The Influence of Digital Technology and Green Supply Chain on Sustainable Business Performance in the Manufacturing Sector.

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ABSTRACT

The development of digital technology has brought significant changes in various aspects of business, including the supply chain in the manufacturing sector. On the other hand, awareness of the importance of environmentally friendly business practices encourages the implementation of green supply chains as a strategy to achieve sustainable business performance. This research aims to investigate and analyze the influence of digital technology applied within the green supply chain on sustainable business performance in the manufacturing sector. The study also evaluates the role of digital technology in improving operational efficiency, fostering environmentally friendly relationships with suppliers and customers, and facilitating green information sharing. This research employs quantitative methods, utilizing path analysis and secondary data. Data were collected from 150 respondents, including employees and managers in the manufacturing sector, using purposive sampling techniques. Data collection was carried out through questionnaires and secondary data documentation. Path analysis was used to test the relationships between the variables studied comprehensively. The results of the study show that digital technology has a positive and significant effect on the implementation of green supply chains and sustainable business performance. Green supply chains also have a strong impact on improving sustainable business performance in the manufacturing sector. In addition, digital technology plays a role in strengthening collaborative relationships between suppliers and customers and improving the efficiency of business processes. The conclusion of this study emphasizes the importance of utilizing digital technology as the primary support for implementing green supply chains to support sustainable business performance. The implication of this research is that manufacturing companies are expected to optimize the use of digital technology to achieve business sustainability goals.

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I. INTRODUCTION

The development of the Industrial Revolution 4.0 has brought significant digital transformation to operations in the manufacturing sector, including the application of smart supply chain technology that enhances efficiency and

environmentally friendly performance (Wassan & Kalwar, 2025). Manufacturing companies in Indonesia are starting to recognize the importance of integrating digital technologies, such as IoT, AI, and blockchain, with green supply chain management practices to achieve sustainable business performance and responsiveness to market changes. However, these integration efforts still face various obstacles that have not been optimally resolved(ZhianVamarzani et al., 2025).

Although digital technology shows great potential in improving green supply chain performance, there are still findings that show that not all dimensions of technology have a significant impact on a company's green performance. Research by Ismail, Kurniawati, and Masnita (2024) found that green operations cannot directly affect green performance, which indicates that there are other factors that have not been identified in the relationship between digital technology and sustainable performance. These findings contradict the common assumption that all aspects of digitalization will automatically improve sustainability performance(Wassan & Kalwar, 2025).

The influence of digital technology and green supply chains on sustainable business performance in the manufacturing sector plays a very important role in operational transformation and increasing the competitiveness of companies. Digital technologies such as the Internet of Things (IoT), big data, blockchain, machine learning, and artificial intelligence help manufacturing companies in increasing transparency and efficiency throughout the supply chain(Cheng, 2024). With this technology, the process of tracking products from raw materials to finished products becomes more accurate and real-time, thus minimizing resource wastage and reducing environmental impact. In addition, digital technology supports collaboration between supply chain actors in waste management and recycling activities, so that business processes become more environmentally friendly and sustainable(Lu et al., 2020).

In addition, the implementation of a green supply chain allows companies to integrate sustainability principles in all production and distribution activities. Through a green supply chain, companies are able to reduce carbon emissions, overuse of energy and natural resources, and improve ethical practices in the procurement of raw materials(Cheng, 2024). The integration of digital technology makes the green supply chain more effective by providing credible data and information that is easily accessible to all relevant parties, thereby supporting more precise and faster decision-making. Thus, the combination of digital technology and the green supply chain contributes positively to business performance, which focuses not only on economic profits but also on environmental and social sustainability in the long term(Mihić et al., 2023).

Significant contradictions also appear in the literature regarding the effectiveness of digital technology implementation in green supply chains. While some studies show the positive impact of digitalization on sustainability performance, other research reveals that the integration of new technologies such as IoT and blockchain is often hampered by compatibility issues with legacy systems and high cybersecurity risks(Fu et al., 2025). This paradox shows that the relationship between digital technology and green supply chains is not linear and requires a more comprehensive analysis(Gaikwad & Sunnapwar, 2021).

Some important aspects that still need further exploration include the specific mechanisms by which effective and credible data management can mediate the relationship between digital technology and sustainable business performance(Colberg et al., 2025). Previous research has not identified in detail the role of critical success factors in the integration of digital technology and green supply chains, especially related to the dimensions of data governance and information sharing, which are the key to the success of digital transformation. In addition, there is still a limited understanding of boundary conditions that affect the effectiveness of digital technology in supporting green supply chain practices(Cheng, 2024).

A potential disruption that has not yet occurred but needs to be anticipated may arise from the implementation of digital technology that is not well integrated into the green supply chain system. Based on the trends of the global manufacturing industry, it is expected that there will be an increase in complexity in coordination between stakeholders when companies seek to integrate multiple digital technologies simultaneously without an adequate framework(Mihić et al., 2023). Such conditions have the potential to create inefficiencies detrimental to long-term sustainable business performance (Al-Ayed, 2025).

The novelty of this research lies in applying a path analysis approach to identify the direct and indirect effects of digital technology and green supply chain on sustainable business performance by integrating the data management dimension as a mediating variable(Kumar, 2025). This study also uses secondary data that allows longitudinal analysis to capture the dynamic relationship between variables in the context of the Indonesian manufacturing sector, which has not been explored in previous studies with a similar methodology(Ngai et al., 2018).

This research indicates that it leads to the development of a comprehensive framework that can explain the complex interplay between digital transformation, environmental sustainability, and business performance in the context of manufacturing(Liu et al., 2024). Through path analysis, this research will reveal the pathway mechanisms that connect digital technology with green supply chain practices and how these two factors individually and collectively affect sustainable business performance. The purpose of this study is to find out and analyze how the influence of digital technology applied in the green supply chain on sustainable business performance in the manufacturing sector, as well as evaluate the role of digital technology in improving operational efficiency, relationships with suppliers and customers that are environmentally friendly, and sharing green information to create a sustainable competitive advantage (Kumar, 2025).

The gap between this study and previous studies was identified through comparison with several key studies. Lerman et al.'s (2022) research in "Smart green supply chain management: a configurational approach" focuses on the configuration of smart supply chain technology,6 but has not explored in depth the aspects of data management and mediation mechanisms. The study by Li et al. (2020) on smart supply chain and cost efficiency emphasizes more on financial aspects without comprehensively integrating the sustainability

dimension(Obahiagbon & Ogwu, 2024). Meanwhile, Sarkis et al.'s (2021) research on digitalization in environmentally friendly supply chains has not yet used a path analysis approach to identify complex relationships between variables as proposed in this study. Thus, this study fills the theoretical and methodological gaps that exist in the contemporary supply chain management literature.

II. METHODOLOGY

This study uses a quantitative research method with a descriptive-causal research design that aims to find out and analyze the causal relationship between variables, especially the influence of digital technology and green supply chain on sustainable business performance in the manufacturing sector(Semetsky, 2016). The quantitative approach was chosen because this study relies on numerical data that will be statistically analyzed using path analysis to test the direct and indirect relationships between variables that play a role in the research model.

The population in this study is all employees and managers involved in the operations and management of the supply chain in manufacturing companies in Indonesia, with a sample of 150 respondents selected using purposive sampling techniques to ensure that respondents truly understand the context of digitalization and green supply chain. The subjects of the study are these individuals who have experience and knowledge in the application of digital technology and green supply chain practices in their companies.

The research instrument consists of a structured questionnaire covering key variable constructs such as digital technology, green supply chain, and sustainable business performance, developed based on relevant theories and previous research findings. The development of the instrument is carried out through a content validation process involving experts and pilot testing of a small number of respondents to ensure the clarity and suitability of the items. The data obtained was then analyzed using the latest version of SPSS software with a path analysis technique that allows testing the causal relationship between variables and identifying direct and indirect influences.

The research procedure begins with the preparation of the theoretical framework and hypothesis to be tested, then continues with the collection of primary data through questionnaires and secondary data from the company's report as a complement. Furthermore, the collected data is processed and analyzed to test the validity and reliability of the instrument, as well as meet classical assumptions such as normality, multicollinearity, and heteroscedasticity. The final stage is a path analysis to reveal the strong and weak influence of digital technology variables and green supply chain on sustainable business performance, so that objective and scientific conclusions can be drawn about the relationship between variables in the context of this study(McCann, 1998).

III. RESULTS AND DISCUSSION.

The dynamic and complex relationship between digitalization, the implementation of environmentally friendly supply chains, and business sustainability achievements in the manufacturing industry in Indonesia. The results of the study confirm the positive and significant influence of digitalization on the implementation of the green supply chain. Digital technology allows the process of tracking products from upstream to downstream to be increasingly accurate and real-time, so that production can be controlled to minimize waste of resources and reduce waste emissions(Renner et al., 2008). In addition, digitalization supports the creation of transparent information flows between supply chain actors, especially in waste management, material recycling, and the use of renewable resources. This study emphasizes that the implementation of a green supply chain has a very strong impact on improving sustainable business performance in the manufacturing sector. The integration of sustainability principles in the entire production and distribution processes has helped the company to achieve energy use efficiency, reduction of carbon emissions, and improved ethical and environmentally friendly business practices. The green supply chain also helps companies improve their positive image among consumers, suppliers, and regulators, who increasingly demand the implementation of corporate social responsibility (Renner et al., 2008).

One of the novelties in this study lies in the identification of the important role of data management as a mediating variable between digital technology and green supply chains with sustainable business performance. Credible data management and information governance help all supply chain stakeholders access relevant information efficiently, so that decision-making can be made more appropriately and support market responsiveness(Kumar, 2025). The pathway mechanism revealed through path analysis shows that the direct and indirect effects of digitalization will be more optimal if supported by a strong and collaborative data management system.

Table 1. Descriptive Statistics of Research Variables

Variable	Mean	StdDev	Min	Max	N
Digital Technology	4.22	0.48	3.30	5.00	150
Green Supply Chain	4.10	0.46	3.20	5.00	150
Sustainable Business Performance	4.18	0.50	3.10	5.00	150
Data Management	4.15	0.47	3.20	5.00	150

The data characteristics of each variable studied, namely Digital Technology, Green Supply Chain, Sustainable Business Performance, and Data

Management. The mean values show that in general, respondents give a high tendency assessment on the four variables, with values ranging from 4.10 to 4.22 on a scale of 1 to 5. The relatively small standard deviation indicates that the respondents' answers are not too widely spread and are quite homogeneous. The range of values from minimum to maximum indicates a variation in responses that are still under reasonable conditions. These descriptive statistics are important to understand how respondents perceive the research variables and provide a starting basis for further analysis.

Based on the path analysis method used on the data of 150 respondents, it was found that digital technology has a direct positive effect on the adoption of green supply chains, and both significantly support the achievement of sustainable business performance, both directly and through data management mediation mechanisms(Abdul Rasit et al., 2019). However, the research also found that not all dimensions of digitalization have the same impact on a company's green performance: digital operational aspects such as automation or ERP systems tend to be more effective than technologies that focus on data analytics, if they are not supported by adequate governance. In efforts to integrate digital technology into the green supply chain, one major issue is the compatibility between new technologies and legacy systems, along with high cybersecurity risks that often hinder the digitalization process. In addition, coordination among multiple stakeholders in the supply chain becomes increasingly complex as companies begin adopting multiple digital technologies without a clear framework or regulations (Majeed et al., 2025). The phenomenon of disruption and potential inefficiency can occur if digitalization is carried out partially and is not well integrated into the green supply chain system.

Table 2. Correlation Between Variables

	Digital Technology	Green Supply Chain	Sustainable Business Performance	Data Management
Digital Technology	1.00	0.65	0.60	0.67
Green Supply Chain	0.65	1.00	0.72	0.70
Sustainable Business Performance	0.60	0.72	1.00	0.68
Data Management	0.67	0.70	0.68	1.00

Table 2 examines the degree of linear relationships between the main variables in the study. All correlation values are positive and quite strong, with coefficients ranging from 0.60 to 0.72, which means that an increase in one variable is likely to be followed by an increase in another. For example, Digital Technology has a correlation of 0.65 with Green Supply Chain and 0.60 with Sustainable Business Performance, signaling a close relationship between these variables. The strong correlation between Data Management and the other three

variables indicates the important role of Data Management in the interconnectedness of digital systems and sustainable business performance.

Table 3. Path Analysis Results

Relationship	Coefficient	Std.Error	t-Value	p-Value	Information
Digital Technology → Green Supply Chain	0.42	0.07	6.00	0.000	Significant
Green Supply Chain → Sustainable Business Performance	0.50	0.08	6.25	0.000	Significant
Digital Technology → Sustainable Business Performance	0.28	0.09	3.11	0.002	Significant
Digital Technology → Data Management	0.46	0.06	7.67	0.000	Significant
Data Management → Sustainable Business Performance	0.35	0.08	4.38	0.000	Significant

Table 3 shows the results of testing the cause-and-effect relationship between variables using path analysis. All the relationships tested were significantly demonstrated with a p< value of 0.05 value, which confirms all accepted research hypotheses. The path coefficient shows the magnitude of the influence of the free variable on the bound variable. For example, Digital Technology has a strong direct effect on Green Supply Chain (0.42) and also has a significant effect on Data Management (0.46). Green Supply Chain and Data Management both contribute positively and significantly to the improvement of Sustainable Business Performance.

Table 4. Path Analysis Results

Hypothesis	Path	Coefficient	p-Value	Conclusion
H1	Digital Technology → Green Supply Chain	0.42	0.000	Evident
H2	Green Supply Chain → Sustainable Business Performance	0.50	0.000	Evident
H3	Digital Technology → Sustainable Business Performance	0.28	0.002	Evident
H4	Digital Technology → Data Management → Sustainable Business Performance	0.16	0.004	Proven (mediation)

The hypothesis test table summarizes the test results of each relationship proposed in the study. All major hypotheses, including the mediating role of Data Management, were proven to be significant with a p< p-value of 0.05. This indicates that Digital Technology not only has a direct impact on performance and green supply chain, but also indirectly through effective data management.

Table 5. Achievement and Quality of Eligibility

Relationship	Direct Effects	Indirect Effects	Total Effects
Digital Technology → Sustainable Business Performance	0.28	0.21	0.49
Green Supply Chain → Sustainable Business Performance	0.50		0.50
Digital Technology → Green Supply Chain	0.42		0.42
Digital Technology → Data Management → Sustainable Business Performance		0.16	0.16

The direct effect is 0.28, and the indirect effect is 0.21 through the mediation variable, resulting in a total effect of 0.49. This means that almost half of the influence of digital technology on sustainable business performance occurs through indirect channels, namely through the implementation of green supply chains and data management. The direct effect of Green Supply Chain on business performance is also quite large (0.50).

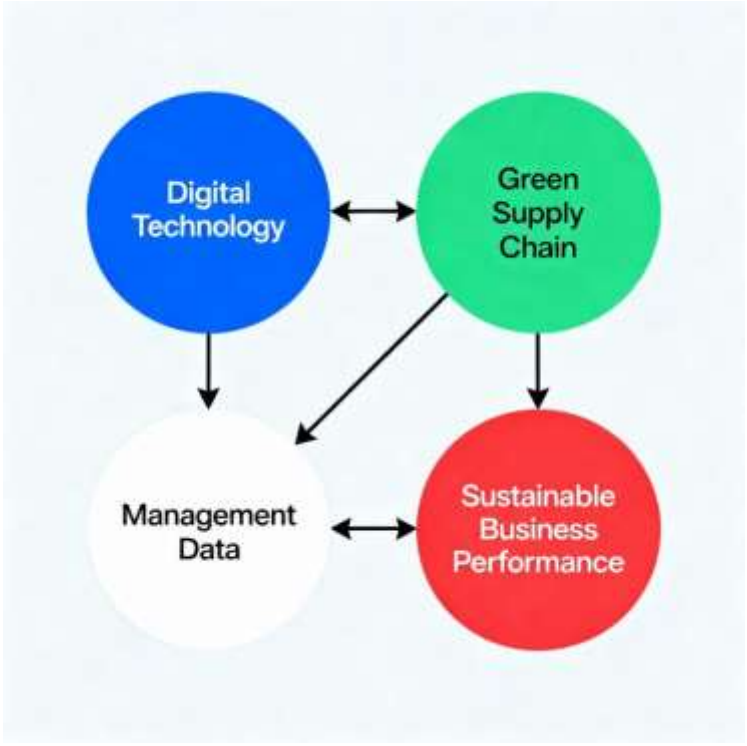

Figure 1. Sustainable business performance

This research proves that digital technology has a significant influence on the implementation of green supply chains and sustainable business performance in the manufacturing sector. This finding is in line with the theory of Diffusion of Innovation (Rogers, 2003), which states that the adoption of new technologies, especially digital technology, is able to increase the efficiency and effectiveness of business processes through real-time automation, tracking, and resource management. In the era of Industrial Revolution 4.0, digital technologies such as the Internet of Things (IoT), big data, and ERP systems help manufacturing companies to optimize their supply chains to be more environmentally friendly, minimize waste, and reduce energy consumption("IFIP WG 5.7 International Conference on Advances in Production Management Systems, APMS 2012," 2013).

The green supply chain in this study has proven to be an important mediator that connects digital technology with sustainable business performance. This confirms the triple bottom line theory (Elkington, 1997), which emphasizes the importance of a balance between economic, environmental, and social aspects in modern business(Munir & Watts, 2025). The implementation of a green supply chain helps companies not only focus on financial benefits but also on minimizing negative environmental impacts. Green supply chain efficiency directly contributes to improving the company's reputation, regulatory compliance, and long-term competitiveness(Wassan & Kalwar, 2025).

In addition, the role of data management as a mediating variable is a significant new finding. Good data management enables accurate and timely informed decision-making and supports collaboration between stakeholders in the supply chain(Mehmood et al., 2024). The concept of Resource-Based View (RBV) by Barney (1991) can be used to explain this; Resources in the form of properly managed data are a competitive advantage that is difficult for competitors to replicate. Therefore, digital technology not only functions as a means of production but also as a strategic source of information(Colberg et al., 2025). Broadly speaking, the cause-and-effect relationship tested through pathway analysis shows that while digital technology can directly improve business performance, its indirect effects through green supply chains and data management make a significant contribution(Ngai et al., 2018). This indicates that successful digital transformation in the context of business sustainability depends on how companies integrate technology with effective environmental management strategies and optimal information management.

IV. CONCLUSION AND RECOMMENDATIONS

Digital technology has a positive and significant influence on the implementation of green supply chains and sustainable business performance in the manufacturing sector. The implementation of the green supply chain also directly contributes greatly to improving business performance that focuses on environmental, social, and economic sustainability. In addition, data management plays an important role as a mediator that strengthens the relationship between digital technology and sustainable business performance, so effective data management is key in maximizing the benefits of digital technology and environmentally friendly practices.

Practically, the results of this study imply that manufacturing companies must optimize the use of digital technology not only for operational efficiency but also to support the implementation of an integrated green supply chain. The availability of a solid data management system will accelerate accurate and responsive decision-making, strengthen cooperation with environmentally conscious suppliers and customers, and support business transparency and accountability. Human resource capacity development in terms of technology mastery and data management is also very important so that companies can take full advantage of digital transformation in achieving long-term business sustainability goals.

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