

Research Paper



BUILDING ENTREPRENEURIAL RESILIENCE: HOW INDONESIAN MSMEs NAVIGATE GLOBAL SUPPLY CHAIN DISRUPTIONS AND CLIMATE CHANGE CHALLENGES

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ABSTRACT. Micro, small, and medium enterprises (MSMEs) in Indonesia play significant role in advancing the Indonesian economy; however, they are vulnerable to challenges caused by climate change as a global consequence, as well as challenges stemming from global supply chain issues. In this regard, with a focus on rapid technological change and sustainability, MSMEs have considerable potential for transformation. With the above elaboration, this research aims to examine from the perspective of MSMEs in Indonesia the impact of entrepreneurial resilience and business sustainability on the adoption of green innovation, digital technology, diversified supply chains, and collaborative ecosystems. To address the research questions, a quantitative approach using partial least square -structural equation modelling (PLS-SEM) was employed with a sample of 250 MSMEs from three provinces in Indonesia: West Java, Central Java, and North Sumatra. Model assessment is focused on indicator weights, average variance extracted and composite reliability. Result shows that digitization and supplier diversification were recorded and having a positive impact on entrepreneurial resilience, whereas green innovation has a significant negative influence on entrepreneurial resilience. Resilience was proven have positive effect on business sustainability. Within the framework of the entire model, the strength of explanation reaching R^2 of 0.995 for entrepreneurial resilience and R^2 of 0.885 for business sustainability. The components such as Digital transformation and flexible supply chain management are vital for enhancing the resilience and sustainability of MSMEs in the long term, while the effects of green innovation and ecosystem collaboration appear to be more contextually contingent.

INTRODUCTION

Micro, small, and medium enterprises (MSMEs) are crucial to Indonesia's economy, accounting for over 60% of the national GDP and 97% of the national workforce (Kurniadi *et al.*, 2024). This contribution has earned MSMEs the recognition of being important for economic development, equitable distribution of income, and social inclusion (Akram *et al.*, 2024; Canwat *et al.*, 2024; Nursini, 2020). Moreover, MSME activities alleviate poverty in urban and rural areas. However, MSMEs are vulnerable to external disruptions, especially global supply chains and climate change. These issues are most severe for resource- and technology-poor MSMEs.

The COVID-19 pandemic, recent geopolitical conflicts, and unsteady economies have all impacted the availability of raw materials and intermediate goods, affecting the operations of MSMEs (Nugroho *et al.*, 2025; Shoffiyati and Kristianto, 2025). In previous studies, digitalization and supplier diversification have been shown to lessen such exposures (Canwat *et al.*, 2024). In contrast, Indonesian MSMEs have traditional supply systems and a small network of suppliers, limiting their collaborative and alternative sourcing capabilities (Koberg and Longoni, 2019; Sinulingga and Susilawati, 2025; Srinivasan *et al.*, 2025; Srivastava, 2007). Consequently, the greater the dependence on a small group of suppliers, the greater the risk of operational disruptions during unstable times

(Andanu *et al.*, 2025; He *et al.*, 2021; Siswanto and Dolah, 2023; Wahyuni and Sara, 2020).

Climate change adds risks to Indonesian MSMEs. Increased environmental volatility caused by climate change, such as severe weather, changing rainfall patterns, and increased frequency of natural disasters, impacts the dependence of natural resource-based sectors (agriculture, fisheries, and resource-based manufacturing) (Bagis *et al.*, 2024; Hendrawan *et al.*, 2025). Climate change impacts can cause raw materials to become scarce, resulting in high production and supply chain costs, and firms must reconfigure their supply chains. In this regard, eco-innovation is the answer to this problem by reducing the environmental impact of business activities while ensuring business continuity of the business (Greeni and Burkhard, 2025; Nursini, 2021; Ramezani and Camarinha-Matos, 2019)

Faced with this condition, resilient entrepreneurship is the most appropriate. Resilient entrepreneurship is a company's ability to absorb shocks, adapt to changing conditions, and sustain the business under uncertain and changing conditions (Sari *et al.*, 2022). Resilience is not built only by having sufficient finance, but by the presence and application of adaptive strategies that can affect the flexibility of the organization. From the strategies mentioned above, the application of digital technology, ease of operation, supplier diversification, reduction in dependence on a single supplier, and eco-innovation as a driver of sustained competitiveness and sustainability.

Research in Indonesia has shown that sustainable practices improve the competitiveness of MSMEs. For example, Priambudi *et al.* (2025) demonstrated that both the environmental performance of *batik* production and the ability of production to stand out in the market are enhanced with the implementation of natural-dye standards. Similarly, Ismayana *et al.* (2022) showed that in the kraft paper industry, cleaner production practices reduce waste and better manage resources. Abidin (2023) argued that for competitiveness in the agro-industrial sector, the synergy of innovative and effective resource management, along with institutional support, is crucial. Overall, these studies confirm that eco-innovation has the potential to yield value for MSMEs in the long run. However, the immediate effect of eco-innovation on improving MSMEs' resilience is contingent on the preparedness and resource allocation of the firm.

The role of digital adoption in MSME development is also widely accepted. Digital platforms have been proven to increase market reach and the availability of

information, as well as improve the coordination of operational functions (Akmal and Arifa, 2023; Harymawan *et al.*, 2022; Ruminta *et al.*, 2018). Furthermore, vendor diversification alleviates dependency concerns and enhances supply chain (Oyeyemi *et al.*, 2023). Although eco-innovation and entrepreneurial resilience have been studied separately, the few studies that have focused on the two have shown that eco-innovation does support sustainable performance (Akmal and Arifa, 2023; Tedjaningtyas, 2025; Winarsih, 2025).

Collaboration across the wider business ecosystem is another topic frequently mentioned in MSME studies. Collaborative relationships with public sector agencies, banks, universities, and industry associations create opportunities for knowledge, funding, and markets (Bagis *et al.*, 2024; Shulei, 2025; Rizvi *et al.*, 2025). Such relationships may enhance learning and social capital. However, the empirical literature is inconclusive regarding the role of ecosystem collaboration in enhancing entrepreneurial resilience.

MSMEs are extremely heterogeneous across sectors and geographies. In agricultural businesses, for example, climate-related uncertainties are tackled using a combination of diversification and irrigation (Skouloudis *et al.*, 2020; Putri *et al.*, 2023), whereas in manufacturing, the focus is typically on product innovation and improvements in the supply chain (Kashem *et al.*, 2024). Such differences reiterate the importance of context in the study of resilience.

This study applies a quantitative method using partial least squares structural equation modeling (PLS-SEM) to analyze MSMEs located in four geographically and economically significant regions in Indonesia, namely, West Java, Central Java, East Java, and North Sumatra, which are primary locations for MSME clustering and recurrent supply chain and environmental disruptions. This method provides a systematic understanding of the elements determining MSMEs' resilience and sustainability (Arifin *et al.*, 2023; Audretsch *et al.*, 2024; Seraj *et al.*, 2022). Although some studies have examined the separate impacts of digitalization, supplier diversification, and eco-innovation, most have not considered these approaches simultaneously using a single framework for analysis. The collaboration of ecosystem actors as a form of relational mechanism integrating these approaches to strengthen entrepreneurial resilience has not been widely researched.

Accordingly, this study aims to construct a structural model that views digital adoption, supplier diversification, and eco-innovation as forms of

adaptive capability, and entrepreneurial resilience, and ecosystem collaboration as a relational mechanism for the flow of knowledge and the availability of external resources. This positions entrepreneurial resilience as a primary component of sustained business viability in the face of disruptive and uncertain circumstances (Donn and Moreno, 2021; Hindarsah *et al.*, 2025; Srinivasan *et al.*, 2025).

RESEARCH AND METHODS

Research Design and Data Collection

With a focus on the quantitative side of primary data collection via a structured questionnaire directed at MSME owners and managers, this practice identified its target respondents as businesses operating in the manufacturing, agribusiness, and food processing sectors across four prominent MSME regions: West Java, Central Java, East Java, and North Sumatra. These areas serve as essential production hubs, are highly susceptible to supply chain disruptions and climate-related challenges and risks (Kurniawan *et al.*, 2023; Oyeyemi *et al.*, 2023; Saleh *et al.*, 2025).

Purposive sampling was used for this research and targeted respondents familiar with the firm's operational and strategic decision-making. To achieve this, participants had to be owners, directors, or senior managers of the firm, and the firm must have been in operation for at least three years. This was done to guarantee that the participant could provide meaningful and knowledgeable information about the firm, organizational resilience, and business sustainability.

A total of 312 questionnaires were distributed, 267 were completed and returned. Data cleaning was conducted, and 17 questionnaires were completed sufficiently, leaving a total of 250 valid questionnaires, representing 80.13% of the research respondents. This research has met the minimum benchmark for PLS-SEM analysis (Hair *et al.*, 2022).

Data were collected from March to June 2025 using both digital and in-person methodologies. Surveys were distributed online via email and professional network platforms, while physical surveys were conducted during MSME meetings and regional business forums. Participation in the survey was voluntary, and respondents were informed about the study's objectives prior to participation.

Measurement of Constructs

The measurement items that had been adapted came from instruments used in other studies that had been tested and validated. The frameworks were slightly

revised to fit the context of Indonesian MSMEs while maintaining the same meaning (Gölgeci and Ponomarov, 2015; Filho, 2019; Umami *et al.*, 2023). All the variables were evaluated using a five-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree), to indicate respondents' level of agreement.

The level of digital adoption in MSMEs is evidenced by how well MSMEs have embedded digital processes into their operations, including, but not limited to, e-commerce and digital payments, digital supply chain monitoring, and online marketing. Supplier diversification refers to the use of multiple sources of supply to reduce dependence on any one supplier and to enhance supply chain resiliency. Eco-innovation deals with innovative activities that contribute to improvements in the environment, such as the development of eco-friendly products, energy-saving processes, and resource use that reduces waste and enables sustainable resource use. Ecosystem collaboration is the collaboration between MSMEs and other actors (government, banks, suppliers, and educational institutions) to create partnerships that will enable MSMEs to access knowledge and resources. Entrepreneurial resilience is the ability of a firm to foresee, absorb, and recover from disruption, and to do so with the capability to adapt, manage crises, and engage in organizational learning. Finally, business sustainability is a measure of how stable a firm's operations are over a period. The goals of business sustainability are sustained operations, competitiveness in the market, and an increase in business.

Instrument Testing and Validation

Prior to the actual survey, the questionnaire was distributed to 30 MSMEs as part of the pre-testing. The goal of the pre-testing was to simplify, ascertain the appropriateness of the phrasing, and evaluate the context of the items being measured. After receiving input from the pre-test participants, several questions were revised to enhance clarity and readability.

A set of standard procedures used in PLS-SEM analysis was used to assess the reliability and validity of measurement instruments. Internal consistency reliability was assessed using Cronbach's alpha and composite reliability (CR). Convergent reliability was assessed using average variance extracted (AVE), and the Fornell-Larcker criterion and cross-loading (Hair *et al.*, 2022) were used for discriminant reliability.

Research Framework and Hypotheses Development

The conceptual model of this study aims to identify the relationships among digital adoption, supplier

diversification, eco-innovation, ecosystem collaboration, entrepreneurial resilience, and business sustainability (see Figure 1). Eco-innovation, digital adoption, and supplier diversification are considered adaptive capacities that impact entrepreneurial resilience. Furthermore, ecosystem collaboration is added as a mediating variable that is likely to enhance the effects of these adaptive capacities. Business resilience is then expected to affect business sustainability.

From the theoretical discussion in the Introduction, the following hypotheses have been formulated:

- H1 : Digital adoption positively influences entrepreneurial resilience
- H2 : Supplier diversification positively influences entrepreneurial resilience
- H3 : Eco-innovation positively influences entrepreneurial resilience
- H4 : Ecosystem collaboration mediates the relationships between digital adoption, supplier diversification, eco-innovation, and entrepreneurial resilience
- H5 : Entrepreneurial resilience positively influences business sustainability

Data Analytics Method

The empirical analysis was performed using the SmartPLS software for PLS-SEM analysis. This software can be used for complex structural equations for which the number of samples is moderate, and the researcher is uncertain about the normality of the data (Hair *et al.*, 2022; Kock and Hadaya, 2018; Shmueli *et al.*, 2019).

The analysis was performed in two steps. First, the measurement model was analyzed, and second, the structural model was analyzed. In the measurement model, the following components were evaluated: indicator reliability, reliability of internal consistency, convergence validity through average variance extracted (AVE), and Fornell and Larcker test for discriminant validity.

In the structural model, the relationships among the latent constructs were analyzed through the estimation of path coefficients. In addition, the following were evaluated: the coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2). The mediation impact of ecosystem collaboration (co-creation) was analyzed through bootstrapping with a sample size of 5,000.

Ethical issues were considered prior to the study and other activities during the study showed respect for the participants and maintained the confidentiality and anonymity of participant responses. All the above were done to maintain the credibility of the findings and the integrity of the study.

Descriptive Statistics of Respondents and Variables

Table 1 describes the 250 MSME respondents in the survey. Regarding geolocation, the respondents were from West Java (36%), Central Java (24%), East Java (24%), and North Sumatra (16%). Despite West Java having the largest share, the inclusion of other regions enables greater MSME coverage both within and outside Java to capture the varying geolocations of MSMEs.

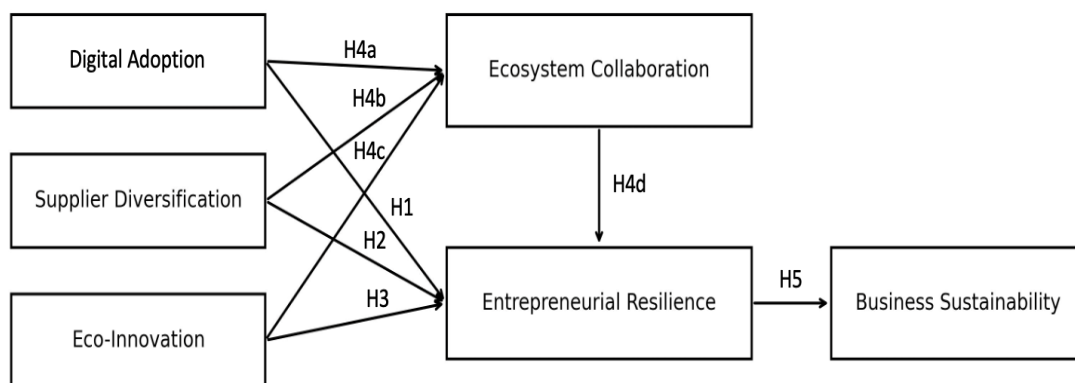


Figure 1. Structural model of entrepreneurial resilience within the MSME business ecosystem

Table 1. Respondent demographic characteristics

Category	Classification	Frequency (N)	Percentage (%)
Region	West Java	90	36
	Central Java	60	24
	East Java	60	24
	North Sumatra	40	16
Business Sector	Trading	78	31.2
	Culinary	59	23.6
	Creative Services	48	19.2
	Manufacturing	36	14.4
	Agriculture	29	11.6
Business Size	Micro	142	56.8
	Small	73	29.2
	Medium	35	14

RESULTS AND DISCUSSION

In terms of sector, the largest chunk is in trading (78 firms, or 31.2%), followed by culinary (59 firms, or 23.6%), creative services (48 firms, or 19.2%), manufacturing (36 firms, or 14.4%), and agriculture (29 firms, or 11.6%). Although trade and culinary are the most dominant, other economic activities are also represented in the distribution, and manufacturing is included.

The respondent firms were classified in accordance with the provisions of Government Regulation No. 7/2021. Micro enterprises formed most of the respondents (142 firms, 56.8%), followed by small enterprises and medium enterprises (73 firms, 29.2%; and 35 firms, 14.0%, respectively). This observation is in alignment with the predominant trends for MSMEs in Indonesia.

All constructs show high means in Table 2. Out of the five-point Likert scales, entrepreneurial resilience has the highest mean of 4.22. This is followed by digital adoption at 4.21 and business sustainability at 4.18. These scores show that participants perceive their businesses as adaptive, digitally engaged, and capable of sustaining business operations over time.

Table 2. Descriptive statistics of latent variables

Variable	Mean
1 Digital Adoption	4.21
2 Supplier Diversification	4.08
3 Eco-Innovation	3.97
4 Ecosystem Collaboration	4.15
5 Entrepreneurial Resilience	4.22
6 Business Sustainability	4.18

Ecosystem collaboration has another high mean score of 4.15. This means that a considerable number of MSMEs work and collaborate with stakeholders

beyond their business. Supplier diversification has a mean of 4.08, which shows that a firm has several suppliers to mitigate reliance on a single supplier. Eco-innovation has a mean of 3.97 and the lowest score, which also means that it practices at least some environmentally conscious practices. MSMEs possess strong digital capabilities, collaborative networks, supply chain strategies, and resilient and sustainable business performance.

Measurement Model Evaluation

The measurement models were assessed for indicator reliability and convergent validity to remain within the parameters of standard practice for PLS-SEM (Hair *et al.*, 2022). Generally, indicator reliability is considered sufficient when the outer loading is greater than 0.70. A construct loading between 0.50 and 0.70 is acceptable provided the construct demonstrates sufficient composite reliability and an acceptable AVE.

As shown in Table 3 and Figure 2, the measurement models complied. Each construct had sufficient internal consistency (Cronbach's alpha, 0.901–0.961; composite reliability, 0.930–0.970). Convergent validity was established for all constructs, and the reliability AVE of the constructs was 0.732–0.913.

Most of the indicators had sufficient loading for the constructs, attaining the recommended minimum of 0.80. The only exception was the ecosystem collaboration construct, whose indicator EC2 had a loading of 0.553, which is considered a low loading. Regardless of the lower loading value, the construct still had the required reliability and AVE; thus, the indicator was retained, and the construct demonstrated good convergent validity. The HTMT ratios in Table 4 point to potential problems related to discriminant validity.

Table 3. Measurement model assessment (outer loadings, reliability, and convergent validity)

Construct	Indicator	Outer Loading	Cronbach's α	CR	AVE
Digital Adoption (DA)	DA1	0.837	0.914	0.936	0.745
	DA2	0.884			
	DA3	0.825			
	DA4	0.860			
	DA5	0.906			
Supplier Diversification (SD)	SD1	0.939	0.961	0.970	0.866
	SD2	0.944			
	SD3	0.953			
	SD4	0.938			
	SD5	0.877			
Eco-Innovation (EI)	EI1	0.903	0.930	0.950	0.826
	EI2	0.940			
	EI3	0.910			
	EI4	0.880			
Ecosystem Collaboration (EC)	EC1	0.866	0.901	0.930	0.732
	EC2	0.553			
	EC3	0.940			
	EC4	0.932			
	EC5	0.925			
Entrepreneurial Resilience (ER)	ER1	0.828	0.935	0.949	0.757
	ER2	0.890			
	ER3	0.807			
	ER4	0.849			
	ER5	0.915			
	ER6	0.924			
Business Sustainability (BS)	BS1	0.953	0.953	0.969	0.913
	BS2	0.967			
	BS3	0.947			

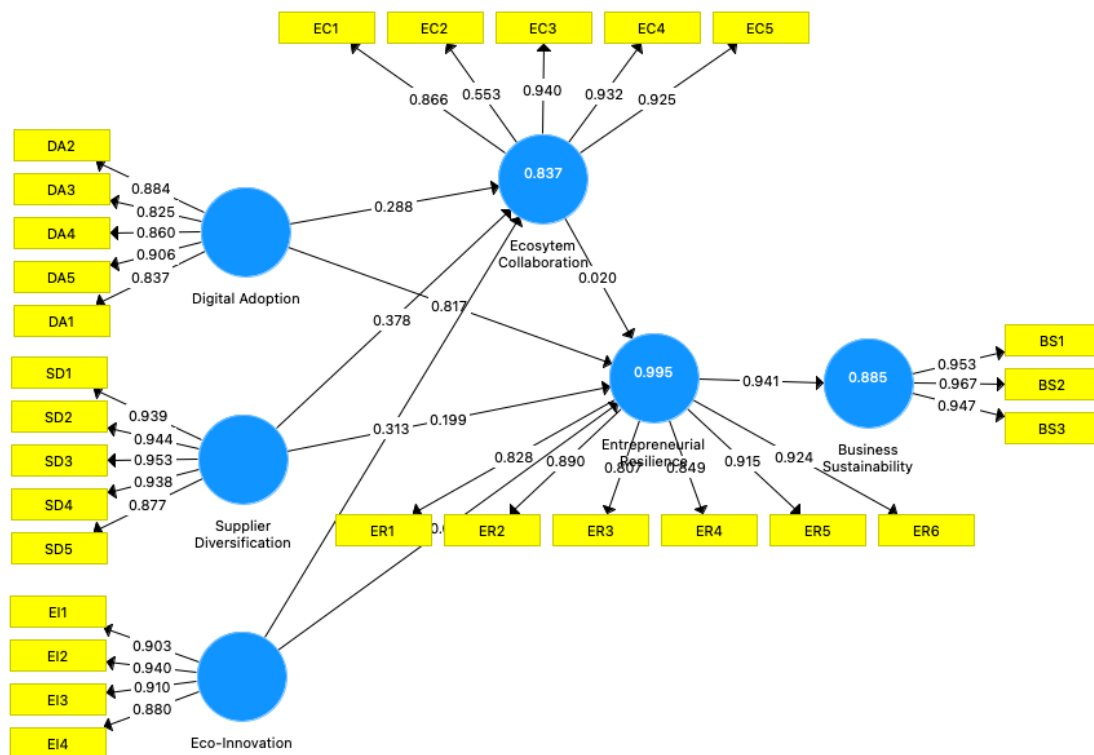


Figure 2. Outer model (measurement model)

Some construct pairs present extremely high values (≥ 0.90), and some even exceed 1.00 (e.g., Digital adoption–entrepreneurial resilience = 1.077; business sustainability–supplier diversification = 1.033; entrepreneurial resilience–supplier diversification = 1.003). These results suggest that some constructs may largely overlap. Therefore, the structural relationships should be interpreted with caution. High HTMT values could be the result of construct redundancy or extremely high similarity between the variables.

Structural Model Assessment and Hypothesis Testing

MSMEs in Indonesia show varying outcomes of the proposed adaptation strategies with respect to entrepreneurial resilience and business sustainability. Some strategic capabilities demonstrate strong direct effects. However, others appear to function more indirectly or only under certain circumstances, as shown by the structural model results in Table 5.

H1: Entrepreneurial Resilience and Digital Adoption

Table 5 illustrates that digital adoption correlates positively and significantly with entrepreneurial resilience ($\beta = 0.8169$, $t = 70.18$, $p < 0.001$, 95% BCa

CI [0.7936, 0.8388]). The exclusion of zero in the confidence interval indicates strong statistical evidence of the correlation. A very strong contribution to explained variance in entrepreneurial resilience is supported by the effect size ($f^2 = 16.660$). Therefore, H1 is valid. The digital technology literature confirms that MSMEs become more resilient when they employ digital technologies, such as improved information access, operational monitoring, and response capability to supply chain changes (Akmal and Arifa, 2023; Harymawan *et al.*, 2022; Ruminta *et al.*, 2018). Under supply chain disruptions and technology-embedded disruptions, digital solutions enhance firms’ anticipatory and responsive capacity to external shocks. The coefficient’s magnitude affirms the critical role of digital adoption in enhancing resilience within the framework.

H2: Supplier Diversification and Entrepreneurial Resilience

As shown in Table 5, supplier diversification has a positive and statistically significant relationship with entrepreneurial resilience ($\beta = 0.1987$, $t = 14.81$, $p < 0.001$, 95% BCa CI [0.1705, 0.2243], $f^2 = 0.878$). Therefore, because the confidence interval is entirely positive, we accept H2.

Table 4. Discriminant validity assessment (HTMT)

	BS	DA	EI	EC	ER	SD
BS	1.000	0.988	0.758	0.913	0.993	1.033
DA	0.988	1.000	0.789	0.948	1.077	0.995
EI	0.758	0.789	1.000	0.896	0.779	0.798
EC	0.913	0.948	0.896	1.000	0.945	0.932
ER	0.993	1.077	0.779	0.945	1.000	1.003
SD	1.033	0.995	0.798	0.932	1.003	1.000

Note: Digital adoption (DA), entrepreneurial resilience (ER), supplier diversification (SD), eco-innovation (EI), ecosystem collaboration (EC), and business sustainability (BS) are positively related.

Table 5. Structural model results and hypothesis testing (bootstrapping)

	Hypothesis	Beta (O)	t	p	95% BCa CI	f ²	Decision
H1	DA -> ER	0.8169	70.18	<0.001	[0.7936, 0.8388]	16.660	Supported
H2	SD -> ER	0.1987	14.81	<0.001	[0.1705, 0.2243]	0.878	Supported
H3	EI -> ER	-0.0345	3.92	<0.001	[-0.0505, -0.0162]	0.087	Not supported
H4a	DA -> EC	0.2875	3.57	<0.001	[0.1284, 0.4450]	0.062	Significant
H4b	SD -> EC	0.3781	4.12	<0.001	[0.2159, 0.5677]	0.099	Significant
H4c	EI -> EC	0.3126	8.00	<0.001	[0.2379, 0.3839]	0.254	Significant
H4d	EC -> ER	0.0202	1.79	0.074	[-0.0016, 0.0419]	0.014	Not significant
H5	ER -> BS	0.9406	78.69	<0.001	[0.9145, 0.9587]	7.669	Supported

Note: Digital adoption (DA), entrepreneurial resilience (ER), supplier diversification (SD), eco-innovation (EI), ecosystem collaboration (EC), and business sustainability (BS) are positively related.

This illustrates that the broader the supplier base, the lower the dependency risks, and the more sustained business operations can be (Oyeyemi *et al.*, 2023). The growing instability of the global supply chain, identified by Nugroho *et al.* (2025) and Shoffiyati and Kristianto (2025), clarifies the need for flexible sourcing in the supply chain. When MSMEs implement a multiple-supplier sourcing strategy, they reduce their vulnerability to supply interruptions. The demonstrated strength in the supply chain is crucial for determining supply chain resilience.

H3: Eco-Innovation and Entrepreneurial Resilience

In contrast, eco-innovation was significantly and negatively correlated with entrepreneurial resilience ($\beta = -0.0345$, $t = 3.92$, $p < 0.001$, 95% BCa CI $[-0.0505, -0.0162]$, $f^2 = 0.087$). Despite the significance of the coefficient, the opposing relationship rejects H3. This contradicts previous literature, which states that eco-innovation positively reinforces the sustainability and adaptive capacity of a business (Greeni and Burkhard, 2025; Yulistika *et al.*, 2023). A possible explanation is the operational and cost-related aspects of environmentally focused innovations. MSMEs that lack adequate financial and/or technological structures receive a high environmental burden, which leads to a temporary loss of financial and management capacity. Although the literature suggests that eco-innovation supports competitiveness and sustainability in the long run (Abidin, 2023; Ismayana *et al.*, 2022), the current findings contradict this by suggesting that eco-innovation has a negative short-term impact on the entrepreneurial resilience of eco-innovating firms.

H4: The Role of Mediating Ecosystem Collaboration

The analysis also incorporates ecosystem collaboration as a possible mediating factor. The data in Table 5 show that digital adoption ($\beta = 0.2875$, $p < 0.001$), supplier diversification ($\beta = 0.3781$, $p < 0.001$), and eco-innovation ($\beta = 0.3126$, $p < 0.001$) all show positive and significant associations with ecosystem collaboration. This can be interpreted as firms that adopt adaptive strategies also adopt a high degree of engagement in the business ecosystem and collaboration with institutions. This has also been observed in previous research focused on the role of integrated ecosystem collaborations in the development of MSMEs (Bagis *et al.*, 2024; Rizvi *et al.*, 2025;

Shulei, 2025). The relationship between ecosystem collaboration and entrepreneurial resilience was not significant ($\beta = 0.0202$, $t = 1.79$, $p = 0.074$, 95% BCa CI $[-0.0016, 0.0419]$, $f^2 = 0.014$). Since the confidence interval includes zero, collaboration is not seen as a predictor of resilience in the structural equation model.

H5: Entrepreneurial Resilience and Business Sustainability

Finally, entrepreneurial resilience was positively and strongly correlated with business sustainability ($\beta = 0.9406$, $t = 78.69$, $p < 0.001$, 95% BCa CI $[0.9145, 0.9587]$, $f^2 = 7.669$), as shown in Table 5. Given that the confidence interval is narrow and completely positive, this indicates a highly stable estimate. Thus, H5 is supported. This finding is consistent with conceptual frameworks asserting that resilience is a strategic resource that allows firms to persist in their operations under the uncertainties of a given period (Audretsch *et al.*, 2024; Donn and Moreno, 2021). Consequently, MSMEs that withstand shocks and thrive in the flux of the environment are likely to endure high levels of performance and remain in the industry for a long duration. Such strength suggests that resilience is the main factor that interlinks adaptive approaches and enduring business success outcomes.

Mediation Analysis

Table 6 summarizes the mediation results, offering additional explanations regarding the role of the market ecosystem in the structural model. The indirect effect of digital adoption on entrepreneurial resilience through market ecosystem collaboration is significant; however, the effect is quite small (VAF = 0.70%). A similar effect was noted for supplier diversification. The indirect effect was significant but small (VAF = 3.70%). In contrast, eco-innovation does not present a significant indirect effect because of the market ecosystem (eco-innovation's indirect effect). The confidence interval contained zero.

Digital adoption and supplier diversification indicate indirect relationships with eco-collaboration; however, the effect of mediation is not observed in eco-innovation. The VAF evidence, which is relatively modest, affirms the presence of direct relationships above any other; the will of digital adoption and supplier diversification will directly affect resilience, and not through the ecosystem market collaboration closure.

Table 6. Mediation test for H4 (specific indirect effects via ecosystem collaboration)

Predictor	Indirect Effect (a×b)	95% BCa CI (indirect)	Indirect sig.	Direct Effect (c')	Total Effect (c)	VAF
DA	0.0058	[0.0002, 0.0145]	Yes	0.8169	0.8227	0.70%
SD	0.0076	[0.0005, 0.0203]	Yes	0.1987	0.2064	3.70%
EI	0.0063	[-0.0005, 0.0141]	No	-0.0345	-0.0282	-22.39%

Note: Digital adoption (DA), entrepreneurial resilience (ER), supplier diversification (SD), eco-innovation (EI), ecosystem collaboration (EC), and business sustainability (BS) are positively related.

Adoption of the aforementioned indirectly, strategies from other actors. The external network contracts in there also do not indicate great collaboration to be the case, strengthening the market ecosystem in the model's resilience, above its other aspects.

Model Explanatory Power and Collinearity Diagnostics

The R² values in Table 7 demonstrate that the structural model explains a large proportion of the variance in the endogenous constructs. In particular, the R² values are 0.837 for ecosystem collaboration, 0.995 for entrepreneurial resilience, and 0.885 for business sustainability. This indicates that the predictors within the model explain a large portion of the variance in resilience and sustainability outcomes.

Table 7. Demonstrate structural model explains a large proportion of the variance in the endogenous constructs

Endogenous Construct	R ²	R ² Adjusted	Max Inner VIF
Business Sustainability	0.885	0.884	1.000
Ecosystem Collaboration	0.837	0.835	8.840
Entrepreneurial Resilience	0.995	0.995	9.716

However, the inner VIF values for the predictors of EC (maximum VIF = 8.840) and ER (maximum VIF = 9.716) indicate a significant amount of collinearity. Over the span of collinearity, there can be an increased amount of shared variance, which can negatively impact the predictability of individual path coefficients. Therefore, although the model has a large predictive capability, the R² values are somewhat limited because a portion of the model's predictive capability can result from closely associated adaptive capabilities.

Integrated Discussion of Findings

The relationships between digital adoption, supplier diversification, eco-innovation, ecosystem collaboration, entrepreneurial resilience, and business sustainability, as revealed by PLS-SEM, are shown in Figure 3 and describe the structural model. The results show that entrepreneurial resilience among Indonesian MSMEs is principally driven by internal adaptive capacities, particularly the ability to flexibly integrate digital supply. While ecosystem collaboration may facilitate greater involvement in resilience-constructing outer ecosystems, it is not the leading mechanism in this model. The negative and short-term relationship between eco-innovation and resilience may stem from the differences in readiness and resource adequacy that firms face when implementing sustainable practices. MSME resilience is shown from the results to be more associated with the development of internal capabilities as opposed to reliance on external networks.

Managerial Implications

The development of strong internal capabilities is the main focus of MSME resilience. Instead of reactive adjustments to supply constraints, climate change, and market changes, managers should strengthen operational systems. Integrated digital solutions can be used to improve financial control, procurement, customer engagement, and inventory control, and can support the operational integration of cloud-based accounting, QRIS, and other digital payment services, marketplaces, and inventory management analytics. However, operational integration of these solutions can improve integrated digital solutions; furthermore, their use can improve the digital literacy of the users; therefore, collaboration, training, and technological assistance are necessary.

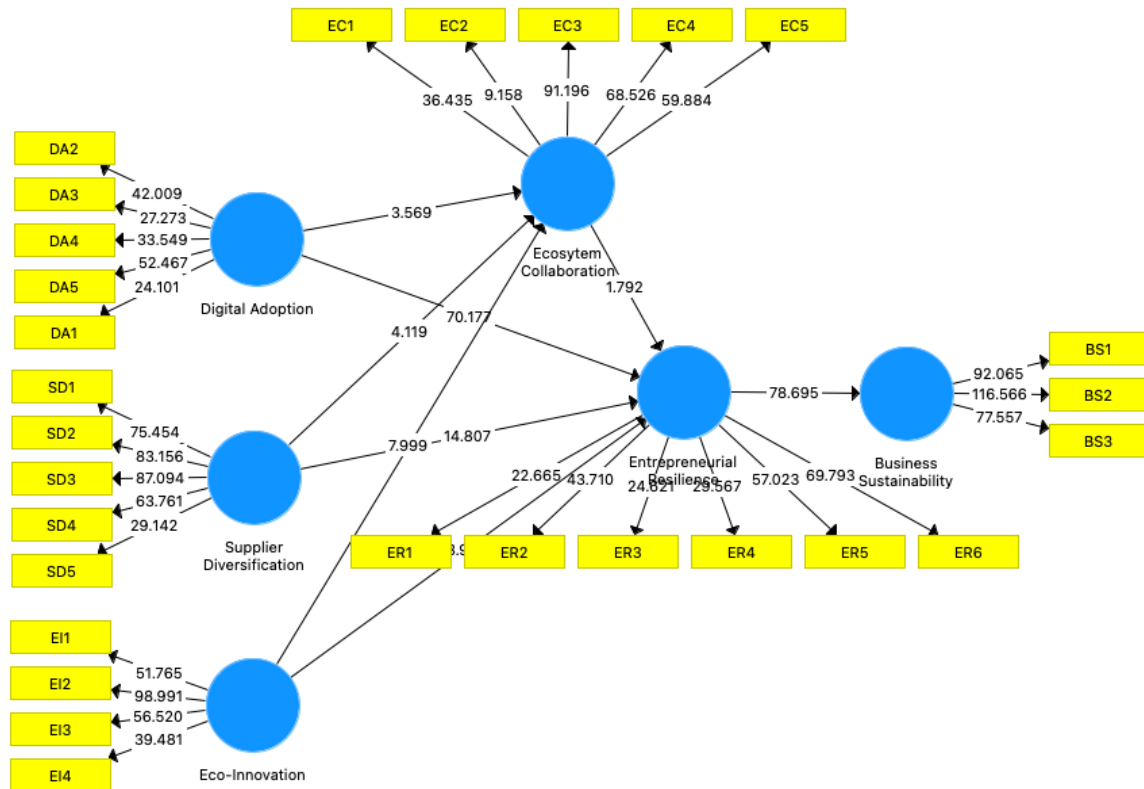


Figure 3. Structural model (PLS-SEM)

Based on the initial development of supply chain resilience, managers can identify the main supply inputs and diversify the suppliers' network. Moreover, gradual improvements in the environment, the establishment of a structured approach to risk control, and collaboration with external partners can improve MSMEs' stable conditional competitiveness.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study analyzed how digital adoption, supplier diversification, eco-innovation, entrepreneurial resilience, and sustainable business growth interrelate with Indonesian MSMEs, particularly the mediating role of ecosystem collaboration. The findings illustrate that digital adoption and supplier diversification significantly increase resilience, and that out of both, digital adoption is the most influential, indicating the importance of technological capacity to strengthen a firm's resilience and operational continuity during a disruption.

Despite the typical injuries of eco-innovation, the practiced operational adjustments that are required are temporary, and thus, for a period of time, firm resilience is perpetually strained. Based on the findings, it can be concluded that MSMEs possess

resilience internally and without partner collaborations. Entrepreneurial resilience once again proves to be a constant in moderating a firm's ability to stabilize, sustain, and compete. The findings support H1, H2, H5, partially support H4, and H3 is unsupported.

These are some of the limitations of the study. First, the VIF and HTMT showed high correlations, yet the structural model R^2 for entrepreneurial resilience was high. These conditions raise some questions about the stability of the path coefficients. Other model configurations and measurement refinements are suggested for future studies. Self-reported, cross-sectional data are subject to bias, including a lack of causality and cross-method bias, with repeated measures and different methods outlined to improve future studies. The authors suggest future studies on the economy to better understand the dynamics of entrepreneurial resilience. Finally, the study suggests further research on the economy to better understand the dynamics of entrepreneurial resilience.

Recommendations

Fostering an adaptive organizational culture increases an organization's adaptive culture. The

effective use of digital tools may require continual training, as integration will help with the use of these digital tools in core operations such as financial management, supply coordination, customer interaction, performance monitoring, and require training, as the effective use of these digital tools may require continual training. Proactive and pre-emptive inclusive contingency procurement options to minimize risk in case of disruptions

In conjunction with organizational capacity, eco-innovation can and should be implemented in a series of steps. Improvements to sustainability, such as in the management of waste, energy, and resources, will assist, without placing an excessive burden, in the short term. In line with the firm's internal capacity, external stakeholders should be saved, as the resistance behind policymakers should be preserved.

REFERENCES

- Abidin A. 2023. Faktor-faktor yang mempengaruhi pengembangan agroindustri kelapa berdasarkan principal component analysis. *Jurnal Teknologi Industri Pertanian*. 33(3):228–236. doi:10.24961/j.tek.ind.pert.2023.33.3.228.
- Akmal NH and Arifa C. 2023. Resiliensi bisnis pada usaha mikro kecil dan menengah dalam masa pandemi COVID-19 (studi kasus pada pengusaha batik di Daerah Istimewa Yogyakarta). *ABIS: Accounting and Business Information Systems Journal*. 11(1):1–34. doi:10.22146/abis.v11i1.82078.
- Akram MU, Islam N, Chauhan C, Yaqub MZ. 2024. Resilience and agility in sustainable supply chains: A relational and dynamic capabilities view. *Journal of Business Research*. 183:114855. doi:10.1016/j.jbusres.2024.114855.
- Andanu O, Setyowati EDP, and Idsan RS. 2025. Performance measurement and risk mitigation of pineapple supply chain in Central Kalimantan Province. *Jurnal Teknologi Industri Pertanian*. 35(1). doi:10.24961/j.tek.ind.pert.2025.35.1.76.
- Arifin MA, Zakaria M, and Bustaman HA. 2023. Digital adoption, self-efficacy, and business success: towards resilience and sustainability of micro-entrepreneurs in the post-pandemic world. *Cogent Business & Management*. 10(3). doi:10.1080/23311975.2023.2260128.
- Audretsch DB, Belitski M, Caiazza R, Drapeau MD, Menter M, Wales WJ. 2024. Resilience and digitally-advanced entrepreneurship. *Entrepreneurship & Regional Development*. 36(1–2):1–9.
- Bagis F, Faridli EM, Suyoto S, Awaludin A, Umairoh JPM. 2024. Invigorating survival and resilience of MSMEs: the role of entrepreneurial knowledge, motivation, and technological advancement. *Journal of Social Entrepreneurship Theory and Practice*. 3(2):28–43. doi:10.31098/jsetp.v3i2.2701.
- Canwat V. 2024. COVID-19-related supply chain disruptions: resilience and vulnerability of micro, small, and medium enterprises. *Cogent Business & Management*. 11(1). doi:10.1080/23311975.2024.2315691.
- Chamberlain J, Turpin B, and O'Callaghan K. 2021. Designing for collective intelligence and community resilience on social networks. *Human Computation*. 8(2):15–32. doi:10.15346/hc.v8i1.116.
- Chen Y and Guo C. 2025. Industrial diversification, entrepreneurship, and urban economic resilience. *Systems*. 13(5). doi:10.3390/systems13050366.
- Donn G and Moreno EL. 2021. The impact of entrepreneurial characteristics on the business resiliency of micro, small, and medium enterprises in the Philippines. *International Journal of Management Studies and Social Science Research*. 3(3):243–253.
- Filho WL. 2019. Handbook of Climate Change Resilience. Cham: Springer.
- Gölgeci I and Ponomarov SY. 2015. How does firm innovativeness enable supply chain resilience? The moderating role of supply uncertainty and interdependence. *Technology Analysis & Strategic Management*. 27(3):267–282. doi:10.1080/09537325.2014.971003.
- Greeni AM and Burkhard JS. 2025. Emerging trends in social entrepreneurship and sustainability: a Southeast Asia analysis. *Business Leadership Review*. doi:10.1108/BL-06-2024-0064.
- Hair JF, Hult GTM, Ringle CM, Sarstedt M. 2022. Partial Least Squares Structural Equation Modeling (PLS-SEM) using R. Cham: Springer.
- Harymawan I, Indahsari AT, and Putra FKG. 2022. Penguatan keberlanjutan UMKM Indonesia melalui sustainable finance lab. *Jurnal Layanan Masyarakat*. 6(2):421–438. doi:10.20473/jlm.v6i2.2022.421-438.
- He Z, Zhou Y, Wang J, Li C, Wang M, Li W. 2021. The impact of motivation, intention, and contextual factors on green purchasing behavior. *Business Strategy and the Environment*. 30(2):1249–1269. doi:10.1002/bse.2682.

- Hendrawan L and Krisnawati S. 2025. Generative AI strategies for building resilience in MSMEs. *Management Research and Business Journal*. 3(2):101-111.
- Hindarsah I, Fauzi TH, Fachrudin A, Ali S. 2025. The impact of green innovation on business sustainability: a case study of SMEs. *International Journal of Social Science Research*. 7.
- Ismayana A, Puspaningrum T, Putri MU, Indrasti NS. 2022. Kajian implementasi peluang produksi bersih pada industri kertas sack kraft PT X. *Jurnal Teknologi Industri Pertanian*. 32(1):74–83. doi:10.24961/j.tek.ind.pert.2022.32.1.74.
- Issa A, Khadem A, Alzubi A, Berberoğlu A. 2024. The path from green innovation to supply chain resilience. *Sustainability*. 16(9):3762. doi:10.3390/su160937762.
- Kashem MA, Shamsuddoha M, and Nasir T. 2024. Digital-era resilience: navigating logistics and supply chain operations after COVID-19. *Businesses*. 4(1):1–17. doi:10.3390/businesses4010001.
- Khumairo H, Hersiyah H, and Mashudi M. 2025. The role of MSMEs in driving economic growth and income equality in Indonesia. *Ekonomipedia*. 3(1):1–15. doi:10.55043/ekonomipedia.v3i1.274.
- Koberg E and Longoni A. 2019. A systematic review of sustainable supply chain management in global supply chains. *Journal of Cleaner Production*. 207:1084–1098. doi:10.1016/j.jclepro.2018.10.033.
- Kock N and Hadaya P. 2018. Minimum sample size estimation in PLS-SEM. *Information Systems Journal*. 28(1):227–261. doi:10.1111/isj.12131.
- Kurniadi A, Sudarmiatin S, and Wardana LW. 2024. The role of MSMEs in local economic improvement and labor absorption in Indonesia. *Nusantara Economics and Entrepreneurships Journals*. 333-341.
- Kurniawan AM and Iskandar Y. 2023. The effect of technology adaptation and government financial support on sustainable performance of MSMEs. *Cogent Business & Management*. 10(1). doi:10.1080/23311975.2023.2177400.
- Mohite R, Chourasiya R, Sharma S, Akre S. 2025. Enhancing the competitiveness of MSMEs through industrial engineering innovations. *International Journal of Engineering Management*. 9 (1):30–38. doi:10.11648/j.ijem.20250901.14.
- Nugroho A, Santosa B, and Khoa TM. 2025. The role of supply chain resilience in enhancing operational efficiency among manufacturing SMEs. *Journal of Economics and Management*. 3(2):34–41. doi:10.70716/ecoma.v3i2.234.
- Nursini N. 2020. Micro, small, and medium enterprises and poverty reduction. *Development Studies Research*. 7(1):153–166. doi:10.1080/21665095.2020.1823238.
- Oyeyemi OP, Anjorin KF, Ewim SE, Igwe AN, Sambulya NJ. 2023. Integrating digital marketing strategies for enhanced SME supply chain resilience. *Global Journal of Advanced Research and Reviews*. 1(2):60–70. doi:10.58175/gjarr.2023.1.2.0062.
- Panjaitan R. 2022. Towards resilient MSMEs: the role of organizational resilience and entrepreneurial resilience. *Jurnal Manajemen dan Keuangan*. 11(1):97–111. doi:10.33059/jmk.v11i1.5035.
- Priambudi R, Fauzi AM, and Muslich. 2025. Developing a quality standard for batik with natural dyes: a proposal to improve batik competitiveness. *Jurnal Teknologi Industri Pertanian*. 35(1):31–38. doi:10.24961/j.tek.ind.pert.2025.35.1.31.
- Putri AU, Mirani D, and Khairunnisyah T. 2023. Digital transformation for MSME resilience in the era of Society 5.0. Di dalam: *IAPA Proceedings Conference*. hlm 154. doi:10.30589/proceedings.2023.886.
- Qureshi NA and Ali SA. 2025. The impact of supplier diversification on supply chain resilience in the post-COVID era. *The Critical Review of Social Sciences Studies*. 3(3):2234–2242. doi:10.59075/gtef5x07.
- Ramezani J and Camarinha-Matos LM. 2019. A collaborative approach to resilient and antifragile business ecosystems. *Procedia Computer Science*. 162:604–613. doi:10.1016/j.procs.2019.12.029.
- Rizvi ASH, Ilyas A, Habib H, Jawad J, Shahzaib S. 2025. How proactiveness and entrepreneurial resilience drive business innovation. *Physical Education, Health and Social Sciences*. 3(3):299–310. doi:10.63163/jpehss.v3i3.593.
- Ruminta R, Handoko H, and Nurmala T. 2018. Indications of climate change and its impact on rice production in Indonesia. *Jurnal Agro*. 5 (1):48–60. doi:10.15575/1607.
- Saleh C, Mohamad S, Talipi N, Budiawan S. 2025. Measuring the impact of digital technology adoption on MSME operational efficiency.

- Amsir *Accounting & Finance Journal*. 3(1):27–34. doi:10.56341/aafj.v3i1.570.
- Sari Y, Oktarina Y, Munajat, Kenamon M. 2022. The role of innovation capability in MSME sustainability. *International Journal of Social Science and Business*. 6(4):502–511. doi:10.23887/ijssb.v6i4.46158.
- Seraj AHA, Fazal SA, and Alshebami AS. 2022. Entrepreneurial competency, financial literacy, and sustainable performance: the mediating role of entrepreneurial resilience. *Sustainability*. 14(17):10689. doi:10.3390/su141710689.
- Setiadi S and Maulana R. 2025. The role of collaboration in overcoming MSME challenges. *International Journal of Social Science Research*. 7.
- Shah S, Chen S, and Ganji EN. 2024. Impact of digitalisation on manufacturing supply chains. *Engineering World*. 6:61–89. doi:10.37394/232025.2024.6.8.
- Shmueli G, Sarstedt M, Hair JF, Cheah JH, Ting H, Vaithilingam S, Ringle CM. 2019. Predictive model assessment in PLS-SEM. *European Journal of Marketing*. 53(11):2322–2347. doi:10.1108/EJM-02-2019-0189.
- Shoffiyati P and Kristianto FP. 2025. Furniture industry green supply chain success factors: a systematic literature review. *Jurnal Teknologi Industri Pertanian*. 35(1). doi:10.24961/j.tek.ind.pert.2025.35.1.95.
- Shulei Y. 2025. Research on the impact of entrepreneurial orientation on organizational resilience. *The EURASEANs: Journal on Global Socio-Economic Dynamics*. 2(51):113–124. doi:10.35678/2539-5645.2(51).2025.113-124.
- Sinulingga P, Machfud, and Susilawati D. 2025. Supply chain performance and risk analysis of Sidikalang Arabica coffee. *Jurnal Teknologi Industri Pertanian*. 35(3): 229–243. doi:10.24961/j.tek.ind.pert.2025.35.3.229.
- Siswanto RA and Dolah JB. 2023. Identity dynamics and recognisability in Indonesian SMEs. *WSEAS Transactions on Business and Economics*. 20:373–381. doi:10.37394/23207.2023.20.34.
- Skouloudis A, Tsalis T, Nikolaou I, Evangelinos K, Leal Filho W. 2020. SMEs, organizational resilience capacity and flash floods. *Sustainability*. 12(18):7437. doi:10.3390/su12187437.
- Srinivasan K, Kamruddin S, Mallika VV, Nalluri V, Chang JR, KS VK, Sinha P. 2025. Digitizing the chain: effects of supply chain digitalization on efficiency in Indian manufacturing SMEs. *Asian Journal of Interdisciplinary Research*. 8(3):141–160.
- Srivastava SK. 2007. Green supply-chain management: a state-of-the-art review. *International Journal of Management Reviews*. 9(1):53–80. doi:10.1111/j.1468-2370.2007.00202.x.
- Susilawati M. 2024. Entrepreneurial resilience: strategies for MSMEs to navigate uncertainties and challenges in contemporary markets. *International Journal of Business, Law, and Education*. 5(2):1687–1695. doi:10.56442/ijble.v5i2.661.
- Tedjaningtyas A. 2025. Penguatan economic resilience sebagai upaya adaptif masyarakat Indonesia dalam menghadapi perlambatan ekonomi 2025. *Journal of Comprehensive Science (JCS)*. 4(8). doi:10.59188/jcs.v4i8.3487.
- Umami I, Pee ANBC, Sulaiman HAB, Hariyanto, Mar’ati FS. 2023. MSME success factors: technology acceptance, financial access, and strategic cooperation. *Multidisciplinary Reviews*. 6.
- Wahyuni NM and Sara IM. 2020. Entrepreneurial orientation and business performance in SMEs. *Journal of Workplace Learning*. 32(1):35–62. doi:10.1108/JWL-03-2019-0033.
- Wendji CM and Pilag Kakeu CB. 2022. External knowledge and SME innovation capacity. *African Journal of Science, Technology, Innovation and Development*. 14(6):1655–1666. doi:10.1080/20421338.2021.1979170.
- Winarsih S. 2025. Pengalaman wirausaha UMKM dalam menghadapi ketidakpastian ekonomi. *RIGGS: Journal of Artificial Intelligence and Digital Business*. 4(3):3000–3005. doi:10.31004/riggs.v4i3.2425.