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The Impact of Green Logistics Practices on Sustainable Performance

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Abstract

This research focuses on eco-friendly logistics and its implementation within logistics companies that utilize sea transport and operate in Indonesia. Carbon emissions generated by transport vehicles are continuously rising, posing a serious threat to society and prompting the development of various solutions—one of which is eco-friendly logistics. However, there remains a lack of understanding regarding the application of a "green economy" within the Indonesian logistics sector. Furthermore, a scarcity of resources presents an additional challenge for the country in integrating eco-friendly logistics practices. A quantitative research design was employed, involving a survey of ten logistics companies, with data analyzed using SPSS software. In this study, green logistics practices are categorized into three main activities: reverse logistics, green warehousing, and sustainability performance. the sample consists of 28 logistics companies that utilize shipping or sea transport for their operations. This research demonstrates that the implementation of green logistics practices by logistics service providers has a significant positive impact on the economic, environmental, and social performance of logistics companies that utilize sea transport. These findings contribute to the theoretical understanding of green logistics by highlighting its crucial role in achieving sustainable performance. Furthermore, this study offers practical implications for logistics service providers in Indonesia that rely on sea transport, emphasizing the importance of adopting green logistics practices. Green logistics practices to enhance their long-term sustainability and competitiveness. Reverse logistics influences sustainable performance. Sustainability-oriented company leaders tend to invest in waste management systems, including sorting, reuse, and resource recovery. While green warehousing is a relatively new concept with limited literature and empirical data, global trends indicate growing interest in sustainable warehousing practices.

Keywords:
Green Logistics; Sustainable Performance; Reverse Logistics; Green Warehouse.

1. INTRODUCTION

Green logistics is an approach aimed at minimizing all negative environmental impacts resulting from logistics business activities, particularly the carbon footprint. This means that every activity within the supply chain—including storage and packaging—must be designed to minimize carbon emissions, avoid environmental harm, and adhere to the principles of sustainability. Once a product reaches the end of its useful life, it can be returned to the manufacturer for reprocessing or recycling, thereby retaining its utility without polluting the environment. This approach aims to mitigate ecological impacts and reduce the carbon footprint

associated with logistics activities, which encompass storage, packaging, transportation, and production. Green logistics has emerged because environmental considerations are a primary driver for adopting this concept; its implementation enables the reduction of greenhouse gas emissions and energy consumption, as well as the minimization of waste. Indonesia's logistics sector plays a strategic role in supporting international trade flows. As an archipelagic nation, Indonesia faces significant challenges in integrating logistics infrastructure across its regions, making sustainability principles in logistics management increasingly vital.

The concept of green logistics—often equated with sustainable logistics—emphasizes the integration of environmental, social, and economic considerations into logistics decision-making to create supply chains that are both efficient and responsible. Enhancing logistics efficiency is not merely a matter of national economic performance; it also determines Indonesia's standing within global supply chains. An effective logistics system enables companies to reduce transportation costs, boost operational efficiency, and accelerate their response to market demands. This enhances corporate competitiveness and strengthens the contribution to the domestic economy. Conventional logistics activities continue to exert significant environmental pressure, primarily through Gases emitted by motorcycles, cars, trains, ships, airplanes, and other fuel-powered vehicles contain chemicals that pose a serious threat to the environment. World Bank statistics on per capita carbon dioxide emissions in Indonesia show significant fluctuations in emissions between 2010 and 2020 remains the primary source of CO_2 emissions (Santika., 2023; Popescu et al., 2024).

In recent years, the global development paradigm has shifted toward a more sustainable approach. The UN Sustainable Development Goals (SDGs) This framework contains 17 societal-level goals, 169 targets, and 231 indicators aimed at achieving global sustainability by 2030. In this study, the implementation of the SDGs focuses on Goal 9 (Industry, Innovation, and Infrastructure) and Goal 13 (Climate Action), both of which underscore the importance of transforming transport systems to make them more environmentally friendly and efficient. In this context, the green logistics approach encompassing strategies such as emission reduction, energy efficiency, distribution network optimization, and the adoption of eco-friendly technologies is highly relevant for implementation within Indonesia's maritime transportation system. This serves not only as a response to the climate crisis but also as a strategic opportunity to generate economic value by enhancing the image of products as sustainable.

Various studies have highlighted the urgent need to transform logistics toward a greener approach. Rodrigue, Notteboom, and Pallis (2020) explain that maritime shipping is a significant contributor to global carbon emissions but also holds great potential for energy efficiency through route optimization, fleet modernization, and the use of alternative energy sources such as LNG and biofuels. Energy-intensive warehouse operations (Zhang & Li, 2020), and rising packaging consumption in the e-commerce sector (Duan, 2024) further exacerbate environmental issues. Research confirms that without the implementation of green logistics, the logistics sector's ecological impact will continue to rise (Maji et al., 2023), and studies on green logistics have been conducted across various sectors. Research by Winata et al. (2023) indicates that while this concept is crucial for advancing the green economy and achieving the SDGs, its implementation in Indonesia remains limited due to a lack of public awareness.

To address a research gap, this study examines the impact of implementing green logistics practices on the sustainable performance of logistics service providers that utilize sea transport for shipments—an area that has not yet been explored in the context of maritime-based logistics companies. Employing a mixed-methods approach—combining qualitative and quantitative techniques—data were collected and analyzed to assess the relationship between green logistics practices and key dimensions of sustainable business performance, encompassing environmental, economic, and social aspects, with a focus on green warehousing, reverse logistics, and sustainability performance. The findings offer valuable insights into how logistics companies can enhance their green logistics practices, thereby improving long-term sustainability. Furthermore, the study provides a set of practical management recommendations to help logistics service providers strengthen their green logistics strategies and foster sustainable growth.

1.1. Green Logistic

Environmentally friendly logistics has emerged in response to the current, highly damaging state of the environment—a consequence of the massive carbon emissions generated by vehicle exhaust. Beyond simply ensuring that customers receive the goods they have ordered, green logistics—or eco-friendly logistics—serves as a practical application of the green economy.

In the current state of the art, "Green Logistics" is a branch of the "Green Supply Chain" concept, which encompasses both Green Logistics and Reverse Logistics. This framework aims to facilitate the development of "Lean" City Logistics—an approach that integrates environmentally friendly (green) industrial and logistical practices within a specific region. Green Logistics refers to a form of logistics that prioritizes environmental responsibility throughout all supply chain operations, ensuring that the environmental impact of every process is kept to a minimum. It is a logistics concept that prioritizes minimizing environmental impact and utilizes, to the greatest extent possible, eco-friendly raw materials throughout the entire process, from the initial handling of goods until they reach the end customer.

An integrated and sustainability-oriented logistics ecosystem. Various concrete initiatives have begun to emerge, ranging from the operation of electric vehicle fleets and the use of alternative fuels to the

implementation of route optimization systems based on intelligent algorithms and the utilization of renewable energy in storage facilities.

1.2. Reverse Logistics

Reverse logistics is the process of moving products from their final destination back to their point of origin, with the aim of recovering value or addressing product defects (Farouk & Darwish, 2020). It encompasses the return of materials into the production process for reuse, recycling, or remanufacturing, or ensures an environmentally friendly end-of-life outcome—including the recovery and recycling of materials, packaging waste, and returned products. Reverse logistics plays a crucial role in minimizing waste and supporting sustainable practices within the supply chain. Its primary objective is to extract value from goods or to dispose of them in an environmentally responsible manner. Furthermore, reverse logistics has the potential to enhance economic performance and strengthen a company's image among consumers and throughout the distribution chain (Zai et al., 2023; Nurmalasari, Amin, Hastuti, Syarifah, & Hernando, 2023).

1.3. Green Warehouse

Green warehousing is a warehouse management concept that emphasizes operational efficiency while considering environmental impact. In practice, a green warehouse serves not only as a storage facility but also engages in environmentally friendly activities—such as waste reduction, energy efficiency, and the selection of materials and operational methods that do not harm the environment (Syahfitri et al., 2023).

1.4. Sustainable Performance

Sustainability performance employs a multidimensional approach that encompasses environmental, social, and economic indicators. This includes carbon footprint, energy efficiency, and waste reduction. Social aspects cover community engagement, labor practices, and diversity, while economic indicators measure profitability, cost savings through sustainable practices, and overall financial stability. Frameworks for sustainability performance include the Global Reporting Initiative (GRI) and the Triple Bottom Line. Integrating these diverse indicators enables a comprehensive evaluation of an organization's commitment to balancing environmental responsibility, social well-being, and economic viability in order to implement sustainable practices. Environmental performance refers to a company's ability to manage its environmental impact, including the reduction of emissions, waste, and the consumption of hazardous materials. It involves developing strategies and mechanisms that foster corporate responsibility regarding environmental sustainability.

1.5. Reverse Logistics Influences Sustainable Performance

Reverse logistics encompasses the return of products from consumers due to end-of-life, the need for repair, or warranty claims (Paduloh et al., 2020), as well as the ecological evaluation of products (Julianelli et al., 2020). Within reverse logistics, products pass through key facilities for processes such as repair, reuse, recycling, and remanufacturing (Roudbari et al., 2021). Reverse logistics is characterized by product return options, as these represent a crucial phase in reverse logistics activities (Aćimović et al., 2020). Used products (referred to as returned products) are collected from customers with the intention of being reused in some capacity (Zarbakhshnia et al., 2020). Consequently, reverse logistics prioritizes the logistical activities involved in recovering products from customers over the movement of products to customers (Richnák & Gubová, 2021).

H1: Reverse Logistics Influences Sustainable Performance

1.6. Green Warehousing Influences Sustainable Performance

Environmental management systems are developed to provide fundamental guidance for ensuring that business activities remain environmentally friendly. Supply chain management emphasizes an integrated approach to the flow of products from suppliers, manufacturers, and retailers, all the way to the end consumer. In the concept of Supply Chain Management, the sequence of activities from the supplier to the final consumer functions as a seamless, integrated whole, allowing the entire chain to work together to become more competitive. (Pujawan, 2005; Chopra and Meindl, 2004).

Warehouses play a crucial role as a central point within any industrial supply chain. The growth of the trade industry and the increasing need for mass customization have driven a high demand for warehouse space and facilities. In line with global trends, the emphasis on eco-friendly and sustainable warehousing methods has spurred new research into management principles, technologies, and machinery aimed at reducing carbon emissions in warehouses. A warehouse's carbon footprint refers to the cumulative greenhouse gas (GHG) emissions—measured in carbon-equivalent units—generated directly from various activities within that warehouse.

H2: Green Warehousing Influences Sustainable Performance

2. RESEARCH METHOD

This study was conducted on logistics service companies that utilize maritime shipping for transportation. Questionnaires were distributed to these companies to determine whether they implement green logistics concepts in their operations. Data was gathered through in-depth case studies focusing on two key areas: Reverse Logistics (X1)—a transportation concept emphasizing the reduction of environmental impacts associated with the transport of goods and services, particularly through lower carbon emissions and energy efficiency—and Green Warehousing (X2)—a warehouse management concept that prioritizes operational efficiency while considering environmental impact. In this study, the sample consists of 28 logistics companies that utilize shipping or sea transport for their operations. Data collection was carried out using questionnaires, and the collected data was analyzed using multiple linear regression with SPSS software.

3. RESULTS AND DISCUSSION

3.1. Results

This study focuses on three key elements: reverse logistics, eco-friendly warehousing, and sustainable performance. Data were collected through a survey of 28 logistics companies that utilize ships as their mode of transport, followed by validity and reliability testing for each variable.

Table 1. Validity Test of the Reverse Logistics Variable

Validity Test of the Reverse Logistics Variable	
RL - 1	0.613
RL - 2	0.788
RL - 3	0,811
RL - 4	0,774
RL - 5	0,779
RL - 6	0,845
RL - 7	0,839
RL - 8	0,751

Table 2. Validity Test of the Green Warehouse Variable

Validity Test of the Green Warehouse Variable	
GW - 1	0,732
GW - 2	0,822
GW - 3	0,779
GW - 4	0,838
GW - 5	0,760
GW - 6	0,867
GW - 7	0,779
GW - 8	0,818

Table 3. Validity Test of the Sustainable Performance Variable

Validity Test of the Sustainable Performance Variable	
SP - 1	0,866
SP - 2	0,724
SP - 3	0,725
SP - 4	0,742
SP - 5	0,785
SP - 6	0,890
SP - 7	0,828
SP - 8	0,782

Based on the results presented in Tables 1 through 3 for the three variables, the validity test calculations for Reverse Logistics, Green Warehouse, and Sustainable Performance indicate that every item (question) included is valid. This is because the calculated r-values (r-count) in the tables are greater than the critical r-value (r-table) of 0.2706 (r-count > r-table). Following the validity test, a reliability test was conducted using Cronbach's alpha.

Table 4. Reliability Test

Reliability Statistics	
Reverse Logistik	0.986
Green Warehouse	0.877
Sustainable Performance	0.949

The table above presents the results of the reliability test conducted with 28 respondents. The results indicate that all variables (both X and Y) are reliable, as their coefficients exceed the R-table value of 0.26. Consequently, these variables can consistently be used in subsequent analyses.

Following the reliability test, a normality test is conducted. This test is used to determine whether the dependent and independent variables in a regression model follow a normal distribution. A regression model that exhibits a normal distribution is considered appropriate and valid for statistical testing; the Kolmogorov-Smirnov test is employed for this purpose.

Table 5. Normality Test

Information	P-Value	Conclusion
Normality	4,775	Test for Normal Distribution

Based on Table above, where the tolerance value exceeds 0.01 and the VIF is less than 10, it can be concluded that there are no inter-variable relationships meaning the variables are free from multicollinearity in the assessment of sustainable performance for logistics companies utilizing sea transportation.

Following the normality test, a heteroscedasticity test is conducted to determine whether the variance of the residuals differs across observations within a regression model. The results of the heteroscedasticity test are assessed using a scatterplot.

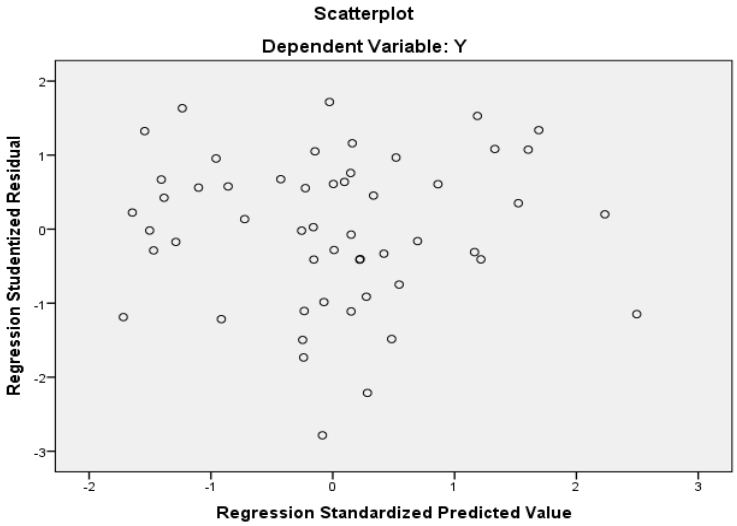


Figure 1. Heteroscedasticity test

The scatterplot results indicate that none of the variables exhibit heteroscedasticity, as all data points are distributed around the zero mark. The results of the multiple linear regression analysis can be seen in Table 6.

Table 6. Regression Table

Variabel	Koefisien	t	Sig.
Sustainable Performance	0,163	0,046	0,964
Reverse Logistik	0.446	8,041	0,000
Green Warehouse	0.637	4,905	0,000

Based on the calculations in Table 6, the following regression equation is obtained: Y = 0.163 + 0.446 (Reverse Logistics) + 0.637 (Green Warehouse) + e. This regression equation can be interpreted as follow:

a. The constant value of 0.163 indicates that if the Reverse Logistics and Green Warehouse variables are assumed to be constant or equal to zero, Sustainable Performance in logistics companies utilizing sea transportation modes tends to increase.
b. The regression coefficient for the Reverse Logistics variable is positive, at 0.446. This result indicates that improved implementation of Reverse Logistics in logistics companies utilizing sea transportation modes leads to enhanced sustainable performance within those companies.

c. The positive regression coefficient of 0.637 for the Green Warehouse variable indicates that improved implementation of Green Warehouse practices in logistics companies utilizing sea transportation modes will enhance the sustainable performance of those companies.

Next, a coefficient of determination (R^2) test is conducted to assess the goodness of fit of the model. A low R^2 value indicates that the independent variables have a limited capacity to explain the dependent variable (a weak effect), whereas a higher value suggests a greater capacity to explain such variation. Following the calculation, an R^2 value of 0.762 was obtained; this figure indicates that 76.2% of the variance in Sustainable Performance can be explained by Reverse Logistics and Green Warehouse practices, while the remaining 24.8% is attributed to variables outside the regression model. Given this substantial R-squared value, the regression model is considered highly effective for determining Sustainable Performance. Next, hypothesis testing was conducted, and the results of this study are as follows.:

a. The first hypothesis aims to test whether reverse logistics influences sustainable performance. The reverse logistics variable yielded a calculated t-value of 8.041 with a significance level of 0.00. Since the calculated t-value exceeds the t-table value, it can be concluded that the reverse logistics variable at UP3 Jember affects sustainable performance. The positive t-value indicates a direct relationship between the reverse logistics variable and sustainable performance. Thus, it can be concluded that the reverse logistics variable has a significant influence on the sustainable performance of the institution's employees.
b. The second hypothesis aims to test whether the Green Warehouse variable influences Sustainable Performance. The Green Warehouse variable yielded a calculated t-value of 4.095 with a significance level of 0.00. Since the calculated t-value exceeds the t-table value, it can be concluded that the Green Warehouse variable affects Sustainable Performance. The positive t-value indicates a positive relationship between the Green Warehouse variable and Sustainable Performance. Thus, it can be concluded that Green Warehouse has a significant influence on Sustainable Performance.

3.1. Discussion

Sustainability has become a primary concern across various global industrial sectors. Rapid economic growth is often unaccompanied by responsible natural resource management, leading to increased carbon emissions and waste volumes. The World Economic Forum (2024) reports that over 90% of global resources end up as waste within less than a year. This situation is driving a paradigm shift from a linear system toward a circular economy that emphasizes efficiency, recycling, and material reuse.

Although the government has launched the 2030 Green Industry Roadmap and strengthened Extended Producer Responsibility (EPR) policies, implementation remains hindered by logistics costs, infrastructure limitations, and low environmental awareness. The *Indonesia Sustainability Outlook* (2024) report even notes that packaging return rates remain below 20%, falling far short of targets.

This study finds that reverse logistics outcomes influence sustainable performance. Many organizations remain in the conceptualization stage, lacking the practical capabilities to effectively process and repurpose materials. Reverse logistics directly enhances a company's operational capabilities. Sustainability practices—such as material recycling, product return management, or the utilization of industrial by-products—will not yield optimal improvements in operational efficiency without the development of reverse logistics capabilities.

Research by Hardiyanti, Santosa, Widowati, and Atmanda (2026) indicates that reverse logistics influences sustainable supply chains. Companies implementing sustainability initiatives are more inclined to improve and integrate reverse logistics into their operations. This aligns with findings by Haifa and Kusmantini (2026), which show that strong commitment drives companies to develop systems for handling returned goods, recycling, and resource recovery. Sustainability-oriented corporate leaders tend to invest in waste management systems, including sorting, reuse, and resource recovery. In the context of the furniture industry, this entails reusing wood scraps, repairing returned products, or converting production waste into new goods.

Environmental management systems were developed to provide fundamental guidelines ensuring that business activities remain environmentally friendly. Supply chain management emphasizes an integrated approach to the flow of products from suppliers, manufacturers, and retailers to the end consumer (Pujawan, 2005; Chopra and Meindl, 2004). Under the supply chain management concept, the sequence of activities from supplier to end consumer functions as a seamless, unified whole, allowing the entire chain to collaborate effectively and enhance competitiveness (Chopra and Meindl, 2004). All parties within a supply chain must collaborate as closely as possible to improve service delivery. This enables the distribution of goods and services in the right quantities, at the right times, and to the right locations, thereby minimizing costs while meeting consumer needs.

Warehouses play a crucial role as central hubs in every industrial supply chain. The growth of the trade industry and the rising demand for mass customization have driven a high need for warehouse space and facilities. Warehouse operations account for approximately 11% of total greenhouse gas (GHG) emissions in the global logistics industry. Aligning with global trends, the emphasis on eco-friendly and sustainable warehousing methods has spurred new research into management principles, technologies, and machinery aimed at reducing warehouse carbon emissions. A warehouse's carbon footprint refers to the accumulated

greenhouse gas (GHG) emissions—measured in carbon-equivalent units—generated directly from various activities within the facility.

This study finds that green warehousing influences sustainable performance. These results align with the findings of Meliana & Hasibuan (2025), which indicate that—despite green warehousing being a relatively new concept with limited literature and empirical data—global trends show growing interest in sustainable warehousing practices. This research demonstrates that green warehousing can serve as a potential solution for achieving environmental sustainability and supply chain efficiency. Furthermore, the study supports the findings of Sihombing, Purnomo, & Mulyati (2026), showing that sustainability-oriented logistics facility management—such as the use of renewable energy and digital warehouse management systems—can enhance distribution effectiveness.

4. CONCLUSION

Reverse logistics influences sustainable performance. Sustainability-oriented company leaders tend to invest in waste management systems, including sorting, reuse, and resource recovery. The company implements a reverse logistics system as an alternative solution to gain additional economic value and increase productivity. Green Warehousing Influences Sustainable Performance. While green warehousing is a relatively new concept with limited literature and empirical data, global trends indicate growing interest in sustainable warehousing practices.

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