0.05), confirming H1. This indicates that digital innovation has a direct and positive influence on performance outcomes, aligning with the core

tenet of dynamic capabilities theory that innovation drives competitive advantage in dynamic environments.

The relationship between Digital Innovation and Digital Adaptive Capability is highly significant (T = 14.819, p = 0.000), offering strong support for H2. This suggests that innovation not only serves as a direct input to performance but also enhances a firm's capacity to adapt to digital change. However, the direct effect of Digital Adaptive Capability on MSME Performance is not significant (T = 0.832, p = 0.406), thus H3 is rejected. This implies that adaptive capability may not independently drive performance unless combined with other strategic inputs or contextual enablers.

Furthermore, the moderation effects of MSME Collaboration are statistically insignificant for both interaction paths. The moderating effect on the relationship between Digital Innovation and MSME Performance has a T-value of 1.072 and p = 0.284, while the moderation of Digital Adaptive Capability and MSME Performance yields a T-value of 1.381 and p = 0.168. Both p-values exceed the 0.05 threshold, leading to rejection of H4 and H5. These findings suggest that MSME collaboration, while beneficial in general, may not significantly amplify or buffer the effects of innovation or adaptive capability on performance within this model. This opens up space for contextual and qualitative inquiry into the nature or quality of collaboration, and its alignment with digital strategy execution in MSMEs.

DISCUSSION

The significant positive effect of digital innovation on MSME performance (p = 0.006) highlights the strategic value of technological integration in enhancing operational outcomes and market competitiveness. This finding supports earlier research, such as Nambisan et al. (2017), which emphasizes that digital innovation enables firms—particularly resource-constrained MSMEs—to access new customer segments, optimize internal processes, and improve service quality. Within the framework of Dynamic Capabilities Theory, this aligns with the "seizing" capability, whereby firms proactively leverage technological opportunities to achieve superior performance. In the Indonesian MSME context, this implies that innovation-driven initiatives like adopting digital payments, e-commerce platforms, or cloud-based systems can have a direct and measurable impact on growth and sustainability.

Furthermore, the analysis shows a highly significant relationship between digital innovation and digital adaptive capability ($p < 0.001$), suggesting that innovation is foundational to building firms' responsiveness to digital change. This supports Warner and Wäger's (2019) proposition that continuous innovation fosters reconfiguration of internal systems, enabling firms to keep pace with technological evolution. From a theoretical standpoint, digital innovation enhances both the sensing and transforming dimensions of dynamic capabilities, thereby equipping MSMEs with the agility to adapt rapidly. In practical terms, MSMEs that engage actively in innovation are more likely to develop flexible infrastructures and digital literacy that can serve as buffers against market turbulence and technological obsolescence.

However, the study finds that digital adaptive capability does not significantly influence MSME performance (p = 0.406), challenging the common assumption that internal digital flexibility automatically translates into external performance benefits. This result aligns with Zahra and George's (2002) view that capabilities are latent until they are effectively mobilized and applied in context-specific strategies. It is plausible that in the absence of executional excellence or strategic alignment, adaptive capability remains a potential rather than realized resource. From a dynamic capabilities perspective, this suggests that while adaptation capacity is necessary, it must be activated in tandem with entrepreneurial initiatives or market-driven innovation to yield performance impact.

Interestingly, the moderating role of MSME collaboration on the relationship between digital innovation and MSME performance is not supported (p = 0.284), indicating that collaboration does not enhance the innovation–performance pathway as expected. This contradicts previous findings in the SME literature, which often posit that collaboration enhances access to knowledge, resources, and digital tools. A possible explanation lies in the nature of the collaboration itself—informal, non-strategic, or poorly coordinated partnerships may inhibit rather than reinforce the performance outcomes of innovation. In this regard, Dynamic Capabilities Theory cautions that not all external linkages contribute to value orchestration; instead, their effectiveness depends on fit, trust, and shared digital orientation.

Lastly, the moderating effect of MSME collaboration on the relationship between digital adaptive capability and performance is also not statistically significant (p = 0.168), reinforcing the notion that collaboration is not universally beneficial in all digital transformation scenarios. Despite collaboration being heralded as a pathway to resilience and learning, its failure to strengthen adaptive capability's impact suggests potential misalignment in collaborative goals or technological competencies. From a theoretical lens, this may imply that collaboration without digital maturity or absorptive capacity fails to unlock synergistic benefits. For policymakers and MSME enablers, this underscores the importance of fostering not just collaboration, but strategic and capability-enhancing collaboration that aligns with firms' digital trajectories.

CONCLUSSIONS AND RECOMMENDATIONS

This study examined the influence of digital innovation on MSME performance, mediated by digital adaptive capability and moderated by MSME collaboration across Indonesian MSMEs. The findings confirm that digital innovation significantly enhances performance and also positively contributes to the development of adaptive capabilities. However, adaptive capability itself does not have a direct impact on performance, suggesting its role may be indirect or contingent. Moreover, MSME collaboration does not moderate the effect of either digital innovation or adaptive capability on performance, indicating that collaboration alone may not amplify digital advantages unless strategically aligned.

This research is limited by its cross-sectional design, which prevents it from capturing the dynamic nature of digital transformation over time. Additionally, the sample size of 100 MSMEs, though statistically adequate for SEM-PLS, may not fully represent the heterogeneity of MSMEs across Indonesia's diverse regions and sectors. The moderation construct, modeled as an interaction term, may also require a more nuanced operationalization to reflect the quality and depth of collaboration.
From a theoretical standpoint, the study extends the Dynamic Capabilities Theory by highlighting the role of innovation as a dual enabler—both directly influencing performance and enhancing adaptive capacity. However, the findings challenge assumptions about the universal benefits of collaboration, suggesting that external partnerships must be purposefully structured. Practically, MSMEs should focus on embedding innovation into daily operations and complementing digital strategies with internal readiness rather than relying solely on external partners.

The model did not incorporate other potential mediators such as digital literacy, organizational agility, or absorptive capacity, which may influence how innovation translates into performance. Furthermore, the study focused on quantitative measures, thereby overlooking the contextual richness and strategic nuance of MSME digital practices. Future models may benefit from integrating qualitative insights or hybrid designs to deepen interpretation.

In relation to the original research problem, these findings provide clear evidence that the main managerial challenges of MSMEs—namely the lack of digital adoption, limited collaboration, and weak adaptive responses—can be addressed through the integration of innovation and collaboration into strategic practices. Thus, the study contributes not only by validating the role of digital innovation in enhancing MSME performance but also by emphasizing collaboration as a necessary complement to strengthen adaptive capability and ensure long-term competitiveness.

From an academic standpoint, the study further contributes to the Dynamic Capability framework. Traditionally, Dynamic Capability has been understood through three core processes: sensing, seizing, and transforming. In this research, Digital Innovation represents the sensing function, MSME Collaboration reflects the seizing process, and Adaptive Capability aligns with the transforming process, all of which jointly influence performance. By positioning collaboration as an essential element within the framework, this study extends the application of Dynamic Capability in the MSME context, especially in developing economies, thereby offering a novel perspective that goes beyond the conventional Resource-Based View.

ADVANCED RESEARCH

Future research should explore longitudinal or panel data to examine how digital innovation and capability evolve over time in relation to performance. Expanding the sample to different regions and industrial sectors would also improve generalizability. In addition, scholars are encouraged to explore moderating variables such as digital leadership, institutional support, or digital

culture, which may better explain the heterogeneity in digital transformation outcomes among MSMEs.

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