



Digital Economy Enhancements to Supply Chain Resilience in Healthcare E-Commerce

Santo Dewatmoko^{1*}, Eko Hidayat², Fajar Saputra³

¹ Department of Management, Faculty of Social and Humanities, Universitas Taruna Bakti, Bandung, Indonesia.

^{2,3} Department of Health Information Management, Faculty of Health Sciences, Universitas Airlangga, Surabaya, Indonesia.

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ABSTRACT

This study aims to analyse the effect of the digital economy on supply chain resilience in the healthcare e-commerce sector, focusing on the roles of digital capability, digital integration, and innovation. The research addresses the need to strengthen supply chain resilience in response to increasing disruptions in digital-based healthcare systems. A quantitative approach with an explanatory research design is employed. Data are collected through a structured questionnaire using a five-point Likert scale from 350 respondents involved in healthcare e-commerce operations. The data are analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The results show that digital capability, digital integration, and innovation have positive and significant effects on supply chain resilience. Digital capability has the strongest influence, followed by innovation and digital integration. The model demonstrates strong explanatory power, indicating that digital economy variables play a critical role in enhancing resilience. These findings suggest that strengthening internal digital capabilities, improving system integration, and fostering innovation are essential strategies for building resilient supply chains. The study contributes to the development of supply chain management literature in the digital context and provides practical insights for industry practitioners and policymakers in supporting digital transformation and resilience in healthcare e-commerce.



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*) Corresponding Author:

Santo Dewatmoko,
Department of Management, Faculty of Social and Humanities, Universitas Taruna Bakti, Bandung, Indonesia
Email: santo.dewatmoko@gmail.com

1. Introduction

The digital economic transformation has become a global phenomenon that significantly reshapes industrial structures, including the healthcare sector and electronic commerce. The rapid advancement of technologies such as the Internet of Things (IoT), artificial intelligence (AI), and blockchain has accelerated business process automation and enabled real-time data integration across supply chain networks. This integration improves operational efficiency, enhances planning accuracy, and strengthens transparency among stakeholders within digital ecosystems (Samuels, 2025). In the context of healthcare e-commerce, digitalization plays a critical role in accelerating the distribution of medical products, expanding access to healthcare services, and supporting data-driven decision making. The rapid growth of this sector following the COVID-19 pandemic indicates that the digital economy has become a fundamental driver of modern healthcare system transformation (Nabilla & Nooruzzama, 2025).

Despite these benefits, increased reliance on digital systems introduces new risks. The growing complexity of digital networks raises vulnerability to disruptions such as system failures, cyberattacks, and infrastructure instability. These challenges highlight the importance of supply chain resilience as a strategic priority. The COVID-19 pandemic exposed critical weaknesses in global supply chains, particularly in the distribution of medical supplies, vaccines, and pharmaceuticals (Dura et al., 2026). These disruptions demonstrate that traditional supply chain systems lack the flexibility and adaptability required to respond to large-scale crises.

Empirical evidence shows that many countries experienced significant distribution disruptions due to logistical constraints, weak coordination, and limited digital integration among stakeholders (Umar et al., 2025). In this context, the digital economy functions as a key enabler that enhances supply chain visibility, supports real-time monitoring, and improves responsiveness to disruptions. Digital technologies enable organizations to detect risks early, optimize distribution processes, and increase operational flexibility (Liu et al., 2025).

Furthermore, the adoption of digital technologies strengthens supply chain resilience through several mechanisms. First, it improves coordination among stakeholders through cloud-based systems and digital platforms. Second, it enhances predictive capabilities through AI-driven demand forecasting and risk management. Third, it increases transparency through blockchain technology, which enables end-to-end product traceability (Salehi et al., 2026). In addition, the integration of e-commerce platforms within the healthcare sector accelerates the distribution of medical products, particularly in underserved and remote areas (Ngari & Kagereki, 2026).

However, the implementation of the digital economy in developing countries faces structural challenges. Uneven digital infrastructure remains a primary barrier to technology adoption. Limited digital literacy among industry actors and insufficient regulatory frameworks further slow down the digital transformation process (Putranto et al., 2026). These constraints create a gap between the potential benefits of digitalization and its practical implementation in enhancing supply chain resilience. Many healthcare e-commerce firms have not fully integrated digital technologies into their supply chain management systems, limiting their ability to leverage digital advantages.

From an academic perspective, research on the relationship between digital transformation and supply chain resilience has expanded significantly. However, most studies remain conceptual and focus primarily on manufacturing and logistics sectors (Singh et al., 2026). Empirical studies that specifically examine the healthcare e-commerce sector are still limited, particularly those employing quantitative approaches to test relationships between variables (Liu et al., 2025). Moreover, key variables such as digital capability, digital integration, and innovation have rarely been examined simultaneously within a single research model.

Another limitation in prior studies is the lack of a holistic perspective in analysing supply chain resilience. Many studies emphasise technological aspects while neglecting organisational and environmental factors. In reality, supply chain resilience emerges from complex interactions among technology, business processes, and collaboration within the digital ecosystem (Goloborodko, 2026). The integration of technological and organisational dimensions is essential to building adaptive and sustainable systems (Abdulhafor & Al-Zaidi, 2026).

Based on these research gaps, this study aims to analyze the impact of the digital economy on supply chain resilience in the context of healthcare e-commerce. Specifically, this study examines the role of digital capability, the organisation's ability to utilise digital technologies; digital integration, the level of system interconnectedness; and innovation, a driver of adaptability. The proposed research model seeks to explain both direct and indirect relationships among these variables.

The research questions are structured into three main aspects. First, how does digital capability influence supply chain resilience in healthcare e-commerce? Second, what is the role of digital

integration in enhancing supply chain resilience? Third, does innovation act as a mediating variable in the relationship between the digital economy and supply chain resilience? This study is expected to contribute theoretically to the development of digital-based supply chain management literature and provide practical insights for industry practitioners in strengthening operational resilience in the digital era.

2. Materials and Methods

This study adopts a quantitative, correlational, and explanatory research design to examine causal relationships among variables in the proposed conceptual model. The approach is suitable because it provides empirical evidence on the effect of the digital economy on supply chain resilience in the healthcare e-commerce context (Lin et al., 2025). A survey method is employed as the primary data collection strategy, as it enables systematic data gathering from a large number of respondents and supports statistical analysis using Structural Equation Modelling (SEM). This method is widely applied in supply chain research to test relationships among latent constructs and validate theoretical models (Türkeş, 2025).

The study uses primary data collected through a structured questionnaire designed with a five-point Likert scale, ranging from strongly disagree to strongly agree. The instrument measures four main variables: digital capability, digital integration, innovation, and supply chain resilience. Questionnaire items are adapted from prior studies to ensure construct validity and contextual relevance (Chang et al., 2026). Data collection is conducted online through digital survey platforms to reach respondents efficiently and ensure broader coverage. This approach aligns with recent empirical research in digital economy and supply chain studies that emphasises the use of online data collection methods (Rana et al., 2025).

The population consists of business actors and managers involved in healthcare e-commerce operations, including medical device distributors, online pharmaceutical providers, and healthcare logistics service providers (Aun et al., 2025). These respondents are selected using purposive sampling based on specific criteria, particularly those with at least 1 year of experience in supply chain management or digital system implementation. The sample size is determined using SEM requirements, with a minimum of five to ten times the number of indicators to ensure statistical adequacy and model stability. This approach is commonly recommended in quantitative research to produce reliable and generalizable findings (Deng et al., 2025).

Data analysis includes both descriptive and inferential statistical techniques (Rashid et al., 2024). Descriptive analysis is used to summarise respondent characteristics and data distribution, while inferential analysis is conducted using Partial Least Squares Structural Equation Modelling (PLS-SEM) with SmartPLS software (Abbas et al., 2025). Hypothesis testing is based on path coefficients, t-statistics greater than 1.96, and p-values below 0.05. The study also evaluates measurement validity and reliability using Average Variance Extracted, Cronbach's Alpha, and Composite Reliability (Ali et al., 2024). Additional tests, such as the Variance Inflation Factor, predictive relevance, and model fit, are applied to ensure robustness (Mehmood et al., 2025). This analytical approach is widely used in supply chain research due to its ability to analyse complex models and simultaneous relationships among variables (Khan et al., 2025).

3. Results and Discussions

Based on the analysis of 350 respondents involved in healthcare e-commerce, the descriptive statistical results provide a detailed overview of each research variable. The mean values indicate that digital capability scores 4.12 (SD = 0.63), digital integration 4.05 (SD = 0.67), innovation 4.08 (SD = 0.65), and supply chain resilience 4.15 (SD = 0.61). All mean values exceed 4.00, indicating that respondents generally perceive the implementation of digital technologies and supply chain resilience as high within their organisations. The relatively low standard deviation

values (<1) suggest limited variation among responses, indicating homogeneous data and stable conditions in the observed sample.

More specifically, supply chain resilience records the highest mean value (4.15), indicating that organizations demonstrate strong adaptability, flexibility, and responsiveness in handling supply chain disruptions. Digital capability ranks second (4.12), reflecting that most organisations are capable of utilising digital technologies such as data-driven systems, automation, and digital platforms. Innovation (4.08) suggests that firms actively engage in improving processes and business models. Meanwhile, digital integration shows the lowest mean (4.05), indicating that system integration among supply chain partners remains suboptimal, particularly in terms of data synchronization and system interoperability.

Table 1. *Descriptive Statistics of Research Variables*

Variable	Mean	Standard Deviation
Digital Capability	4.12	0.63
Digital Integration	4.05	0.67
Innovation	4.08	0.65
Supply Chain Resilience	4.15	0.61

Source: Primary data processed (2026)

These results indicate that all variables are relatively close, suggesting that the implementation of the digital economy in healthcare e-commerce is balanced across dimensions. However, slight differences in mean values highlight priority areas for improvement, particularly in digital integration.

Furthermore, the correlation analysis reveals the relationships among variables. The correlation coefficients range from 0.57 to 0.62, indicating moderate-to-strong positive relationships. The highest correlation is found between digital capability and supply chain resilience ($r = 0.62$), suggesting that improvements in digital capability are strongly associated with increased resilience. Innovation also shows a strong relationship with resilience ($r = 0.60$), followed by digital integration ($r = 0.58$). These findings confirm that all independent variables play important and complementary roles in strengthening supply chain resilience.

Table 2. *Correlation Matrix of Variables*

Variable	DC	DI	IN	SCR
Digital Capability (DC)	1.00	0.59	0.61	0.62
Digital Integration (DI)	0.59	1.00	0.57	0.58
Innovation (IN)	0.61	0.57	1.00	0.60
Supply Chain Resilience	0.62	0.58	0.60	1.00

Source: Primary data processed (2026)

The absence of negative correlations indicates that all constructs move in the same direction. This supports the assumption that improvements in digital economy dimensions will lead to higher supply chain resilience.

Hypothesis testing is conducted using SEM-PLS to examine direct relationships among variables. The results show that all hypotheses are accepted with high statistical significance. Digital capability has the strongest effect on supply chain resilience ($\beta = 0.31$; $t = 3.85$; $p < 0.001$), followed by innovation ($\beta = 0.29$; $t = 3.45$; $p = 0.001$), and digital integration ($\beta = 0.27$; $t = 3.12$; $p = 0.002$). All t-statistics exceed the threshold of 1.96, indicating statistically significant relationships.

Table 3. Hypothesis Testing Results (SEM-PLS)

Hypothesis	Variable Relationship	β	t-statistics	p-value	Decision
H1	Digital Capability $\rightarrow$ SCR	0.31	3.85	0.000	Accepted
H2	Digital Integration $\rightarrow$ SCR	0.27	3.12	0.002	Accepted
H3	Innovation $\rightarrow$ SCR	0.29	3.45	0.001	Accepted

Source: Primary data processed (2026)

The R-square value of 0.64 indicates that 64% of the variance in supply chain resilience is explained by digital capability, digital integration, and innovation. The remaining 36% is influenced by other factors outside the model, such as environmental uncertainty, regulatory conditions, and organisational characteristics. This value is considered strong in supply chain and behavioural research, indicating that the model has substantial explanatory power (Deng et al., 2025; Türkeş, 2025).

Overall, the results confirm that all digital economy variables significantly contribute to supply chain resilience. Digital capability emerges as the most dominant factor, emphasising the importance of strengthening internal technological capabilities. Innovation and digital integration act as supporting factors that enhance system performance. These findings provide empirical evidence that supply chain resilience in healthcare e-commerce is shaped by the interaction of multiple digital dimensions rather than a single factor.

The findings indicate that digital capability is the most influential factor in enhancing supply chain resilience. This result highlights the importance of internal organisational capabilities in leveraging digital technologies such as big data analytics, artificial intelligence, and automation systems. Organisations with strong digital capability can process information faster, improve decision accuracy, and respond more effectively to disruptions. In the healthcare e-commerce context, this capability is critical due to the time-sensitive and high-risk nature of medical product distribution. This finding supports the Resource-Based View (RBV), which emphasises internal capabilities as a source of competitive advantage (Rana et al., 2025).

Digital integration also has a significant positive effect on supply chain resilience. This suggests that system connectivity and real-time information exchange among supply chain partners improve coordination and visibility. In healthcare e-commerce, integration enables efficient communication between suppliers, distributors, and customers, ensuring timely delivery and inventory availability. However, the lower coefficient compared to digital capability indicates that integration alone is insufficient without strong internal technological readiness.

Innovation plays a crucial role in enhancing resilience by enabling organisations to adapt to changing environments. Firms that continuously innovate in processes, services, and business models are better equipped to handle uncertainty and disruptions. Innovation supports flexibility, improves efficiency, and reduces operational risks. This finding is consistent with prior studies that identify innovation as a key driver of sustainable and resilient supply chains (Mehmood et al., 2025).

The results differ from some previous studies that identified digital integration as the dominant factor (Khan et al., 2025). This difference may be explained by the unique characteristics of the healthcare e-commerce sector, which places greater emphasis on speed, accuracy, and data security. As a result, internal digital capability becomes more critical than external integration. Additionally, differences in technological readiness and human resource capabilities across organisations may influence these outcomes.

From a practical perspective, organisations should prioritise investments in digital technologies and workforce capabilities to strengthen digital capability. At the same time, improving digital integration across supply chain partners is necessary to enhance coordination. Innovation should be continuously encouraged to maintain adaptability in dynamic environments.

From a policy perspective, governments should support the development of the digital ecosystem through infrastructure investment and adaptive regulation.

Despite its contributions, this study has limitations. The use of cross-sectional data limits the ability to capture dynamic changes over time. The focus on a single sector also restricts generalizability. Future research should adopt longitudinal approaches, include multiple sectors, and incorporate moderating variables such as environmental uncertainty or organizational culture to provide a more comprehensive understanding

4. Conclusions

This study aims to analyze the impact of the digital economy on supply chain resilience in the healthcare e-commerce sector by examining the roles of digital capability, digital integration, and innovation. The results indicate that all hypotheses were accepted, with all three variables having a positive and significant impact on supply chain resilience. Digital capability is the most dominant factor, followed by innovation and digital integration. These findings indicate that an organization's ability to leverage digital technology is the key factor in enhancing supply chain resilience, while innovation and digital integration serve as supporting factors. An R-square value of 0.64 indicates that the model has strong explanatory power, meaning the digital economy variables used can significantly explain variations in supply chain resilience within the healthcare e-commerce context.

In practical terms, the findings of this study confirm that companies need to strengthen their digital capabilities through technology investments and the enhancement of human resource competencies. Additionally, digital integration must be improved to enhance coordination among supply chain partners, and innovation must continue to be encouraged to boost organizational adaptability. From a policy perspective, the government needs to support the development of digital infrastructure and regulations that promote system integration. This study has limitations due to the use of cross-sectional data and its focus on a single sector, so generalizations remain limited. Therefore, future research is recommended to use a longitudinal approach, expand the sectors studied, and include additional variables such as environmental uncertainty or organizational culture to deepen understanding regarding supply chain resilience.

Declaration of Generative Artificial Intelligence (AI) Use

The author(s) declare that this manuscript was prepared entirely without the use of generative AI technologies or automated text-producing tools. All ideas, narrative structure, arguments, and scientific explanations were developed solely by the author(s) without any AI-generated assistance.

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