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The impact of green supply chain management on the performance: A case study of Vietnamese large manufacturing enterprises

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ABSTRACT
The study aims to evaluate the impact of green supply chain management on the performance of large manufacturing enterprises in Vietnam. Based on the evaluation results of 332 survey samples, combined with quantitative analysis on SPSS 26 software. The results show that green purchasing, green construction, green marketing, environmental education, and reverse logistics are factors that have a positive impact on the performance of large manufacturing enterprises in Vietnam. Based on the findings, the study proposes some management implications to help enterprises build more effective green management strategies, meet integration requirements and aim for long-term sustainable development.

Keywords: Green supply chain management, operational efficiency, manufacturing enterprises, Vietnam

INTRODUCTION:

In the context of the world economy shifting strongly to a green growth and low-emission model, the need to improve sustainability in production and business has become a real pressure for all businesses. The increase in environmental standards in international trade, global commitments to reduce greenhouse gas emissions, and changes in investor and consumer awareness have made the "green" factor an important measure of competitiveness. With a central role in the global value chain, manufacturing enterprises are forced to restructure their operations, innovate technology and adjust their governance models to meet increasingly stringent requirements for sustainable development. In Vietnam, the large manufacturing enterprise sector plays a driving role in economic growth, contributing significantly to exports and attracting foreign investment. However, this is also the group of enterprises that is under the greatest environmental pressure due to high energy consumption, use of many raw materials and significant emissions and waste generation during operations.

Faced with that reality, the Government has set a target of net zero emissions by 2050 and issued many policies to promote the circular economy, forcing large manufacturing enterprises to seek a suitable governance model to minimize environmental impact while still ensuring operational efficiency and competitiveness. Based on these requirements, Green Supply Chain Management (GSCM) was born and is considered a comprehensive and sustainable approach, because it improves the greenness of the entire value chain - from supplier selection, product design, production, transportation, to recovery - recycling. Applying GSCM not only helps businesses reduce costs through saving energy and raw materials but also supports compliance with international standards, enhances brand reputation, and expands export markets. However, the implementation of GSCM in large manufacturing enterprises is still not really synchronous and strategic. Many businesses still see GSCM as a cost burden, lacking clear evidence of benefits, or lacking a specific impact assessment model on operational efficiency. Therefore, the study aimed at assessing the impact of green supply chain management on operational efficiency of large manufacturing enterprises in Vietnam was conducted to provide reliable scientific evidence, contributing to the completion of the theoretical basis, and at the same time supporting businesses in building more effective green management strategies. The research results are expected to not only have academic significance but also have profound practical value, helping businesses improve operational efficiency, meet integration requirements, and move towards sustainable development in the long term.

2. Literature review

Fundamental studies on Green Supply Chain Management (GSCM) began to take shape in the early 1990s, in the context of increasingly serious global environmental problems such as pollution, resource depletion, and climate change. Studies by Srivastava (2007), Seuring and Müller (2008), or Fahimnia et al. (2015) all show that GSCM quickly became a mainstream approach in supply chain management research, because it directly integrates environmental goals into all activities from supply, production, to distribution and recovery. GSCM originates from the need to harmonize economic and environmental goals, in line with the foundation of Resource Dependence Theory and Resource-Based Theory (RBV). These theories argue that investments in green processes, clean technology, and environmental cooperation can become strategic resources, helping businesses improve operational capacity and competitive advantage.

According to Rao and Holt (2005), GSCM helps businesses improve environmental performance and create a "green value chain" that contributes to increased competitiveness. Along with that, Woo et al. (2016) pointed out that environmental cooperation between businesses and suppliers not only reduces waste treatment costs and reduces environmental risks, but also strengthens long-term competitive advantages. Many studies have assessed the impact of each green practice on environmental, economic and social performance. Balasubramania and Shukla (2017) asserted that activities such as green design, green procurement, green transportation and green construction all bring significant benefits to environmental and economic performance. Similarly, Çankaya and Sezen (2019) further analyzed the components of GSCM, including green manufacturing, green marketing, green packaging, green distribution and internal environmental management and demonstrated their simultaneous impact on economic, environmental and social performance, emphasizing the integrative role of GSCM in the entire value chain. Nguyen et al. (2020) pointed out that green design and green manufacturing had the most positive impact on economic, environmental and social performance; while green procurement only impacted economic and social performance without significantly affecting environmental performance, reflecting the limitations in suppliers' green standard control capacity. Fianko et al. (2021) further reinforced this argument by finding that green procurement, green design and green construction had a direct, positive impact on environmental performance, thereby recommending that businesses increase the integration of environmental factors into supplier selection and evaluation. Business performance is often approached according to the three criteria of sustainability, including economic, environmental and social efficiency (Wang & Dai, 2018; Das, 2018). In which environmental efficiency reflects the extent to which enterprises control and minimize negative impacts on the ecosystem, demonstrated through the ability to reduce greenhouse gas emissions, limit the amount of solid waste and untreated wastewater, as well as reduce the consumption of energy and natural resources (De Giovanni & Vinzi, 2012; Laari, 2016). In Vietnam, research by Tran (2022) shows that green practices, environmental cooperation with suppliers and customers, and environmental monitoring activities play an important role in improving environmental and social results, and indirectly impact the economic results of enterprises. This clearly reflects the characteristics of Vietnamese enterprises that economic benefits from GSCM are often recognized through cumulative environmental and social performance rather than appearing immediately.

Green marketing refers to the activities of designing, communicating, pricing, and distributing products in a way that emphasizes environmental value (Pride & Ferrell, 1993). Promoting green marketing helps raise customer awareness and increase the commitment of businesses to environmental protection, thereby creating internal pressure to improve environmental performance (Singh & Pandey, 2012; Yildiz Çankaya & Sezen, 2019). Therefore, the author proposes the hypothesis:

H1: Green marketing has a positive impact on business performance

Within the framework of GSCM, green purchasing practices emphasize the selection of input materials that are environmentally friendly, low-toxicity, and have the potential to be recycled or reused (Shao & Ünal, 2019; Foo et al., 2019). These practices help reduce the amount of waste and toxic emissions generated during the production process, thereby contributing to improving the environmental performance of the enterprise (Ahmed et al., 2020). Based on that, the author proposes the hypothesis:

H2: Green purchasing has a positive impact on business performance

Environmental education for employees and managers helps to improve awareness, skills, and behaviors related to environmental protection, thereby forming a green production culture in enterprises (Balasubramania & Shukla, 2017). Training programs on environmental policies and green practices have been shown to increase compliance, reduce environmental risks, and improve the environmental performance of enterprises (Yildiz Çankaya & Sezen, 2019). Therefore, the hypothesis is:

H3: Environmental education has a positive impact on business performance.

Reverse logistics involves the activities of recovering, recycling, reusing, or remanufacturing materials that are discarded during the production process (Sarkis, 2003). When reverse logistics is implemented effectively, businesses can reduce the need for new raw materials, reduce pollution, and limit the consumption of natural resources (Sobotka & Czaja, 2015; Banihashemi et al., 2019). Therefore, the hypothesis is formulated:

H4: Reverse logistics has a positive impact on business performance

Green construction practices focus on the application of construction methods and technologies to minimize negative environmental impacts, such as efficient waste management, prioritizing fuel-efficient equipment, prefabrication technology, and the use of less toxic materials (Balasubramania & Shukla, 2017; Wiguna et al., 2021). Research shows that the promotion of green construction contributes to reducing pollution, reducing energy consumption, and limiting impacts on the ecosystem (Zou & Moon, 2014). Therefore, the hypothesis is posed:

H5: Green construction has a positive impact on business performance

Synthesizing the above hypotheses, the proposed research model is shown as follows:

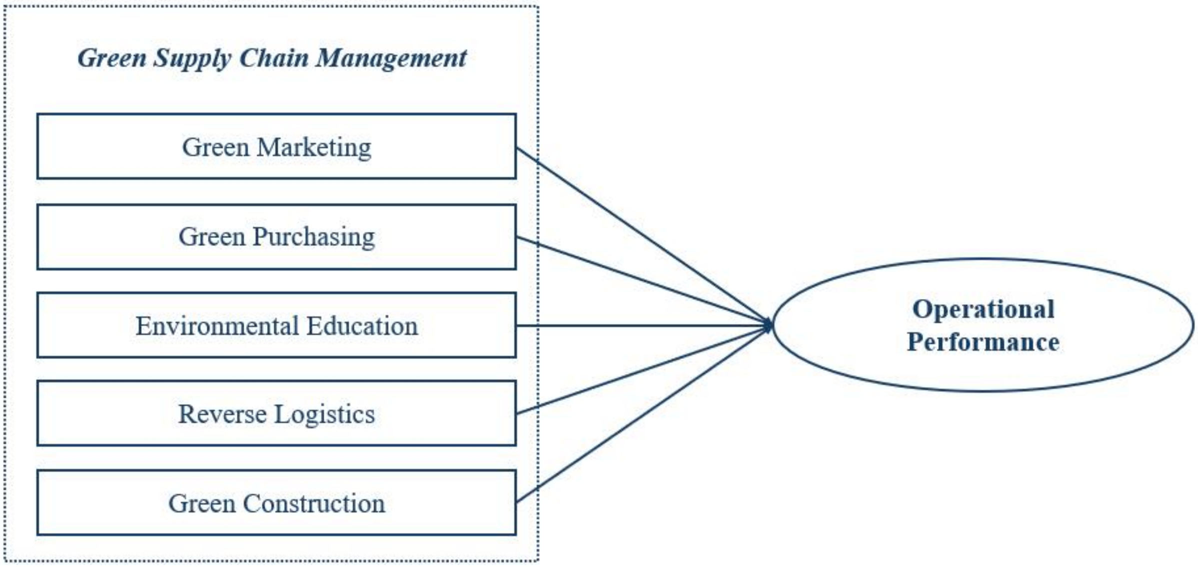

Figure 1. Research model
Source: Author's proposal
From the proposed research hypotheses and models, the general research equation is expressed as follows:

OP = β0 + β1*GM + β2*GP + β3*EE + β4*RL + β5*GC +ε

$$OP = \beta_0 + \beta_1 * GM + \beta_2 * GP + \beta_3 * EE + \beta_4 * RL + \beta_5 * GC + \varepsilon$$

In there:
OP (dependent factor): Operational Performance
Independent include (X_i): Green Marketing (GM), Green Purchasing (GP). Environmental Education (EE), Reverse Logistics (RL), Green Construction (GC)
β_k: Regression coefficient (k = 0, 1, 2,..., 5).
ε: Random error.

3. Methodology

The preliminary scale was built on the basis of inheriting and adjusting from domestic and foreign studies on green supply chain management and business performance, presented in the theoretical overview section. At the same time, the group of authors discussed with several middle and senior managers working at large manufacturing enterprises in Vietnam, combined with consulting experts in the field of supply chain management, to review the suitability of the research model, the structure of the scales and the content of the observed variables. The discussion results showed that the members agreed with the scope and content of the proposed scale; however, some observed variables were adjusted in terms of wording to ensure ease of understanding, suitability with the operating context of manufacturing enterprises and the characteristics of GSCM. The official scale consists of 27 observed variables, corresponding to 5 independent factors in green supply chain management and 1 dependent factor, which is business performance. All variables are measured using a 5-level Likert scale from 1 - "Completely disagree" to 5 - "Completely agree".

The sample size was determined based on the recommendation of Hair et al. (2010), according to which the number of observations should be at least 5 to 10 times the number of variables measured in the model. The study selected the best ratio to ensure reliability, representativeness, and reserve invalid ballots. The study actually distributed a total of 350 survey ballots. The survey was conducted from March 2025 to June 2025 using a non-probability convenience sampling method, broadcast online through email to managers, staff in charge of purchasing, production, logistics, and environment at large manufacturing enterprises in two areas: Hanoi and Ho Chi Minh City. At the end of the collection process, after cleaning the data and removing invalid questionnaires, a total of 332 questionnaires were used for quantitative analysis. The data were processed using SPSS 26 software with a statistical significance level of 5%, including the following steps: Cronbach's Alpha reliability test, EFA exploratory factor analysis, correlation analysis, and linear regression to test the hypotheses of the research model.

4. Results

Table 1. The results of reliability testing

Scales	Sign	No.	Cronbach's Alpha	Corrected Item-Total Correlation	Cronbach's Alpha if item Deleted
Green marketing	GM	5	0.819	0.487 – 0.539	0.796 – 0.751
Green purchasing	GP	4	0.785	0.512 – 0.586	0.773 – 0.729
Environmental education	EE	4	0.792	0.491 – 0.552	0.784 – 0.752
Reverse logistics	RL	4	0.824	0.526 – 0.541	0.817 – 0.746
green construction	GC	5	0.803	0.539 – 0.602	0.795 – 0.753
Operational performance	OP	5	0.836	0.475 – 0.578	0.795 – 0.762

Source: Author's data processing results

The results of the reliability test of the scale show that the Cronbach's Alpha coefficient of all factors is greater than 0.7, meeting the reliability requirements, greater than the minimum recommended level of 0.5 (Hair et al., 2010). At the same time, the total correlation coefficient of the observed variables is greater than 0.3 and the Cronbach's Alpha coefficient if the variable is eliminated is smaller than the total Cronbach's Alpha coefficient, so no observed variables are bad and are eliminated. The scale meets all the conditions to continue to perform EFA factor analysis.

Table 2. The results of EFA of independent factors

KMO = 0.783		
Bartlett's test	Approx. Chi-square value	6259.741
	df	387
	Sig.	0.000

Source: Author's data processing results

	Loadings				
	1	2	3	4	5
GP3	0.825				
GP1	0.809				
GP4	0.788				
GP2	0.763				
GC2		0.813			
GC5		0.802			
GC1		0.794			
GC3		0.771			
GC2		0.769			
GM4			0.808		
GM1			0.797		
GM3			0.763		
GM5			0.750		
GM2			0.742		
RL1				0.786	
RL4				0.771	
RL3				0.765	
RL2				0.743	
EE1					0.791
EE4					0.783
EE2					0.752
EE 3					0.747
Total variance extracted %	31.283	46.597	53.461	68.259	75.899
Eigenvalue	7.159	5.861	4.259	3.184	1.616

The results of the EFA using the PCA extraction method and Varimax rotation with the extraction stop at the Eigenvalue value greater than 1. The KMO coefficient reached 0.783, satisfying the condition (greater than 0.5 and less than 1), proving that the data is suitable for exploratory factor analysis. At the same time, Bartlett's test has a Chi-square value of 6259.741 with a significance level of Sig. = 0.000 < 0.05, showing that the observed variables have a linear correlation with each other, ensuring the conditions for using EFA. At the smallest Eigenvalue value greater than 1, there are 5 groups of factors extracted with the total extracted variance reaching 75.899% and the factor loading coefficients all satisfy greater than 0.5. Therefore, the scale has sufficient reliability and discriminant value, satisfying to be included in the next analysis (Hair et al., 2010).

Table 3. The results of the dependent factor

KMO = 0.813			
Bartlett's test	Approx. Chi-square value		319.258
	df		5
	Sig.		0.000
Scale			Loadings
Operational Performance		OP1	0, 809
		OP5	0.785
		OP2	0.767
		OP3	0.743
		OP4	0.721
Total variance extracted %		71.385	
Eigenvalue		1.862	

Source: Author's data processing results

For the dependent factor, the results of the exploratory factor analysis also satisfy the conditions given by Hair et al. (2010), with the KMO coefficient reaching 0.813 and the Sig value of Bartlett's test being less than 0.05. At the Eigenvalue value reaching 1.862, the observed variables are extracted into a single factor group with the total extracted variance equal to 71.385% and the factor loading coefficients are all greater than 0.5.

Table 4. The results of correlation analysis

	OP	GM	GP	EE	RL	GC
OP	1					
GM	0.619**	1				
GP	0.657**	0.234**	1			
EE	0.703**	0.212*	0.188**	1		
RL	0.648**	0.251**	0.215*	0.172**	1	
GC	0.725**	0.196**	0.243**	0.294*	0.211**	1
**, **. Corresponds to p < 0.05 and p < 0.01*						

Source: Author's data processing results

The results of the correlation coefficient test show that there is a good correlation between the independent factors and the dependent factors, with a correlation coefficient greater than 0.4 and a Sig. coefficient less than 0.05. There is no suspicion of multicollinearity between the independent factors, satisfying the conditions for inclusion in the regression analysis (Hair et al., 2010).

Table 5. Summary of the regression model

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of estimate**	**Durbin-Watson**
1	0.783[a]	0.779	0.758	0.312	1.782

Source: Author's data processing results

Regression analysis was performed using the Enter method, with factors being entered one at a time to test the hypothesis. The summary results of multiple linear regression showed that the model had an R value of 0,783 shows the relationship between the factors in the model is relatively tight. The coefficient of determination R^2 = 0.779 reflects the suitability of the model, reaching 77.9%. At the same time, the adjusted R^2 value indicates more accurately the suitability of the model to the population, reaching 0.758, meaning that 75.8 % of the variation in business performance is explained by 5 factors in the model; the rest is due to factors other than the model and random errors. The Durbin–Watson value reaches 1.782, so there is no violation of the first-order serial autocorrelation assumption. The results of ANOVA analysis and F test also show that the statistical value calculated from R^2 has a Sig value = 0.000, so the linear regression model is suitable for analysis.

Table 6. Results of multiple regression analysis

Factors		**Unstandardized coefficient**		**Standardized coefficient**	**t**	**Sig.**	**Collinearity statistics**	
		B	**Std. Error**	**Beta**			**Tolerance**	**VIF**
1	*(Constant)*	0.176	0.015		0.755	0.000		
	GM	0.289	0.029	0.304	0.681	0.000	0.697	1.645
	GP	0.341	0.014	0.358	0.792	0.002	0.583	1.798

	EE	0.267	0.023	0.273	0.644	0.000	0.641	1.801
	RL	0.242	0.012	0.256	0.617	0.001	0.572	1.732
	GC	0.325	0.027	0.339	0.730	0.000	0.615	1.867
Dependent variable: OP								

Source: Author's data processing results

Testing the research hypotheses shows that all factors included in the model have a significance level of Sig. less than 0.05, indicating that the model is statistically significant. The variance inflation factor (VIF) of the independent factors is less than 2, and the Tolerance acceptance level is greater than 0.5, indicating that there is no multicollinearity between the factors in the model. In addition, regression diagnostic tests such as Scatterplot, Histogram and PP plot show that the residuals are randomly distributed, approximately normal and do not violate the assumptions of the multivariate linear regression model. With the Scatterplot graph representing the residuals compared to the predicted value, there are points randomly scattered around the mean = 0, not forming a regular geometric shape, proving that the assumption of linear relationship and constant variance is guaranteed; The Histogram of the residuals has a normal distribution curve that closely resembles the histogram when the Mean value is approximately 0 and the standard deviation is close to 1. The P–P Plot of the standardized residuals shows that the observation points are distributed close to the 45-degree diagonal, confirming that the assumption of normal distribution of the residuals is not violated. Therefore, the hypotheses are all accepted, and the linear regression equation according to the standardized Beta coefficient is determined as follows:

OP = 0.358*GP + 0.339*GC + 0.304*GM + 0.273*EE + 0.256*RL +ε

Linear regression results show that all five components of green supply chain management have a positive and statistically significant impact on business performance. Among them, green purchasing is the strongest influencing factor (β = 0.358), indicating that prioritizing the selection of environmentally friendly, recyclable and energy-saving materials helps businesses reduce costs, limit environmental risks and improve production efficiency. Green construction/manufacturing ranks second (β = 0.339), confirming the role of applying energy-saving production processes and reducing waste generation in increasing resource efficiency. The impact of green marketing (β = 0.304) shows that businesses that promote communication about green products will improve competitiveness, increase trust and expand markets. In addition, environmental education (β = 0.273) contributes to raising awareness and green behavior of employees, thereby improving the operation process. Although having the lowest impact level, reverse logistics (β = 0.256) still plays an important role in recovering, recycling and reusing material resources to save costs and minimize environmental impacts. Overall, the regression model has demonstrated that the synchronous implementation of green supply chain management practices brings significant benefits to the operational efficiency of large manufacturing enterprises in Vietnam.

5. Implications

First, businesses need to view green purchasing as a pillar of their sustainable development strategy. Enterprises need to prioritize selecting suppliers that meet environmental standards, use environmentally friendly materials, are recyclable and have low emissions. In addition, enterprises need to establish a clear set of green purchasing criteria, increase periodic supplier evaluations, and promote long-term cooperation with partners with the capacity to green the supply chain. This helps reduce environmental risks and optimize long-term operating costs.

Second, businesses need to promote the implementation of green construction/manufacturing practices throughout their entire operations. Enterprises need to invest in technological innovation towards saving energy, optimizing the use of raw materials, and minimizing waste. At the same time, enterprises need to apply international environmental management standards and closely monitor green operating indicators. This helps enterprises improve environmental efficiency and overall operational efficiency.

Third, businesses need to increase green marketing activities to enhance competitive advantage and expand markets. Businesses need to develop communication campaigns that emphasize the sustainable value of their products, provide transparent information about their environmental impact, and encourage customers to choose green products. In addition, businesses need to align their brand positioning with an "environmentally friendly" image to increase trust and build long-term customer relationships.

Fourth, businesses need to focus on environmental training and education to raise awareness and behavior of workers. Enterprises need to organize regular training courses on environmental protection, green labor safety and economical use of resources. At the same time, enterprises need to incorporate criteria for implementing environmental responsibility into the work performance evaluation system to motivate employees. This helps to form an environmentally friendly working culture and improve compliance throughout the organization.

Fifth, businesses need to perfect the reverse logistics system to optimize resources and reduce processing costs. Enterprises need to establish a process for collecting, sorting, reusing and recycling post-consumer materials, and cooperate with reputable recycling units to minimize waste. Enterprises also need to build a mechanism to monitor and measure the effectiveness of reverse logistics to ensure that the operation process is synchronous and brings clear economic and environmental benefits.

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