

From Recovery To Sustainability: The Mediating Role of Resilience In Post-Disaster Msmes

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Abstract.

This study aims to analyze a model of post-disaster resilience and sustainability of Micro, Small, and Medium Enterprises (MSMEs) based on adaptive capability, risk management, and digital transformation in Langkat Regency. This study employed a quantitative approach using Structural Equation Modeling–Partial Least Squares (SEM-PLS). The research variables consisted of adaptive capability, risk management, digital transformation, MSME resilience, and MSME sustainability. The results showed that adaptive capability, risk management, and digital transformation had positive and significant effects on MSME resilience, with path coefficients of 0.310, 0.280, and 0.340, respectively. MSME resilience also had a positive and significant effect on MSME sustainability, with a path coefficient of 0.390. Furthermore, all three independent variables had direct and significant effects on MSME sustainability. The mediation analysis indicated that MSME resilience partially mediated the relationships between adaptive capability, risk management, digital transformation, and MSME sustainability. The R^2 value of 0.624 indicates that the model explains 62.4% of the variance in MSME resilience, while the R^2 value of 0.687 indicates that 68.7% of the variance in MSME sustainability is explained by the model. These findings confirm that strengthening adaptive capability, risk management, and digital transformation through enhanced resilience is important for supporting the sustainability of post-disaster MSMEs in Langkat Regency.

Keywords: Adaptive Capability; Risk Management; Digital Transformation; MSME Resilience and MSME Sustainability..

I. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are one of the strategic sectors of the Indonesian economy, playing an important role in creating employment, generating household income, promoting the equitable distribution of economic activities, and strengthening regional economies (Nurbayan et al., 2025). The existence of MSMEs not only serves as business units that produce goods and services, but also provides livelihoods for communities and constitutes one of the foundations of regional economic resilience (Hardiansyah et al., 2025). Therefore, the sustainability of MSMEs is an important factor in maintaining economic stability and growth, particularly when regions face crises and disasters (Khairani et al., 2026).

However, MSMEs generally have a relatively high level of vulnerability to external disruptions (Fadli, 2021). Limited access to capital, human resources, technology, information, marketing networks, and managerial capabilities makes it more difficult for MSMEs to recover when facing business disruptions (Ginting et al., 2026). This situation becomes increasingly complex when MSMEs are affected by natural disasters (Khairani et al., 2025). Disasters not only cause damage to physical assets but can also disrupt production activities, distribution, marketing, supply chains, cash flows, customer access, and relationships with suppliers (Khairumi et al., 2025). Consequently, some MSMEs may experience declining revenues, loss of customers, difficulties in meeting financial obligations, and even suspension of their business operations (Djohan et al., 2025).

Table 1. Data on MSMEs Affected by the Disaster

Indicator	Data
Number of sub-districts in Langkat Regency	23
Sub-districts affected by flooding	16 sub-districts
Percentage of affected sub-districts	69.57%
Micro and Small Enterprises (MSEs) recorded	±5,000
MSEs in affected areas	>1,000 business operators
Disaster period	November–December 2025
Type of disaster	Flood/Hydrometeorological Disaster

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Source: Langkat Regency Government & Department of Cooperatives and SMEs

In this context, the ability of MSMEs to survive, respond, adapt, and recover their business activities following a disaster becomes highly important. This capability is known as organizational resilience or MSME resilience. Resilience is not merely concerned with the ability of a business to return to its pre-disaster condition, but also encompasses the ability to learn from crises, implement strategic changes, capitalize on new opportunities, and build capacity to become better prepared for future disruptions (Razaq et al., 2024). Thus, resilience constitutes one of the essential foundations for MSME sustainability under conditions of uncertainty.

II. RESEARCH METHODS

This study employed the *Structural Equation Modeling–Partial Least Squares* (SEM-PLS) method. This method was selected because it is capable of simultaneously analyzing relationships among latent variables and is appropriate for studies with relatively limited sample sizes. The research variables consisted of Adaptive Capability (X1), Risk Management (X2), and Digital Transformation (X3) as independent variables, MSME Resilience as the intervening variable (Z), and MSME Sustainability (Y) as the dependent variable. The data were analyzed using SmartPLS software through two stages: evaluation of the *outer model* (validity and reliability assessment) and evaluation of the *inner model* (testing relationships among variables and research hypotheses).

The data used in this study were primary data collected through questionnaires distributed to the target population and sample. The selected sub-districts were chosen because these areas were affected by the flash floods that occurred in Langkat Regency in 2025, resulting in significant declines in income and economic activity among local business operators. The population of this study consisted of 1,000 MSMEs affected by flooding across 16 sub-districts in Langkat Regency. The sample size was determined using the Slovin formula with a 5% margin of error, resulting in a sample of 286 MSMEs. Subsequently, the sample was proportionally distributed across the 16 affected sub-districts based on the number of MSMEs in each sub-district.

III. RESEARCH RESULTS AND DISCUSSION

Research Results

Based on the questionnaire instrument and the results of the questionnaire instrument pilot test, the Adaptive Capability variable consisted of six statement items, Risk Management consisted of six statement items, Digital Transformation consisted of six statement items, MSME Resilience consisted of six statement items, and MSME Sustainability consisted of six statement items. All variables obtained a *Cronbach's Alpha* value greater than 0.70, indicating that the questionnaire was reliable and could therefore be distributed to respondents who met the predetermined characteristics.

Based on the data obtained from the questionnaire responses, the main SEM-PLS model was constructed using 30 statement items. An evaluation of the measurement model was then conducted, as presented in Figure 1. The *PLS-Algorithm* procedure was subsequently performed to obtain the values of *Cronbach's Alpha*, *Composite Reliability*, and *Average Variance Extracted* (AVE).

The evaluation process involved several stages, beginning with an assessment of the *outer loadings* to analyze *convergent validity*. The outer loading values for each indicator of Adaptive Capability, Risk Management, Digital Transformation, MSME Resilience, and MSME Sustainability were above 0.70. Therefore, the measurement model met the criteria for *convergent validity*.

The next stage involved evaluating *discriminant validity* by examining the *cross-loadings* of the indicators.

Tabel 2. AVE

Variabel	AVE
X1 Adaptive Capability	0,650
X2 Risk Management	0,637

X3 Digital Transformation	0,676
Z Resilience	0,692
Y Sustainability	0,715

Source: Primary data, processed in 2026

Tabel 3. Outer Loadings

Indicator	Adaptive Capability (AC)	Risk Management (RM)	Digital Transformation (DT)	MSME Resilience (MR)	MSME Sustainability (MS)
AC1	0,781				
AC2	0,824				
AC3	0,806				
AC4	0,792				
AC5	0,847				
AC6	0,815				
RM1		0,766			
RM2		0,795			
RM3		0,823			
RM4		0,858			
RM5		0,775			
RM6		0,861			
DT1			0,759		
DT2			0,805		
DT3			0,793		
DT4			0,880		
DT5			0,867		
DT6			0,828		
MR1				0,777	
MR2				0,801	
MR3				0,846	
MR4				0,787	
MR5				0,893	
MR6				0,824	
MS1					0,786
MS2					0,812
MS3					0,769
MS4					0,884
MS5					0,903
MS6					0,871

Source: Primary data, processed in 2026

Based on the values presented in Tables 2 and 3, the measurement model meets the required criteria. The Cronbach's Alpha values for all latent variables are greater than 0.70, while the Composite Reliability values are also above 0.70, indicating satisfactory internal consistency and reliability. Furthermore, the Average Variance Extracted (AVE) values for all constructs are greater than 0.50. Therefore, all constructs meet the criteria for convergent validity. The Fornell–Larcker criterion indicates that the square root of the AVE for each construct is greater than its correlations with the other constructs. Thus, all constructs demonstrate adequate discriminant validity.

Table 4. Summary of Hypothesis Testing Results

Hypothesis	Relationship Between Variables	Path Coefficient (β)	T-Statistic	P-Value	Effect Size (f²)	Interpretation
H1	Adaptive Capability (X1) → Resilience (Z)	0,310	4,850	0,000	0,090	Signifikan
H2	Risk Management (X2) → Resilience (Z)	0,280	4,210	0,000	0,157	Signifikan

H3	Digital Transformation (X3) → Resilience (Z)	0,340	5,170	0,000	0,223	Signifikan
H4	Resilience (Z) → Sustainability (Y)	0,390	6,020	0,000	0,374	Signifikan
H5	Adaptive Capability (X1) → Sustainability (Y)	0,190	2,940	0,003	0,061	Signifikan
H6	Risk Management (X2) → Sustainability (Y)	0,220	3,360	0,001	0,096	Signifikan
H7	Digital Transformation (X3) → Sustainability (Y)	0,250	3,810	0,000	0,124	Signifikan

Source: Primary data, processed in 2026

Discussion

The results of the study indicate that adaptive capability, risk management, and digital transformation have positive and significant effects on MSME resilience, while resilience has a positive and significant effect on MSME sustainability. These findings can generally be explained through Dynamic Capability Theory (DCT), which views an organization's ability to sense changes, seize opportunities, and transform itself as a fundamental basis for responding to a dynamic environment (Wakhyuni et al., 2024). This perspective is highly relevant to post-disaster MSMEs because business conditions can change rapidly and are characterized by considerable uncertainty (Pasaribu et al., 2023). Previous studies have also demonstrated that dynamic capabilities play an important role in building business resilience when organizations face crises and disasters (Ayuni et al., 2025).

The results show that adaptive capability has a positive and significant effect on MSME resilience, with a coefficient of 0.310, a *t-statistic* of 4.850, and a *p-value* of 0.000. The *effect size* of 0.090 indicates a small effect. This finding supports Dynamic Capability Theory, particularly the organization's ability to adjust its resources and strategies in response to environmental changes (Nasib et al., 2026). In the context of MSMEs in Langkat Regency, adaptive capability enables business owners to adjust their products, business processes, marketing strategies, and resource utilization following a disaster (Sihombing et al., 2024). Thus, the higher the adaptive capability, the greater the ability of MSMEs to survive and recover (Rusiadi et al., 2023)(Khairani et al., 2026). This finding is consistent with the view that adaptive capability is an important mechanism for building MSME resilience when operating in uncertain environments (Umam et al., 2022).

Risk management was found to have a positive and significant effect on MSME resilience, with a coefficient of 0.280, a *t-statistic* of 4.210, and a *p-value* of 0.000. The *effect size* of 0.157 falls within the medium-effect category. This result indicates that MSMEs' ability to identify, analyze, evaluate, and control risks can strengthen their capacity to cope with the impacts of disasters (Harianto, Honkley, et al., 2024). Theoretically, risk management enables organizations to anticipate uncertainty and maintain business functions when disruptions occur (Anjaningrum et al., 2024). This finding is also consistent with studies on MSME risk management, which position risk management, business continuity, and dynamic capabilities as important approaches for developing the capacity to cope with disruptions and strengthening organizational resilience (Fajaryati et al., 2026)(Amelia et al., 2025).

Digital transformation has a positive and significant effect on MSME resilience, with a coefficient of 0.340, a *t-statistic* of 5.170, and a *p-value* of 0.000. The *effect size* of 0.223 falls within the medium-effect category. This result indicates that the use of digital technologies can help MSMEs maintain their business activities when facing post-disaster disruptions. The utilization of social media, online marketplaces, digital payment systems, and technology-based communication can expand market access and accelerate business processes (Merín-Rodríguez et al., 2024). This finding supports Dynamic Capability Theory, as digital technologies can serve as an important means for MSMEs to engage in *sensing*, *seizing*, and *transforming* (Sang et al., 2024). Research on MSMEs in Indonesia has also found that dynamic capabilities and digital transformation are associated with improved business resilience (Hardiansyah et al., 2025)(Sari, 2026).

The results show that MSME resilience has a positive and significant effect on MSME sustainability, with a coefficient of 0.390, a *t-statistic* of 6.020, and a *p-value* of 0.000. The *effect size* of 0.374 falls within

the large-effect category. This result demonstrates that resilience is a highly important factor in maintaining the sustainability of MSMEs following disasters. MSMEs that are able to survive, adapt, recover, and capitalize on opportunities after experiencing disruptions have a greater capacity to maintain their business operations in the long term (Deku et al., 2023). Theoretically, this finding strengthens the relationship between resilience theory and sustainability, suggesting that an organization's ability to cope with and recover from external pressures provides a foundation for business continuity (Appiah-Kubi, 2024). The literature on MSME resilience also indicates that resilience is associated with the ability to cope with crises, economic changes, and natural disasters (Harianto, Hou, et al., 2024)(Al Omoush et al., 2023).

Adaptive capability has a positive and significant effect on MSME sustainability, with a coefficient of 0.190, while risk management has a coefficient of 0.220 and digital transformation has a coefficient of 0.250. These findings indicate that MSME sustainability is determined not only by the ability to survive after a disaster but also by the ability to adapt, manage risks, and utilize technology. From the perspective of Dynamic Capability Theory, these three capabilities enable MSMEs to modify and recombine their resources in accordance with changes in the external environment. Thus, MSMEs that are able to implement strategic changes, anticipate risks, and utilize digital technologies have greater opportunities to maintain business continuity (Ayokunmi et al., 2025)(Abu Jaish et al., 2023).

In other words, resilience serves as a linking mechanism that transforms adaptive capability, risk management, and technology utilization into the capacity to maintain business sustainability. The finding that resilience can develop through dynamic capabilities is also supported by previous research on SMEs facing crises.

The R^2 value for MSME Resilience of 0.624 indicates that adaptive capability, risk management, and digital transformation explain 62.4% of the variance in MSME resilience. Meanwhile, the R^2 value for MSME Sustainability of 0.687 indicates that the model explains 68.7% of the variance in MSME sustainability. These results demonstrate that the proposed research model has substantial explanatory power in explaining post-disaster MSME sustainability.

Overall, the findings reinforce Dynamic Capability Theory. Adaptive capability reflects the ability of MSMEs to adjust to changing conditions, risk management helps MSMEs cope with uncertainty, while digital transformation provides the means to facilitate change and innovation. These three capabilities subsequently strengthen resilience, which ultimately contributes to MSME sustainability. This model is also consistent with previous research indicating that digital transformation and dynamic capabilities can serve as important mechanisms for strengthening MSME resilience during crises.

IV. CONCLUSION

Overall, the findings demonstrate that digital transformation, adaptive capability, and risk management are important factors in building post-disaster MSME resilience. Furthermore, resilience emerges as a strong factor in promoting MSME sustainability. Therefore, the post-disaster MSME resilience and sustainability model based on adaptive capability, risk management, and digital transformation in Langkat Regency receives strong empirical support, with the model explaining 68.7% of the variance in MSME sustainability.

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