

Risk Management, Digitalization, and the Sustainability of Indonesian MSMEs

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Received: 06/05/2026 | Revised: 15/08/2026 | Accepted: 29/08/2026 | Published: 16/09/2026

Abstract: This study examines whether MSME digitalization transmits the effect of risk-management strategy to business sustainability. A cross-sectional survey collected responses from 300 Indonesian MSME decision makers who used digital technologies in their operations, and the proposed relationships were tested using partial least squares structural equation modeling (PLS-SEM). The model integrates the resource-based view (RBV), which treats risk management as an internal organizational capability, with the technology–organization–environment (TOE) framework, which explains the conditions through which that capability supports digital readiness and use. Risk-management strategy was positively associated with sustainability ($\beta = 0.256$, $p = 0.001$) and digitalization ($\beta = 0.645$, $p < 0.001$), while digitalization was positively associated with sustainability ($\beta = 0.568$, $p < 0.001$). The indirect effect was also significant ($\beta = 0.367$, $p < 0.001$). Because the direct and indirect effects were significant and pointed in the same direction, the result indicates complementary partial mediation. The study's main contribution is to specify digitalization as a conversion mechanism through which risk-management capability becomes operational efficiency, adaptability, market access, and resilience. Practically, capability-building programs should connect risk identification and mitigation with concrete digital investment and adoption decisions rather than treating both agendas separately.

Keywords: Risk Management Strategy, Digitalization, Business Sustainability, MSMEs

How to Cite: Pambudy, A. P., Susanti, I., Kristiawati, I., & Safaatillah, N. (2026) Risk Management, Digitalization, and the Sustainability of Indonesian MSMEs. *Journal of Economics and Management*, 4(3), 1023-1040. <https://doi.org/10.70716/ecoma.v4i3.544>

INTRODUCTION

The number of Micro, Small, and Medium Enterprises (MSMEs) in Indonesia is very large and continues to increase year to year. Data from the Ministry of Cooperatives and SMEs show that the number of MSMEs has reached more than 65 million business units, contributing approximately 61% to the national Gross Domestic Product (GDP) and absorbing around 97% of the national workforce (DPP GAPEMBI, 2024). Furthermore, recent data indicate that approximately 30 million MSMEs have been verified through a national administration-based system (UKM Indonesia, 2023). These figures confirm that MSMEs are not merely a complementary component of the economic structure, but rather the main foundation of national economic growth. This strategic position is further strengthened by their contribution to exports, which reaches approximately 15.7%, as well as their potential to improve competitiveness through digital transformation (Coordinating Ministry for Economic Affairs, 2025). These conditions position MSMEs as a sector that plays a crucial role in maintaining economic stability while promoting inclusive growth.



The development of digital technology has driven significant changes in MSME activities, particularly in transactions, marketing, and distribution. Data show that more than 25 million MSMEs had entered the digital ecosystem by 2024, reflecting accelerated technology adoption in business activities (Tech in Asia, 2025). This transformation is also supported by innovations in payment systems, such as QRIS, which tens of millions of small and micro business actors in Indonesia use (Ministry of Finance, 2025). Digitalization provides opportunities to improve operational efficiency, expand market reach, and enhance competitiveness. However, increasing dependence on digital technology also brings new risks, such as data security risks, system instability, and digitally driven financial risks.

The development of digital technology has brought substantial changes to MSME activities, particularly in transactions, marketing, and distribution. Digitalization enables business actors to reach wider markets at relatively lower costs. Van Hoang et al. (2025) emphasize that digital capability has become a new source of competitive advantage for modern organizations. Wang et al. (2023) also explain that digital transformation improves operational efficiency and drives business model innovation. In Indonesia, MSMEs' adoption of digital technology continues to increase, in line with internet penetration and government policy support (Purba et al., 2025). However, the growing use of digital technology also brings new risks that may affect business sustainability.

The risks faced by digital-based MSMEs are not limited to operational aspects; they also include data security risks, financial risks, and the risk of technological system failure. Nestiti et al. (2025) show that digitalization without proper risk management can increase business vulnerability to operational disruptions. This condition highlights the importance of risk management strategies as an integral part of modern business management. Dvorsky et al. (2021) explain that effective risk management can improve the performance and sustainability of small and medium enterprises. Therefore, the ability to identify, analyze, and mitigate risks becomes a key factor in maintaining business stability, particularly in the digital era.

The Resource-Based View (RBV) provides the internal-capability foundation for this study: competitive advantage depends on how firms deploy and combine resources, not merely on possessing them (Barney, 1991; Lubis, 2022). For MSMEs, a structured capacity to identify, assess, mitigate, and monitor risk can therefore be treated as an organizational capability that protects scarce resources and improves the quality of strategic decisions. This capability is expected to support sustainability directly and to shape decisions concerning digital investment and use.

On the other hand, the Technology-Organization-Environment (TOE) framework explains that the success of technology adoption is influenced by three main factors: technology, organization, and environment (Malik et al., 2021). Triandini et al. (2023) state that technological readiness, organizational support, and external environmental pressures play important roles in determining successful technology implementation. Shahadat et al. (2023) further show that environmental factors, such as competition and regulation, also influence the level of technology adoption within organizations. In the context of MSMEs in Indonesia, environmental factors such as government support, access to digital platforms, and the development of the digital ecosystem are critical drivers in promoting business digitalization.

Previous studies indicate that digitalization positively impacts the performance and sustainability of MSMEs. Maharani and Hasibuan (2024) show that digital capabilities enhance business competitiveness. Wujarso (2023) emphasizes that digital

transformation accelerates innovation and operational efficiency. However, other studies report different findings when they do not consider risk management. Luo (2021) finds that digitalization without risk mitigation can actually increase business vulnerability. Meanwhile, Moschella et al. (2023) highlight that the success of small enterprises is strongly influenced by their ability to manage risks. These differing findings suggest that the relationship between digitalization and sustainability remains inconsistent.

Prior evidence does not establish a uniform relationship among risk management, digitalization, and sustainability. Studies of internal capabilities often explain performance without specifying the technological mechanism through which those capabilities operate (Hsiao, 2024), whereas TOE-based studies emphasize conditions for technology adoption but do not explain how risk-management capability shapes readiness and adoption decisions (Skachko et al., 2021; Harianto et al., 2025). Other work warns that digitalization can introduce operational, security, and market risks that may offset its benefits when mitigation capability is weak (Afrioza et al., 2025; Luo, 2021). The unresolved issue is therefore not simply whether digitalization is beneficial, but whether it converts risk-management capability into efficiency, adaptability, market access, and resilience that sustain MSMEs.

This study tests an integrative RBV–TOE model in which risk-management strategy is positioned as an internal capability, digitalization as the intervening conversion mechanism, and MSME sustainability as the outcome. Its novelty lies in combining these three elements in the context of digitally active Indonesian MSMEs and in distinguishing the direct protective effect of risk management from its indirect, technology-enabled effect. The study consequently examines whether digitalization complements, rather than replaces, the contribution of risk-management capability to sustainability.

The Resource-Based View (RBV) explains that an organization's competitive advantage depends on its ability to manage internal resources effectively. Barney (1991) emphasizes that resources that are valuable, rare, inimitable, and non-substitutable form the foundation for achieving sustainable competitive advantage. This perspective positions internal capabilities as a key factor in determining organizational performance and long-term business sustainability.

In the context of MSMEs, RBV is highly relevant because small businesses generally face limitations in accessing external resources. Therefore, their main strengths lie in internal capabilities, such as innovation, adaptability, and risk management. Bari et al. (2022) further argue that organizations that manage their capabilities effectively tend to be more competitive in responding to dynamic business environments. Thus, risk management strategies can be viewed as strategic capabilities that support the sustainability of digital-based businesses.

The Technology–Organization–Environment (TOE) framework explains technology adoption as a decision shaped by technological characteristics, organizational readiness, and environmental conditions (Tornatzky & Fleischer, 1990). In the present model, TOE is not treated as an alternative to RBV. RBV identifies risk management as an internal capability, whereas TOE clarifies how that capability informs assessments of technological feasibility, organizational preparedness, and external pressure or support. The combined mechanism is sequential: risk-management capability improves the recognition and mitigation of adoption risks; this strengthens informed digital readiness and use; and digital use can then improve efficiency, adaptability, market reach, and resilience.

Shahadat et al. (2023) demonstrate that technological factors, such as system complexity; organizational factors, such as human resource competence; and environmental factors, such as competition and regulation, significantly influence technology adoption. In the context of Indonesian SMEs, TOE is a relevant approach to explain the level of business digitalization and how internal and external factors affect the success of digital transformation.

Risk management strategies refer to systematic efforts to identify, analyze, and control risks that may hinder the achievement of organizational objectives. Singh (2022) explains that risk management functions not only as a protective mechanism but also as a strategy to enhance organizational value. In the context of SMEs, risk management is crucial because limited resources make businesses more vulnerable to both internal and external disruptions.

Nurjannah et al. (2023) emphasize that SMEs that manage risks effectively tend to achieve better performance and higher levels of sustainability. Furthermore, Igbekoyi et al. (2024) highlight that adaptive risk management strategies improve an organization's ability to deal with uncertainty, particularly in the digital era, which is characterized by rapid change and technological dependence. Therefore, risk management strategies are not merely defensive measures but also form part of a proactive approach to maintaining business continuity. The dimensions of risk management strategies include: (1) risk identification; (2) risk analysis; (3) risk mitigation; and (4) risk monitoring and evaluation (Hopkin, 2018).

MSME digitalization refers here to the organizational readiness for, and effective use of, digital technologies in business processes and strategy. Digitalization can improve process efficiency, information quality, market access, and customer interaction (Antonucci et al., 2021; Matalamäki & Joensuu-Salo, 2022). TOE variables such as government support, competitive pressure, and ecosystem support are conceptually antecedent contextual conditions rather than direct manifestations of technology use. Accordingly, the empirical construct in this manuscript should be interpreted as digitalization readiness and enabling conditions, not as technology-use intensity alone.

This interpretation matters because the retained indicators in the measurement model predominantly represent organizational readiness and environmental support. Low et al. (2022) provide the TOE basis for assessing those enabling conditions. The construct therefore captures whether MSMEs possess and encounter the conditions needed to translate risk-management decisions into digital action. Future measurement should distinguish actual breadth and intensity of digital use from its technological, organizational, and environmental antecedents.

MSME sustainability refers to a firm's ability to maintain its performance and existence over the long term. Elkington (1997) introduced the concept of the triple bottom line, which includes economic, social, and environmental aspects as the basis for assessing organizational sustainability. In the MSME context, sustainability is determined not only by profitability but also by the ability to maintain operational stability and contribute to society and the environment.

Ardiansyah and Alnoor (2024) explain that business sustainability can be achieved by integrating economic strategies with social and environmental responsibilities. Furthermore, Hendrawan et al. (2024) show that MSMEs that can manage risks and use technology effectively have greater opportunities to achieve business sustainability. Therefore, MSME sustainability results from the interaction between internal capabilities and adaptation to the external environment. The dimensions of MSME sustainability

include economic, operational, and social and environmental sustainability (Vásquez et al., 2021).

Risk management strategies play an important role in maintaining business stability and sustainability, especially for MSMEs facing uncertainty in the business environment. The Resource-Based View perspective proposed by Barney (1991) emphasizes that internal capabilities, such as the ability to manage risk, are sources of competitive advantage that can improve organizational performance and sustainability. Paul Hopkin (2018) also explains that structured risk management can minimize potential losses and increase business resilience.

Nurjannah et al. (2023) show that MSMEs with well-established risk management systems tend to sustain their businesses better in the long term. Therefore, the better the risk management strategy implemented, the higher the sustainability level of digital-based MSMEs. Based on the hypothesis development described above, the following hypothesis is proposed:

H1: Risk management strategy has a positive effect on MSME sustainability. Risk management strategies not only help maintain business stability but also encourage organizational readiness to adopt digital technology. Tornatzky and Fleischer (1990), through the TOE framework, explain that organizational readiness is an important factor in successful technology adoption. Pomaza-Ponomarenko et al. (2023) further state that effective risk management can increase organizational confidence in implementing technological innovations. Li et al. (2021) also emphasize that organizations with strong internal capabilities are better prepared to utilize digital technology to support business activities. Therefore, effective risk management strategies are expected to increase MSME digitalization. Based on the hypothesis development described above, the following hypothesis is proposed:

H2: Risk management strategy has a positive effect on MSME digitalization in Indonesia. MSME digitalization is a crucial factor in enhancing competitiveness and business sustainability. Yu et al. (2022) explain that digital transformation enables organizations to improve operational efficiency and expand market access. Van Hoang et al. (2025) emphasize that digital capabilities contribute to sustainable competitive advantage. In addition, Ye et al. (2024) show that the appropriate use of digital technology can increase business resilience against external disruptions. In the context of MSMEs, digitalization not only improves productivity but also strengthens customer relationships and expands business opportunities. Thus, the higher the level of MSME digitalization, the greater the level of business sustainability achieved. Based on the hypothesis development described above, the following hypothesis is proposed:

H3: MSME digitalization has a positive effect on MSME sustainability. Digitalization can mediate the relationship between risk-management strategy and sustainability through a concrete causal sequence. The capacity to identify and evaluate operational, financial, cybersecurity, and market risks improves the selection, timing, and governance of digital investments. Appropriate digital tools can then reduce transaction costs, improve information processing, expand market access, and accelerate responses to disruption. RBV explains the origin of this advantage in an internal risk-management capability, while TOE explains how technological feasibility, organizational readiness, and environmental support condition its conversion into digital practice. Thus, digitalization should transmit part of the effect of risk management to sustainability while a direct protective effect remains.

H4: MSME digitalization mediates the effect of risk management strategies on MSME sustainability. Based on the hypothesis development above, the research framework is presented as follows.

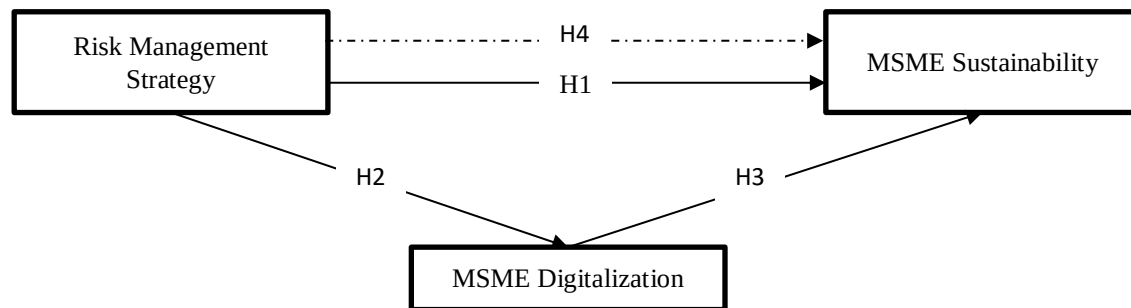


Figure 1. Research Framework

RESEARCH METHODS

Research Design

This study uses a quantitative, cross-sectional survey to test associations among risk-management strategy, MSME digitalization, and sustainability. Respondents were owners or managers directly involved in business decisions and using at least one digital technology in their operations. Data were collected online from March to May 2026 through MSME associations, entrepreneurship communities, and business-support networks. Of 327 returned questionnaires, 27 were excluded because they were incomplete, duplicated, or completed by respondents who were not business decision-makers, yielding 300 usable responses. Business age was not used as an exclusion criterion, which is consistent with the inclusion of 36 businesses operating for less than one year. The respondents were provisionally distributed across Java (168; 56%), Sumatra (54; 18%), Sulawesi (30; 10%), Kalimantan (24; 8%), Bali and Nusa Tenggara (15; 5%), and Maluku and Papua (9; 3%). Because purposive sampling was used, these data describe the surveyed digitally active MSMEs and do not establish national statistical representativeness.

Population and sample

The final sample comprised 300 respondents. An a priori power analysis for a fixed multiple-regression model with two predictors, a small anticipated effect ($f^2 = 0.05$), $\alpha = 0.05$, and statistical power of 0.95 indicated a minimum requirement of approximately 263 observations. The achieved sample therefore exceeded this requirement. This power-based justification is more appropriate than multiplying the total number of reflective indicators by ten. Data were analyzed using PLS-SEM with 5,000 bootstrap subsamples, a two-tailed significance level of 5%, and five-point Likert measures.

Table 1. Variable Operationalization

Variable	Operational Definition	Dimension	Indicator	Code	Scale
Risk Management Strategy (X)	The ability of MSMEs to identify, analyze, and control business risks to maintain business stability. (Hopkin, 2018)	Risk Identification Capability	1) Ability to identify digital operational risks	X1.1	Likert 1–5
			2) Ability to identify	X1.2	

Variable	Operational Definition	Dimension	Indicator	Code	Scale
MSME Digitalization (Z)	The level of digital technology utilization in MSME operations and business strategies. (Low et al., 2022)	Risk Analysis Capability	financial risks	X1.3	Likert 1–5
			3) Ability to recognize data		
			security risks		
			4) Ability to analyze risk impacts	X1.4	
			5) Ability to prioritize risks	X1.5	
		Risk Mitigation Capability	6) Implementation of digital risk mitigation strategies	X1.6	
			7) Availability of risk management SOPs	X1.7	
			8) Ability to adapt to changes in digital risks	X1.8	
		Adaptation Capability	9) Flexibility in risk-related decision-making	X1.9	
		Technology	1) Availability of digital infrastructure (internet, devices)	Z1.1	
			2) Use of digital platforms (e-commerce, QRIS, etc.)	Z1.2	
			3) Level of digital system security	Z1.3	
		Organization	4) Human resource digital competence	Z1.4	
			5) Management support for digitalization	Z1.5	

Variable	Operational Definition	Dimension	Indicator	Code	Scale
MSME Sustainability (Y)	The ability of MSMEs to maintain business performance economically, operationally, and socially in the long term. (Vásquez et al., 2021)	Environment	6) Organizational readiness for digital transformation	Z1.6	Likert 1–5
			7) Government support for digitalization	Z1.7	
			8) Digital competitive pressure	Z1.8	
			9) Ecosystem support (fintech, marketplace)	Z1.9	
		Economic Sustainability	1) Increase in business revenue	Y1.1	
			2) Cash flow stability	Y1.2	
			3) Operational cost efficiency	Y1.3	
			4) Long-term business continuity	Y1.4	
		Operational Sustainability	5) Ability to survive during crises	Y1.5	
			6) Consistency of product/service quality	Y1.6	
			7) Environmental awareness	Y1.7	
			8) Relationship with customers and community	Y1.8	
			9) Corporate social responsibility	Y1.9	

Data Analysis Technique

The data analysis in this study consists of descriptive and inferential analyses. Descriptive analysis describes the characteristics of 300 respondents by gender, age, education, type of business, and level of digital technology usage. Inferential analysis is conducted using Structural Equation Modeling based on Partial Least Squares (SEM-PLS). The analysis stages include evaluating the outer model, covering convergent validity (outer loading > 0.7), discriminant validity (Fornell-Larcker criterion and cross-loading), and construct reliability (Cronbach's Alpha and Composite Reliability). Furthermore, the inner model is evaluated through testing the coefficient of determination (R^2), predictive relevance (Q^2), and hypothesis testing using t-statistics and p-values through bootstrapping (Hair et al., 2019). This approach allows for a comprehensive examination of both direct and indirect (mediating) relationships among variables in the research model.

RESULTS AND DISCUSSION

Research Results

The characteristics of respondents in this study describe the profile of 300 digital-based MSME actors in Indonesia who served as respondents and objects of analysis in examining the influence of risk management strategies on business sustainability through the role of digitalization. The data presented in Table 2 provide a descriptive overview of the distribution of respondents based on gender, age, education level, type of business, duration of business operation, length of digitalization usage, and types of digitalization utilized. This information is essential for understanding the empirical context of the study and ensuring that the respondents are directly relevant to the research objective, namely MSMEs that have adopted digital technology in their business activities.

Table 2. Frequency Distribution of Respondent Characteristics

Characteristics	Category	Frequency (N=300)	Percentage (%)
Gender	Male	162	54,0
	Female	138	46,0
Age	< 25 Years	48	16,0
	25 – 34 Years	102	34,0
	35 – 44 Years	78	26,0
	45 – 54 Years	48	16,0
	≥ 55 Years	24	8,0
	Senior High School/Vocational School	126	42,0
Highest Education	Diploma	54	18,0
	Bachelor's Degree	96	32,0
	Master's Degree	18	6,0
	Others	6	2,0
Type of Business	Culinary (Food & Beverage)	90	30,0
	Fashion (Clothing, Accessories)	55	18,3
	Retail/Grocery Store	40	13,3
	Services (Laundry, Salon, Repair, etc.)	35	11,7
	Handicraft	20	6,7

Characteristics	Category	Frequency (N=300)	Percentage (%)
	Agribusiness (Agriculture, Livestock, Fisheries)	18	6,0
	Digital/Creative (Design, Content, Printing)	15	5,0
	Health & Beauty	12	4,0
	Automotive (Workshops, Spare Parts)	10	3,3
	Others	5	1,7
	< 1 Year	36	12,0
	1 – 3 Years	96	32,0
Business Duration	4 – 6 Years	84	28,0
	< 6 Months	42	14,0
	6 Months – 1 Year	78	26,0
	1 – 3 Years	108	36,0
	> 3 Years	72	24,0
Duration of Digitalization Use	Use of Marketplaces (Shopee, Tokopedia, etc.)	210	70,0
	Marketing via Social Media (Instagram, TikTok, etc.)	240	80,0
	Digital Payments (QRIS, e-wallets)	255	85,0
	Digital POS/Cashier Applications	150	50,0
	Digital-Based Inventory Management	120	40,0
	Online Delivery Services (GoSend, GrabExpress, etc.)	195	65,0
	Independent Website/Platform (Webstore)	90	30,0

*) Multi-response (checklist)

Based on Table 2, the distribution of respondents shows that most MSME actors are male (54.0%), while females account for 46.0%, indicating relatively balanced participation between the two groups. In terms of age, the productive age group of 25–34 years dominates at 34.0%, followed by those aged 35–44 years at 26.0%, suggesting that digital-based MSME actors are largely composed of individuals in their productive phase with a relatively high capacity for technological adaptation. Regarding educational background, respondents are predominantly high school/vocational school graduates (42.0%) and bachelor's degree holders (32.0%), indicating that digital adoption is not limited to higher education levels but is also widespread among those with secondary education. Based on business type, the culinary sector dominates at 30.0%, followed by fashion at 18.3% and retail at 13.3%.

From the perspective of business experience, most respondents have operated their businesses for 1–3 years (32.0%) and 4–6 years (28.0%), indicating that most MSMEs are in the growth stage. Meanwhile, in terms of digitalization usage, most respondents have adopted digital technology for 1–3 years (36.0%), followed by more than 3 years (24.0%), suggesting that digitalization has become part of business operations in recent years. In the multi-response category of digitalization types, digital payment usage has the highest percentage (85.0%), followed by social media marketing (80.0%) and marketplace utilization (70.0%). This indicates that digitalization is primarily applied in transaction and marketing activities. Meanwhile, the use of more integrated systems, such as

inventory management (40.0%) and independent websites (30.0%), remains relatively low.

The final measurement model was evaluated using outer loadings, Cronbach's alpha, composite reliability, and average variance extracted (AVE). Indicators X.3, X.4, X.5, X.9, and Z.1–Z.5 were removed after considering both their loadings and construct content. All retained indicators loaded above 0.70. Cronbach's alpha ranged from 0.799 to 0.919, composite reliability from 0.869 to 0.933, and AVE from 0.608 to 0.643, supporting internal consistency and convergent validity. Because the retained Z indicators primarily represent organizational readiness and environmental support, the construct is interpreted more precisely as MSME digitalization readiness rather than technology-use intensity.

Table 3. Final Measurement-Model Results

Variable	Retained Indicator	Final Outer Loading	Cronbach's alpha	Composite reliability	AVE
Risk Management Strategy (X)	X.1	0.782	0.861	0.900	0.643
Risk Management Strategy (X)	X.2	0.804			
Risk Management Strategy (X)	X.6	0.769			
Risk Management Strategy (X)	X.7	0.835			
Risk Management Strategy (X)	X.8	0.818			
MSME Sustainability (Y)	Y.1	0.757	0.919	0.933	0.608
MSME Sustainability (Y)	Y.2	0.823			
MSME Sustainability (Y)	Y.3	0.738			
MSME Sustainability (Y)	Y.4	0.857			
MSME Sustainability (Y)	Y.5	0.748			
MSME Sustainability (Y)	Y.6	0.777			
MSME Sustainability (Y)	Y.7	0.770			
MSME Sustainability (Y)	Y.8	0.731			
MSME Sustainability (Y)	Y.9	0.810			
MSME Digitalization Readiness (Z)	Z.6	0.789	0.799	0.869	0.624
MSME Digitalization Readiness (Z)	Z.7	0.809			
MSME Digitalization Readiness (Z)	Z.8	0.780			
MSME Digitalization Readiness (Z)	Z.9	0.782			

Indicator removal was restricted to items whose deletion improved convergent validity without eliminating the conceptual core of the retained construct. Nevertheless, the substantial reduction of the digitalization block from nine to four indicators narrows its domain. This limitation is acknowledged explicitly, and future research should measure actual digital use separately from organizational readiness and external enabling conditions.

Discriminant validity was assessed using HTMT and the Fornell–Larcker criterion. The HTMT ratios were Z–Y = 0.799, Z–X = 0.734, and Y–X = 0.702, all below 0.90. The square roots of AVE were 0.790 for digitalization readiness, 0.780 for sustainability, and 0.802 for risk-management strategy. Each diagonal value exceeded the corresponding interconstruct correlations, supporting discriminant validity.

Table 3. Discriminant Validity Results

Discriminant Validity	Variable	MSME Digitalization (Z)	MSME Sustainability (Y)	Risk Management Strategy (X)
HTMT	MSME Digitalization (Z)			
	MSME Sustainability (Y)	0.799		
	Risk Management Strategy (X)	0.734	0.702	
Fornell-Lacker Criterion	MSME Digitalization (Z)	0.790		
	MSME Sustainability (Y)	0.734	0.780	
	Risk Management Strategy (X)	0.645	0.623	0.802

The inner model evaluation measures the strength of relationships among latent variables using R-square, f-square, and Q².

Table 4. Inner Model Results

Path	f-square	R-square	R-square adjusted	Q ²
MSME Digitalization (Z) -> MSME Sustainability (Y)	0.445			
Risk Management Strategy (X) -> MSME Sustainability (Y)	0.091			
Risk Management Strategy (X) -> MSME Digitalization (Z)	0.712	0.416	0.414	0.311

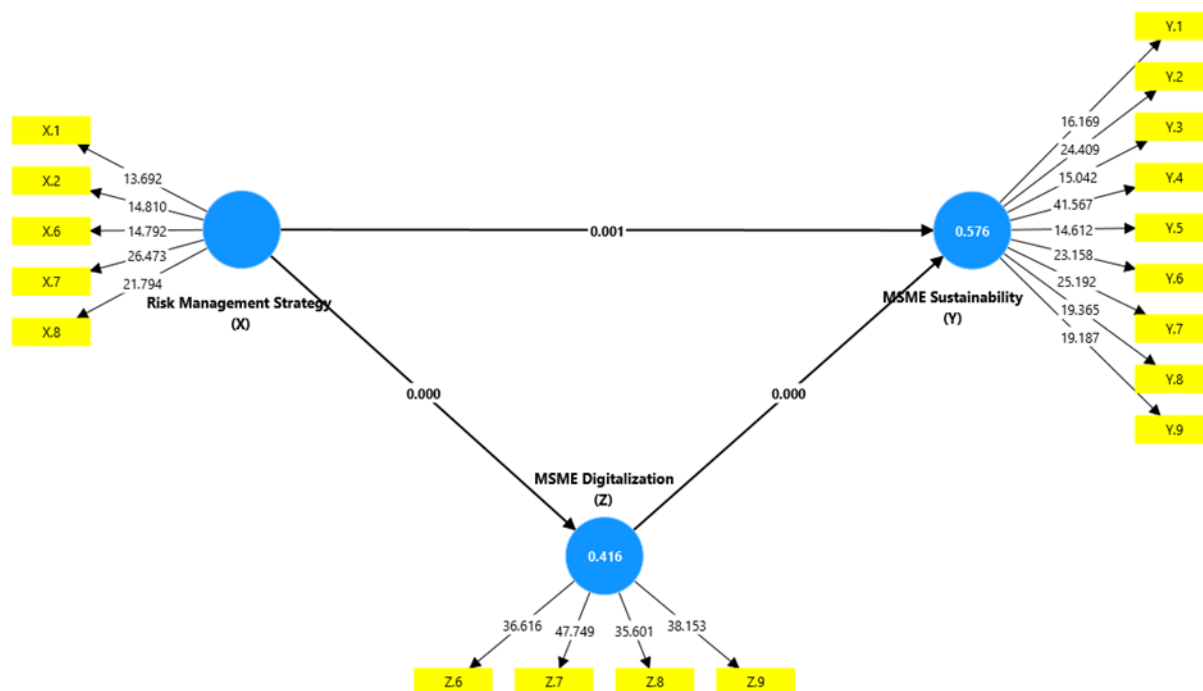
For MSME Sustainability (Y), $R^2 = 0.576$ and adjusted $R^2 = 0.574$; for MSME Digitalization Readiness (Z), $R^2 = 0.416$ and adjusted $R^2 = 0.414$. Q² values of 0.340 and 0.311 indicate predictive relevance above zero. The f² values indicate a large effect of digitalization readiness on sustainability (0.445), a small effect of risk management on sustainability (0.091), and a large effect of risk management on digitalization readiness (0.712). R², adjusted R², and Q² are construct-level statistics, whereas f² is path-specific. To assess common method bias, a full-collinearity test produced VIF values of 2.21 for risk-management strategy, 2.47 for digitalization readiness, and 2.18 for sustainability. All values were below the conservative threshold of 3.3, indicating that common method bias was unlikely to dominate the estimated relationships.

Table 5. Hypothesis Testing Results

Hypothesis	Variable Relationship	Coefficient	t statistic	P values	Remark
H1	Risk Management Strategy (X) -> MSME Sustainability (Y)	0.256	3.299	0.001	Accepted
H2	Risk Management Strategy (X) -> MSME Digitalization (Z)	0.645	9.903	0.000	Accepted
H3	MSME Digitalization (Z) -> MSME Sustainability (Y)	0.568	8.588	0.000	Accepted
H4	Risk Management Strategy (X) -> MSME Digitalization (Z) -> MSME Sustainability (Y)	0.367	7.78	0.000	Accepted: complementary partial mediation

All four hypothesized paths are positive and statistically significant. Risk-management strategy predicts sustainability ($\beta = 0.256$, $t = 3.299$, $p = 0.001$) and

digitalization ($\beta = 0.645$, $t = 9.903$, $p < 0.001$); digitalization predicts sustainability ($\beta = 0.568$, $t = 8.588$, $p < 0.001$); and the specific indirect effect is significant ($\beta = 0.367$, $t =$



7.780, $p < 0.001$). Because the direct and indirect effects are both significant and have the same sign, digitalization exhibits complementary partial mediation. This classification is more precise than stating only that mediation exists.

Figure 2. Structural Model Diagram of SEM-PLS Research

Figure 2 illustrates the SEM-PLS structural model depicting the relationships among Risk Management Strategy (X), MSME Digitalization (Z), and MSME Sustainability (Y). The R-square value for the MSME Digitalization variable is 0.416, indicating that the risk management strategy explains 41.6% of the variation in digitalization. Meanwhile, the R-square value for MSME Sustainability is 0.576, showing that risk management strategy and digitalization explain 57.6% of the variation in business sustainability. The relationships among variables are positive and statistically significant (p -values of 0.000 and 0.001), indicating that all paths are statistically significant. Furthermore, the remaining indicators for each variable exhibit high loading values, reflecting a strong contribution in forming the constructs.

Discussion

The discussion of the research findings indicates that risk management strategies have a positive and significant effect on MSME sustainability, with a coefficient of 0.256, a t -statistic of 3.299, and a p -value of 0.001; thus, H1 is accepted. This result confirms that MSME actors' ability to identify, analyze, and control risks directly contributes to business sustainability. These findings are consistent with Nurjannah et al. (2023), who state that effective risk management enhances the resilience of small businesses, and with Dvorsky et al. (2021), who emphasize the importance of risk management in maintaining MSME performance stability. Barney (1991), through the Resource-Based View, also supports the idea that internal capabilities such as risk management constitute a source of competitive advantage that sustains business continuity. However, this result does not fully align with Luo (2021), who found that, under certain conditions, risk management

does not directly impact sustainability without support from other factors such as technology. This suggests that although the influence is significant, risk management strategies still require support from other mechanisms to generate more optimal outcomes.

The findings also show that risk management strategies have a positive and significant effect on MSME digitalization, with a coefficient value of 0.645, a t-statistic of 9.903, and a p-value of 0.000; thus, H2 is accepted. The high coefficient indicates that risk management strategies strongly encourage MSME actors to adopt digital technologies. These findings align with Pomaza-Ponomarenko et al. (2023), who explain that risk management enhances organizational readiness to adopt innovation, and with Li et al. (2021), who state that internal capabilities play a crucial role in digital transformation. The TOE framework proposed by Tornatzky and Fleischer (1990) further reinforces that organizational readiness is a key factor in successful technology adoption. However, these findings are not entirely consistent with Skachko et al. (2021), which places greater emphasis on external factors as the primary determinants of digitalization. This indicates that, in the context of Indonesian MSMEs, internal factors such as risk management strategies play a more dominant role in driving digitalization than external factors.

Furthermore, MSME digitalization has a positive and significant effect on MSME sustainability, with a coefficient of 0.568, a t-statistic of 8.588, and a p-value of 0.000; therefore, H3 is accepted. This result indicates that the higher the level of digital technology utilization, the greater the level of business sustainability achieved. These findings are consistent with Yu et al. (2022), who state that digitalization enhances business efficiency and competitiveness, and with Van Hoang et al. (2025), who emphasize that digital capability is a source of competitive advantage. In addition, Ye et al. (2024) also demonstrate that digital technology can improve business resilience against external disruptions. However, these results are not entirely consistent with Luo (2021), who found that digitalization without proper risk management may increase business vulnerability. This suggests that while digitalization positively affects sustainability, its effectiveness depends heavily on risk management.

CONCLUSION AND RECOMMENDATIONS

Risk-management strategy is positively associated with both MSME sustainability and digitalization, while digitalization is positively associated with sustainability. The simultaneous significance of the direct and indirect effects indicates complementary partial mediation: risk management supports continuity directly and also works through digitalization. The theoretical contribution is therefore more specific than a general confirmation of RBV and TOE. The findings connect RBV's internal-capability logic to TOE's adoption-context logic by identifying digitalization as the mechanism that converts risk identification and mitigation into efficiency, adaptability, market access, and resilience.

The implications of this study highlight the importance of strengthening risk management strategies as part of MSME capacity development in the digital era. MSME actors need to view risk management not merely as a protective measure but as a foundation for making adaptive business decisions, including the use of digital technologies. For the government and MSME support institutions, these findings can serve as a basis for designing assistance programs that integrate risk literacy, digital readiness, and business sustainability. Theoretically, this study reinforces the use of the

Resource-Based View and the Technology-Organization-Environment framework as complementary approaches in explaining the sustainability of digital-based MSMEs.

The findings should be interpreted in light of several limitations. Cross-sectional, self-reported data do not establish temporal causality. However, the provisional full-collinearity VIF results do not indicate severe common method bias; procedural and statistical bias cannot be ruled out completely—purposive online sampling and unequal regional coverage limit national generalization. In addition, the digitalization construct combines readiness and environmental enabling conditions, so future research should separate adoption antecedents from actual technology-use intensity. Longitudinal, multisource, and geographically stratified designs would provide stronger tests of the proposed mechanism.

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