DIGITAL SUPPLY CHAIN AGILITY: STRATEGIES TO IMPROVE MSME EFFICIENCY AND PERFORMANCE IN THE DIGITAL ERA

Sutarmin[1], Siti Badiatul Umroh[2], Sugeng Rianto[3], Tria Putri Yani[4], Khairun Nisa Ambary[5]
[1,2,3,4,5]Department of Management, Faculty of Economics And Business, Peradaban University, Paguyangan, 52276, Central Java, Indonesia

Email: Sutarmin74@gmail.com

Abstract. Digital transformation has become a strategic necessity for Micro, Small, and Medium Enterprises (MSMEs) to increase competitiveness in the digital economy era. This study aims to analyze the effect of digital supply chain adoption on efficiency, digital supply chain agility, and organizational performance of MSMEs. In addition, this study also examines the mediating role of digital supply chain efficiency and agility in this relationship. The study was conducted on MSMEs in Banyumas Regency that have adopted digital technology, using a quantitative method using the Structural Equation Modelling (SEM) approach assisted by AMOS software. The results show that digital supply chain adoption has a positive and significant effect on efficiency, digital supply chain agility, and organizational performance. Digital supply chain efficiency and agility are also proven to have a positive effect on organizational performance, while also acting as mediating variables that strengthen the relationship between digital supply chain adoption and organizational performance. These findings emphasize the importance of strengthening digital-based supply chain agility and efficiency to create resilient, adaptive, and competitive MSMEs in the era of digital transformation.

Keywords: Digital adoption, digital supply chain agility, supply chain efficiency, organizational performance, MSMEs.

1. Introduction

Micro, Small, and Medium Enterprises (MSMEs) play a crucial role in supporting the national economy. MSMEs not only contribute to increasing the national Gross Domestic Product (GDP) but also serve as the backbone of employment. According to data from the Ministry of Cooperatives and SMEs, the MSME sector can absorb up to 97% of the workforce and contribute more than 61% to Indonesia's GDP (1,2). This situation confirms that empowering and strengthening the competitiveness of MSMEs is one of the keys to national economic resilience, especially amidst the challenges of digital disruption and market globalization.

Despite this enormous potential, MSMEs still face various fundamental problems, one of which is supply chain inefficiency. This inefficiency is often caused by limited access to technology, weak information management, and a lack of integration between actors in the supply chain network (3). Yet, an efficient supply chain is a crucial foundation for improving organizational performance and competitiveness (4)

With the advancement of digital technology, new opportunities have emerged for MSMEs to improve their supply chain systems through digital supply chain digitization. Adopting digital technologies such as inventory management systems, cloud computing, and customer relationship management enables business processes to be more efficient, transparent, and responsive to market changes (5). With digital integration, MSMEs can monitor logistics in real time, optimize raw material procurement, and accelerate distribution to end consumers.

Implementing digitalization in the MSME supply chain is not easy. Challenges include low digital literacy, limited technological infrastructure in non-urban areas, and minimal support for digital technology adoption (6). These conditions often lead to a digital adoption gap, where technology adoption fails to significantly improve organizational performance(7).

To bridge this gap, this study develops a new concept called digital supply chain agility. This concept stems from Dynamic Capability theory (8), which emphasizes the importance of an organization's ability to adapt quickly to changes in the business environment through innovation and dynamic resource management. In the context of MSMEs, digital supply chain agility describes the ability of business actors to respond to market changes quickly, flexibly, and efficiently with the support of digital technology (9). Therefore, developing digital supply chain agility is expected to be an effective strategy for improving the operational efficiency and organizational performance of MSMEs in today's digital era. This research not only provides an empirical contribution to the supply chain management literature but also presents a practical approach that MSMEs can implement to survive and thrive amidst constantly changing economic dynamics.

2. Methods

2.1. Sampling and Data Collection

The data obtained in this study comes from two categories: primary and secondary sources. Primary sources were obtained from answers from micro, small, and medium enterprises (MSMEs) regarding closed-ended and open-ended questions about digital adoption in the supply chain system and factors causing inefficiencies in the supply chain. Meanwhile, secondary sources were obtained from literature and related statistical data, including the total number of MSMEs, the number of MSMEs that have adopted digital technology in their supply chains, and research on advances in digital technology in the supply chain. The data collection process was carried out by distributing questionnaires through an online form. The sampling technique used to select MSMEs was purposive sampling, aimed at creative MSME entrepreneurs who use digital technology in their supply chains and who are facing efficiency issues in the supply chain.

2.2. The Measurement Model

Partial least squares structural equation modeling (PLS-SEM) was performed using Stata 18.0 to analyze data. First, confirmatory factor analysis (CFA) was carried out to assess convergent validity and discriminant validity of the constr ucts. Items with low factor loadings were removed from subsequent analysis, and the remaining items for each construct are presented in Table 3. Model fit indices, including $\chi 2 = 1883.675$, df = 136, root mean square error of approximation (RMSEA) = 0.057, comparative fit index (CFI) = 0.947, and standardized root mean square residual (SRMR) = 0.045, indicate a good fit between the collected data and the proposed model (Hu & Bentler, 1999).

2.3. Convergen Validity

Following standard PLS-SEM procedures (10), our first step was to assess the measurement model through item robustness, construct robustness, and validity. As shown in Table 2, the standardized factor loadings for all measurement items exceeded the minimum threshold of 0.7, indicating good robustness. Cronbach's α values for all variables were above 0.7, composite reliability (CR) values were above 0.8, and average variance extracted (AVE) values were above 0.5, indicating sufficient reliability and construct validity(10)

Table 2: Construct and indicators

ELEMENT	Indicator	Cronbach's α	composite reliability (CR)	AVE	Factor Loading
Digital Supply Chain Adoption	DSCAD 1	0,800	0,812	0,559	0,622
	DSCAD 2				0,792
	DSCAD 3				0,727
	DSCAD 4				0,775
	DSCAD 5				0,806
Digital Supply Chain Efficiency	DSCE 1	0,900	0,901	0,714	0,832
	DSCE 2				0,810
	DSCE 3				0,872
	DSCE 4				0,884
	DSCE 5				0,825
Digital Supply Chain Agility	DSCAG 1	0,898	0,904	0,712	0,829
	ADSCG 2				0,833
	ADSCG 3				0,858
	ADSCG 4				0,847
	ADSCG 5				0,703
	ADSCG 6				0,676
Organizational Performance	OP 1	0,881	0,892	0,631	0,741
	OP 2				0,862
	OP 3				0,885
	OP 4				0,896
	OP 5				0,827

2.4. Discriminant Validity

Discriminant validity is crucial to ensure that the constructs being measured are truly distinct from one another, not merely correlated. In PLS-SEM analysis, this validity is assessed using several parameters: the Fornell-Larcker standard, cross-loadings, and the Heterotrait-Monotrait Ratio (HTMT). The Fornell-Larcker standard evaluates whether the square root of the AVE for each construct is greater than its correlation with other constructs in the model (11). This standard states that a construct must explain more variance in its indicators than the variance in other constructs. In general, the correlation between one construct and another should be lower than its AVE to meet this requirement. Cross-loadings assess the extent to which items designed to measure a construct contribute more to that construct than to other constructs. Lower cross-loadings indicate better discriminant validity, as items are more relevant to the intended construct than to unrelated constructs (11). The HTMT ratio measures the ratio of correlations between different constructs to correlations within the same construct, with a commonly used threshold of 0.85. This ratio indicates that correlations between different constructs should be significantly lower than correlations within the same construct to demonstrate discriminant validity (12). Furthermore, a multicollinearity value below 0.5 indicates that no collinearity

problem exists (13). The results in Table 3 indicate that the constructs have met the criteria for discriminant validity.

Table 3. Cross Loading

	DSCAD	DSCE	OP	DSCAG
DSCAD.1	**0,622**	0,459	0,504	0,396
DSCAD.2	**0,792**	0,583	0,522	0,520
DSCAD.3	**0,727**	0,470	0,435	0,435
DSCAD.4	**0,775**	0,503	0,522	0,471
DSCAD.5	**0,806**	0,595	0,622	0,608
DSCE.1	0,617	**0,832**	0,652	0,668
DSCE.2	0,572	**0,810**	0,670	0,756
DSCE.3	0,624	**0,872**	0,759	0,716
DSCE.4	0,530	**0,884**	0,714	0,768
DSCE.5	0,628	**0,825**	0,663	0,686
OP.1	0,574	0,562	**0,741**	0,590
OP.2	0,540	0,659	**0,862**	0,672
OP.3	0,605	0,764	**0,885**	0,704
OP.4	0,625	0,766	**0,896**	0,719
OP.5	0,620	0,687	**0,827**	0,670
DSCAG.1	0,615	0,708	0,631	**0,829**
DSCAG.2	0,580	0,690	0,659	**0,833**
DSCAG.3	0,585	0,738	0,707	**0,858**
DSCAG.4	0,553	0,748	0,650	**0,847**
DSCAG.5	0,369	0,608	0,534	**0,703**
DSCAG.6	0,386	0,540	0,602	**0,676**

2.5. Hypothesis Result

The next phase of the analysis involved testing the study hypotheses using the structural model. The results indicate that DSCAD has a significant and positive impact on DSCE, thereby supporting hypothesis H1. Similarly, DSCAD significantly and positively effect DSCAG supporting hypothesis H2. DSCAD also demonstrates a significant and positive influence on OP confirming hypothesis H3. DSCE is found to have a significant and positive effect on OP. supporting Hypothesis H4. DSCAG also found to have a significant and positive effect on OP, thus supporting hypothesis H5. The result show that DSCAD positively influence OP with the mediating effect of DSCE, supporting hypothesis H6. Likewise DSCAD positively impacts OP tih the mediating effect of DSCAG thereby supporting hypothesis H7. The direct and mediating effects of these relationship are summarized in Table.4

Tabel 4. Hypothesis Result

	Original sample (O)	*Sample mean (M)*	*Standard deviation (STDEV)*	*T statistics (|O/STDEV|)*	*P values*
DSCAD -> DSCE	0,704	0,710	0,046	15,349	0,000
DSCAD -> OP	0,211	0,219	0,080	2,649	0,004
DSCAD -> ADSC	0,659	0,668	0,050	13,134	0,000
DSCE -> OP	0,405	0,406	0,124	3,254	0,001
DSCE -> OP	0,313	0,305	0,123	2,554	0,005
DSCAD -> DSCE -> OP	0,285	0,288	0,090	3,180	0,001
DSCAD-> DSCAG-> OP	0,206	0,203	0,083	2,485	0,007

3. Results And Discussion

With digital supply chain agility and efficiency, this study aims to investigate how implementing a digital-based supply chain affects the performance of a company. Among the UMKM in Banyumas Regency, Indonesia, as a mediating element. Questionnaires distributed through online forms are used to gather data. The purposive sampling technique employed emphasizes creative UMKM entrepreneurs that use digital technology in their supply chain systems and UMKM yang finds challenges in the efficiency of his supply chain system.

The findings of this study offer insight into the use of digital in the supply chain system as well as the elements contributing to inefficiencies in that chain. First, analysis of the structural model clearly reveals a significant and beneficial impact of applying a digital supply chain on the efficiency of an existing digital supply chain. These results line up with prior studies(14,15). Rising significance of digitalisasi, defined as the use of digital technologies in supply chain processes (16,17), helps to enhance several aspek efisiensi rantai pasok, thus helping overall performance and competitiveness. Furthermore, the implementation of a digital supply chain enhances organizational performance. By reducing reliance on physical artifacts and prototypes, digital processes help to boost efficiency in product development and speed up the design process (18). Along with increased internal efficiency, digital transformation helps businesses grow by creating value for customers. By enabling more effective transactions and service delivery, which satisfies growing and personalized product demand (19), a system and process built on digital helps customer experience.

Second, the analysis of the structural model clearly demonstrates a major positive influence of digital supply chain adoption on the agility of the supply chain. The results fit past study (20). With improved virtualisation and simplified information flow, digital technologies have been shown to boost supply chain agility (21,22). along with partner businesses (21,23,24) claim that information technology can improve supply chain flexibility and agility by means of greater visibility of data between firms. Digitalization enables supported transformation of business driven by technology, therefore improving competitiveness, agility, and ambidextrousness (25–27).

Often entailing collaboration with outside partners including suppliers, distributors, and logistic providers, digitalizing the supply chain usually involves partnerships. Using digital platforms and technology, companies may more effectively share best practices, coordinate joint initiatives, and exchange information, therefore promoting supply chain agility (28) Consequently, the agility of the digital supply chain improves organizational performance (29). According to (22), kelincahan involves using information, technology, and management of supply chain, thereby enabling businesses to react. quickly toward unanticipated disruptions. Achieving supply chain agility calls for the synchronization of internal resources, therefore allowing businesses to successfully adjust to unexpected shifts in the supply chain environment (30). In this study, (30,31) define digital supply chain agility as one whole comprising resiliency and agility.

Thirdly, it was discovered that digital supply chain agility greatly moderates the link between organizational performance and adoptions of the digital supply chain. These results match earlier studies by (32). According to dynamic capability theory, organizations must develop agility and get valuable digital assets in reaction to technological advancements and convert these resources. Fast passing (33)

Moreover, a great degree of digital supply chain efficiency was discovered to mediate the relationship between adopsi digital supply chain and organizational performance, therefore corroborating earlier results (15). These results point to the impact of digital transformation on organizational performance conveyed via enhancements in efficiency, therefore validating the hypothesis that digitalization acts as a driving force (34).

4. Conclusion

According to this study, small, medium, and micro businesses (MSMEs) benefit in terms of efficiency, agility, and overall performance from the adoption of digital supply chains. The results show that both agility and efficiency are major mediators of these impacts, therefore showing that digital transformation not only straightens performance but also It also increases operating efficiency and market change adaptation capacity. While greater agility boosts flexibility and responsiveness both critical for competitive success in the modern digital scene increased supply chain efficiency results in decreased waste and cheaper expenses. Practically speaking, this points to a need for improving infrastructure, boosting digital skills, and offering implementation support to fully realize the benefits. The introduction of digital supply chain agility and efficiency as mediating variables provides a deeper understanding and so constitutes the theoretical contribution of this research. of contradictory findings in past research and lays the groundwork for next studies on external influences including policy, ecosystem support, and new technologies.

5. Acknowledgement

The authors would like to express their sincere gratitude to the Directorate of Research, Community Service, and Publication (DPPM), Ministry of Higher Education, Science, and Technology, for the funding support provided in 2025. Indonesian instruction for the financial aid given for this project. They also want to recognize Universitas Peradaban for their institution support together with all the participants engaged, notably the MSME entrepreneurs from Banyumas Regency. who kindly participated as responders and offered insightful views that aided in concluding this study.

References

[1] Wangge YBR, Anggrismono A. Analisis Penyerapan Tenaga Kerja pada Sektor Usaha Mikro Kecil dan Menengah (UMKM) di Kabupaten Sleman. Jurnal Teknik Industri Terintegrasi. 2024 Jan 19;7(1):520–7. doi:10.31004/jutin.v7i1.25920

[2] Asri A, Aslan A, Soimah N. Pengaruh Usaha Mikro Kecil dan Menegah (UMKM) dan Tenaga Kerja Terhadap Produk Domestik Bruto (PDB) di Indonesia. Madani: Jurnal Ilmiah Multidisiplin. 2023;1(7).

[3] Kot S, Haque AU, Baloch A. Supply chain management in SMEs: Global perspective. Montenegrin journal of economics. 2020;16(1):87–104.

[4] Sutarmin S, Rastuti U. Analisis Rantai Nilai (VCA) Budidaya Tanaman Nilam dengan Pemodelan System Thinking Vensim PLE x 32. Fokus Bisnis Media Pengkajian Manajemen dan Akuntansi. 2022;21(2):188–97.

[5] Wu L, Zhang Z, Huang J, Su IH, Tian S. Digital Technologies and Supply Chain Resilience: A Resource-Action-Performance Perspective. Information Systems Frontiers. 2025 Mar 26. doi:10.1007/s10796-025-10595-1

[6] Omrani N, Rejeb N, Maalaoui A, Dabić M, Kraus S. Drivers of digital transformation in SMEs. IEEE Trans Eng Manag. 2022;71:5030–43.

[7] Zhang S, Gu C, Zhang P. The Effect of Supply Chain Digitalization on Firm Competitiveness: Evidence from China. Journal of the Knowledge Economy. 2025;1–29.

[8] Teece DJ, Pisano G, Shuen A. Dynamic capabilities and strategic management. Strategic Management Journal. 1997;18(7):509–33. doi:10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

[9] Sutarmin H, Haryadi H, Setianto NA. Harmony supply chain: A new construct towards company resilience. Supply Chain Management. 2020;9(2):157–64.

[10] Hair JF, Risher JJ, Sarstedt M, Ringle CM. When to use and how to report the results of PLS-SEM. European business review. 2019;31(1):2–24.
[11] Rasoolimanesh SM. Discriminant validity assessment in PLS-SEM: A comprehensive composite-based approach. 2022 Feb 1;1–8.
[12] Henseler J, Ringle CM, Sarstedt M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. J Acad Mark Sci. 2015 Jan 22;43(1):115–35. doi:10.1007/s11747-014-0403-8
[13] Hair J, Hollingsworth CL, Randolph AB, Chong AYL. An updated and expanded assessment of PLS-SEM in information systems research. Industrial Management & Data Systems. 2017 Apr 10;117(3):442–58. doi:10.1108/IMDS-04-2016-0130
[14] Hu M, Chaudhry SS. Enhancing consumer engagement in e-commerce live streaming via relational bonds. Internet Research. 2020 May 18;30(3):1019–41. doi:10.1108/INTR-03-2019-0082
[15] Salamah E, Alzubi A, Yinal A. Unveiling the Impact of Digitalization on Supply Chain Performance in the Post-COVID-19 Era: The Mediating Role of Supply Chain Integration and Efficiency. Sustainability. 2023 Dec 28;16(1):304. doi:10.3390/su16010304
[16] Büyüközkan G, Göçer F. Digital Supply Chain: Literature review and a proposed framework for future research. Comput Ind. 2018 May;97:157–77. doi:10.1016/j.compind.2018.02.010
[17] Zhao N, Hong J, Lau KH. Impact of supply chain digitalization on supply chain resilience and performance: A multi-mediation model. Int J Prod Econ. 2023;259:108817.
[18] Björkdahl J. Strategies for Digitalization in Manufacturing Firms. Calif Manage Rev. 2020 Aug 5;62(4):17–36. doi:10.1177/0008125620920349
[19] Gorbach G. The great digitization of industry. Supply Chain Managment Review, September/October. 2017;24–9.
[20] Wang M, Hill A, Liu Y, Hwang K, Lim MK. Supply Chain Digitalization and Agility: How Does Firm Innovation Matter in Companies? Journal of Business Logistics. 2025 Jan 27;46(1). doi:10.1111/jbl.70007
[21] Shashi, Centobelli P, Cerchione R, Ertz M. Managing supply chain resilience to pursue business and environmental strategies. Bus Strategy Environ. 2020 Mar 29;29(3):1215–46. doi:10.1002/bse.2428
[22] Swafford PM, Ghosh S, Murthy N. Achieving supply chain agility through IT integration and flexibility. Int J Prod Econ. 2008 Dec;116(2):288–97. doi:10.1016/j.ijpe.2008.09.002
[23] Lim MK, Li Y, Wang C, Tseng ML. A literature review of blockchain technology applications in supply chains: A comprehensive analysis of themes, methodologies and industries. Comput Ind Eng. 2021 Apr;154:107133. doi:10.1016/j.cie.2021.107133
[24] Wang ETG, Wei H. Interorganizational Governance Value Creation: Coordinating for Information Visibility and Flexibility in Supply Chains*. Decision Sciences. 2007 Nov 7;38(4):647–74. doi:10.1111/j.1540-5915.2007.00173.x
[25] Gligor DM, Holcomb MC. Antecedents and Consequences of Supply Chain Agility: Establishing the Link to Firm Performance. Journal of Business Logistics. 2012 Dec 13;33(4):295–308. doi:10.1111/jbl.12003

[26] Vial G. Understanding digital transformation: A review and a research agenda. The Journal of Strategic Information Systems. 2019 Jun;28(2):118–44. doi:10.1016/j.jsis.2019.01.003

[27] Seyedghorban Z, Tahernejad H, Meriton R, Graham G. Supply chain digitalization: past, present and future. Production Planning & Control. 2020 Feb 17;31(2–3):96–114. doi:10.1080/09537287.2019.1631461

[28] Wang M, Hill A, Liu Y, Hwang K, Lim MK. Supply chain digitalization and agility: how does firm innovation matter in companies? Journal of Business Logistics. 2025;46(1):e70007.

[29] Al Tera A, Alzubi A, Iyiola K. Supply chain digitalization and performance: A moderated mediation of supply chain visibility and supply chain survivability. Heliyon. 2024 Feb;10(4):e25584. doi:10.1016/j.heliyon.2024.e25584

[30] Sheng ML, Saide S. Supply chain survivability in crisis times through a viable system perspective: Big data, knowledge ambidexterity, and the mediating role of virtual enterprise. J Bus Res. 2021 Dec;137:567–78. doi:10.1016/j.jbusres.2021.08.041

[31] Ivanov D. Viable supply chain model: integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 pandemic. Ann Oper Res. 2022 Dec 22;319(1):1411–31. doi:10.1007/s10479-020-03640-6

[32] Elmouhib S, Idrissi ZY. Agility in the Digital Era: Bridging Transformation and Innovation in Supply Chains. Sustainability. 2025 Apr 13;17(8):3462. doi:10.3390/su17083462

[33] Teece D, Peteraf M, Leih S. Dynamic Capabilities and Organizational Agility: Risk, Uncertainty, and Strategy in the Innovation Economy. Calif Manage Rev. 2016 Aug 1;58(4):13–35. doi:10.1525/cmr.2016.58.4.13

[34] Ngo VM, Nguyen HH, Pham HC, Nguyen HM, Truong PVD. Digital supply chain transformation: effect of firm's knowledge creation capabilities under COVID-19 supply chain disruption risk. Operations Management Research. 2023 Jun 14;16(2):1003–18. doi:10.1007/s12063-022-00326-z