

Improving Supply Chain Performance with Green Warehouse, Logistics and Green Supply Chain Management

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Abstract. The research aims to determine the effect of Green Warehouse, Logistics, and Green Supply Chain Management on Supply Chain Performance. The method used is quantitative, by share questionnaires to 100 respondents. Smart PLS software was used to evaluate the collected data. This research shows that implementing Green Warehouse significantly improves green supply chain management. This study found that the most dominant green warehouse is minimizing warehouse waste and ensuring waste disposal is managed appropriately. Logistics activities support efficiency and synergy in minimizing transportation pollution from the warehouse in shipping goods to consumers. Green Supply Chain Management (GSCM) helps improve supply chain performance by implementing environmentally friendly activities, encompassing aspects such as product design, procurement and choice of materials, production process, and ultimate delivery of the final product to customers.

Keywords : green warehouse, green scm, supply chain performance, freight forwarding

Abstrak. Penelitian ini bertujuan untuk mengetahui pengaruh Green Warehouse, Logistik, dan Green Supply Chain Management terhadap Kinerja Rantai Pasokan. Metode yang digunakan adalah kuantitatif, dengan membagikan kuesioner kepada 100 responden. Perangkat lunak Smart PLS digunakan untuk mengevaluasi data yang terkumpul. Penelitian ini menunjukkan bahwa penerapan Green Warehouse secara signifikan meningkatkan manajemen rantai pasokan hijau. Penelitian ini menemukan bahwa gudang hijau yang paling dominan adalah meminimalkan limbah gudang dan memastikan pembuangan limbah dikelola dengan tepat. Kegiatan logistik mendukung efisiensi dan sinergi dalam meminimalisir polusi transportasi dari gudang dalam pengiriman barang ke konsumen. Green Supply Chain Management (GSCM) membantu meningkatkan kinerja rantai pasokan dengan menerapkan kegiatan yang ramah lingkungan, meliputi aspek-aspek seperti desain produk, pengadaan dan pemilihan bahan, proses produksi, dan pengiriman akhir produk akhir ke pelanggan.

Kata Kunci : pergudangan ramah lingkungan, scm ramah lingkungan, kinerja rantai pasokan, pengiriman barang

1. Pendahuluan

Nowadays, global supply chains generate enormous environmental pollution due to heating, cooling, and lighting in warehouses (Agyabeng-Mensah et al., 2020a). Corporate supply chain activities have resulted in environmental pollution caused by warehouses, factors contributing to global warming are climate change, potential harm to human activities contribute to greenhouse gas emissions, production of non-biodegradable products inadequate waste management, storing

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dangerous and explosive materials incorrectly, and excessive consumption of resources and other factors (Yildiz Çankaya & Sezen, 2019)

Improper waste management, global warming, and climate change are included as issues in Green Warehouse (S. R Singh & Dipti Singh, 2022). Additionally, 2% to 3% of global energy-related CO₂ emissions are attributable to warehouse issues (Abushaikha, 2018). The implementation of waste reduction practices and policies is crucial in order to mitigate the detrimental effects of warehousing activities on the environment and human life within the supply chain (Agyabeng-Mensah et al., 2020b).

Accordingly, green warehouse should be implemented to reduce environmental impacts, increase efficiency and to improve supply chain performance, but there are several challenges that can arise in achieving the goal (Sahar et al., 2020). Green warehouse issues affect GSCM, such as energy consumption, warehouses that require large amounts of energy to operate, electricity, heating, and cooling systems.

However, challenges arise in optimizing energy use and ensuring that energy-saving measures are implemented consistently (Jum'a et al., 2022). Waste management is essential to Green Warehouse by implementing proper disposal or recycling to improve supply chain performance (Maemunah & Cuaca, 2021). Green warehouse strive to minimize waste generation and implement recycling and waste reduction programs. Effectively managing and separating different types of waste and ensuring environmental pollution, disposal, or recycling are managed appropriately (Banihashemi et al., 2023 ; Jum'a et al., 2022).

Transportation logistics contributes around 8% of the global energy-related CO₂ emissions, leading to environmental pollution (S. A. R. Khan et al., 2020). Environmentally sustainable logistics can reduce CO₂ emissions (Ihsan & Risonarta, 2023).

Green logistics competition is gaining worldwide attention as part of the logistics and supply chain (Castillo et al., 2022). Sustainability in business operations is interdependent on the supply chain and the environmental, economic, and social (Purnomo et al., 2021; Maemunah, 2021).

The phenomena that occur also include a lack of public awareness, resistance to global warming changes, and conflicting interests among stakeholders, which can hinder collaboration and coordination efforts related to GSCM performance (Naidelage et al., 2021; Srivastav et al., 2019).

Green supply chain management issues affect supply chain performance. These issues include performance measurement, as it is critical to evaluate the effectiveness of GSCM practices and identify areas for improvement (Lerman et al., 2022). However, the need for standardized performance metrics and difficulties in measuring the environmental and social impacts of GSCM practices can pose significant challenges to performance measurement (M. T. Khan et al., 2022).

The lack of commitment, cooperation, and communication among partners can hinder the application of green supply chain management (GSCM) strategies and their impact on supply chain performance (Nureen et al., 2022). Barriers in technology the use of new technologies is very

important for putting GSCM process into action. However, the lack of technological infrastructure, high cost, and complexity of new technologies can pose significant barriers to adopting GSCM (Lerman et al., 2022).

Therefore, GSCM must be implemented because it influences supply chain performance. Among them, the application of GSCM practices can increase competitive advantage (Almasarweh, 2022), improve company reputational and stakeholders relationships by showing a responsibility to sustainability and social responsibility, such as green or environmentally friendly marketing and labeling can improve company reputation and attract environmentally conscious customers (Bolaji et al., 2022).

The use of GSCM has a substantial effects on business performance and competitiveness. Green supply chain management significantly positively affects business performance mediated by SME competitiveness (Gibral et al., 2022).

This research aims to improve supply chain performance in green warehouse, logistics, and green supply chain management. Previous research shows the relationship between green innovation and supply chain management and the environment (Abu Seman et al., 2019). The second research is green warehouse practice in the Philippines (Castillo et al., 2022). The third research is Lean management and supply chain management in the logistics industry in Indonesia (M. A. Firmansyah & Maemunah, 2021)

A green warehouse is a warehouse that aligns organizational, technological, economic, and social functions and concerns for the environment (Castillo, 2022). Green warehouses are an essential part of a sustainable supply chain. The development of green warehouses is needed because the balance between the environment, economy, and society must be maintained (Castillo et al., 2022). Warehouse is a place used to store goods in the type of raw materials, work in process goods or finished goods (Rizaldy Wynd et al., 2021)

The concept of a "green warehouse" refers to a management idea that combines and carries out operations that are good for the environment and aim to lower harmful emissions, reduce resource consumption, and increase the facility's ecological value (Muttaqin et al., 2022a).

A green warehousing company will consider economic factors, the social and environmental impacts of the warehouse, and its surroundings. Green warehouses are a significant part of sustainable supply chain operations (Muttaqin et al., 2022b).

Logistics is the storage, planning, also distribution of items, services, and information from the point of production to the point of consumption, with the aim of satisfying consumer needs (Song et al., 2022).

Logistics, from an enterprise-level standpoint, involves the coordination and control of material movement across several tasks, including storage, packaging, shipment processes, transportation, distribution and information management (Dallasega et al., 2022). The process entails the coordination and integration of diverse operations, such as warehousing, transportations, packaging,

inventory control, and security, with the objective of guaranteeing the punctual and economical delivery of products to consumers (Muduli et al., 2023).

Logistics includes shipping goods to suppliers and customers (Rasool et al., 2023). Moreover, what is even more important is the performance of the logistics sector as an essential driving factor for trade (Tang & Abosedra, 2019)

Green Supply Chain Management (GSCM) includes all parts of supply chain management that are good for the environment. This includes things like designing products, buying materials, the production process, customer shipping, and management of product disposal of end life cycle (Al-Ghwayeen & Abdallah, 2018).

GSCM is essential in supporting efficiency and synergy between suppliers, improving environmental performance, minimizing waste, and minimizing environmental risks and effects can help a business make more money and gain market share (Setyaning et al., 2020).

Through the adoption of green supply chain management (GSCM), companies have the capacity to resist or mitigate pressures from external factors, including governmental regulations and consumer demands (Abu Seman et al., 2019). This approach can address challenges related to implementing environmentally-friendly practices for various stakeholders and can also lead to improved overall performance (Novitasari & Agustia, 2021). The influence of GSCM practices on economic, environmentally, and social sustainability performance underscores the vital role of green supply chain management in enhancing sustainability performance (Yildiz Çankaya & Sezen, 2019b).

The supply chain encompasses the various entities engaged in the creation of new products and services, procuring raw materials, and converting these inputs into intermediate and final goods, and delivering these goods to the final consumer (Patel, 2022). In today's global market, supply chains compete with each other. Various internal and external factors have an impact on the efficiency of a supply chain, for example the way it is set up, how it manages its inventory, how it shares information, how it predicts customer demand, how long lead times are, and how long review periods are, which can be optimized to improve supply chain performance (George & Madhusudanan Pillai, 2019).

Needed to improve sustainable performance include green warehouse, logistics, and green supply chain management (Okeudo et al., 2022 ; Maemunah et al., 2023)

An optimal supply chain is characterized by minimal costs while simultaneously satisfying client requirements in operational aspects, such as precise delivery and lead time, particularly if the product has a short shelf life (Negi, 2021). Supply chain performance also enhances sustainable development, and the supply chain is considered the basic path to solving resources and the environment, overcoming climate change, and fostering a new economic climate (Mahesh Prabhu et al., 2020).

Efficient supply chain management is crucial in modern business to enhance organizational efficiency and competitiveness. In the age of global marketing and outsourcing, numerous organizations have embraced supply chain management as an important element of their corporate operations. Therefore, proper measurement of supply chain performance is required. (Karamouz et al., 2021)

The supply chain performance is determined by the systematic also strategic, and effective cooperation of capable business functions both internally and outside to the organization. The process encompasses the necessary steps and activities to convert unprocessed materials into finished goods (Maulina & Natakusumah, 2020).

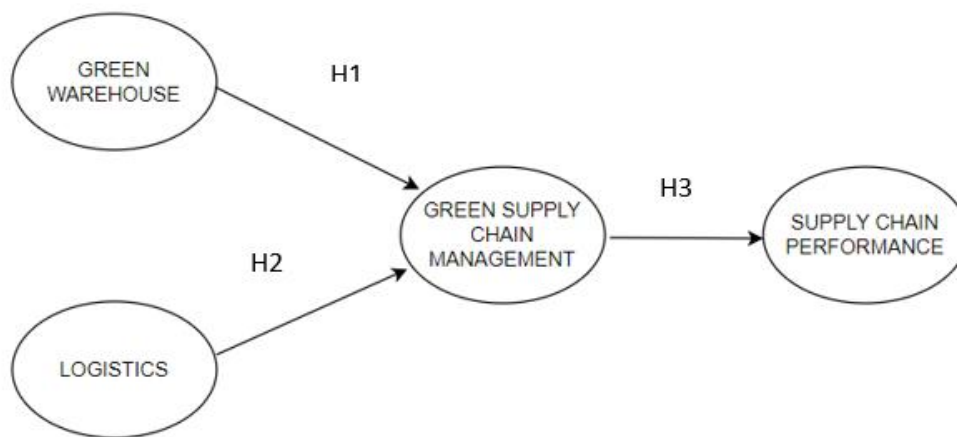


Figure 1 Hypothesis Framework

H1: The Effect of Green Warehouse on Green Supply Chain Management (GSCM)

Green warehouses have a substantial impact on green supply chain management, particularly in terms of reducing costs, improving operational efficiency, and providing environmental advantages, and competitive advantage. Green warehouse can reduce costs. Implementing a green warehouse can effectively decrease expenses related to the manufacturing process. An Environmental Management System (EMS) directly influences both the Environmental Impact (EI) and Environmental Cost Savings (ECS). This means that implementing an EMS leads to a reduction in both the environmental impact and the costs associated with the production process (García Alcaraz et al., 2022).

H2: The Effect of Logistics on Green Supply Chain Management (GSCM)

Logistics refers to the process of planning, executing, and controlling the efficient and effective flow of goods, services, and information from the point of origin to the point of consumption. It involves coordinating and integrating various activities, including transportation, warehousing, inventory management, packaging, and safety, to ensure that products are delivered to customers in a timely and cost-effective manner (Muduli et al., 2023).

H3: The Effect of Green Supply Chain Management (GSCM) on Supply Chain Performance

By implementing green supply chain management (GSCM), companies can withstand or minimize demands from external factors, such as governments and consumers or customers (Abu Seman et al., 2019). Green supply chain management (GSCM) practices significantly impact economic, environmental, and social sustainability performance, highlighting the importance of GSCM in improving sustainability performance (Yildiz Çankaya & Sezen, 2019b)

2. Research Method

This research design uses quantitative methods. The quantitative method is a research method that uses numerical data to answer research questions (Syifa Rofifa Putri Rizq & Istyakara Muslichah, 2023). This method is used to test hypotheses and explain the relationship between the variables studied. Research with quantitative methods usually involves data collection through surveys, experiments, or statistical analysis (M. Firmansyah et al., 2021). A type of research that is systematic, planned, structured, and objective is the definition of quantitative research (Imron, 2019).

The populations in this study is all freight forwarding companies in Indonesia, totaling 3,521 ALFI member companies, of which 43% are located in the Jakarta area (ALFI, 2023).

The data collected is quantitative with the aim that researchers can see more broadly the effects of green warehouses, logistics, and green supply chain management on supply chain performance. Data was obtained by distributing questionnaires to 100 respondents as a sample. To analyze the data using the Smart-PLS analysis tool.

Table 1 Variable

No	Variable	Item	Statements
1	Green Warehousing	Waste Management	The company treats warehousing waste properly to avoid environmental hazards.
		Saving Energy	The company regulates the amount of energy consumption in the warehouse to avoid waste.
		Enviromentally Awareness	Warehousing operates by raising awareness to keep the environment safe.
		Green Materials	The Company avoids using products that may harm human health and the environment.
		Green Operations and Maintenance	The company conducts a green operation and maintenance program consisting of training, licensing, and control to preserve green materials in the warehouse in accordance with environmental needs.
2	Logistics	Green Transportations	Reduce CO2 emissions by using environmentally friendly transportation

			(such as Electric Vehicles & environmentally friendly fuels.
		Reverse Logistics	The company uses materials or materials from recycled products.
		Green Distribution	The company prioritizes the efficiency and efficacy of transportation when doing distribution.
		Green Packaging	The company conducts packaging using environmentally friendly materials.
		On-Time Delivery	The company is able to provide delivery services in accordance with the delivery time that should be or on time.
3	Green Supply Chain Management	Green Manufacturing	The company focuses on planning and controlling for the reduction of hazardous wastes and the use of environmentally friendly materials.
		Renewable Energy	Using renewable energy for the operation process.
		Green Marketing	The company engages and fulfills consumers by actively promoting and enhancing understanding regarding the significance of environmental safety.
		Green Logistics	Recycling of existing activities to reduce costs.
		Full efficient vehicles	The company focuses on selecting more effective transportation modes to support efficiency in distribution.
4	Supply Chain Performance	Customer Loyalty	Customer loyalty provides a good assessment of the company's performance.
		Customer Service & Flexibility	Flexible service for customers can provide good value for company performance.
		Delivery Reliability	Reliable delivery for customers provides positive value for the company's performance.
		Cost Reduction	Cost reduction can improve the company's efficiency and make the company's performance better.
		Quality Consistency	Consistency in quality is the main thing that the company does to maintain company performance.

3. Results and discussion

Validity and Reliability Testing

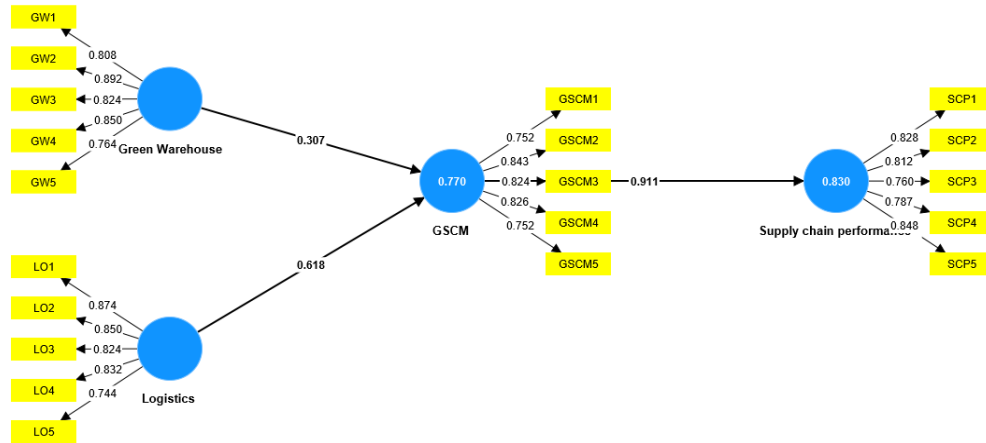


Figure.1 PLS Algorithm

Table 1. Validity Test

Indicators	Green Warehouse	Logistics (X1)	GSCM (X2)	Supply chain Performance (Y)	Result
GW.1	0.808				Valid
GW.2	0.892				Valid
GW.3	0.824				Valid
GW.4	0.850				Valid
GW.5	0.764				Valid
Log.1		0.874			Valid
Log.2		0.850			Valid
Log.3		0.824			Valid
Log.4		0.832			Valid
Log.5		0.744			Valid
GSCM.1			0.752		Valid
GSCM.2			0.843		Valid
GSCM.3			0.824		Valid
GSCM.4			0.826		Valid
GSCM.5			0.752		Valid
SCP.1				0,828	Valid
SCP.2				0,812	Valid
SCP.3				0,760	Valid
SCP.4				0,787	Valid
SCP.5				0,848	Valid

Determine the reliability of each indication using convergent validity. Outer loading value > 0.7, communality > 0.5, Average Variance Extracted (AVE) > 0.5 are frequently employed as guidelines for determining convergent validity. Table 1 shows that the validity value for each assertion is more than 0.70, thus we can safely say that they are all valid.

Table 2. Reliability test

Variable	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)	Result
Green warehouse	0.859	0,899	0,640	Reliable
Logistics	0.885	0,904	0,652	Reliable
GSCM	0.883	0,915	0,682	Reliable
Supply Chain Performance	0.867	0,916	0,687	Reliable

Table 2 shows that the square root of the AVE for each variable exceeds the coefficient for any other variable. This metric can be used with any variable that has a reliable validity determinant. All four variables (Green warehouse, Logistics, Green supply chain management, and Supply chain performance) met or above AVE of 0.50 in the discriminant validity test.

Table 3. R Square

	R Square	R Square Adjusted	Result
GSCM (X3)	0,770	0,765	Strong
Supply chain performance (Y)	0,830	0,828	Strong

The strong R-squared value would be 0.75, while moderate would be 0.50 and weak would be 0.25. This concerns the predictive significance of Q2 based on the R2 values of the two variables. The Q-square provides the following insight into the structural model's fit:

$$\begin{aligned}
 Q^2 &= 1 - (1 - 0,770) (1 - 0,830) \\
 &= 1 - (0,23) (0,17) \\
 &= 1 - 0,0391 \\
 &= 0.96
 \end{aligned}$$

The resulting Q-square is 0.96. Due to the fact that $Q^2 > 0.07$. Predictive value and utility of the model are demonstrated

Hypotheses Test

Table 4. Path coefficients and T-values

Path	B	t-value	p-value	Result
GSCM-> Supply chain performance	0.911	62.381	0.000	Significant

Green warehouse -> GSCM	0.307	2.788	0.005	Significant
Logistics -> GSCM	0.618	5.937	0.000	Significant

- The correlation between Green warehouse -> GSCM is statistically significant with t-value = 2.788, p-value = 0.005. In this context, it can be accepted or "Accepted" with a large strength of effect.
- The correlation between the variables Logistics -> GSCM is statistically significant with t-value = 5.937, p-value = 0.0000. In this context, the relationship is acceptable or "Accepted" with a large strength of effect.
- The correlation between GSCM -> Supply chain performance is statistically significant t-value = 62.381, p-value = 0.0000. This relationship is acceptable or "Accepted" with a large effect strength.

All reported indicators of the research variables have an outer loading value of > 0.7 , as indicated by the data. Additionally, there exists an outside loading value when the value is smaller than 0.7. Given these outcomes, it is safe to say that all variables in question have high levels of discriminant validity. The preceding table also demonstrates that for a number of variables, the composite dependability value is more than 0.7.

Based on these findings, it appears that multiple variables have achieved the required level of composite reliability, allowing us to conclude that all variables are very reliable. These results can show that the output has met the Cronbach alpha value requirements.

Discriminant validity is carried out to ensure that each concept of each latent model is different from other variables. Validity testing is carried out to determine how precisely a measuring instrument performs its measurement function. It can be seen from the numbers listed from different latent variables, this shows that the validity of the Green warehouse, Logistics, Green supply chain management & Supply chain performance variables is appropriate.

4. Conclusion

This research is intended to determine the effects of green warehouse, logistics, and green supply chain management on supply chain performance. Green warehouse and logistics positively and significantly affect GSCM in freight forwarders in Indonesia. The freight forwarders company is committed to reducing warehouse waste and managing the waste appropriately. Logistics activities implement efficiency in storage, packaging, and shipping processes. The freight forwarders company also implements transportation from the warehouse from storage and shipping, including designing its environmentally friendly products.

Implications

This research contributes to freight forwarders companies related to Improving Supply Chain Performance with Green Warehouse, Logistics, and Green Supply Chain Management in Indonesia.

This study reveals that green warehouse, logistics, and green supply chain management have a significant effect on supply chain performance.

Research limitations

This research only focuses on the variables of green warehouse, logistics, green supply chain management, and supply chain performance, therefore it is imperative to incorporate various elements, such as lean management and environmental performance.

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