Asian Journal of Management Analytics (AJMA)
Vol. 4, No. 2, 2025: 571-586

Achieving Sustainability in Supply Chain: The Dual Role of Digital Transformation and Integration

Cyrril Ario Damar[1*], Siti Nursyamsiah[2]
Fakultas Bisnis dan Ekonomika, Universitas Islam Indonesia, Yogyakarta, Indonesia
Corresponding Author: Cyrril Ario Damar 21311593@students.uii.ac.id

A R T I C L E I N F O

Keywords: Digital Transformation, Supply Chain Integration, Sustainability Performance, Internal Integration, Supplier Integration

Received : 4, March
Revised : 20, March
Accepted: 22, April

A B S T R A C T

This study aims to analyze the impact of Digital Transformation on sustainability performance, with supply chain integration as a mediating variable in manufacturing companies in Indonesia. This study employs a quantitative approach using purposive sampling, resulting in 215 respondents from manufacturing companies in Indonesia. Data was collected through an online survey via Google Forms and analyzed using Structural Equation Modeling (SEM) based on Partial Least Squares (PLS). The findings indicate that Digital Transformation does not directly affect sustainability performance. However, Digital Transformation positively influences Internal Integration, Supplier Integration, and Customer Integration. Furthermore, Internal Integration and Supplier Integration positively impact sustainability performance, whereas Customer Integration does not. Additionally, Internal Integration and Supplier Integration mediate the relationship between Digital Transformation and sustainability performance.

DOI: https://doi.org/10.55927/ajma.v4i2.14298
ISSN-E: 2963-4547
https://journal.formosapublisher.org/index.php/ajma

INTRODUCTION

In the modern business landscape, digital technologies play a vital role in supply chain management, strengthening digital transformation as a new driving component for corporate development (Meng et al., 2023). The gradual advancement of technology has pushed many companies to adopt digital transformation, because it theoretically allows organizations to increase process efficiency and optimize resource management (L. Li, 2022). Digitalization has great potential to improve efficiency, transparency and sustainability in corporate operations, while digital transformation supports sustainability goals by improving process control and auditing (J. Y. Ma et al., 2023).

Despite its great potential, the implementation of digital transformation in the supply chain to achieve sustainability is still not optimal. Many companies still have difficulty in effectively integrating digital systems with their supply chains, both in terms of technology and collaboration between suppliers and customers (Oubrahim et al., 2023). The main barriers to achieving optimal sustainability performance are environmental uncertainty and the lack of synergy between digital transformation and supply chain practices (Ning & Yao, 2023).

This study aims to analyze the combined effect of digital transformation and supply chain integration on sustainability performance. Specifically, this study focuses on how the implementation of digital transformation accompanied by supply chain integration, both internally and externally, can contribute to sustainability performance in economic, social, and environmental aspects (Meng et al., 2023).

This research has relevance and significance because it provides insights for companies, especially managers, in designing integrated digital-based sustainability strategies. The results of this study can offer a framework for companies to maximize operational efficiency while achieving stronger sustainability. For academics, this study is expected to fill the research gap related to the impact of digital transformation and supply chain integration on sustainability performance (Lee, 2021).

LITERATURE REVIEW

Digital Transformation

Digital transformation is a series of activities undertaken to create value closely related to technological innovation within a company, utilizing openly provided data resources efficiently to restructure business processes and models. Digitalization has eliminated physical boundaries, transformed organizational operational perceptions, and fundamentally realized value. Digital transformation benefits companies by enhancing service quality, predicting customer behavior more accurately, and significantly reducing production, operational, and management costs (Meng et al., 2023). According to Oubrahim et al. (2023), digital transformation encompasses digital platforms, infrastructure, high-class asset management, political and lexical capabilities, and supporting and necessary technologies. Technologies associated with digital transformation include sensors and tracking devices that provide data and insights to optimize supply chain operations. Digitalization offers companies opportunities to

dynamically meet customer needs in a timely manner, address supply chain management challenges, and achieve competitive advantage. Supply chain integration is divided into two categories: internal and external integration. Digital transformation is described as the integration of digital technology into all aspects of a business to enhance efficiency, innovation, and customer value. Researchers define digital transformation as a systematic approach enabling companies to collect, analyze, and utilize data more efficiently to optimize corporate performance, both in operations and market strategy. Digital transformation provides significant benefits, including increased operational efficiency, cost savings, and improved adaptability to market changes (L. Li, 2022). It fundamentally alters business processes by digitalizing everything that can be digitized, aiming for stronger collaboration in business processes through the use of smart technologies (Nasiri et al., 2020).

Supply Chain Integration

Supply chain integration refers to the strategic collaboration between companies and their supply chain partners to manage and optimize the flow of resources, information, and products across the entire supply chain network. Cooperation among supply chain partners helps companies adapt and respond quickly to market changes, aiming to achieve higher efficiency, improve product quality, reduce delivery or distribution time, and enhance responsiveness to market demand (Meng et al., 2023). According to Oubrahim et al. (2023), integration practices among supply chain partners continue to grow due to intense global competition and evolving customer demand patterns. Supply chain integration reflects the extent to which all business activities within a company align with suppliers, customers, and other supply chain partners. Companies recognize that developing strategies and integrating internal functions, suppliers, and customers is essential for achieving competitive advantage. Supply chain integration is a multidimensional concept. L. Li (2022) defines supply chain integration as the process of aligning internal and external functions and activities to improve efficiency and responsiveness to market needs and demands. It involves close collaboration among manufacturers, suppliers, and customers to ensure an effective flow of information, materials, and products throughout the supply chain. The level of supply chain integration is determined by how strategically manufacturers collaborate with partners and manage both intra-company and inter-company processes. The goal is to enhance the efficiency and effectiveness of product and service flows, information, financial transactions, and decision-making processes, ultimately maximizing customer value with lower costs and higher speed. Supply chain integration consists of three dimensions: internal integration and external integration, which includes supplier and customer dimensions (Flynn et al., 2010).

Sustainability Performance

Sustainability is a crucial aspect of business operations, encompassing the triple bottom line: economic, social, and environmental performance. Many companies have implemented sustainable supply chain practices to enhance economic performance, increase social responsibility, and reduce environmental

impact. Digital transformation positively influences sustainability performance by improving information flow, collaboration, and decision-making within supply chain practices. According to Meng et al. (2023), sustainability performance refers to a company's ability to achieve economic, environmental, and social goals while minimizing negative impacts on stakeholders. Stroumpoulis & Kopanaki (2022) describe sustainability performance as the management of material, information, and capital flows, along with corporate collaboration throughout the supply chain, while considering the objectives of the three-dimensional pillars of sustainability performance. Sustainable supply chain performance is achieved through sustainability development, requiring performance evaluations beyond traditional efficiency, effectiveness, and economic factors.

Instead, environmental, economic, and social sustainability must be integrated simultaneously, as government and stakeholder pressures drive this integration. From the perspective of dynamic capabilities, achieving sustainability performance can be approached through risk management and digital network capability management (L. Ma et al., 2023). Sustainability performance represents an organization's capacity to achieve results that go beyond economic objectives, positively impacting both the environment and society. This concept is often depicted through the triple bottom line, which includes financial profitability, social responsibility, and environmental stewardship, emphasizing the need for organizations to consider all three aspects to achieve sustainable performance (Elkington, 1998).

Hypotheses Development

Digital Transformation and Sustainability Performance

Digital Transformation can drive performance improvements and can ensure that information is used more efficiently. Digital technology allows for broader data vision capabilities, real-time decision making, automation, and collaboration (Meng et al., 2023). Digital transformation in the supply chain can increase the efficiency of business processes through the use of technology systems that will have an impact on reducing production and transaction costs, as well as increasing inventory turnover (Liu & Chiu, 2021). Along with the development of the times, many new technologies have emerged that can create new business models, thus directing companies to increase sustainable results with the principles of economic circulation (Dudukalov et al., 2021).

H1: Digital Transformation has a positive influence on Sustainability Performance.

Digital Transformation and Supply Chain Integration

Digital technology is a strategic resource that enables companies to integrate products and services functionally, organizationally and geographically (Meng et al., 2023). Digital transformation plays a role in increasing the efficiency and effectiveness of supply chain integration, both internally and externally, through the use of technologies such as ERP and CRM that enable process coordination and continuous improvement of company performance (Liu & Chiu, 2021; Oubrahim et al., 2023). Internal integration

includes data systems, inventory monitoring, and management of corporate functions with blockchain technology, while external integration involves aligning strategies with suppliers and customers to increase market competitiveness (Oubrahim et al., 2023). In addition, strategic partnerships based on trust and collaborative culture with suppliers are important factors in maintaining long-term relationships and identifying sustainability challenges in the supply chain (Kang et al., 2018).

H2a: Digital Transformation has a positive influence on Internal Integration.
H2b: Digital Transformation has a positive influence on Supplier Integration.
H2c: Digital Transformation has a positive influence on Customer Integration.

Supply Chain Integration and Sustainability Performance

Supply chain integration has a positive impact on sustainability performance due to increasing volatility in market demand, making supply chain risk management increasingly important (Oubrahim et al., 2023). To achieve competitive advantage, companies need to combine internal and external functions by building strong collaboration and coordination in the supply chain. Internal integration focuses on solving functional problems through information sharing, joint decision making, and cross-functional work, while external integration encourages long-term partnerships with suppliers and a better understanding of customer needs (Kang et al., 2018). Strategic partnerships with suppliers enable companies to identify sustainability challenges and improve operational efficiency, while customer integration contributes to improving customer satisfaction and company competitiveness. Therefore, an optimal level of supply chain integration can strengthen supply chain management capabilities and support overall sustainability performance practices.

H3a: Internal Integration has a positive influence on Sustainability Performance.
H3b: Supplier Integration has a positive influence on Sustainability Performance.
H3c: Customer Integration has a positive influence on Sustainability Performance

Supply Chain Integration, Digital Transformation and Sustainability Performance

Digital transformation not only contributes directly to sustainability performance, but also forms the basis for more effective supply chain integration (Meng et al., 2023). Through internal integration, companies can manage data and collaborate in real-time to achieve sustainability goals (L. Li et al., 2018). Technologies such as blockchain and the Internet of Things increase transparency and efficiency in supplier relationships, enabling more optimal resource management and waste reduction (Gong, 2018). In addition, customer integration through data analytics, CRM, and e-commerce helps businesses understand and meet customer expectations for sustainability (Kang et al., 2018) Thus, supply chain integration acts as a mediating mechanism that strengthens the impact of digital transformation on sustainability performance.

H4a: Internal Integration mediates the relationship between Digital Transformation and Sustainability Performance.

H4b: Supplier Integration mediates the relationship between Digital Transformation and Sustainability Performance.
H4c: Customer Integration mediates the relationship between Digital Transformation and Sustainability Performance.

Research Framework

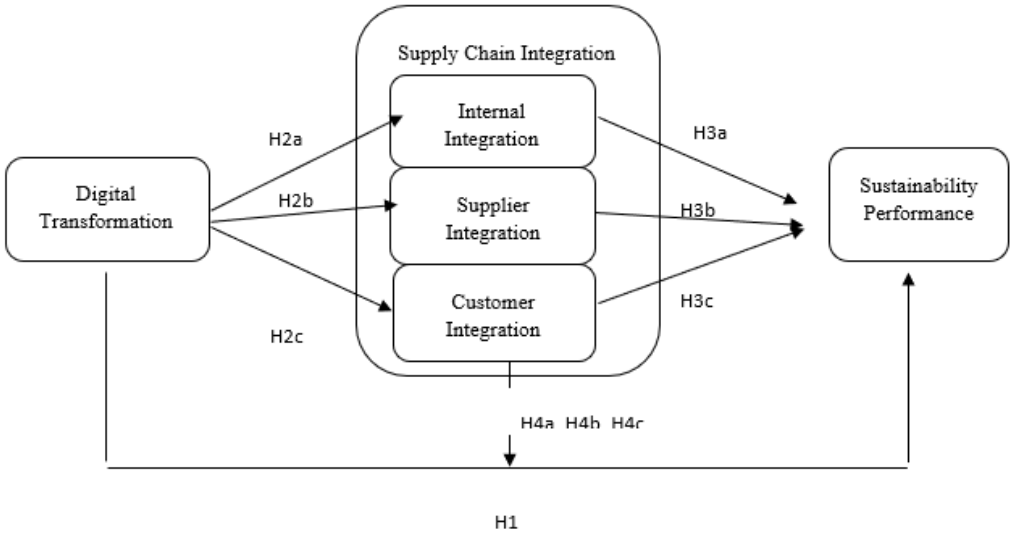

Figure 1. Research Framework

METHODOLOGY

This study employs a quantitative approach using a survey method to collect data through questionnaires distributed to manufacturing companies in Indonesia. A quantitative approach was chosen as it allows for measuring relationships between variables using statistical analysis, providing more objective results that can be generalized to a broader population (Sugiyono, 2020). The objective of this study is to examine the impact of digital transformation and supply chain integration on sustainability performance (Meng et al., 2023).

The population refers to a generalized area consisting of subjects or objects with specific qualities and characteristics selected by researchers for study, from which conclusions are drawn (Sugiyono, 2020). The population in this study comprises manufacturing companies in Indonesia, totaling 32,193 companies as of 2023.

According to (Sugiyono, 2020), a sample is derived from the population based on specific characteristics. If the population is too large for researchers to examine all aspects due to financial, labor, or time constraints, a representative sample can be used to draw conclusions applicable to the entire population. Hair et al. (2017) suggest that obtaining an excessively large sample can complicate model estimation; thus, a recommended sample size is between 100 and 200 respondents to adequately represent the population. This study collected data from 215 manufacturing companies in Indonesia.

Primary data was gathered through a structured questionnaire divided into two main sections. The first section collected demographic information

about the companies and respondents, while the second section focused on measuring constructs related to Digital Transformation, Supply Chain Integration, and Sustainability Performance using a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

This study is structured around five constructs: Digital Transformation, Internal Integration, Supplier Integration, Customer Integration, and Sustainability Performance. The Digital Transformation indicators were adopted from the research conducted by Meng et al. (2023). The Internal Integration indicators were also based on Meng et al. (2023), while Supplier Integration indicators were adapted from Flynn et al., (2010). The Customer Integration indicators were derived from both Meng et al. (2023) and Flynn et al. (2010). whereas Sustainability Performance indicators were adopted from Meng et al. (2023)

Data analysis in this study was conducted using Structural Equation Modeling-Partial Least Squares (SEM-PLS) to explore the relationships between Digital Transformation, Supply Chain Integration, and Sustainability Performance. The analysis was performed in two stages: evaluation of the measurement model (Outer Model) and evaluation of the structural model (Inner Model). The target population in this study includes manufacturing companies in Indonesia. A total of 215 manufacturing companies participated, Directors or general managers, supervisors, employees or staff, and other stakeholders directly involved in the company's business processes.

RESEARCH RESULT AND DISCUSSION

Data Analysis

Data analysis in this study was conducted using Structural Equation Modeling-Partial Least Squares (SEM-PLS) to explore the relationship between Digital Transformation, Supply Chain Integration, and Sustainability Performance. The demographic profiles of respondents, including information related to Industrial Type, Company Size, Number of Employees, Market Share, and Position.

Table 1. Respondent Demographic

Respondent Demographics		Frequency	Percent
Industrial Type	Automotive	37	17.2%
	Electronics	37	17.2%
	Food and Beverage	48	22.3%
	Chemicals	27	12.6%
	Textiles	34	15.8%
	Mining	32	14.9%
Company Size	Small	69	32.1%
	Middle	112	52.1%
	Big	34	15.8%

Number of Employees	<50	58	27.0%
	50-200	96	44.7%
	201-500	48	22.3%
	>500	13	6.0%
Market Share	Local	75	34.9%
	National	87	40.5%
	Regional (southeast Asia)	30	14.0%
	International	23	10.7%
Position	Director / General Manager	53	24.7%
	Supervisor	72	33.5%
	Employee/staff	89	41.4%
	Marketing	1	0.5%

Source: Processed Data, 2025

Respondent profiles can be described based on several categories, namely industry type, company size, market share, number of employees, and respondent position. The data shows that the majority of manufacturing companies participating in this study operate in the food and beverage sector, consisting of 48 respondents or around 22.3% of the total respondents. In addition, 37 (17.2%) respondents are involved in the automotive and electronics industry, 34 (15.8%) respondents in the textile sector, 32 (14.9%) in the mining sector and 27 (12.6%) in the chemical sector. The size of the company based on revenue in this questionnaire was filled in by the majority of medium-sized companies with a total of 112 respondents or 52.1% of the total respondents. In addition, small companies 69 (32.1%) respondents and large companies 34 (15.8%). The number of employees in manufacturing companies that filled out this questionnaire mostly had 50-200 employees or 44.7% of the total respondents. In addition, companies that have <50 employees are 58 (27%), those with 201-500 employees are 48 (22.3%) respondents and the smallest >500 are 13 (6%) respondents. Furthermore, based on market share, most operate in the national market, with 87 companies, or 40.5%. In addition, companies that enter the local market are 75 (34.9%), regional markets 30 (14%), and international 23 (10.7%) respondents. In this study, the majority of respondents who participated were in the position of employees or staff, namely 89 people (41.4%). Then in the position of supervisor with a total of 72 (33.5%), director or general manager 53 (24.7%) and marketing only 1 (0.5%) respondent.

In this data processing, 20 indicators from 5 variables were removed. According to Hair et al. (2017), an indicator should be retained if it has a value greater than 0.4, while those below this threshold are recommended to be

removed or eliminated. Several indicators within the defined variables have been removed, reducing their numbers in each category. In Digital Transformation, the indicators have been reduced from six to two, retaining only business process efficiency and employee involvement in digitalization. Meanwhile, in Internal Integration, the number of indicators has been reduced from five to two, keeping only collaboration between departments using technology and the implementation of digitalization across the company, while indicators related to information exchange and internal responsiveness systems have been removed. Supplier Integration has also been reduced from five to two indicators, with only regular information sharing with key suppliers and process synchronization with business partners retained, while supplier involvement in product innovation and efficient order coordination has been removed.

A similar reduction occurred in Customer Integration, where the number of indicators was reduced from five to two, keeping only digital communication with customers and systems that support responsiveness to customer needs, while other indicators were removed. In Sustainability Performance, the number of indicators was reduced from nine to two, retaining only the creation of a supportive work environment and the use of technology in waste management, while indicators related to revenue growth, cost efficiency, profit growth, and corporate social contributions were removed. With these changes, the remaining indicators focus more on strategic aspects that have a tangible impact on internal efficiency, digital integration with partners, and sustainability in environmental management and employee well-being.

To obtain a clearer and more accurate description of each studied variable, the initial step involves testing the validity and reliability of the research instrument. The validity test ensures that the instrument accurately measures the intended variable, while the reliability test assesses the consistency of the measurement results when repeated under the same conditions. Ensuring both validity and reliability enhances the credibility of the collected data, making it a more dependable foundation for hypothesis analysis. The analysis was conducted in two stages: evaluation of the measurement model (Outer Model) and evaluation of the Structural model (Inner Model).

Measurement Model Evaluation

The measurement model is assessed in terms of validity and reliability to ensure that the constructs are measured appropriately. Convergent validity is evaluated using the Outer Loading and Average Variance Extracted (AVE) indicators. All indicators tested have Outer Loading above the accepted threshold of 0.70, indicating that convergent validity is declared valid. The AVE value for all constructs exceeds 0.50, indicating that most of the variance is explained by the latent variables. Reliability is assessed using Cronbach's alpha and Composite Reliability. The composite reliability of all constructs has a value above 0.70, while Cronbach's alpha has a value below 0.70 because the constructs only use a few indicators. This still shows that the construct has good consistency even though it has a Cronbach's alpha value below 0.70, as presented in table 2.

Table 2. Construct Outer Model

Construct	Item	*Outer Loading*	AVE	Cronbach's Alpha	Composite Reliability
Digital Transformation	X5	0.805	0.607	0.353	0.755
	X6	0.752			
Internal Integration	Z1.2	0.870	0.665	0.503	0.798
	Z1.3	0.757			
Supplier Integration	Z2.4	0.787	0.570	0.247	0.726
	Z2.5	0.721			
Customer Integration	Z3.1	0.804	0.621	0.390	0.766
	Z3.4	0.772			
Sustainability Performance	Y5	0.799	0.676	0.523	0.807
	Y8	0.846			

Source: Processed Data, 2025

Structural Model Evaluation

In this study, the results of the bootstrapping analysis can be seen in Figure 1 below. Meanwhile, the results of the path coefficient can be seen in Table 3 and Table 4 (mediation), with the results of the path coefficient showing that most of the research hypotheses are supported, but there are three supported hypotheses. The supported hypothesis has a T-Statistic value of more than 1.96 and the P value must be less than 0.05, while the unsupported hypothesis has a T-Statistic value of less than 1.96 and a P value of more than 0.05. Tables 3 and 4 below provide a detailed explanation of the path coefficient test.

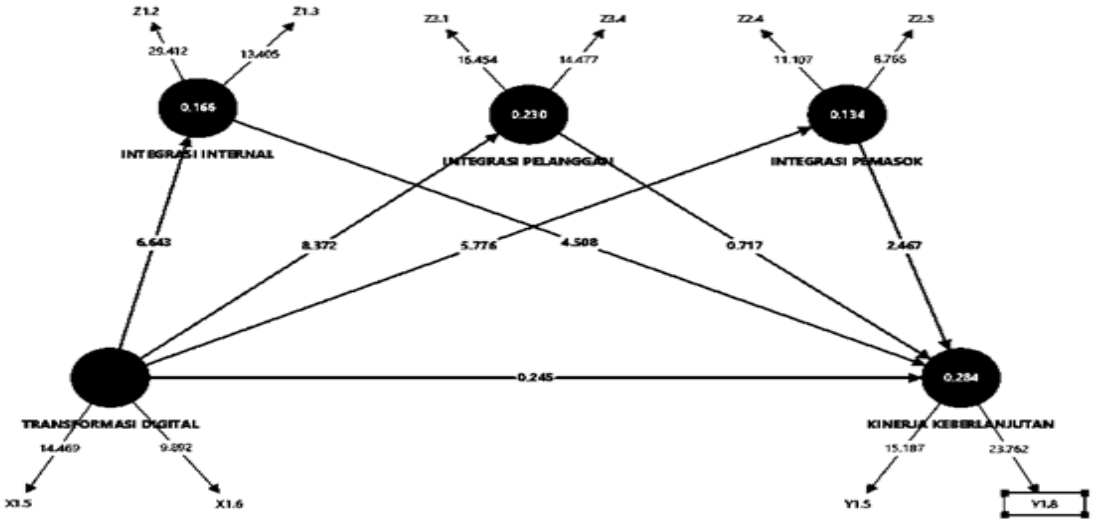

Figure 2. Hypothesized Model

The structural model was analyzed to test the hypothesized relationships between Digital Transformation, Intenal Integration, Supplier Integration, Customer Integration, and Sustainability Performance. The analysis shows that Digital Transformation has a significant positive effect on Internal Integration, Supplier Integration, and Customer Integration; but has no effect on Sustainability Performance. This shows that good Digital Transformation will

improve Supply Chain Integration but in it's implementation Digital Transformation does not always have a direct impact on Sustainability Performance within the company. And Internal Integration and Customer Integration have a positive and significant effect on Sustainability Performance but Customer Integration has no effect on Sustainability Performance as shown in table 3. The mediation analysis in table 4 reveals that Internal Integration and Supplier Integration significantly mediate the relationship between Digital Transformation and Sustainability Performance but Customer Integration does not significantly mediate the relationship between Digital Transformation and Sustainability Performance. These findings underscore the importance of Supply Chain Integration as an important factor in linking Digital Transformation to Sustainability Performance.

Table 3. Path Coefficients

	Standard Deviation	T Statistics (|O/STDEV|)	P-values	Results
DT -> SP	0.070	0.245	0.806	H1 Not accepted
DT -> II	0.071	6,643	0.000	H2a Accepted
DT -> SI	0.063	5,776	0.000	H2b Accepted
DT -> CI	0.057	8,372	0.000	H2c Accepted
II -> SP	0.080	4,508	0.000	H3a Accepted
SI -> SP	0.078	2,467	0.014	H3b Accepted
CI -> SP	0.076	0.717	0.474	H3c Not accepted

Source: Processed Data, 2025

Table 4. Mediation Path Estimates

	Standard Deviation	T Statistics (|O/STDEV|)	P-values	Results
DT -> II -> SP	0.041	3,630	0.000	H4a Accepted
DT -> SI -> SP	0.033	2.160	0.031	H4b Accepted
DT -> CI -> SP	0.038	0.696	0.487	H4c Not accepted

Source: Processed Data, 2025

The results of this study provide important insights into the dynamics between Digital Transformation, Internal Integration, Supplier Integration, Customer Integration, and Sustainability Performance in the context of manufacturing companies in Indonesia. The analysis confirms the hypothesis that Digital Transformation has an indirect impact on Sustainability Performance. In addition, Internal Integration and Supplier Integration are found to play an important role in strengthening the relationship between Digital Transformation and Sustainability Performance. However, Customer Integration

is found to have no strong role in the relationship between Digital Transformation and Sustainability Performance.

The impact of Digital Transfomation that does not affect Sustainability Performance underlines that although digital transformation can improve efficiency in operations, in its implementation it does not always have a direct impact on sustainability performance within the company. This may be due to the lack of integration of sustainability strategies in digital transformation initiatives. In addition, this result is in line with the statement (Mohaghegh et al., 2024) that adopting digital technology does not directly impact sustainability performance, this is due to various factors such as organizational readiness, corporate culture, and effective technology integration playing an important role in determining the impact of digital transformation on sustainability.

The impact of Digital Transformation on Supply Chain Integration states the importance of effective Digital Transformation in achieving superior Supply Chain Integration. The implementation of Digital Transformation strengthens Internal Integration to improve coordination and communication between departments. In addition, the application of Digital Transformation to Supplier Integration provides facilities for more era collaboration between companies and suppliers so as to improve supply chain efficiency and responsiveness. And the application of Digital Transformation to Customer Integration allows companies to have closer relationships with customers, be more responsive to customer needs and preferences, and increase customer interaction and engagement.

This finding is in line with previous studies that highlight the importance of Digital Transformation in improving the efficiency of Internal, Supplier, and customer (Anthony & Hamali, 2019; Cui et al., 2023; J. Li et al., 2024; Oubrahim et al., 2023). These results reinforce the assertion that companies must prioritize Digital Transformation to improve the effectiveness of their Supply Chain Integration.

The mediation effect of Internal Integration, Supplier Integration, Customer Integration on the relationship between Digital Transformation and Sustainability Performance is one of the important findings in this study. This mediation shows that the benefits of Digital Transformation are not only direct but also significantly enhanced through Internal Integration and Supplier Integration. However, it is not significantly enhanced by Customer Integration. If manufacturing companies implement good Internal Integration, Supplier Integration, and Customer Integration, they are in a better position to achieve Sustainability Performance because the flow of information between departments can run more efficiently, collaboration between companies and suppliers facilitated by digital technology will be more effective and have good responsibility in aligning customer needs with customer needs initiatives.

The role of Supply Chain Integration including Internal Integration, Supplier Integration, and Customer Integration as a mediator is very important in the context of manufacturing companies, which often face operational challenges. By promoting Supply Chain Integration, manufacturing companies can overcome these challenges and leverage Digital Transformation more effectively to achieve Sustainability Performance. This finding is in line with the

literature that emphasizes the importance of Supply Chain Integration in achieving sustainable performance (Cui et al., 2023; J. Li et al., 2024; Oubrahim et al., 2023).

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis and hypothesis testing on manufacturing companies in Indonesia, it was found that Digital Transformation does not have a direct effect on Sustainability Performance. However, Digital Transformation has a positive and significant effect on Internal Integration, Supplier Integration, and Customer Integration. Furthermore, only Internal Integration and Supplier Integration have a positive effect on Sustainability Performance, while Customer Integration does not have a significant effect. In addition, Internal Integration and Supplier Integration are proven to be significant mediators in the relationship between Digital Transformation and Sustainability Performance, while Customer Integration does not have a mediating role in the relationship.

The managerial implications of this study confirm that digital transformation does not directly improve sustainability performance, so manufacturing companies must integrate digital technology into the supply chain to gain maximum benefits. Digital transformation has been shown to strengthen internal, supplier, and customer integration, which can improve operational coordination and efficiency. Therefore, investment in digital infrastructure such as ERP and SCM is crucial. In addition, internal and supplier integration has a positive effect on sustainability, while customer integration is not significant, so companies need to focus more on optimizing internal processes and collaborating with suppliers, for example through IoT-based technology and sustainability standards in supplier selection. The success of digital transformation in improving sustainability is highly dependent on the effectiveness of internal and supplier integration, so companies need to develop a structured and synergistic digitalization strategy with business partners. In addition, customer involvement in digital strategies must be further studied in order to have a more significant impact on the company's sustainability.

Several limitations of this study need to be considered: (1) Limited sample area, the majority of respondents come from manufacturing companies in Kalimantan and Java, so the results of the study are less able to describe the conditions of manufacturing companies throughout Indonesia. (2) Data collection method, data was obtained through an online survey using Google Form, which risks causing ambiguity or misunderstanding in understanding the questions, so that it can affect the quality of respondents' answers. (3) Weaknesses of research indicators, several indicators in the study have values below 0.4, so they must be removed so as not to affect the validity and reliability of the analysis results.

ADVANCED RESEARCH

Building upon the findings and limitations of this study, future advanced research should aim to explore the nuanced mechanisms through which digital transformation can more effectively drive sustainability performance in

manufacturing sectors across broader geographical regions in Indonesia. A more representative sample, encompassing diverse industrial zones beyond Kalimantan and Java, could offer deeper insights into regional disparities in digital adoption and integration capabilities. Additionally, employing mixed-method data collection approaches—combining qualitative interviews with quantitative surveys—may enhance the depth and accuracy of respondents' interpretations. Future studies should also refine and validate measurement instruments to ensure higher indicator reliability and validity. Moreover, since customer integration did not show a significant impact on sustainability performance, further investigation is required to identify potential moderating or mediating variables (e.g., customer digital literacy, market orientation, or co-creation practices) that could strengthen this link. Research can also be expanded to examine sector-specific digital strategies and the role of emerging technologies such as blockchain, artificial intelligence, and big data analytics in enhancing supply chain sustainability. Ultimately, a longitudinal approach could be adopted to assess the long-term effects of digital transformation initiatives on sustainability outcomes, providing a more dynamic understanding of their impact over time.

REFERENCES

Anthony, K., & Hamali, S. (2019). Pengaruh Integrasi…. / Adhitya Trubus Hanggara, Kelvin Anthony, Stephanie, Sambudi Hamali. 16(2), 127–140.

Cui, L., Wu, H., Wu, L., Kumar, A., & Tan, K. H. (2023). Investigating the relationship between digital technologies, supply chain integration and firm resilience in the context of COVID-19. Annals of Operations Research, 327(2), 825–853. https://doi.org/10.1007/s10479-022-04735-y

Dudukalov, E. V., Terenina, I. V., Perova, M. V., & Ushakov, D. (2021). Industry 4.0 readiness: The impact of digital transformation on supply chain performance. E3S Web of Conferences, 244, 1–11. https://doi.org/10.1051/e3sconf/202124408020

Elkington, J. (1998). Partnerships from cannibals with forks: The triple bottom line of 21st-century business. Environmental Quality Management, 8(1), 37–51. https://doi.org/10.1002/tqem.3310080106

Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. Journal of Operations Management, 28(1), 58–71. https://doi.org/10.1016/j.jom.2009.06.001

Gong, Y., Jia, F., Brown, S. and Koh, L. (2018). Supply Chain Learning of Sustainability in Multi-tier Supply Chains: A resource orchestration perspective. International Journal of Operations and Production Management, 38(4), 1061–1090. supply chain learning, multi-tier supply chain, resource orchestration, %0Agovernance mechanisms, Sustainability, Case study

Hair, J. F., Hult, G. T., Ringle, C., & Sarstedt, M. (2017). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) - Joseph F. Hair, Jr., G. Tomas M. Hult, Christian Ringle, Marko Sarstedt. In Sage.

Kang, M., Yang, M. G. (Mark), Park, Y., & Huo, B. (2018). Supply chain integration and its impact on sustainability. Industrial Management and Data Systems, 118(9), 1749–1765. https://doi.org/10.1108/IMDS-01-2018-0004

Lee, S. Y. (2021). Sustainable supply chain management, digital-based supply chain integration, and firm performance: a cross-country empirical comparison between south korea and vietnam. Sustainability (Switzerland), 13(13). https://doi.org/10.3390/su13137315

Li, J., Zhong, D., Ru, H., & Jia, L. (2024). Assessing the Nexus between Supplier and Customer Integration and Environmental Cost Performance: Insights into the Role of Digital Transformation. Sustainability (Switzerland), 16(14). https://doi.org/10.3390/su16145989

Li, L. (2022). Digital transformation and sustainable performance: The moderating role of market turbulence. Industrial Marketing Management, 104(April), 28–37. https://doi.org/10.1016/j.indmarman.2022.04.007

Li, L., Su, F., Zhang, W., & Mao, J. Y. (2018). Digital transformation by SME entrepreneurs: A capability perspective. Information Systems Journal, 28(6), 1129–1157. https://doi.org/10.1111/isj.12153

Liu, K. P., & Chiu, W. (2021). Supply Chain 4.0: the impact of supply chain digitalization and integration on firm performance. Asian Journal of Business Ethics, 10(2), 371–389. https://doi.org/10.1007/s13520-021-00137-8

Ma, J. Y., Shi, L., & Kang, T. W. (2023). The Effect of Digital Transformation on the Pharmaceutical Sustainable Supply Chain Performance: The Mediating Role of Information Sharing and Traceability Using Structural Equation Modeling. Sustainability (Switzerland), 15(1), 1–21. https://doi.org/10.3390/su15010649

Ma, L., Zhang, X., & Dong, L. (2023). Enhancing Sustainable Performance: The Innovative Strategy of Digital Transformation Leading Green Collaborative Management. Sustainability (Switzerland), 15(17). https://doi.org/10.3390/su151713085

Meng, J., Hao, Z., Yang, J., & Hong, Y. (2023). How does digital transformation affect organisational sustainable performance: the mediating roles of supply chain agility and integration. International Journal of Logistics Research and Applications, 1–26. https://doi.org/10.1080/13675567.2023.2257139

Mohaghegh, M., Blasi, S., Russo, I., & Baldi, B. (2024). Digital transformation and sustainable performance: the mediating role of triple-A supply chain capabilities. Journal of Business and Industrial Marketing, August. https://doi.org/10.1108/JBIM-02-2023-0098

Nasiri, M., Ukko, J., Saunila, M., & Rantala, T. (2020). Managing the digital supply chain: The role of smart technologies. Technovation, 96–97(January), 102121. https://doi.org/10.1016/j.technovation.2020.102121

Ning, L., & Yao, D. (2023). The Impact of Digital Transformation on Supply Chain Capabilities and Supply Chain Competitive Performance. Sustainability (Switzerland), 15(13), 1–22. https://doi.org/10.3390/su151310107

Oubrahim, I., Sefiani, N., & Happonen, A. (2023). The Influence of Digital Transformation and Supply Chain Integration on Overall Sustainable Supply Chain Performance: An Empirical Analysis from Manufacturing Companies in Morocco. Energies, 16(2). https://doi.org/10.3390/en16021004

Stroumpoulis, A., & Kopanaki, E. (2022). Theoretical Perspectives on Sustainable Supply Chain Management and Digital Transformation: A Literature Review and a Conceptual Framework. Sustainability (Switzerland), 14(8). https://doi.org/10.3390/su14084862

Sugiyono. (2020). Metodologi Penelitian Kuantitatif, Kualitatif dan R & D.