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The Influence of Green Supply Chain Management on Environmental Entrepreneurship through Waste Management and Green Innovation

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ABSTRACT
This study aims to analyze the effect of Green Supply Chain Management on Environmental Entrepreneurial Performance, mediated by Waste Management and Green Innovation in cement manufacturing companies. A total of 205 respondents participated in this study, consisting of managers, supervisors, and operational staff operating in the Citeureup area, Bogor Regency. Data were collected through questionnaire distribution using a non-probability sampling technique with a purposive sampling approach. The collected data were analyzed using the Partial Least Squares–Structural Equation Modeling (PLS-SEM) method with the assistance of SmartPLS 4.0 software. The results indicate that: (1) Green Supply Chain Management has a positive effect on Waste Management, (2) Green Supply Chain Management has a positive effect on Green Innovation, (3) Green Supply Chain Management has a positive effect on Environmental Entrepreneurial Performance, (4) Waste Management has a positive effect on Environmental Entrepreneurial Performance, (5) Green Innovation has a positive effect on Environmental Entrepreneurial Performance, (6) Green Supply Chain Management has a positive effect on Environmental Entrepreneurial Performance through the mediation of Waste Management, and (7) Green Supply Chain Management has a positive effect on Environmental Entrepreneurial Performance through the mediation of Green Innovation.

Keywords: Green Supply Chain Management, Waste Management, Green Innovation.

I. Introduction

Climate change, environmental pollution, the energy crisis, as well as the declining quality of natural resources, have become pressing global challenges. Industrial activities contribute significantly to carbon emissions and environmental degradation, accounting for more than 20% of global emissions (UNEP et al., 2023). These conditions demand that companies not only be financially profit-oriented, but also integrate environmental responsibility into their business operations to ensure long-term sustainability (Rayhan Fadillah & Gatri Lunarindiah, 2024). In response to these demands, Green Supply Chain Management has become an important strategy for integrating environmental aspects into all supply chain activities, with the objective of reducing energy consumption, minimizing waste, and improving production efficiency (Rasheed et al., 2024). The success of implementing this strategy is highly dependent on the effectiveness of Waste Management, starting from the collection process to the systematic processing of waste (Mohammed et al.,

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2021). Good waste management also has the potential to create new economic value through the implementation of the circular economy concept, such as reuse, recycling, and remanufacturing (Al-Rahmi et al., 2021).

In addition, Green Innovation plays an important role in encouraging more sustainable company operations through the development of clean technology, energy efficiency, and environmentally friendly product design (Yang et al., 2022). The implementation of green innovation has been proven to enhance a company's competitiveness while strengthening Environmental Entrepreneurial Performance (Rasheed et al., 2024). In Indonesia, the cement industry is one of the sectors with high emissions due to its high energy consumption and clinker production processes (International Energy Agency, 2023). This sector contributes more than 8% of national industrial emissions, while the utilization of waste as an alternative raw material remains below 30% (Ministry of Environment and Forestry, 2023). Although green innovation has begun to be implemented, its level of application is still uneven, especially in medium-scale and large-scale cement manufacturing companies (Setya Negara et al., 2023). Therefore, it is necessary to conduct a study on the influence of Green Supply Chain Management on Environmental Entrepreneurial Performance, mediated by Waste Management and Green Innovation, in cement manufacturing companies.

II. Literature Review and Hypothesis Development

Green Supply Chain Management is a development of conventional supply chain management that integrates environmental aspects into all flows of the supply chain, starting from raw material procurement to the distribution of final products. According to Dhillon et al. (2023), the implementation of Green Supply Chain Management focuses on efforts to reduce environmental impacts through energy savings, waste minimization, and emission control. Heizer et al. (2024) confirm that this approach not only improves operational efficiency but also strengthens a company's competitiveness amid increasing regulatory pressure and sustainability demands. In addition, Rasheed et al. (2024) state that the integration of environmental aspects into the supply chain can enhance a company's legitimacy in the eyes of stakeholders. Waste management refers to a company's ability to control and manage waste systematically so that it does not cause negative impacts on the environment and human health. Heizer et al. (2020) explain that waste management includes waste reduction at the source, sorting, processing, and the safe reuse of waste. Modern waste management approaches emphasize the principles of reuse, recycling, and remanufacturing as key strategies in supporting the circular economy (Ebele et al., 2017). Furthermore, Afum et al. (2020) reveal that effective waste management practices not only reduce environmental impacts but also improve cost efficiency and corporate reputation.

Green innovation describes a company's ability to develop environmentally friendly products, processes, and managerial systems in order to increase resource efficiency and reduce emissions. Zhu et al. (2019a) differentiate green innovation into product innovation and process innovation, such as the use of clean technology and energy efficiency. According to Heizer et al. (2020), green innovation has become an important part of sustainable operational strategies that help companies adapt to regulatory changes and evolving market preferences. In addition to technological aspects, Guo et al. (2023) emphasize that green innovation also includes policy updates and managerial practices that support sustainability, as reinforced by the findings of Rasheed et al. (2024). Environmental entrepreneurial performance reflects a company's ability to create economic value through the utilization of sustainability-oriented environmental business opportunities. Du and Wang (2022) state that this concept emphasizes a balance between economic, social, and ecological achievements as the basis for long-term sustainability. Mowen et al. (2022) add that environmental entrepreneurial performance aims to create shared value between the company and the environment. With strong environmental entrepreneurial performance, companies tend to be more adaptive to market changes, possess stronger reputations, and are able to build competitive advantages based on sustainable innovation (Rofiaty et al., 2024).

H1: Management Chain Green Supply is influential positive to Management Management Waste

Green Supply Chain Management encourages companies to integrate the principles of environmental sustainability into all supply chain activities, starting from raw material procurement to the production process. The implementation of efficient resource use, as well as the 3R concept (reduce, reuse, recycle), plays an important role in reducing waste generation and improving the effectiveness of waste management. Rasheed et al. (2024) state that Green Supply Chain Management practices have a strategic role

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in strengthening a company's waste management system. This is in line with the findings of Jiménez et al. (2020), which confirm that the implementation of a green supply chain encourages companies to adopt more efficient and environmentally friendly production processes, thereby positively affecting waste management in a comprehensive manner.

H2: Green Supply Chain Management has a positive effect on Waste Management.

Green Supply Chain Management plays a strategic role in encouraging Green Innovation through the integration of sustainability principles in the management of raw materials, energy, and production processes, which creates an internal drive for companies to develop more environmentally friendly technologies and production methods. Rasheed et al. (2024) show that green supply chain practices increase a company's capability to generate green innovation through resource efficiency and organizational learning, although these findings are still general in nature and require further empirical testing in specific industrial contexts. Gallardo-Zavaleta et al. (2023) confirm that external pressures, in the form of environmental regulations and consumer demands, also accelerate the adoption of green innovation in the supply chain. The combination of these internal and external pressures shows that Green Supply Chain Management is not only reactive in nature, but also becomes a strategic instrument in shaping the direction of corporate innovation. Therefore, this study originally proposes the hypothesis that Green Supply Chain Management has a positive effect on Green Innovation, with the practical implication that strengthening green supply chain practices can enhance a company's competitiveness while fulfilling environmental sustainability demands.

H3: Green Supply Chain Management has a positive effect on Green Innovation.

Green Supply Chain Management contributes to the improvement of Environmental Entrepreneurial Performance through enhanced operational efficiency and the reduction of integrated environmental impacts in supply chain activities. The implementation of green practices allows companies not only to reduce costs and emissions, but also to create economic value that is harmonious with sustainability objectives. Sharabati et al. (2021) show that the implementation of a green supply chain is able to strengthen a company's competitiveness through the creation of environmental-based value; however, their findings still emphasize competitive aspects in a general sense. Liu et al. (2024) confirm that the integration of green practices encourages the development of sustainable business models, which directly improve Environmental Entrepreneurial Performance. Based on the limitations and complementarities of previous studies, this research originally proposes the hypothesis that Green Supply Chain Management has a positive effect on Environmental Entrepreneurial Performance, with the practical implication that companies adopting green supply chain practices consistently have greater opportunities to strengthen competitiveness while achieving long-term sustainability.

H4: Green Supply Chain Management has a positive effect on Environmental Entrepreneurial Performance.

Effective Waste Management reflects a company's commitment to resource efficiency and environmental responsibility, while also becoming a strategic instrument in improving sustainability-based company performance. Integrated waste management enables companies to reduce production costs, minimize pollution risks, and optimize the reuse of waste materials. Rasheed et al. (2024) show that good waste management practices not only function as an environmental compliance effort, but are also capable of creating new economic value for companies. In line with this, Šidlauskaitė et al. (2022) confirm that sustainable waste management contributes directly to the improvement of Environmental Entrepreneurial Performance through the creation of opportunities aligned with sustainability principles.

H5: Waste Management has a positive effect on Environmental Entrepreneurial Performance.

Green Innovation plays a strategic role in improving Environmental Entrepreneurial Performance through the development of environmentally friendly products and production processes, thereby enabling companies to achieve energy efficiency and sustainable waste reduction. The implementation of green innovation not only affects environmental performance improvement, but also strengthens a company's ability to create sustainable economic value. Šidlauskaitė et al. (2022) show that green innovation contributes directly to the improvement of Environmental Entrepreneurial Performance, while Matyi and Tamás (2023) confirm that companies that consistently adopt green innovation tend to have sustainable competitive

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advantages. These findings indicate that green innovation functions as a link between environmental objectives and entrepreneurial performance achievement, so this study confirms the importance of green innovation as a determinant factor in improving Environmental Entrepreneurial Performance.

H6: Green Innovation has a positive effect on Environmental Entrepreneurial Performance.

Green Supply Chain Management forms a strong foundation for the implementation of sustainable Waste Management through the integration of resource efficiency principles across all supply chain activities. The implementation of these practices allows companies to improve the effectiveness of waste management while reducing the environmental impact of operational processes. Rasheed et al. (2024) show that the implementation of a green supply chain contributes directly to strengthening a company's waste management system. Furthermore, Kanjal et al. (2023) confirm that waste management acts as a mediating variable that explains how green supply chain practices can be translated into improved Environmental Entrepreneurial Performance. These findings indicate that Waste Management has a strategic role in strengthening the relationship between Green Supply Chain Management and Environmental Entrepreneurial Performance.

H7: Green Supply Chain Management has a positive effect on Environmental Entrepreneurial Performance through Waste Management.

The implementation of Green Supply Chain Management encourages companies to develop Green Innovation as an integral part of their sustainability strategy through the integration of resource efficiency principles and environmental impact reduction in supply chain activities. Environmentally oriented innovation not only improves operational efficiency, but also creates additional sustainable economic value. Kanjal et al. (2023) show that green supply chain practices have a positive effect on the development of green innovation, while Sakaria et al. (2023) confirm that green innovation serves as a mediating variable that bridges the relationship between sustainable practices and the improvement of Environmental Entrepreneurial Performance. These findings indicate that Green Innovation is an important mechanism for translating Green Supply Chain Management into improved environmentally based entrepreneurial performance.

H8: Green Supply Chain Management has a positive effect on Environmental Entrepreneurial Performance through Green Innovation.

III. Research Method

This study employs a quantitative approach with a hypothesis-testing design to analyze the influence of Green Supply Chain Management on Environmental Entrepreneurial Performance, as well as the mediating role of Waste Management and Green Innovation. The theoretical foundation used in this study is the Resource-Based View (RBV), which emphasizes that a company's competitive advantage can be achieved through the utilization of valuable internal resources and capabilities that are difficult to imitate and sustainable over time. In the context of this study, Green Supply Chain Management practices, Waste Management, and Green Innovation are viewed as strategic capabilities that enable companies to create value and improve environmental entrepreneurial performance sustainably, in line with the RBV perspective (Rasheed et al., 2024). The originality of this study lies in the testing of an integrated model that positions Waste Management and Green Innovation as mediating mechanisms in the relationship between Green Supply Chain Management and Environmental Entrepreneurial Performance. This research specifically focuses on the cement industry in Indonesia, which has received relatively limited empirical attention.

Primary data were collected through the distribution of questionnaires to employees, supervisors, and managers working in cement industry companies in Indonesia who are involved in supply chain activities, waste management, and sustainability innovation, with a minimum of one year of work experience. The questionnaire instrument was developed based on relevant previous studies and adapted to the context of the cement industry. Secondary data were obtained from scientific journals, textbooks, and academic publications to support the development of the research variables and conceptual framework. The primary data were measured using a five-point Likert scale, producing ordinal data for analysis. The research instrument was constructed based on relevant previous studies and adjusted to the characteristics of the

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cement industry. The instrument also underwent content validity evaluation and preliminary reliability testing before being used for the main data collection. In addition to primary data, this study also utilized secondary data obtained from scientific journals, textbooks, and academic publications to support the development of research variables and the conceptual framework.

The sampling technique used in this study was non-probability sampling with a purposive sampling approach, considering that not all employees possess sufficient involvement and understanding related to green supply chain practices, waste management, and green innovation. Therefore, respondents were selected based on their relevance to the research objectives in order to obtain more accurate and representative data. The determination of the sample size followed the rule of 5–10 times the number of indicators (Hair et al., 2019). With a total of 34 indicators, the minimum sample size required was 170 respondents. This study successfully collected data from 205 respondents, thus fulfilling the requirements for analysis. Data analysis was conducted using Partial Least Squares–Structural Equation Modeling (PLS-SEM) with the assistance of SmartPLS 4.0 software. The measurement model was evaluated through reliability and validity testing of the constructs, including Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE), as recommended by Hair et al. (2019). Furthermore, the structural model was evaluated by analyzing the R-square value and path coefficients to assess the strength and direction of the relationships between variables. Hypothesis significance testing was performed using the bootstrapping technique, with the hypothesis acceptance criterion based on p-values ≤ 0.05 (Hair et al., 2019). The entire research process was conducted in accordance with research ethics principles, where respondents' participation was voluntary, anonymity was maintained, and the collected data were used solely for academic purposes in an aggregated form.

IV. Results and Discussion

4.1. Respondent Characteristics

This study targeted respondents ranging from employees to top management in cement manufacturing companies operating in the Citeureup area, Bogor Regency. Based on the results of the questionnaire distribution, a total of 205 respondents were successfully collected. This number has met and exceeded the minimum required sample size; therefore, the data obtained were considered appropriate and sufficient to be used in the analysis and hypothesis-testing process. Based on gender, the majority of respondents in this study were male, totaling 132 people (64.4%), while female respondents totaled 73 people (35.6%). This composition reflects the characteristics of the workforce in the cement manufacturing industry, which is generally still dominated by male workers, especially in operational and technical fields. In terms of age group, respondents were dominated by those aged 31–40 years, with a total of 117 people (57.1%). Furthermore, respondents aged 20–30 years numbered 54 people (26.3%), followed by those aged 41–50 years with 32 people (15.6%). Meanwhile, respondents aged over 50 years consisted of only 2 people (1.0%). This age composition shows that most respondents were in the productive age range, which generally plays an active role in company operations and decision-making processes.

Based on length of service, the majority of respondents had worked for 6–10 years, namely 109 people (52.2%). Respondents with a work period of 1–5 years totaled 59 people (28.8%), followed by those with 11–15 years of work experience, totaling 28 people (13.7%), and respondents with more than 15 years of work experience, totaling 9 people (4.4%). This indicates that most respondents had sufficient work experience to understand the company's operational conditions, including green supply chain management practices, waste management, and the implementation of environmentally friendly innovations. In terms of educational level, respondents in this study were dominated by those holding a bachelor's degree (S1), totaling 117 people (57.1%). Furthermore, respondents with a master's degree (S2) numbered 37 people (18.0%), those with a diploma degree (D1–D4) numbered 22 people (10.7%), and those with a senior high school education or equivalent totaled 28 people (13.7%). Meanwhile, respondents holding a doctoral degree (S3) amounted to only 1 person (0.5%). This relatively high educational background indicates that respondents had adequate capability to understand the research instrument and provide relevant answers in accordance with the study context.

Based on job position, the largest number of respondents came from the staff category, totaling 86 people (42.0%), followed by managers with 83 people (40.5%), supervisors with 31 people (15.1%), and directors with 5 people (2.4%). This diversity of positions reflects representation from various organizational

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levels, so the data obtained were able to provide a comprehensive overview of the conditions and practices implemented in the cement manufacturing companies under study.

4.2. Prerequisites test

According to (Sekaran & R Bougie, 2013) state that variables is factors that are overall represent different values or varies, and the value the have variation time for the same object or same time for varied objects.

Table 1. Validity Test

Question Items	Loading Factor	Decision
Green Design		
1. Using fewer or non-hazardous/toxic materials.	0.829	Valid
2. Environmentally friendly packaging design or levels (e.g., using less paper and plastic materials) for existing or new products.	0.802	Valid
3. Processing end-of-life product waste and recycling.	0.783	Valid
4. Using eco-friendly materials or eco-friendly labels.	0.802	Valid
Green Operations		
1. Conduct environmental audits for suppliers.	0.845	Valid
2. Has achieved ISO 14001 certification in environmental maintenance.	0.814	Valid
3. Suppliers must comply with certain regulations such as emission limits, hazardous material labeling, product specifications, environmental related documents.	0.782	Valid
Reverse Logistics		
1. The company manages the reverse flow of materials.	0.775	Valid
2. The company controls environmental risks associated with supplier operations during reverse logistics.	0.776	Valid
3. The company ensures proper management of the use of materials by customers.	0.797	Valid
Green Purchase		
1. The company incorporates green supply chain management strategies into its strategic purchasing process.	0.808	Valid
2. The company has integrated suppliers to reduce costs and improve customer service.	0.822	Valid
3. Our purchasing performance has increased (customer base and loyalty).	0.805	Valid
4. Suppliers must develop and maintain an environmental management system.	0.822	Valid
Green Logistics Implementation Level		
1. Companies recognize logistics as one of the most critical developments in environmental impact assessment.	0.776	Valid
2. The company recognizes sustainability as a critical factor in assessing the company's environmental impact.	0.846	Valid
3. We consider the impact of production on the environment and society.	0.840	Valid
4. The company recognizes the need for environmentally friendly products and reduces energy consumption and increases customer loyalty.	0.810	Valid
Waste Management		
1. Designate separate disposal points for hazardous and non-hazardous waste.	0.815	Valid
2. Providing a variety of products with color-coded containers for hazardous and non-hazardous waste.	0.824	Valid

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3. Provide containers for disposing of both non-hazardous and hazardous waste.	0.822	Valid
4. Provide separate trolleys used for transportation in risky and non-risky locations.	0.767	Valid
Green Innovation		
Green Innovation Process		
1. The company uses low energy (e.g.: water, electricity, gas etc.) during production, construction and manufacturing.	0.835	Valid
2. Companies use cleaner technologies to save and avoid pollution such as energy, water and waste.	0.706	Valid
3. Our company implements 3R, namely Recycling, Reusing, and Reassembling materials within the company.	0.776	Valid
4. Our company invests in facilities, equipment, lighting, heating and services that are tailored to environmental evaluations.	0.800	Valid
Green Managerial Innovation		
1. Our company is re-identifying production and operational processes to ensure internal efficiency.	0.826	Valid
2. Our company redesigns and improves products or services to meet new environmental criteria or guidelines.	0.759	Valid
3. Our company encourages employees to adopt a responsible attitude in reducing waste.	0.813	Valid
4. Our company Manages environmental audits regularly and implements necessary corrective actions.	0.818	Valid
5. The company recognizes the need to advocate environmentally friendly processes to eliminate waste and pollution and preserve the environment.	0.774	Valid
Environmental Entrepreneurship Performance		
1. Companies use entrepreneurial innovation to reduce the use of hazardous, harmful, or toxic materials such as carbon emissions or solid waste.	0.798	Valid
2. Companies reduce consumption of materials and resources to reduce the frequency of environmental accidents.	0.819	Valid
3. The company increases compliance with business environmental regulations.	0.856	Valid
4. The company encourages recycling and reuse of raw materials and avoids fines for violating environmental regulations.	0.865	Valid
5. Our company reduces the frequency of environmental accidents.	0.816	Valid
6. Our company integrates waste management.	0.714	Valid
7. Our company reduces waste generated from operations.	0.779	Valid
8. Our company reduces the waste generated from pollution.	0.801	Valid
9. Our company recycles different colored waste.	0.741	Valid
10. Our company reduces product costs in new ways.	0.759	Valid
11. Our company increases the profits of our organization.	0.720	Valid
12. Our Company Improves operational efficiency.	0.819	Valid

Validity test results show that indicator in study This own mark loading factor above 0.40, so that declared valid and can used for testing furthermore analyzed at the reliability test stage next .

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Table 2. Average Variance Extracted (AVE) Value

Variables	AVE	Decision
Green Innovation	0.628	Valid
Environmental Entrepreneurship Performance	0.630	Valid
Waste management	0.652	Valid
Green Supply Chain Management	0.650	Valid

Based on results testing on the table, all construct in study This show Average Variance Extracted (AVE) value above minimum limit of 0.5, so that can stated fulfil criteria validity convergent. Variable Green Innovation has AVE value of 0.628, which indicates that indicators on variables the capable explain construct in a way adequate. Furthermore, the Entrepreneurship Performance variable Environment get AVE value of 0.630, which indicates that part big variance indicator can explained with both by the construct being measured. Besides that , variable Management Waste own AVE value of 0.652, which confirms that indicators used in measure variables This has fulfil condition validity convergent. Variable Management Chain Green Supply also shows high AVE value, namely of 0.650, so that can conclude that construct This capable represent indicator the gauge optimally. With Thus, the results AVE testing on all variables study This show that instruments used has been validated convergent and feasible for used at the stage analysis furthermore .

Table 3. Validity Test Discriminant

Variables	Circular Economy Performance	Green Process Innovation	Green Product Innovation	Green Supply Chain Management
Green Innovation	**0.801**			
Environmental Entrepreneurship Performance	0.791	**0.802**		
Waste management	0.574	0.622	**0.821**	
Green Supply Chain Management	0.689	0.801	0.577	**0.819**

Based on the test results, it can be concluded that the discriminant validity in this study has been fulfilled, because the square root of the Average Variance Extracted (AVE) for each construct is higher than its correlations with other constructs. For example, the Green Innovation variable has an AVE square root value of 0.801, which is higher than its correlations with Environmental Entrepreneurial Performance, Waste Management, and Green Supply Chain Management. This indicates that the Green Innovation construct has clear distinctions from the other constructs in the research model. Furthermore, the Environmental Entrepreneurial Performance variable shows an AVE square root value of 0.802, which is greater than its correlations with Waste Management (0.574), Green Supply Chain Management (0.689), and Green Innovation (0.791). Similarly, the Waste Management variable has an AVE square root value of 0.821, which is higher than its correlations with the other constructs in the model. This confirms that the construct is able to distinguish itself well from other constructs in the research framework. In addition, the Green Supply Chain Management variable also shows an AVE square root value of 0.819, which is greater than its correlations with other constructs, such as Green Innovation and Environmental Entrepreneurial Performance (0.689). Therefore, these results indicate that each variable in the research model has an adequate level of discrimination. Thus, all constructs can be declared to have met discriminant validity and are appropriate for further structural analysis.

Table 4. Reliability Test

Variables	*Cronbach Alpha*	*Composite Reliability*	Information
Green Innovation	0.915	0.917	Reliable
Environmental Entrepreneurship Performance	0.946	0.949	Reliable
Waste management	0.823	0.830	Reliable
Green Supply Chain Management	0.970	0.970	Reliable

The results of the reliability test of the variables Green Supply Chain Management, Waste Management, Green Innovation , Environmental Entrepreneurship Performance show *a Cronbach's Alpha*

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value greater than > 0.60. Thus, all variables are declared reliable and all indicators of this research variable are feasible or trustworthy.

4.3. Goodness of Fit

Table 5. Goodness of Fit

Index	Saturated Model	Estimated Model	Information
SRMR	0.060	0.064	Good fit
D_ULS	3,451	3,832	Good fit
D_G	5,226	5,270	Good fit
NFI	0.623	0.622	Poor fit
Chi-square	3926,488	3937,781	Poor fit

The Goodness of Fit test results were used to evaluate the suitability of the research model with the observed data. The SRMR value of 0.064 is below 0.08, indicating that this index can be categorized as good fit. The d_ULS and d_G indices also indicate a good fit, because the differences between the saturated model and the estimated model are relatively small, suggesting that the model is sufficiently consistent and stable. On the other hand, the NFI value, which is only around 0.62, is still below the minimum acceptable standard of 0.80, and is therefore categorized as poor fit. A similar result is reflected in the very large Chi-square value, which indicates a mismatch between the observed data and the estimated model, and therefore also falls into the poor fit category. Nevertheless, although several indicators suggest that the model does not yet fully meet the overall fit criteria, some of the main fit measures still show acceptable performance. Therefore, the model can still be used for the hypothesis-testing stage, while taking into account the need for possible improvements to enhance the overall model fit in future studies. Following This is the framework used For testing hypothesis:

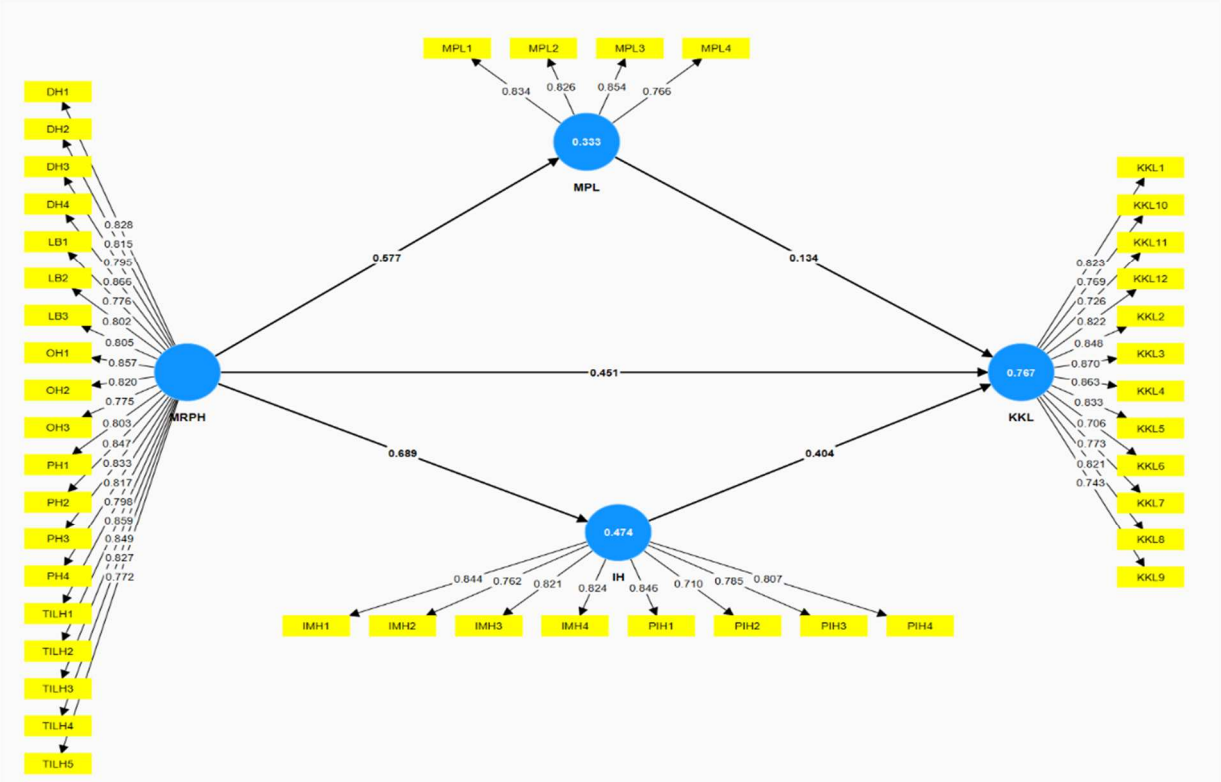

Figure 2. Graph

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4.4. Hypothesis Test Results

Table 4. Hypothesis Test Results

Hypothesis	Original sample (O)	T statistics	P values	Decision
H 1: Management Chain Green Supply has influence positive to Management Waste	0.595	6,023	0,000	H1 is supported
H 2: Management Chain Green Supply has influence positive to Green Innovation	0.697	9,096	0.000	H2 is supported
H 3: Management Chain Green Supply has influence positive on Entrepreneurial Performance Environment	0.440	6,023	0.000	H3 supported
H 4: Management Waste own influence positive on Entrepreneurial Performance Environment	0.156	3,209	0.001	H4 supported
H 5: Green Innovation has influence positive on Entrepreneurial Performance Environment	0.388	5,003	0.000	H5 supported
H 6: Management Chain Green Supply has influence positive on Entrepreneurial Performance Environment with mediation Management Waste	0.093	2,897	0.004	H6 supported
H 7: Management Chain Green Supply has influence positive on Entrepreneurial Performance Environment with mediation Green Innovation	0.270	4,099	0.000	H7 supported

Hypothesis 1 examines the effect of Green Supply Chain Management on Waste Management, and the test results show that Green Supply Chain Management has a positive and significant effect on Waste Management. These findings indicate that the implementation of environmentally oriented supply chain practices not only affects operational aspects, but also encourages the establishment of more planned and integrated waste management systems within the company. The integration of sustainability principles into procurement activities, material flow control, and production processes enables companies to identify sources of waste at an early stage, so that waste reduction and treatment efforts can be carried out preventively. Rasheed et al. (2024) explain that the implementation of sustainability principles in the supply chain plays an important role in reducing waste generation from the procurement stage to distribution, while Zahran et al. (2024) confirm that effective waste management is a direct consequence of the consistent implementation of green supply chains in manufacturing companies. Furthermore, these results indicate that Green Supply Chain Management functions as a mechanism for strengthening internal control, inter-unit coordination, compliance with environmental standards, and the allocation of resources more efficiently in waste management. Thus, the findings of this study emphasize that the success of Waste Management is highly dependent on the extent to which green supply chain principles are comprehensively integrated into the company's strategies and operations.

Hypothesis 2 examines the effect of Green Supply Chain Management on Green Innovation, and the analysis results show that Green Supply Chain Management has a positive and significant effect on Green Innovation. These findings indicate that a company's commitment to implementing environmentally friendly supply chain practices is not only oriented toward regulatory compliance, but also encourages the company to actively develop innovation in both production processes and more sustainable products. The implementation of practices such as supplier selection based on environmental criteria, energy efficiency, emission reduction, and the use of environmentally friendly raw materials creates a need for companies to adapt their technologies and operational methods innovatively. This condition makes Green Innovation a strategic response for companies in maintaining sustainability and long-term competitiveness. Ahmad et al.

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(2022) state that environmental pressure in the supply chain triggers companies to seek innovative solutions to improve resource efficiency and reduce environmental impacts significantly. In addition, Rasheed et al. (2024) confirm that green supply chains act as a catalyst in encouraging the emergence of sustainable green innovation, especially in the manufacturing sector, because the integration of environmental principles into the supply chain accelerates the adoption of environmentally friendly technologies and innovative practices that support a company's environmental entrepreneurial performance.

Hypothesis 3 examines the effect of Green Supply Chain Management on Environmental Entrepreneurial Performance, and the test results show a positive and significant effect between the two variables. These findings indicate that the implementation of green supply chain practices not only contributes to reducing environmental impacts, but also encourages companies to become more proactive in developing sustainability-oriented entrepreneurial activities. Through the integration of environmentally friendly principles in procurement, production, and distribution, companies are able to create new business opportunities, improve operational efficiency, and optimize the use of resources innovatively. This condition strengthens the company's ability to generate economic value in line with environmental objectives. Surachman and Prabandari (2024) explain that green supply chain practices open opportunities for the creation of new economic value through process efficiency and more optimal use of resources. These findings are also supported by Dewi et al. (n.d.), who state that sustainable supply chain strategies play an important role in increasing a company's environmental entrepreneurial orientation, because they encourage companies to innovate and adapt to increasing market demands that are concerned with sustainability aspects.

Hypothesis 4 examines the effect of Waste Management on Environmental Entrepreneurial Performance, and the analysis results show that Waste Management has a positive and significant effect on Environmental Entrepreneurial Performance. These findings indicate that waste management carried out effectively and systematically is able to encourage companies to transform waste into a value-added resource that supports environmentally based entrepreneurial activities. Through practices such as recycling, reuse, utilization of waste materials, and reduction of production waste, companies not only reduce operational costs, but also open opportunities for innovation in environmentally friendly products and processes. Albitar et al. (2024) state that companies capable of managing waste efficiently tend to have greater opportunities to create environmentally based entrepreneurial activities, because good waste management increases corporate innovation awareness and sustainability orientation. Thus, waste is no longer viewed merely as an operational burden, but as a strategic economic potential that can strengthen environmental entrepreneurial performance while supporting long-term business sustainability.

Hypothesis 5 examines the effect of Green Innovation on Environmental Entrepreneurial Performance, and the test results show that Green Innovation has a positive and significant effect on Environmental Entrepreneurial Performance. These findings indicate that innovation in environmentally friendly processes and products is able to increase a company's competitiveness while opening new business opportunities based on sustainability. Through the development of clean technology, energy efficiency, and more environmentally friendly product design, companies can create additional economic value while fulfilling market demands and environmental regulations. Rasheed et al. (2024) confirm that Green Innovation is a key factor in driving the growth of environmental entrepreneurship because such innovation strengthens a company's ability to identify and exploit sustainable business opportunities. In addition, Chen et al. (2022) state that Green Innovation plays an important role in creating long-term competitive advantage for manufacturing companies, so that companies that consistently innovate in a green manner tend to have higher and more sustainable Environmental Entrepreneurial Performance.

Hypothesis 6 examines the role of Waste Management as a mediating variable in the relationship between Green Supply Chain Management and Environmental Entrepreneurial Performance. The analysis results show that Waste Management significantly mediates this relationship, indicating that the influence of Green Supply Chain Management on Environmental Entrepreneurial Performance becomes stronger when companies are able to manage waste effectively and in an integrated manner. The implementation of green

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supply chain practices encourages companies not only to focus on reducing environmental impacts, but also to optimize the waste management process as part of their operational and business strategies. Through systematic waste management, companies can reduce costs, reuse waste materials, and create new environmentally based business opportunities. Liu et al. (2024) explain that waste management serves as an important mechanism in translating green supply chain practices into sustainable economic value. Thus, Waste Management functions as a strategic connector that strengthens the transformation of environmental policies into improved sustainable Environmental Entrepreneurial Performance.

Hypothesis 7 examines the role of Green Innovation as a mediating variable between Green Supply Chain Management and Environmental Entrepreneurial Performance. The test results show that Green Innovation significantly mediates this relationship. These findings indicate that the implementation of green supply chains will be more effective in improving Environmental Entrepreneurial Performance if it is able to encourage the emergence of Green Innovation. Rasheed et al. (2024) state that Green Innovation acts as a bridge between sustainability practices and the creation of economic value. This confirms that Green Innovation is a key mechanism in strengthening the impact of green supply chains on Environmental Entrepreneurial Performance. In the context of the cement industry, which is operated by large-scale manufacturing companies, the implementation of Green Supply Chain Management has a relatively strategic, consistent, and structured role. The capital-intensive characteristics of the cement industry, its mass-production orientation, and its strict operational standards make green supply chain practices more focused on the efficient use of resources, emission control, and reduction of production waste. Therefore, the implementation of Green Supply Chain Management tends to directly encourage improvements in Waste Management and Green Innovation as part of compliance with environmental regulations and sustainability demands. These conditions explain why the influence of Green Supply Chain Management on Waste Management and Green Innovation in this study shows significant results.

Furthermore, in the cement industry, effective and integrated waste management not only functions to reduce environmental impacts, but also opens opportunities for the creation of added value through the reuse of waste as alternative raw material. This practice contributes to improving Environmental Entrepreneurial Performance because companies are able to develop more innovative and sustainable business approaches without having to depend on extreme operational flexibility. A similar pattern can also be seen in the role of Green Innovation, where innovation is more focused on improving production processes and energy efficiency rather than creating radically new products. With relatively stable supply chain characteristics and demand that tends to be predictable, the improvement of Environmental Entrepreneurial Performance in the cement industry is influenced more by the consistent implementation of environmentally friendly practices than by extreme adaptive capability. These findings confirm that the strategies of Green Supply Chain Management, Waste Management, and Green Innovation need to be aligned with the characteristics of the industrial sector in order to produce an optimal impact on a company's Environmental Entrepreneurial Performance.

V. Conclusion

Green Supply Chain Management has a positive effect on Waste Management in cement companies. These results indicate that the implementation of environmentally friendly practices in the supply chain, such as green design, green purchasing, supplier environmental audits, and reverse logistics, is able to strengthen the company's waste management system in a more structured manner. With the proper implementation of Green Supply Chain Management, the processes of sorting, storage, and waste treatment can be carried out more effectively. These findings are in line with the study by Zhu et al. (2019), which states that green supply chain practices play an important role in increasing the effectiveness of industrial waste management. Green Supply Chain Management also has a positive effect on Green Innovation. This shows that cement companies that implement green supply chain principles are encouraged to innovate in clean technology, energy efficiency, environmentally friendly production processes, as well as sustainability-oriented managerial improvements. Green supply chain practices encourage companies to continuously seek innovative solutions

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to reduce the environmental impact of their operational activities. This result is supported by the research of Chen et al. (2022), who found that green supply chain practices can enhance a company's green innovation capability.

Green Supply Chain Management has a positive effect on Environmental Entrepreneurial Performance. These findings indicate that the better the implementation of green principles in the supply chain, the higher the company's ability to create economic value while maintaining environmental sustainability. Cement companies that consistently apply Green Supply Chain Management are able to reduce waste, improve operational efficiency, and strengthen sustainable business orientation. These results are in line with the study by Chen et al. (2022), which states that environmentally friendly practices in the supply chain contribute directly to the improvement of Environmental Entrepreneurial Performance. Waste Management has a positive effect on Environmental Entrepreneurial Performance. This indicates that cement companies with good waste management systems are able to improve operational effectiveness while reducing the risk of environmental pollution. Waste management that is carried out systematically through sorting, handling of hazardous waste, and proper treatment processes is able to strengthen the company's Environmental Entrepreneurial Performance. These findings are supported by the research of Makki et al. (2020), which confirms that effective waste management is an important factor in improving a company's environmental performance.

Green Innovation has a positive effect on Environmental Entrepreneurial Performance. These results show that the implementation of environmentally friendly innovations, such as energy efficiency, reduction in the use of hazardous materials, and improvements in production processes, is able to increase a company's sustainability-based competitiveness. Cement companies that are oriented toward green innovation not only gain environmental benefits, but also improve their overall business performance. These results are in line with the findings of Rasheed et al. (2024), which state that green innovation plays a significant role in driving Environmental Entrepreneurial Performance. Waste Management has been proven to mediate the relationship between Green Supply Chain Management and Environmental Entrepreneurial Performance. This means that the effect of Green Supply Chain Management on Environmental Entrepreneurial Performance becomes stronger when it is accompanied by an effective waste management system. The implementation of green supply chain practices helps companies build a more efficient waste management structure, which directly affects the improvement of environmental performance. These findings support the study by Rasheed et al. (2024), which states that waste management is an important mechanism in translating green practices into actual environmental performance. Green Innovation also plays a mediating role in the relationship between Green Supply Chain Management and Environmental Entrepreneurial Performance. These results indicate that the influence of green supply chain practices on a company's environmental performance will increase when the company actively engages in innovation in technology, processes, and management. Thus, green innovation becomes a key element in strengthening the relationship between Green Supply Chain Management and the achievement of Environmental Entrepreneurial Performance.

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