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The Impact of Green Supply Chain Management on Environmental and Economic Performance in The Ceramic Industry: A Case Study of PT. Muliakeramik Indahraya

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ABSTRACT

The ceramic industry plays a vital role in Indonesia's economy, particularly in supporting the growing property and infrastructure sectors. However, its development brings environmental concerns, including carbon emissions from the firing process, production waste, and excessive use of natural resources. As stakeholder pressure and global demands for sustainable practices intensify, companies are expected to implement strategies that improve efficiency while reducing environmental harm. Green Supply Chain Management (GSCM) offers a strategic approach to address these challenges. This study examines the impact of GSCM on environmental and economic performance, using PT. Mulia Keramik Indahraya as a case study. Employing a quantitative associative-causal approach, data were collected from 72 employees and analyzed using Structural Equation Modeling with Partial Least Squares (SEM-PLS). The findings show that stakeholder pressure significantly influences GSCM adoption. GSCM, in turn, has a positive impact on economic performance, but does not significantly affect environmental performance. However, improved environmental performance does contribute positively to economic outcomes.

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1. INTRODUCTION

In line with global trends, Indonesia is experiencing very rapid urbanization, with the urban population increasing significantly from 30% in 1990 to 59.3% in 2024. In fact, the United Nations projects that by 2050 around 85% of Indonesia's population will live in urban areas. This condition creates high demand for infrastructure development, especially the property sector which drives the growth of other industrial sub-sectors, including the ceramics industry [1]. The development of the property industry supported by government programs such as the construction of 3 million houses and stable economic growth projections, has also expanded the growth opportunities for the ceramics industry [2]. Based on data from the Central Statistics Agency (2024), the growth of Indonesian ceramic production from 2019 to 2024 increased by 17.5%, with annual production increasing from 560 million m^2 to 658 million m^2. Despite experiencing a contraction in 2020 due to the COVID-19 pandemic, the industry has shown resilience with consistent recovery since 2021. However, behind this growth, the ceramics industry also faces serious challenges related to the environmental impact of its production process. The ceramic production process involves the utilization of natural resources such as clay, silica, and feldspar which are often obtained through mining which can damage natural habitats and cause soil and water pollution due to improper waste disposal [3]. In addition, the ceramic firing process produces greenhouse gas emissions, such as CO_2, NOx, and SOx, which contribute to global climate change [3]. Therefore, strategic efforts are needed to manage this environmental impact through the implementation of Green Supply Chain Management (GSCM). Implementation of GSCM at PT. Mulia Keramik Indahraya is a concrete example of how a company strives to balance economic and environmental performance by managing solid and liquid waste sustainably, using recycled raw materials, optimizing environmentally friendly transportation, and energy efficiency [4]. This strategy has not only succeeded in reducing harmful gas emissions but has also been able to reduce operational costs, improve the company's reputation, and ensure compliance with increasingly stringent environmental regulations [5]. Furthermore, previous studies have confirmed that the success of GSCM implementation cannot be separated from the influence of stakeholder pressure. Pressure from external parties such as the government, consumers, and environmental institutions encourages companies to be more proactive in adopting environmentally friendly practices [6]. This pressure also has an impact on the development of the company's internal resources, including the company's ability to manage green procurement, internal environmental management, ecological product design, cooperation with customers, and investment in green information systems [7], [8]. By strengthening these internal resources, companies can improve supply chain efficiency while having a positive impact on the company's environmental and economic performance [9], [10]. Although there have been many studies in various industrial sectors, research on the implementation of GSCM in the Indonesian ceramics industry is still relatively limited [11]. This study is highly relevant in addressing gaps in existing research and offering practical insights for effective environmental management within the ceramics industry. It focuses on exploring PT. Mulia Keramik Indahraya's perspectives on GSCM, assessing the role of stakeholder pressure in driving GSCM adoption, evaluating its impact on environmental performance, and analyzing its influence on the company's economic outcomes. The findings are expected to inform strategic recommendations that support sustainable growth in the ceramics sector and contribute to achieving Indonesia's Sustainable Development Goals (SDGs) [12].

2. LITERATURE REVIEW

Operations Management encompasses a set of coordinated activities that convert resources into final products or services, aiming to deliver added value and enhance organizational efficiency. This discipline emphasizes optimizing processes through improved effectiveness, reduced costs, enhanced quality, and faster workflows. Achieving excellence in operations can lead to a competitive edge, driven by ten key strategic areas: product development, quality management, process optimization, facility location, layout design, workforce management, supply chain coordination, inventory control, scheduling, and maintenance [13], [14]. Meanwhile, the supply chain represents the network of interconnected entities—ranging from raw material suppliers to end consumers—collaborating to maximize overall value creation. It typically includes suppliers, producers, distributors, retailers, and final customers [15]. Supply Chain Management is an approach to efficiently integrating the flow of information and products, in order to meet market needs. SCM involves strategic, tactical, and operational planning, and must be aligned with the company's competitive strategy. The success of SCM depends on balancing efficiency and responsiveness through the management of facilities, inventory, transportation, information, resources, and prices, while addressing dynamic challenges such as technology and sustainability [15], [16], [17].

In the 21st century, Sustainability has become a priority in the supply chain, focusing on the balance of economic, social, and environmental (Triple Bottom Line: people, planet, profit) [13], [15], [18]. SCM improves supply chain performance by taking into account the environment, providing benefits such as increased productivity, reduced costs, investment opportunities, increased profits, quality human resources, and energy efficiency [19].

GSCM is a strategy to achieve a balance between economic benefits and environmental performance. This includes Green Design that focuses on environmentally friendly products (recycling, energy saving, minimal waste) using Life Cycle Assessment [20], [21]. In addition, Green Operation integrates environmental practices into production, including green purchasing, green manufacturing, green distribution, green logistics, and waste management [14], [22], [23]. Stakeholder Pressure from regulators, shareholders, employees, and customers plays an important role in driving the implementation of GSCM practices, turning resources into competitive advantages [7], [24]. GSCM impacts Environmental Performance by reducing emissions, maximizing resources, recycling, and managing waste, often supported by ISO 14000 standards [13], [23]. Another impact is Economic Performance, which is seen from cost reductions and increased profitability through material and energy savings, as well as effective waste management [7], [11], [25].

3. METHODOLOGY

This study used a sample of 72 employees of PT Mulia Keramik Indahraya, determined by the Isaac and Michael formula. Primary data were collected through questionnaires. To ensure precise and consistent measurement, the research instruments underwent validity and reliability testing. Quantitative data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with a second-order construct approach. The analysis involved evaluating both the measurement model (outer model) for its convergent and discriminant validity, as well as reliability, and the structural model (inner model) to determine the strength and significance of variable relationships. Hypotheses were tested through the bootstrapping technique, while data credibility was further reinforced using source triangulation.

Table 1. Variable Description

Variables	Brief Definition	Main Dimensions
Stakeholder Pressure	Influence of external and internal parties on company management.	Regulation, Internal
Green Supply Chain Management (GSCM)	Operational activities to reduce environmental impacts along the supply chain.	Internal Environmental Management, Green Procurement, Customer Collaboration, Waste Recycling, Ecological Design, Green Information Systems
Environment Performance	Environment Performance The results of reducing the company's negative impact on the environment.	-
Economic Performance	Economic Performance The company's financial results related to cost reductions and increased profitability.	-

4. RESULTS AND DISUSSION

4.1 *Descriptive Analysis*

Descriptive analysis was conducted to provide an overview of the characteristics of research data at PT. Mulia Keramik Indahraya. This analysis aims to determine the average score level of each variable and its dimensions, which are then categorized into a good or very good assessment scale. The results of the descriptive analysis are presented in Table 2.

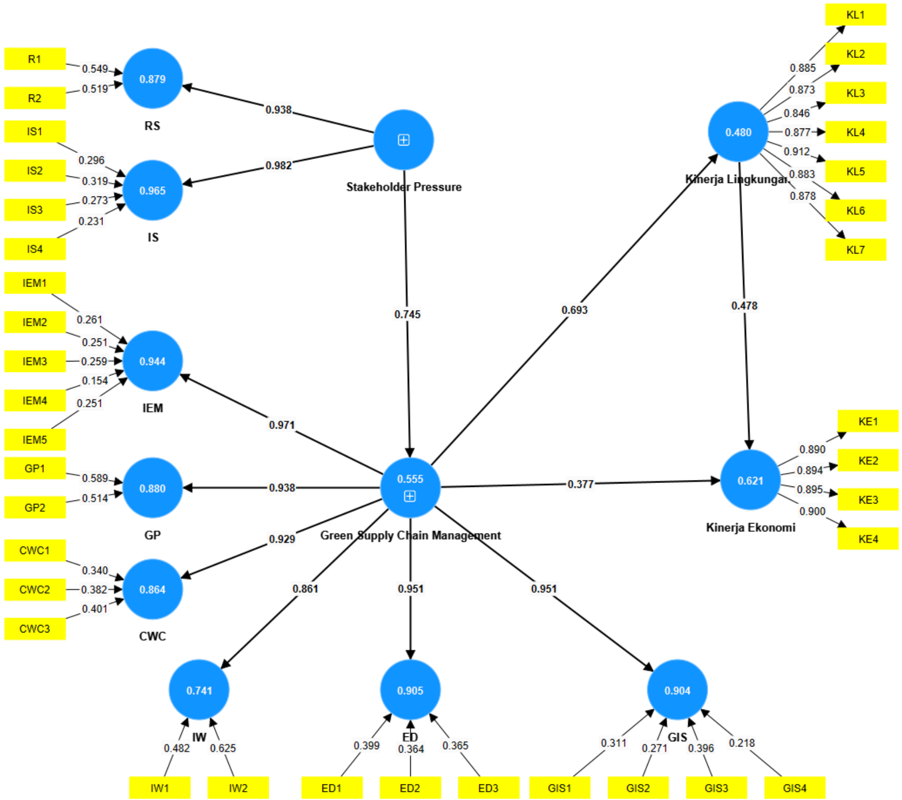
Table 2. Descriptive Analysis of Variables

Variable	Average Percentage (%)	Category
Stakeholder Pressure		
Regulatory Stakeholder	80.69	Good
Internal Stakeholder	79.93	Good
Green Supply Chain Management (GSCM)		
Internal Environment Management	83.17	Good
Green Procurement	83.47	Good
Corporation With Customer	83.15	Good
Investment Waste Recycling	79.31	Good
Ecological Design	81.85	Good
Green Information System	81.67	Good
Environment Performance	84.48	Very Good
Economic Performance	83.47	Good

Based on the results of descriptive analysis at PT. Mulia Keramik Indahraya, all research variables show an average percentage score in the good to very good category. The Stakeholder Pressure dimension on Regulatory Stakeholder and Internal Stakeholder each obtained an average value of 80.69% and 79.93% which are in the good category. All dimensions of GSCM are also in the good category, with the highest value in Green Procurement (83.47%) and the lowest in Investment Waste Recycling (79.31%). Meanwhile, Environment Performance obtained the highest score of 84.48% with a very good category, while Economic Performance was in the good category with a score of 83.47%.

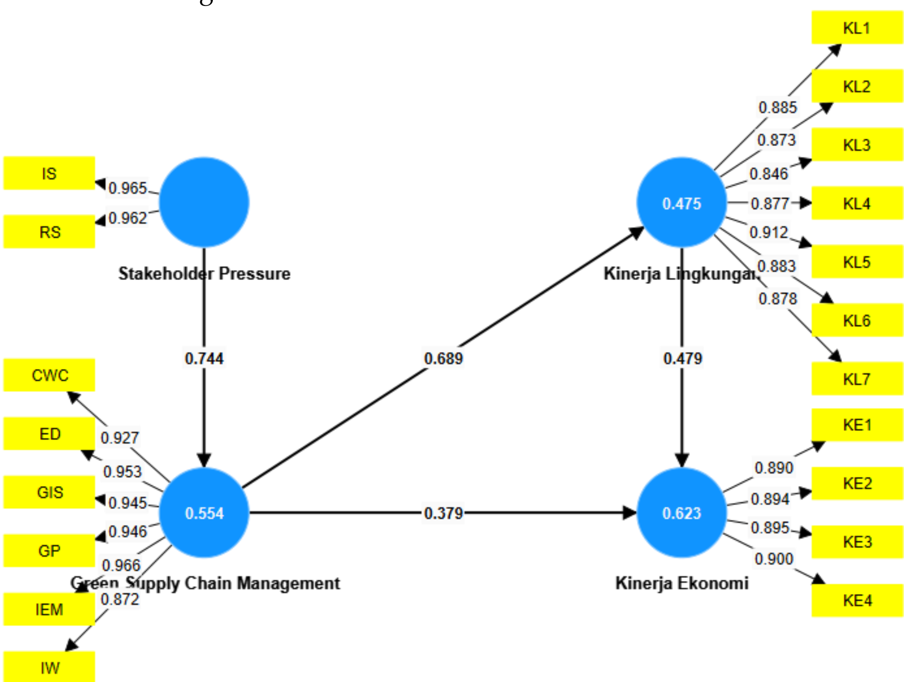
4.2 *Outer Model*

Outer model testing is conducted to assess the validity and reliability of the research instruments used. The outer model examines how well the indicators are able to represent the latent constructs being measured, both for reflective and formative indicators. The evaluation of the outer model includes testing convergent validity, discriminant validity, and construct reliability through outer loading values, AVE, Cronbach's Alpha, Composite Reliability, and HTMT. The results of the outer model testing are shown in Figure 1, Figure 2, and Table 3 below.



Gambar 1. Outer Model 1

Figure 4.1 shows the first iteration outer model that combines first-order and second-order constructs. This outer model consists of constructs with reflective and formative indicators used to measure research variables. Based on the results of factor loadings, all indicators have met the outer loading value above 0.70 so that convergent validity is met. Furthermore, using SmartPLS 4, a new dataset was created containing indicators represented as latent variables. Based on this new data, a simpler measurement model was then created, which can be seen in Figure 4.2 as outer model 2.



Gambar 2. Outer Model 2

Based on Figure 4.2, it can be seen that all indicators have outer loadings values above 0.70. These values indicate that each indicator has a significant contribution to the construct it represents. This strengthens the assumption that the indicators used in this study have been able to represent the construct appropriately.

Table 3. Discriminant Validity and Construct Validity Reliability

Construct	AVE	Cronbach's Alpha	Composite Reliability	Discriminant Validity Criteria (HTMT < 0.90)
Green Supply Chain Management	0.875	0.971	0.977	Meets (HTMT range 0.713 - 0.785)
Economic Performance	0.801	0.917	0.941	Meets (HTMT range 0.747 - 0.787)
Environment Performance	0.773	0.951	0.960	Meets (HTMT range 0.675 - 0.787)
Stakeholder Pressure	0.928	0.923	0.963	Meets (HTMT range 0.675 - 0.785)

The results of construct validity and reliability testing indicate that all constructs meet the required standards: the AVE values (ranging from 0.773 to 0.928) exceed the 0.50 threshold, confirming strong convergent validity; Cronbach's Alpha (0.917–0.971) and Composite Reliability (0.941–0.977) values are well above the minimum criteria, ensuring high internal consistency; and the HTMT values (0.675–0.787) remain below 0.90, demonstrating that discriminant validity is satisfactorily achieved.

4.3 Inner Model

After establishing the validity and reliability of the measurement model, the analysis proceeds to the structural model (inner model) to examine the robustness of the relationships among constructs. This involves evaluating key indicators such as the coefficient of determination (R^2), effect size (F^2), predictive relevance (Q^2), and overall model fit using indices like SRMR and NFI.

Table 4. Inner Model dan Model Fit

Aspek	Aspect Variable	Result	Category/Description
R-square	Green Supply Chain Management	0.554	55.4% of variance explained by Stakeholder Pressure
	Economic Performance	0.623	62.3% of variance explained by GSCM & Environmental Performance
	Environmental Performance	0.475	47.5% of variance explained by GSCM
F-square	GSCM → Economic Performance	0.2	Medium
	GSCM → Environmental Performance	0.904	Large
	Environmental Performance → Economic Performance	0.319	Medium
	Stakeholder Pressure → GSCM	1.241	Very Large
Q-square	Green Supply Chain Management	0.802	Predictive Relevance Very Good
	Economic Performance	0.65	Predictive Relevance Good
	Environmental Performance	0.685	Predictive Relevance Good
	Stakeholder Pressure	0.644	Predictive Relevance Good
Model Fit	SRMR (Saturated)	0.048	Fit (good, <0.08)
	NFI (Saturated)	0.847	Fit (close to 1)

The R-square results indicate that 55.4% of the variance in Green Supply Chain Management is explained by Stakeholder Pressure. Meanwhile, 62.3% of the variance in Economic Performance is accounted for by Green Supply Chain Management and Environmental Performance, and 47.5% of Environmental Performance is influenced by Green Supply Chain Management. The highest effect size (F-square) is observed in the relationship between Stakeholder Pressure and Green Supply Chain Management, showing a very strong impact (1.241). All Q-square values exceed 0.5, reflecting strong predictive relevance. Model fit indicators show an SRMR of 0.048 and NFI of 0.847, suggesting a good alignment between the model and the empirical data. Overall, the research model applied at PT. Mulia Keramik Indahraya is statistically sound—valid, reliable, and predictive—making it appropriate for testing the hypothesized relationships among variables.

4.4 Hypothesis Test

Following the confirmation that the outer and inner models meet the criteria for validity, reliability, and model fit, the next step is hypothesis testing. This phase aims to assess the relationships between variables established in the research model applied to PT. Mulia Keramik Indahraya. The hypothesis testing is conducted using the Partial Least Squares (PLS) approach by examining the original sample values, t-statistics, and p-values to determine whether each hypothesis is accepted or rejected. The detailed results of the hypothesis testing are presented in Table 4.

Table 4. Hypothesis Testing

No	Variable	Original sample (O)	T statistics	P values	Remarks
1	Stakeholder Pressure -> Green Supply Chain Management	0.744	5.436	0.000	Accepted
2	Green Supply Chain Management -> Environmental Performance	0.689	3.973	0.000	Accepted
3	Green Supply Chain Management -> Economic Performance	0.379	1.852	0.064	Rejected
4	Environmental Performance -> Economic Performance	0.479	2.57	0.01	Accepted

Based on the results of hypothesis testing at PT. Mulia Keramik Indahraya, it was determined that Stakeholder Pressure has a significant impact on the adoption of Green Supply Chain Management (GSCM) with a p-value of 0.000. This proves that stakeholders such as the government, customers, and the community exert pressure on companies to integrate environmental considerations into their supply chain management. This is in line with the research findings of [7] that stakeholder expectations play a vital role in driving companies to adopt GSCM to maintain their reputation, meet environmental standards, and become competitive [7].

In addition, GSCM application has a large effect on PT. Mulia Keramik Indahraya's environmental performance with a p-value of 0.000. Through more environmentally friendly raw material management, energy usage efficiency, and minimizing wastes, the company is able to minimize negative impacts on the environment. This is corroborated by a research conducted by [26] which shows that GSCM implementation has a positive impact on improving the environmental performance of the company through having environmentally based and controlled supply chain management from downstream to upstream [26].

But the impact of GSCM on economic performance of the company was expressed as not significant with a p-value of 0.064. Despite the fact that the company has implemented various environmental efficiency programs, direct impact of implementing GSCM on economic performance has not been seen yet. External factors such as market fluctuations, level of competition in the business, and amount of investment required for implementing GSCM also affect the said outcome. This outcome is in contrast to [26] where they found a positive effect of GSCM on economic performance due to the variation in the environment of the industries and stages of implementation at both companies [26]. Concurrently, environmental performance has a statistically significant effect on the economic performance of the firm with a p-value of 0.001. This means that companies that are able to improve their environmental performance reap economic benefits such as cost savings in operations, improved customer loyalty, easy access to markets, and improving the firm's reputation. These results support [27] contention that environmental innovation not only improves the firm's operating efficiency but also improves the firm's competitiveness in the market [27].

5. CONCLUSION AND POLICY IMPLICATIONS

The hypothesis testing results at PT. Mulia Keramik Indahraya indicate that stakeholder pressure exerts a positive and significant influence on the implementation of green supply chain management (GSCM). Furthermore, GSCM significantly enhances economic performance, though its impact on environmental performance, while positive, is not statistically significant. On the other hand, environmental performance shows a positive and significant relationship with economic performance. These findings suggest that the company should continue to reinforce GSCM practices with active stakeholder involvement, invest more in eco-friendly technologies, and promote wider collaboration across the supply chain. Additionally, government policies—such as supportive regulations and incentives—are essential to maximize the benefits of GSCM for both environmental sustainability and economic outcomes.

TRANSPARENCY

The authors affirm that this manuscript accurately and clearly represents the research conducted, with all key aspects included and any changes to the original plan fully explained. The study was also conducted in accordance with ethical standards.

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The researchers formally declare that this academic work constitutes an authentic, methodologically rigorous, and fully disclosed account of investigative activities. All essential components of the study design, implementation, and analysis have been inclusively documented, with substantive explanations provided for any modifications to predetermined research protocols. The scholarly endeavor maintains unwavering compliance with international ethical standards governing scientific inquiry, encompassing experimental procedures, data handling protocols, and scholarly communication practices.

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