

Resilient MSMEs in the digital era: managing environmental uncertainty through dynamic capabilities

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Abstract

Business resilience is crucial for MSMEs to face post-pandemic challenges such as regulatory changes and economic fluctuations. Dynamic capabilities and digital transformation enable adaptation and innovation, enhancing competitiveness and sustainability, although there is still a lack of in-depth research on this relationship. This study aims to analyse the influence of environmental uncertainty on business resilience and MSME performance with dynamic capabilities and digital transformation as mediators, as well as business age as a moderating variable. This study uses primary data distributed through questionnaires with purposive sampling to 210 respondents who are MSMEs in Indonesia. Data analysis was conducted using SEM-PLS. The results of the analysis show that environmental uncertainty significantly affects dynamic capabilities, digital transformation, and business resilience, with positive coefficients for all three and a p-value below 0.05. Dynamic capabilities also have a positive impact on digital transformation and business resilience. However, dynamic capabilities do not have a significant effect on MSME performance. Both digital transformation and business resilience have a positive effect on MSME performance. In addition, dynamic capabilities moderate the influence of environmental uncertainty on digital transformation, while uncertainty through dynamic capabilities and digital transformation has a positive impact on business resilience and MSME performance. Business age does not moderate the influence of dynamic capabilities on business resilience.

Keywords:

business resilience; digital transformation; dynamic capabilities; environmental uncertainty; msme performance.

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Introduction

Small and medium-sized enterprises (SMEs) are known for their ability to create jobs. They're often more adaptable when it comes to hiring local staff and contributing to their local economies. Nevertheless, SMEs frequently encounter challenges due to the unpredictable nature of the business world. Economic ups and downs, changing laws, and fierce competition are just some of the obstacles they face (Hadi, 2022; Hamid, 2017; Rwigema, 2020). To overcome this uncertainty, SMEs need to build strong dynamic capabilities, enabling them to adapt quickly to changing environments (Ferreira et al., 2020; Yan et al., 2022).

Research on SME resilience is of paramount importance, given that SMEs form the backbone of developing economies (Prakash et al., 2021). Understanding the factors influencing the resilience level of SMEs helps in designing effective policy strategies to support business growth and sustainability. Resilience analysis provides deep insights into SMEs' responses to business environmental uncertainty and crises, which is essential for building a solid foundation for local and global economic development (Lenasari et al., 2024; Sofyan, 2021). Moreover, MSMEs contribute approximately 60.5% to the national GDP and absorb around 123 thousand workers in Indonesia (Kementerian Keuangan, 2023). If MSMEs fail to maintain resilience in the face of dynamic changes, both the national GDP and employment absorption in Indonesia may become increasingly vulnerable.

Dynamic capabilities, measured through sensing (detecting opportunities and risks), seizing (capitalising on opportunities), and reconfiguring (adjusting resources), significantly influence the resilience of MSMEs. Sensing helps MSMEs detect environmental changes, enabling them to respond swiftly. For example, when MSMEs recognise changes in consumer preferences towards healthy food, their sensing capability is reflected in the introduction of healthier product offerings. Seizing allows them to take advantage of new market opportunities or adjust their business models accordingly (Prabowo et al., 2021). Reconfiguring enables MSMEs to flexibly adjust their resources and operational processes, supporting their ability to withstand challenges and crises, and ultimately enhancing their resilience amidst business uncertainties (Peñarroya-Farell & Miralles, 2022). Reconfiguring can be carried out by managing capital in such a way that service quality is maintained, even in the face of rising prices (Peñarroya-Farell & Miralles, 2022).

While dynamic capabilities play a crucial role in business resilience, there is a need to further understand other factors influencing resilience, especially given the advancements in information technology (Khurana et al., 2022). Through technology integration, SMEs can bolster their resilience, enabling them to navigate external challenges and build a more robust business foundation in the face of an uncertain business landscape (Klein & Todesco, 2021).

Businesses with high resilience levels are better equipped to withstand external pressures, crises, and market changes. The ability to recover and adapt

enables companies to maintain operational continuity and minimise losses. Consequently, business resilience has a positive impact on business performance (Van Hoyweghen et al., 2021), creating a stable foundation and providing resistance to uncertainty, which in turn increases the opportunities for long-term growth (Margiutomo et al., 2022).

This research offers a novel approach by exploring a specific resilience model for SMEs, focusing on their sensitivity to business environment uncertainty and elaborating on digital transformation strategies. Furthermore, this research pioneers a conceptual framework that integrates key aspects of business resilience, dynamic capabilities, and digital transformation relevant to SMEs. This holistic approach is expected to provide in-depth insights into how SMEs can build operational resilience and enhance their competitiveness through the integration of dynamic capabilities and the implementation of appropriate digital transformation strategies. In addition, the uniqueness offered lies in the use of an operational approach derived from measurement dimensions specifically designed to capture the unique realities and operational context of MSMEs in Indonesia, such as reliance on local supply chains, technological adaptation for access to financing, and digital marketing. Consequently, this research is expected to make a significant contribution to the development of relevant and sustainable resilience strategies for MSMEs in Indonesia.

Literature review

Business environment uncertainty, dynamic capability, digital transformation, business resilience, and MSMEs performance

When the business environment becomes uncertain due to technological changes, market fluctuations, regulatory shifts, or supply chain disruptions, companies face the need to develop adaptive capabilities that enable them to respond quickly and effectively to these changes (Bouloiz, 2020; Rai et al., 2021). Theoretically, such external environmental pressures create a resource imbalance, namely a gap between the resources possessed by the firm and the new demands imposed by its environment (Sharma & Rautela, 2022). Dynamic capabilities, which involve the processes of identifying opportunities, allocating resources, and recalibrating strategies, serve as a critical element in helping companies survive and thrive under dynamic environmental pressures (Permana & Ellitan, 2020; Rwigema, 2020). From the perspective of the Resource-Based View (RBV), these dynamic capabilities are regarded as strategic resources that are difficult to imitate, enabling firms to reconfigure their bundles of resources in response to external changes (Barney, 1991; Teece, 2017). Furthermore, the RBV emphasises that sustainable competitive advantage under conditions of uncertainty relies heavily on a firm's ability to build, integrate, and leverage valuable and rare resources and capabilities. Previous studies also emphasise that high levels of uncertainty drive companies to continuously enhance their dynamic capabilities as a crucial

mechanism for maintaining market relevance, managing risks, and strengthening long-term competitiveness (Sharma & Rautela, 2022). On the regulatory side, supportive government policy frameworks, such as tax incentives, simplified licensing, and technology assistance programs, are determining factors that can accelerate the adoption of dynamic capabilities by MSMEs (Cunningham et al., 2023; Sudarmanto et al., 2023). Thus, this study proposes the following hypothesis.
H1: Business environment uncertainty influences dynamic capability.

To address the challenges posed by market fluctuations, regulatory shifts, and technological disruptions in the business environment, companies must embrace digital technology as a strategic tool to improve efficiency, drive innovation, and maintain competitiveness (Bouloiz, 2020; Rai et al., 2021). From the perspective of the Resource-Based View (RBV), digital technology is considered a strategic resource that is both valuable and rare, which can be reconfigured to create superior capabilities in responding to environmental changes (Barney, 1991; Teece, 2017). Uncertainty often compels businesses to accelerate the adoption of technologies such as cloud computing, big data analytics, and digital platforms to strengthen their predictive and responsive capabilities in addressing market changes (Permana & Ellitan, 2020). RBV further emphasises that under conditions of uncertainty, firms that successfully integrate digital technology into their resource bundles will develop capabilities that are inimitable and non-substitutable, thereby establishing a sustainable competitive advantage (Bharadwaj, 2000). Previous studies have explained that digital transformation enables firms to optimise their supply chains, expand their customer base, and develop more flexible business models in the face of unpredictable external pressures (Mukherjee, 2018; Sunardi et al., 2022). Research indicates that environmental uncertainty drives businesses not only to undergo digital transformation but also to build digital capabilities as a foundation for sustainability and innovation in the future (Rwigema, 2020). Thus, this study proposes the following hypothesis.

H2: Business environment uncertainty influences digital transformation.

A company's ability to identify opportunities, mobilise resources, and quickly adapt strategies in response to environmental changes serves as a crucial foundation for digital transformation (Rwigema, 2020). Within the RBV framework, these dynamic capabilities are considered intangible strategic resources and function as higher-order capabilities that enable firms to reconfigure their digital resource portfolios (Barney, 1991; Teece, 2017). Dynamic capabilities enable organisations to integrate new technologies, adapt business processes, and develop more flexible operational models to meet evolving market demands (Permana & Ellitan, 2020; Rai et al., 2021). Previous studies have highlighted that dynamic capabilities assist firms in overcoming internal barriers, such as resistance to change, by synergistically managing human resources, technology, and organisational

structures to facilitate and sustain digital transformation (Mukherjee, 2018). Research further highlights that companies with robust dynamic capabilities are better positioned to leverage digital technologies for innovation, operational efficiency, and competitive advantage in addressing increasingly complex business environments (Bouloiz, 2020; Sharma & Rautela, 2022). Based on this, the following hypothesis is proposed. Thus, this study proposes the following hypothesis

H3: Dynamic capability influences digital transformation.

Dynamic capabilities play a significant role in enhancing business resilience, which refers to an organisation's capacity to adapt, recover, and sustain operations amidst disruptions or external pressures (Bouloiz, 2020). From the Resource-Based View (RBV) perspective, dynamic capabilities serve as higher-order capabilities that enable firms to reconfigure their resource portfolios (resource bundling) in order to create resilience that is difficult for competitors to imitate (Teece, 2018; Barney, 1991). These capabilities enable businesses to detect changes in their environment, allocate resources efficiently, and formulate adaptive strategies to effectively navigate complex challenges (Rwigema, 2020). Specifically, sensing capabilities help organisations identify potential risks and disruptions at an early stage, while seizing and reconfiguring capabilities enable rapid responses and the reorientation of resources to sustain operational continuity (Rwigema, 2020). Previous studies have explained that by leveraging dynamic capabilities, firms can enhance operational flexibility, strengthen their capacity to recover from crises, and foster innovations that align with shifting market demands (Permana & Ellitan, 2020). Studies reveal that organisations equipped with strong dynamic capabilities are better positioned to mitigate risks, capitalise on emerging opportunities, and establish sustainable competitive advantages, underscoring the critical role of business resilience in navigating uncertain environments (Mukherjee, 2018; Rai et al., 2021). Accordingly, this study proposes the following hypothesis.

H4: Dynamic capability influences business resilience.

Dynamic capabilities enable MSMEs to adapt to changes in the business environment, identify new market opportunities, and develop innovative strategies that drive business growth (Rwigema, 2020). Based on the Resource-Based View (RBV) perspective, dynamic capabilities function as higher-order capabilities that enable MSMEs to optimise the utilisation of limited resources (resource orchestration) in order to create competitive value and drive superior performance (Teece, 2017). These capabilities allow MSMEs to respond more effectively to consumer needs, enhance the appeal of their products or services, and expand their customer base, ultimately contributing to increased revenue (Permana & Ellitan, 2020). Specifically, sensing capabilities help MSMEs detect market trends and consumer preferences, while seizing capabilities enable them to allocate their

limited resources to the most strategic initiatives, and reconfiguring facilitates the agile adaptation of business models (Yudistira et al., 2022). Previous studies have explained that the ability to efficiently manage resources supports the development of business capital, either through internal investment or by enhancing access to external funding sources (Mukherjee, 2018; Bouloiz, 2020). Improved operational efficiency and innovation also empower MSMEs to scale their businesses, create new job opportunities, and sustainably increase their workforce (Sharma & Rautela, 2022). Therefore, dynamic capabilities serve as a critical factor in fostering the sustainability and growth of MSME performance amid the challenges of a dynamic business environment. Based on this, the following hypothesis is proposed.

H5: Dynamic capability influences MSMEs' performance.

Digital transformation has a significant impact on business resilience, which refers to an organisation's ability to adapt, recover, and sustain operations amid disruptions or environmental pressures. Digital transformation has a significant impact on business resilience, which refers to an organisation's ability to adapt, recover, and sustain operations amidst disruptions or environmental pressures. By adopting digital transformation, organisations can integrate technologies such as big data, artificial intelligence, cloud computing, and digital platforms to enhance operational flexibility, enable data-driven decision-making, and accelerate responses to market changes (Rai et al., 2021; Permana & Ellitan, 2020). From the perspective of the Resource-Based View (RBV), digital technology functions as a strategic resource that is not only valuable and rare but also, when properly configured, inimitable and non-substitutable, thereby forming the foundation for sustainable resilience (Bharadwaj, 2000; Teece, 2017). Previous studies have explained that the adoption of digital technologies enhances supply chain visibility and efficiency, broadens access to global markets, and mitigates operational risks, thereby strengthening resilience against external challenges such as economic fluctuations and market disruptions (Bouloiz, 2020). Moreover, digital transformation empowers businesses to create more adaptive business models, seize new opportunities, and ensure sustainability even amid high uncertainty (Mukherjee, 2018). Research shows that companies successfully implementing digital transformation tend to exhibit greater resilience by mitigating the negative impacts of disruptions while leveraging technology to drive innovation and efficiency (Sharma & Rautela, 2022). Based on this, the following hypothesis is proposed.

H6: Digital transformation influences business resilience.

Digital transformation, measured through the utilisation of financial technology, digital marketing, digital payments, and digital sales, ultimately impacts MSMEs' performance. Within the Resource-Based View (RBV) framework, digital technology is regarded as a strategic resource that is not only

valuable and rare but also, when effectively managed and configured, becomes inimitable and non-substitutable. With these characteristics, digital technology can serve as a foundation for building sustainable resilience (Bharadwaj, 2000; Teece, 2017). By leveraging financial technology, MSMEs can gain easier and faster access to funding sources, enhancing business capital and financial flexibility (Sunardi et al., 2022). Previous studies have explained that digital marketing enables MSMEs to reach broader markets, both locally and internationally, while expanding their customer base through data- and technology-driven marketing strategies (Permana & Ellitan, 2020; Mukherjee, 2018). Meanwhile, the adoption of digital payment systems improves transaction efficiency, reduces operational costs, and provides a seamless experience for customers, fostering consumer loyalty (Bouloiz, 2020; Rai et al., 2021). Digital sales, facilitated through e-commerce platforms, offer MSMEs opportunities to boost revenue by leveraging technology to sell their products or services globally (Sharma & Rautela, 2022). Therefore, digital transformation serves as a critical driver in accelerating MSMEs' growth and enhancing business performance sustainably in the digital era. Based on this, the following hypothesis is proposed.

H7: Digital transformation influences MSMEs' performance.

Business environment uncertainty significantly impacts business resilience, defined as an organisation's ability to adapt, endure, and recover from external disruptions while maintaining sustainable performance. From the Resource-Based View (RBV) perspective, environmental uncertainty creates selective pressures that compel firms to reconfigure their resources in order to build resilience capabilities that are inimitable and strategically valuable (Barney, 1991; Teece, 2017). Uncertainty arising from economic fluctuations, regulatory changes, technological disruptions, and intense competition drives companies to develop flexible and responsive strategies to navigate various challenges. In such circumstances, businesses that successfully enhance their resilience are more effective at managing risks, maintaining operational stability, and leveraging opportunities that emerge amidst uncertainty (Bouloiz, 2020; Rai et al., 2021). Furthermore, business environment uncertainty compels organisations to strengthen data-driven decision-making processes and optimise resources to sustain competitiveness (Ellitan, 2020). RBV highlights resilience capabilities as a strategic source of competitive advantage since they fulfil the VRIO requirements of being valuable, rare, difficult to imitate, and properly organised, which strengthen a firm's ability to endure market turbulence (Barney, 1991). Penelitian terdahulu suggests that higher levels of business resilience enable organisations to remain relevant in the market, mitigate the negative impacts of external pressures, and build a solid foundation for sustainable growth, even in unstable business environments (Sharma & Rautela, 2022). Based on this, the following hypothesis is proposed.

H8: Business environment uncertainty influences business resilience.

The length of business operation reflects the cumulative experience of MSMEs in navigating various challenges in the business environment, such as market changes, economic fluctuations, and technological disruptions (Sharma & Rautela, 2022). MSMEs with longer operational experience tend to have broader networks, better market dynamics understanding, and more mature managerial capabilities, enabling them to leverage dynamic capabilities more effectively to adapt to business environment uncertainty (Mukherjee, 2018). Conversely, MSMEs with shorter operational histories may face limitations in utilising their dynamic capabilities optimally due to a lack of experience or resources ((Bouloiz, 2020; Rai et al., 2021). Therefore, the length of business operation not only strengthens the relationship between dynamic capabilities and resilience against environmental uncertainty but also serves as a critical factor in determining how effectively MSMEs can manage risks and capitalise on opportunities in a dynamic business environment (Permana & Ellitan, 2020).

H9: The length of business operation moderates the influence of dynamic capability on business resilience.

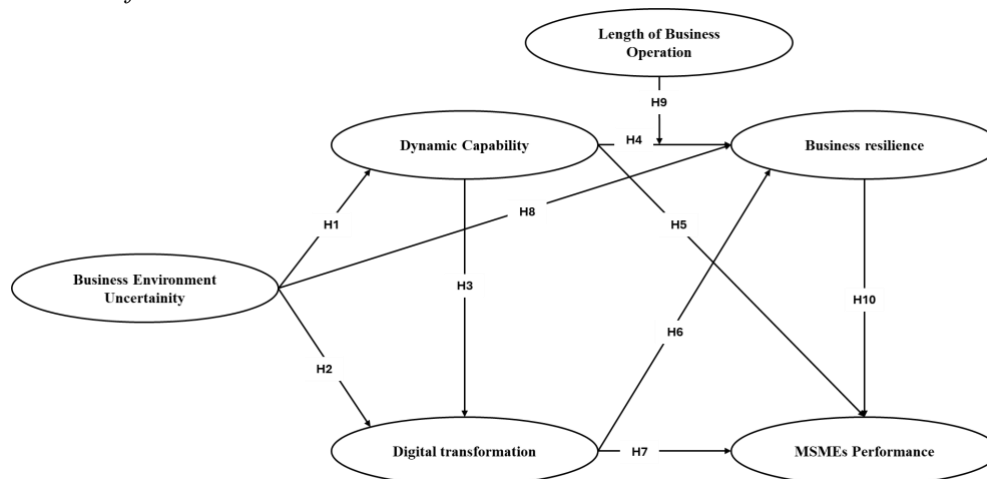
Resilient MSMEs possess the ability to adapt to disruptions, recover quickly from crises, and maintain operational stability, even in uncertain environments. Based on the Resource-Based View (RBV) perspective, this business resilience is the result of a unique resource configuration that meets the VRIO criteria (Valuable, Rare, Inimitable, Organized), thus becoming a source of sustainable competitive advantage (Barney, 1991). This adaptability enables MSMEs to respond effectively to market changes, maintain customer trust, and drive revenue growth (Rai et al., 2021). More specifically, operational resilience, which is developed through adaptive capabilities, enables MSMEs to sustain supply chain and service continuity throughout a crisis. This capability has a direct effect on both customer retention and revenue stability (Ortiz-de-Mandojana & Bansal, 2016). Additionally, a strong resilience framework helps MSMEs secure and optimise their resources, ensuring financial stability and supporting the growth of business capital (Bouloiz, 2020). Resilient businesses also enhance operational efficiency and foster innovation, which attracts more customers and promotes business expansion (Mukherjee, 2018; Permana & Ellilitan, 2020). The ability to withstand and adapt to external pressures further allows MSMEs to increase their workforce by scaling operations. Research highlights that business resilience is a critical determinant of long-term sustainability and improved MSME performance in dynamic market conditions (Sharma & Rautela, 2022). Based on this, the following hypothesis is proposed.

H10: Business resilience influences MSMEs' performance.

The research framework presented in Figure 1 illustrates the relationships among business environment uncertainty, dynamic capability, digital

transformation, business resilience, MSMEs performance, and the moderating role of the length of business operation. The model hypothesises that business environment uncertainty directly affects dynamic capability (H1), digital transformation (H2), and business resilience (H8). Dynamic capability is proposed to have a direct influence on digital transformation (H3), business resilience (H4), and MSMEs' performance (H5). Similarly, digital transformation is hypothesised to impact both business resilience (H6) and MSMEs' performance (H7). Business resilience is further hypothesised to directly contribute to MSMEs' performance (H10). Additionally, the framework suggests that the length of business operation moderates the relationship between dynamic capability and business resilience (H9), emphasising the role of accumulated experience in enhancing adaptability under uncertain conditions. This framework outlines the interconnected pathways through which these variables shape MSMEs' performance.

Figure 1.
Research framework



Source: Authors' work (2025)

Research method

This research employs an explanatory approach through an online survey to gather data and evaluate the proposed hypotheses. The survey instrument is structured to collect information on six research variables. The measurement items are adapted from prior studies and adjusted slightly to align with the context of this study.

Business environment uncertainty is measured using five dimensions, namely consumer preferences such as consumers' tastes that are constantly changing, financial uncertainty (Income and capital flow uncertainty), supply uncertainty, technological changes, and competition, adapted from Bouloiz (2020), Rai et al. (2021), Atanassova & Bednar (2022), Permana & Ellitan (2020), and Klein & Todesco (2021). Dynamic capability is measured using three dimensions, namely sensing, seizing, and reconfiguring, referring to Bouloiz (2020), Rai et al. (2021),

Permana & Ellitan (2020) and Rwigema (2020). Digital transformation is measured using four dimensions, namely financial technology, digital marketing, digital payment, and digital sales, adapted from several previous studies such as Sunardi et al. (2022), and Permana & Ellitan (2020). Business resilience is measured using six dimensions, namely agility, redundancy, flexibility, visibility, robustness, and awareness, adapted from several journals such as Gligor et al. (2019), Pettit et al. (2010), Putritamara et al. (2023), and Jain et al. (2017). MSME performance is measured using four dimensions, namely the increase in revenue, number of customers, capital, and number of employees, adopted from Ratnawati (2020), Subagyo et al. (2020), Winarsih et al. (2021). This study uses a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) to measure respondents' responses.

The sampling technique used in this study is purposive sampling. The respondents were selected based on the following criteria, which were established to ensure the participants have the relevant experience and knowledge to provide meaningful data for this study: 1) respondents are MSMEs that actively use social media; 2) respondents are MSME actors in Indonesia; 3) respondents are at least 17 years old; and 4) respondents are managers of legally established MSMEs that have been operating for a minimum of 10 years. The sample size is determined by multiplying the number of indicators by 5 to 10. The minimum sample size for this research is set at the total number of variable indicators used multiplied by 10 (21 indicators $\times$ 10 = 210) (Hair et al. 2021), resulting in a total of 210 respondents. The type of data used in this study is quantitative data obtained from questionnaire results. The variables used in this research include exogenous variables (X), namely: business environment uncertainty (uncertainty is the feeling of an individual's inability to accurately predict outcomes, measured through changes in consumer preferences, financial uncertainty, uncertainty in raw material supply, technological changes, and competition).

Data analysis

The data processing method in this study employs Structural Equation Modelling (SEM) equations. SEM modelling is a further development of path analysis, allowing for a more comprehensive determination of the causal relationships between exogenous and endogenous variables (Westland, J. C, 2019). This research adopts a quantitative analysis approach utilising Partial Least Squares (PLS). PLS is a powerful analytical method as it does not rely on many assumptions. The steps include evaluating the measurement model (outer model), which consists of convergent validity, discriminant validity, and composite reliability. Following that, an evaluation of the structural model (inner model) is conducted, which includes R-squared, Q² Predictive Relevance, quality index, hypothesis testing, and moderating effect testing to achieve the research objectives.

Results

Descriptive characteristics of respondents

In this analysis, respondent characteristics are shown in Table 1. The respondents' data in this study are required to understand their background, which can serve as input to explain the results obtained from the research. The following is the summary of respondent characteristics:

Table 1.

Recapitulation of respondent characteristics

	Characteristic	Frequency	Percentage
Age	17-20 years	53	25.24%
	21-25 years	74	35.24%
	26-30 years	16	7.62%
	31-35 years	28	13.33%
	36-40 years	21	10.00%
	41-45 years	4	1.90%
	46-50 years	9	4.29%
	>50 years	5	2.38%
Business duration	10-15 years	92	43.81%
	>15-20 years	53	25.24%
	>20-25 years	54	25.71%
	>25 years	11	5.24%
Gender	Male	81	38.57%
	Female	129	61.43%
Type of business	Fashion	62	29.52%
	Beauty	19	9.05%
	Handicraft	22	10.48%
	Culinary	48	22.86%
	Printing	22	10.48%
	Trade	10	4.76%
	Agriculture	18	8.57%
	Farm	9	4.29%
Initial capital	IDR 1 million – 10 million	71	33.81%
	> IDR 10 million – 20 million	71	33.81%
	> IDR 20 million – 30 million	27	12.86%
	> IDR 30 million – 40 million	15	7.14%
	> IDR 40 million – 50 million	17	8.10%
	> IDR 50 million – 100 million	5	2.38%
	> IDR 100 million	4	1.90%
	< IDR 10 million	107	50.95%
Monthly sales revenue	IDR 10 million – 20 million	56	26.67%
	IDR 20 million – 30 million	19	9.05%
	IDR 30 million – 40 million	8	3.81%
	> IDR 40 million	20	9.52%
Education level	Did not complete elementary school	14	6.67%
	Elementary school/equivalent	14	6.67%
	Junior high school/equivalent	13	6.19%
	Senior high school/equivalent	116	55.24%
	Diploma (d3)	5	2.38%
	Bachelor's degree (s1)	42	20.00%
	Master's degree (s2)	6	2.86%

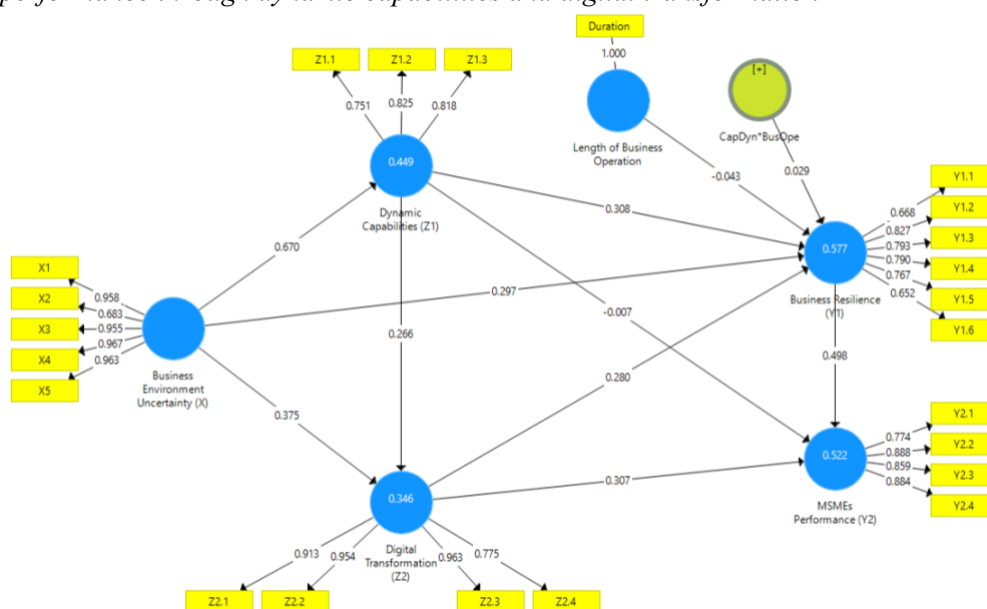
Source: Authors' work (2025)

Based on the computed characteristics of the respondents' data, several demographic and business-related profiles can be identified. In terms of age, most

respondents were between 21 and 25 years (35.24%), followed by those aged 17–20 years (25.24%). Regarding business experience, the largest group had operated their businesses for 10–15 years (43.81%). In terms of gender, female respondents accounted for a larger proportion (61.43%) compared to male respondents (38.57%). With respect to business type, fashion-related businesses were the most common (29.52%), while livestock accounted for the smallest share (4.29%). In terms of initial capital, two groups dominated: IDR 1–10 million and >IDR 10–20 million, each representing 33.81%. Monthly turnover was mostly below IDR 10 million (50.95%). Finally, in terms of educational background, the majority had completed senior high school (55.24%), followed by those holding a bachelor's degree (20.00%).

Figure 2.

The MSMEs resilience model in facing business environment uncertainty to improve performance through dynamic capabilities and digital transformation



Source: Authors' work (2025)

Figure 2 shows the model in facing business environment uncertainty to improve performance through dynamic capabilities and digital transformation. Having established the SME resilience model, the outer model was subjected to rigorous evaluation. The assessment of convergent validity through factor loadings, AVE, and composite reliability revealed satisfactory results. All factor loadings exceeded the recommended threshold of 0.6, and AVE values were greater than 0.5 (Ghozali & Kusumadewi, 2023), confirming the convergent validity of the constructs. Additionally, the Cronbach's alpha and composite reliability values exceeded 0.70 (Ghozali & Kusumadewi, 2023), indicating high reliability (Sarstedt et al., 2021). These findings provide strong evidence for the robustness and validity of the measurement model.

In addition, the HTMT test was conducted. Technically, the HTMT approach provides an estimate of the true correlation between two constructs, assuming they were measured perfectly (i.e., with complete reliability). This true correlation is also referred to as the disattenuated correlation. A disattenuated correlation between two constructs approaching 1 indicates a lack of discriminant validity. Based on the HTMT results in the Appendix 1, no values exceeded 0.90, indicating good discriminant validity. In addition, discriminant validity was assessed using cross-loading analysis and the Fornell–Larcker criterion in Appendix 3. Based on the discriminant validity results from the cross-loading values, the indicators show higher correlations with their respective constructs than with other constructs. Thus, it can be concluded that the research model demonstrates good discriminant validity in terms of cross-loadings. The Fornell–Larcker criterion in Appendix 3 confirmed that the model achieved acceptable discriminant validity.

Based on Table 2, it can be observed that all latent variables have an Average Variance Extracted (AVE) value greater than 0.5. This indicates that the indicators forming the latent constructs exhibit good convergent validity. The discriminant validity, as indicated by the cross-loading values, shows that the indicators have a higher correlation with their respective constructs compared to other constructs as shown in Appendix 2. Therefore, it can be concluded that the research model demonstrates good discriminant validity according to the cross-loading criteria. Furthermore, all latent constructs have Cronbach's alpha and composite reliability values above 0.70, confirming that the model demonstrates good reliability.

Table 2.

AVE, Cronbach's Alpha and Composite Reliability

Latent variables	Cronbach's alpha	Composite Reliability	Average Variance Extracted (AVE)
Business environment uncertainty (X)	0,946	0,961	0,832
Dynamic capabilities (Z1)	0,717	0,840	0,637
Digital transformation (Z2)	0,923	0,947	0,818
Business resilience (Y1)	0,845	0,886	0,566
MSMEs performance (Y2)	0,876	0,914	0,727

Source: Author's work (2024)

After conducting the outer model testing, the next step is to evaluate the inner model, which includes R-square, f-square, Q-square, and GoF. The obtained R-square values are as follows.

As shown in Appendix 4, the R-squared values for the models ranged from 0.346 to 0.577. Environmental uncertainty explained a substantial portion of the variance in dynamic capabilities (R-squared = 0.449) and, when mediated by dynamic capabilities, also explained a significant portion of the variance in digital transformation (R-squared = 0.346). The full model, including environmental uncertainty, dynamic capabilities, digital transformation, and business age,

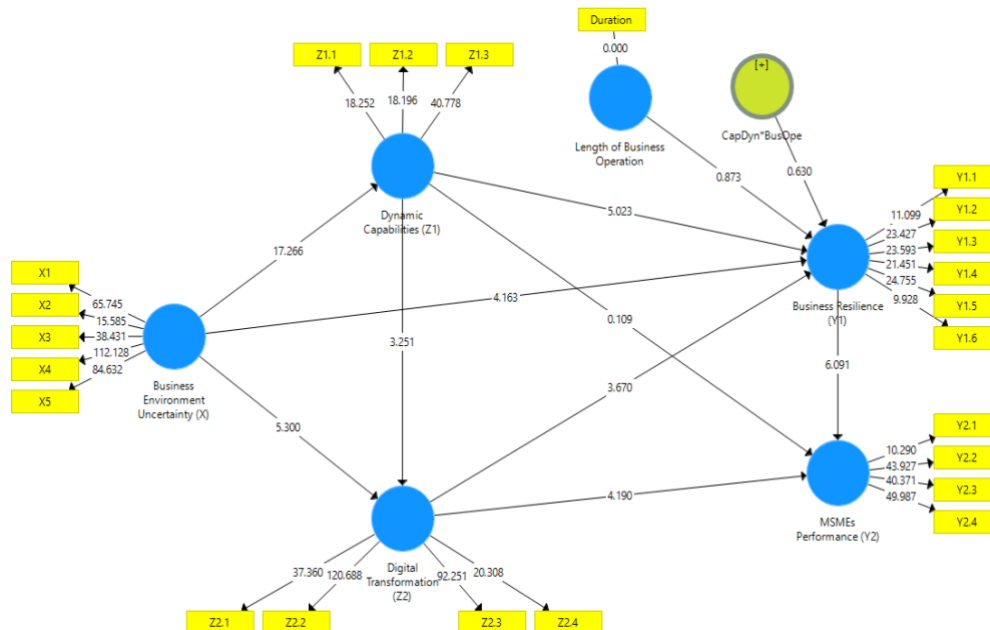
explained 57.7% of the variance in business resilience and 52.2% of the variance in MSMEs' performance. The F-squared values indicated that the effect of environmental uncertainty on dynamic capabilities was the most substantial, while the effects of other variables were generally smaller. The Q-squared values, presented below, provide additional insights into the predictive power of the models.

Based on Appendix 5, it is known that the Q-square value is greater than 0, which indicates that the observed values have been well reconstructed, thus the structural model has predictive relevance. The GoF value for the structural model is 0.614. This result shows that the structural model has a GoF that falls into the high (large) category.

Next, hypothesis testing was conducted by comparing the t-statistic values with the t-table value of 1.96, or by using the p-value compared to the significance levels of α 5% and 10% (0.05 and 0.1). Figure 3 shows the results of the hypothesis testing for the structural model.

Figure 3.

T-values of the MSMEs resilience model in facing business environment uncertainty to improve performance through dynamic capabilities and digital transformation



Source: Author's work (2025)

The findings of the hypothesis test provide empirical support for the theoretical argument that business environment uncertainty stimulates the development of dynamic capabilities. The significant positive relationship between these two variables ($p < 0.000$, path coefficient = 0.670) suggests that firms facing high levels of uncertainty are compelled to become more adaptive, responsive, and proactive. Business environment uncertainty significantly impacts digital transformation, as evidenced by a p-value smaller than the alpha level, specifically

$0.000 < 0.05$. The path coefficient from business environment uncertainty to digital transformation is 0.375, indicating a positive influence. Business environment uncertainty had a significant positive impact on business resilience ($p < 0.000$, path coefficient = 0.297). Dynamic capabilities were found to have a significant positive impact on digital transformation ($p < 0.000$, path coefficient = 0.266). Dynamic capabilities significantly impact business resilience, with a p-value of 0.000, indicating a strong relationship. The positive path coefficient of 0.308 suggests that higher dynamic capabilities enhance business resilience. Dynamic capabilities do not significantly affect MSMEs' performance, as indicated by a p-value of 0.913, which is greater than the alpha level of 0.05. The negative path coefficient of -0.007 suggests that higher dynamic capabilities may correlate with lower MSME performance. Digital transformation significantly impacts business resilience, with a p-value of 0.000, indicating it is less than the alpha level of 0.05. The positive path coefficient of 0.280 suggests that greater digital transformation leads to enhanced business resilience. Digital transformation was found to have a significant positive impact on MSMEs' performance ($p < 0.000$, path coefficient = 0.307). Business resilience was found to have a significant positive impact on MSMEs' performance ($p < 0.000$, path coefficient = 0.498). The moderating effect of the length of business operation weakened the significant relationship between dynamic capabilities and business resilience ($p = 0.529$). The path coefficient of 0.029 indicates that as businesses operate for a longer period, the influence of dynamic capabilities on their resilience diminishes. Business environment uncertainty significantly influences digital transformation through dynamic capabilities, as indicated by a p-value of 0.001, which is less than the alpha level of 0.05. The path coefficient from business environment uncertainty to digital transformation via dynamic capabilities is 0.179, demonstrating a positive influence. The significant positive relationship between dynamic capabilities and digital transformation ($p < 0.007$). Business environment uncertainty significantly influences business resilience through dynamic capabilities and digital transformation (p-value 0.033).

Discussion

Firms facing high levels of uncertainty are compelled to become more adaptive, responsive, and proactive. This is because they must continuously identify new opportunities, make rapid strategic decisions, and leverage emerging technologies to remain competitive in a turbulent environment (Shirooyehpour et al., 2022). Dynamic capabilities assist businesses in rapidly adapting to external changes and challenges (Haarhaus & Liening, 2020).

Business environment uncertainty influence to digital transformation. This implies that as business environment uncertainty increases, digital transformation improves. The significance of business environment uncertainty on digital transformation arises from the necessity for companies to swiftly adapt to market and technological changes to remain competitive. In uncertain conditions, such as

shifts in consumer preferences or fluctuations in raw material prices, businesses are compelled to adopt digital technologies to enhance their efficiency, flexibility, and responsiveness. For instance, leveraging social media for marketing and e-commerce for product distribution are strategic steps to reach a broader customer base, while digital payment solutions facilitate smoother business operations (Gupta & Bose, 2022). In other words, digital transformation serves as a crucial tool for companies to survive and thrive amidst uncertainty (Ning & Yao, 2023).

Business environment uncertainty had a significant positive impact on business resilience. This finding suggests that SMEs operating in dynamic and unpredictable environments are more likely to develop the ability to withstand shocks and adapt to changing circumstances. The positive relationship between these two variables can be attributed to the fact that SMEs facing higher levels of uncertainty are forced to develop flexible strategies, such as building safety stocks, sourcing from alternative suppliers, and expanding their customer base. By being able to quickly adjust to changes, manage risks, and maintain operations in the face of uncertainty, SMEs enhance their resilience and long-term competitiveness (Corrales-Estrada et al., 2021; Hadi, 2020).

Dynamic capabilities were found to have a significant positive impact on digital transformation. It implies that SMEs with a higher capacity to sense, seize, and reconfigure internal and external resources to match rapidly changing environments are more likely to successfully adopt and integrate digital technologies. SMEs with strong dynamic capabilities are better equipped to identify emerging digital technologies that can enhance their business performance, such as e-commerce platforms, social media, and digital payment systems. Moreover, these firms are able to make timely strategic decisions regarding technology adoption and allocate resources effectively to maximise the benefits of digital transformation. Consequently, dynamic capabilities facilitate a faster and more effective digital transformation process, enabling SMEs to remain competitive in an ever-changing business landscape (Magistretti et al., 2021). Dynamic capabilities enable organisations to sense, seize, and reconfigure digital resources to support digital transformation (Ellström et al., 2021; Yu et al., 2022).

These capabilities allow MSMEs to quickly adapt to external changes and challenges, identify new opportunities, and manage resources effectively. For instance, MSMEs that can swiftly adjust their strategies during crises are more resilient and better equipped for long-term survival. Thus, dynamic capabilities help MSMEs remain flexible, reduce risks, and grow despite unexpected challenges, strengthening their overall resilience (Ozanne et al., 2022; Putritamara et al., 2023).

This lack of a significant impact may arise because, while dynamic capabilities enable businesses to adapt and respond to changes, this does not always translate into immediate performance improvements. Other factors, such as resource limitations, restricted market access, and ineffective strategy implementation, can hinder the potential of dynamic capabilities to enhance

performance. Additionally, unforeseen external challenges, like stringent regulations or adverse economic conditions, may diminish the positive impact of dynamic capabilities on MSME performance. This finding, although counterintuitive, highlights that the burdens of continuous adaptation, including financial investment and managerial attention, can in certain contexts outweigh the benefits for MSMEs. From the resource-based view, the effectiveness of dynamic capabilities depends on the presence of complementary resources and a supportive ecosystem. In their absence, the contribution of dynamic capabilities may be neutralised, which explains their lack of significance in this environment. Research has indicated that dynamic capabilities may not directly improve MSME performance, with organisational innovation and entrepreneurial leadership playing a more significant role in driving performance enhancement (Pasaribu, 2023; Widyanti et al., 2023).

Digital transformation significantly impacts business resilience. This significant influence occurs because adopting digital technologies enables businesses to be more flexible and adaptive when facing challenges and changes. Digitalisation allows companies to access real-time market information, expand customer reach through online platforms, and optimise operations through automation and efficient technologies. Furthermore, it enables businesses to respond more swiftly to disruptions, such as sudden changes in supply chains or market demand (Saeed et al., 2023). Thus, digital transformation enhances business resilience in the face of uncertainty, ensuring operational continuity and improving the ability to recover from crises (Putritamara et al., 2023).

Digital transformation was found to have a significant positive impact on MSMEs' performance. This implies that SMEs that have successfully adopted digital technologies are more likely to achieve superior performance outcomes. By leveraging digital tools such as e-commerce platforms, social media marketing, and digital payment systems, SMEs can reach larger customer bases, increase sales, and strengthen their competitive position. Furthermore, digital technologies enable SMEs to optimise resource allocation, streamline business processes, and enhance service quality. The positive effects of digital transformation contribute to increased revenue, customer growth, and capital accumulation, ultimately driving overall SME performance (Abdullah et al., 2024; Aristayudha & Rettobjaan, 2022; Teng et al., 2022).

Business resilience was found to have a significant positive impact on MSMEs' performance. This implies that SMEs with a higher capacity to withstand and recover from disruptions are more likely to achieve superior performance outcomes. The ability of SMEs to adapt and bounce back from challenges, such as economic downturns, natural disasters, or technological disruptions, enables them to maintain operations and remain competitive. Consequently, business resilience is a critical factor in ensuring the long-term sustainability and growth of SMEs (Ali et al., 2023). MSMEs with high resilience are capable of managing risks, quickly

adjusting strategies, and mitigating the impacts of crises such as supply chain disruptions or market fluctuations. This ability helps maintain revenue stability, retain customers, and optimise resources, ultimately enhancing overall business performance (Mushangai, 2023). With strong resilience, MSMEs are better equipped to withstand market pressures and recover from challenging situations, positively impacting growth and business sustainability (Beuren et al., 2022).

The moderating effect of the length of business operation weakened the significant relationship between dynamic capabilities and business resilience. This suggests that the experience and stability accumulated over time may reduce the need for dynamic capabilities to adapt to changing environments. Established SMEs may have well-established systems and processes, making them more likely to rely on traditional business practices rather than constant innovation and change (Soja & Soja, 2020; Van Vianen et al., 2022). Moreover, older businesses may feel more comfortable with established ways of working, which can make them less responsive to changes in the environment, thereby diminishing the potential positive impact of dynamic capabilities on their resilience (Prester, 2023).

Business environment uncertainty significantly influences digital transformation through dynamic capabilities. This implies that higher levels of business environment uncertainty lead to improved dynamic capabilities, which, in turn, enhance digital transformation. The uncertainty in the business environment compels companies to adapt and innovate to remain competitive, thereby highlighting the critical role of dynamic capabilities in navigating challenges and seizing opportunities for digital advancement (Kim & Park, 2021). In the face of rapid changes, such as shifts in consumer preferences and market conditions, companies with strong dynamic capabilities can swiftly identify and leverage new digital technologies to enhance their operations and services. These dynamic capabilities enable businesses to better respond to uncertainty, adopt relevant digital solutions, and transform to meet customer needs. Therefore, environmental uncertainty not only drives companies to undergo digital transformation but also relies on dynamic capabilities to manage the process effectively and efficiently (Mushangai, 2023).

The results provide empirical evidence supporting the argument that business environment uncertainty stimulates the development of dynamic capabilities and digital transformation, which collectively enhance business resilience. The significant positive relationship between these variables indicates that firms operating in uncertain environments are compelled to become more adaptive and innovative to survive and thrive (Chen et al., 2022; Han et al., 2023). Dynamic capabilities empower businesses to be innovative and resilient, allowing them to respond swiftly to market disruptions, identify emerging opportunities, and efficiently manage resources (Ferreira, Coelho, et al., 2020). Furthermore, digital transformation serves as a vital tool for strengthening resilience, as digital technologies assist companies in expanding their market reach, enhancing

operational efficiency, and improving customer experiences (Souza & Pietrafesa, 2023). The combination of dynamic capabilities and digital transformation enables companies not only to survive but also to thrive amid uncertainty, making them more resilient in facing future challenges.

Business environment uncertainty significantly influences business resilience through dynamic capabilities and digital transformation. The path coefficient from business environment uncertainty to digital transformation via dynamic capabilities is 0.025, reflecting a positive influence. This means that as business environment uncertainty increases, dynamic capabilities, digital transformation, and business resilience also improve, ultimately leading to enhanced MSMEs performance (Roy, 2020; Senadjki et al., 2024). Business environment uncertainty significantly influences business resilience through dynamic capabilities, as uncertain situations drive companies to develop adaptive and responsive abilities. When faced with changes in consumer preferences, market fluctuations, or supply chain disruptions, firms with strong dynamic capabilities can quickly recognise and respond to these challenges. These capabilities encompass the ability to innovate, manage risks, and adapt strategies necessary to maintain operations and performance (Belhadi et al., 2022). Thus, environmental uncertainty not only prompts companies to enhance their dynamic capabilities but also contributes to improved resilience, enabling businesses to survive and thrive even in challenging conditions.

Conclusion, limitation, and future research

This study reveals that uncertainty in the business environment plays a crucial role in stimulating the development of dynamic capabilities, digital transformation, and business resilience among MSMEs. Although dynamic capabilities enhance both digital transformation and resilience, their effect on MSME performance is indirect. Instead, digital transformation and resilience stand out as the main drivers of improved business performance. The study contributes novelty by identifying dynamic capabilities as a mediating factor between environmental uncertainty and digital transformation, and by demonstrating that uncertainty indirectly enhances MSME performance through resilience and transformation. From a managerial perspective, MSMEs should strengthen adaptive capabilities—such as sensing market changes, seizing new opportunities, and reconfiguring resources—to better respond to uncertainty. Practically, adopting affordable digital tools (e.g., social media marketing, digital payments, cloud systems) and developing diversified products, flexible supply chains, and collaborative partnerships can reinforce resilience and sustain performance. For policymakers, these findings emphasize the importance of supportive environments that promote MSME digitalization and capability building through training, incentives, and innovation networks. The findings of this study highlight that business environment uncertainty significantly drives the development of dynamic capabilities, digital transformation, and business resilience within MSMEs. While dynamic capabilities strengthen both

digital transformation and resilience, they do not directly enhance MSME performance. Instead, digital transformation and resilience emerge as key determinants of performance improvement. The research provides novelty by establishing dynamic capabilities as a mediator between environmental uncertainty and digital transformation, and by showing that uncertainty indirectly supports MSME performance through enhanced resilience and transformation.

Despite its valuable contributions, this study is limited by its cross-sectional design, which restricts causal interpretation of the relationships among variables. Moreover, the research context focuses on a specific region, which may affect the generalizability of the results. The reliance on self-reported data also raises potential response bias in assessing performance and capability constructs.

Future studies should employ longitudinal or cross-country comparative approaches to capture the dynamic evolution of MSMEs' capabilities and resilience across different contexts. Researchers are also encouraged to integrate objective performance indicators—such as financial growth or innovation output—and to explore other mediating mechanisms like organizational learning, innovation capability, or leadership agility. These directions will enhance the robustness of empirical findings and deepen theoretical understanding of how MSMEs can sustain competitiveness amid environmental turbulence.

Author contribution

Ahmad Ahsin Kusuma Mawardi: Conceptualisation and Research Design. **Lilik Farida:** Data Collection, Methodology. **Tatok Endhiarto:** Conceptualisation, Data Collection. **Tria Apriliana:** Data Collection and Analysis, Editing and Layouting. All Authors have read the final version of the paper.

Declaration of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1.

Heterotrait-Monotrait ratio (HTMT)

	Business environme nt uncertainty (X)	Busines s resilienc e (Y1)	Capdyn*buso pe	Digital transformati on (Z2)	Dynamic capabiliti es (Z1)	Length of busines s operatio n
Business resilience (Y1)	0.736					
Capdyn*buso pe	0.118	0.150				

	Business environme nt uncertainty (X)	Busines s resilienc e (Y1)	Capdyn*buso pe	Digital transformati on (Z2)	Dynamic capabiliti es (Z1)	Length of busines s operatio n
Digital transformatio n (Z2)	0.589	0.679	0.108			
Dynamic capabilities (Z1)	0.814	0.830	0.152	0.619		
Length of business operation MSMEs performance (Y2)	0.037	0.084	0.081	0.015	0.106	
	0.665	0.762	0.056	0.658	0.590	0.022

Source: Authors' work (2025)

Appendix 2.

Cross Loadings

	Business environment uncertainty (X)	Business resilience (Y1)	MSMEs performance (Y2)	Dynamic capabilities (Z1)	Digital transformation (Z2)
X1	0.958	0.608	0.589	0.622	0.537
X2	0.683	0.474	0.274	0.500	0.347
X3	0.955	0.614	0.590	0.616	0.529
X4	0.967	0.668	0.668	0.665	0.563
X5	0.963	0.641	0.633	0.640	0.521
Y1.1	0.383	0.668	0.344	0.350	0.326
Y1.2	0.454	0.827	0.491	0.521	0.639
Y1.3	0.555	0.793	0.604	0.465	0.535
Y1.4	0.454	0.790	0.532	0.506	0.431
Y1.5	0.540	0.767	0.496	0.564	0.457
Y1.6	0.575	0.652	0.552	0.534	0.306
Y2.1	0.480	0.403	0.774	0.342	0.394
Y2.2	0.511	0.622	0.888	0.353	0.441
Y2.3	0.623	0.654	0.859	0.491	0.557
Y2.4	0.486	0.596	0.884	0.433	0.636
Z1.1	0.508	0.438	0.291	0.751	0.271
Z1.2	0.552	0.515	0.486	0.825	0.476
Z1.3	0.545	0.611	0.356	0.818	0.465
Z2.1	0.520	0.528	0.524	0.451	0.913
Z2.2	0.542	0.533	0.570	0.513	0.954
Z2.3	0.530	0.601	0.620	0.515	0.963
Z2.4	0.400	0.531	0.466	0.384	0.775

Source: Authors' work (2025)

Appendix 3.

Fornell-Larcker criterion

	Business environment uncertainty (X)	Business resilience (Y1)	Capdyn *busope	Digital transformation (Z2)	Dynamic capabilities (Z1)	Length of business operation	MSMEs performance (Y)
Business environment uncertainty (X)	0.912						
Business resilience (Y1)	0.663	0.752					
Capdyn* busope	0.112	0.135	1.000				
Digital transformation (Z2)	0.554	0.606	0.101	0.904			
Dynamic capabilities (Z1)	0.670	0.659	0.127	0.518	0.798		
Length of business operation	-0.035	-0.078	-0.081	0.013	-0.084	1.000	
MSMEs performance (Y2)	0.618	0.680	0.017	0.606	0.481	-0.013	0.853

Source: Authors' work (2025)

Appendix 4

R-square

Variable	R square
Dynamic capabilities (z1)	0.449
Digital transformation (z2)	0.346
Business resilience (y1)	0.577
Msmes performance (y2)	0.522

Source: Author's work (2025)

Appendix 5.

Q² predictive relevance

Variabel	R square	1-r square
Dynamic capabilities (Z1)	0.449	0.551
Digital transformation (Z2)	0.346	0.654
Business resilience (Y1)	0.577	0.423
MSMES performance (Y2)	0.522	0.478
Q ² =	$q^2 = 1 - (1-0.449) (1-0.346) (1-0.577) (1-0.522) = 0.927$	
Error =	$q^2 = 100\% - 92.7\% = 7.3\%$	

Source: Authors' work (2025)