The Effect Of Green Supply Chain Management On Firm Performance Mediated By Green Innovation In Cimahi SMEs, Indonesia

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Abstract.

The accelerated growth of economic activities, large-scale industrial expansion, and technological advancements have intensified competition, including among small and medium enterprises (SMEs). Green supply chain management (GSCM), which integrates environmentally conscious practices into supply chain activities, has become a crucial strategy for balancing industrial growth with environmental preservation. This study examines the impact of GSCM on firm performance, mediated by green innovation, in food and beverage SMEs in Cimahi City, Indonesia. SMEs in this sector significantly contribute to the regional economy while generating substantial waste, underlining the need for sustainable practices. The findings reveal that GSCM positively influences Green Innovation, with a strong effect, but has a weak and insignificant direct impact on firm performance. Green Innovation plays a significant role in improving firm performance, with a positive and significant effect. Additionally, Green Innovation acts as a mediator, partially influencing the relationship between GSCM and firm performance. These results underscore the importance of GSCM and Green Innovation in enhancing firm performance and promoting environmental sustainability in SMEs.

Keywords: *Green Supply Chain Management, Firm Performance, Green Innovation and Food and Beverages SMEs.*

I. INTRODUCTION

The rapid economic development and growing public awareness of environmental sustainability have driven various industries to adopt more environmentally friendly business practices. This has encouraged industries to actively engage in creating products that not only meet consumer needs but are also environmentally friendly [1]. According to a survey conducted by Jajak Pendapat (Jakpat), 56.2% of respondents expressed a preference for purchasing environmentally friendly products [2]. Based on this finding, industries are increasingly compelled to consider sustainability aspects in their production processes. One form of commitment that can be implemented is green supply chain management (GSCM), an environmentally friendly approach to supply chain management [3]. Every activity in the supply chain has the potential to create risks and negative impacts on the environment [4]. This condition encourages businesses to recognize the importance of balancing industrial activities and environmental preservation in their operations [5]. Reducing environmental impact can be achieved by integrating environmental factors into every stage of the production flow. This integration spans from upstream to downstream, including raw material procurement, production process design, and inventory management [6]. Green supply chain management represents a modern approach to supply chain operations, incorporating practices like recycling and substituting hazardous materials with eco-friendly options. This approach spans various stages, including raw material processing, product design, manufacturing processes, and the delivery of products to customers [7]. The primary rationale for implementing environmentally friendly practices in supply chains is to mitigate the environmental burdens caused by industrial activities and operations [8]. Therefore, GSCM is essential in influencing the total environmental impact of all components involved in supply chain activities.

The concept of GSCM encompasses several key dimensions, including green purchasing, green manufacturing, green distribution, and green packaging. These dimensions facilitate the adoption of sustainable practices across the supply chain [9]. GSCM not only contributes to reducing environmental impacts but also drives operational efficiency and improves firm performance [10]. Firm performance is

closely related to supply chain efficiency, as optimal performance can be achieved through effective supply chain management that meets stakeholder expectations and enhances productivity efficiently [11]. Firm performance encompasses both operational activities and resource utilization to generate profits. In other words, firm performance serves as an indicator reflecting a company's responsibility and effectiveness in conducting its overall operations. This study defines FP in terms of environmental performance and financial performance. Environmental performance reflects a company's efforts to minimize the negative operational impacts on the environment through its capabilities [12]. Meanwhile, financial performance describes a company's achievements based on its financial condition over a specific period [13].

In addition to implementing environmentally friendly supply chain management, businesses must also integrate environmentally friendly principles into product innovation processes. This approach is known as green innovation. GI is carried out by developing and creating or updating products while ensuring that the processes involved do not harm the environment. This strategic effort provides businesses with significant opportunities to meet customer needs and preferences while simultaneously protecting ecosystems, reducing detrimental environmental impacts, and producing more environmentally friendly products [14].Therefore, it is crucial for businesses to adopt GI within GSCM to enhance the value of existing supply chains [15]. Green innovation can be categorized into two forms: green product innovation and green process innovation [16]. GI is increasingly vital for firm performance [17], as it reduces environmental damage by utilizing resources more efficiently and preventing potential negative effects [18]. GSCM and GI are not only suitable for large companies but are also highly relevant for small-scale businesses such as Small and Medium Enterprises (SMEs).

As one of the sectors responsible for a significant share of environmental issues [19], SMEs play a consistent role in creating environmentally friendly products. In Indonesia's economy, SMEs play a vital role in boosting economic growth [20]. SMEs not only serve as the backbone of Indonesia's economy but also contribute significantly to economic stability [21]. As one of the driving forces of Indonesia's economy, SMEs hold a strategic role in supporting environmental sustainability through the implementation of green supply chain management and green innovation. In Cimahi City, for instance, SMEs comprise over 2,000 units, particularly in the food and beverage sector. However, it must be recognized that industrial activities not only generate positive or negative impacts on the economy but also significantly affect the environment [3]. Small food and beverage businesses in Cimahi City play an essential role in boosting the local economy. Furthermore, as a supporting area for Bandung City, Cimahi must capitalize on significant opportunities, particularly in the production and supply of food and beverage products [22]. Cimahi City faces challenges in managing production waste, which poses potential environmental hazards. According to the SIPSN report in 2023, approximately 84,025 tons of waste were generated from various activities in the region, with a significant contribution from the food and beverage industry. The implementation of GSCM and GI in this sector can serve as a strategic solution to address environmental challenges while enhancing firm performance. SMEs must develop the capacity to consistently produce high-quality and innovative products, including adopting green concepts for their products. The growing awareness of environmental preservation drives the implementation of GSCM and GI in SME businesses. Therefore, it is essential for SMEs to implement efficient green supply chains to overcome environmental barriers in competitive markets [19].

Previous research has demonstrated varying effects of GSCM on firm performance. Studies such as [23] and [24] ound that implementing GSCM positively affects firm performance. These findings suggest that effective GSCM in companies can enhance performance. However, other studies, such as those by [25] and [26] argue that GSCM does not positively influence firm performance. These conflicting findings highlight research gaps that require further exploration to comprehensively understand the impact of GSCM on firm performance. Moreover, prior studies such as [27] evealed a significant relationship between GI and improved firm performance. Similar findings were reported by [28] which demonstrated a positive and significant effect of green innovation on firm performance. Likewise, [29] confirmed that green innovation positively influences firm performance. These studies underscore the significant benefits of environmentally friendly innovations in processes and products on firm performance.To address these research gaps, this study aims to analyze the impact of GSCM on firm performance while introducing GI as a mediating

variable to examine how this innovation strengthens the relationship between GSCM and firm performance. The research focuses on food and beverage SMEs in Cimahi City, aiming to contribute both theoretically and practically.

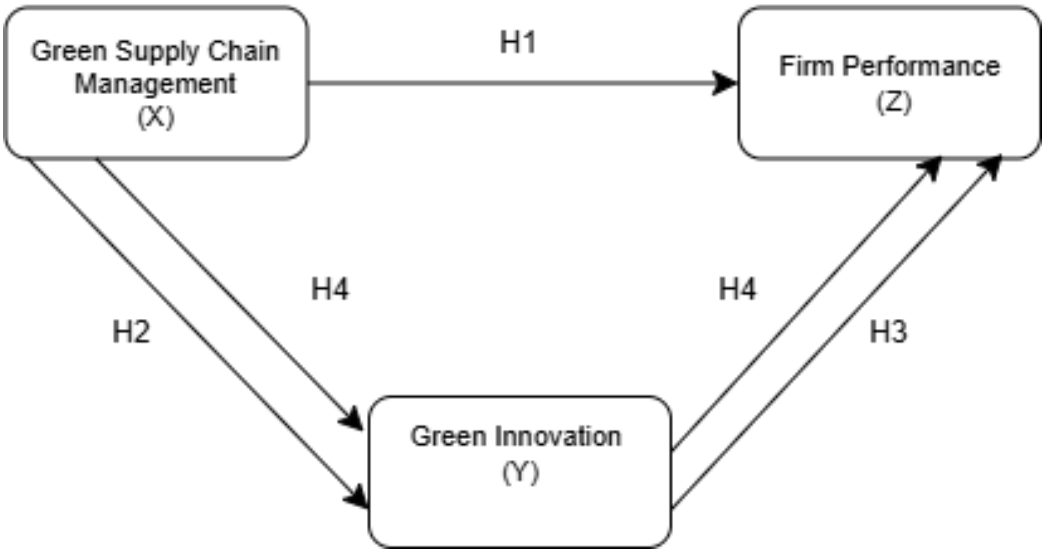

Fig 1. Research Framework

Based on the theoretical framework and the objectives of this study, the researcher proposes the following hypothese

H1: Green supply chain management (X) has a positive effect on firm performance (Z).

H2: Green supply chain management (X) has a positive effect on green innovation (Y).

H3: Green innovation (Y) has a positive effect on firm performance (Z).

H4: Green innovation (Y) mediates the effect of green supply chain management (X) on firm performance (Z).

II. METHODS

This research employs a quantitative approach to analyze the impact of GSCMt on firm performance, mediated by GI. The population for this study consists of food and beverage SMEs in Cimahi City consists of 2.048 units, with a sample size of 100 respondents determined using the Slovin formula with a 10% margin of error. Data were collected using a questionnaire distributed through Google Forms. The questionnaire includes 22 statements related to GSCM, GI, and firm performance, with responses measured using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The analytical technique used in this study is Structural Equation Modeling - Partial Least Squares (SEM-PLS), also known as a prediction-oriented technique. The data analysis is conducted using SmartPLS 4.0 software. SEM-PLS is a method within structural equation modeling that employs an interactive approach to optimize the variance explained by each endogenous variable [30]. The data analysis process involves two main phases: the outer model and the inner model.In the outer model phase, the measurement model is constructed by linking each construct with its corresponding latent variable [31]. The validity and reliability of the model are assessed through several steps. Convergent validity is measured by examining the relationship between latent variables and their indicators, expecting a loading factor value greater than 0.7. Discriminant validity is evaluated by assessing the cross-loading factor values, ensuring that the target construct has a higher value than other constructs. Composite reliability is used to evaluate the construct's reliability, with values above 0.7 indicating high reliability. The average variance extracted (AVE) is calculated to measure the average variance explained by each construct, with a value above 0.5 being considered acceptable. Cronbach's alpha is used to test the reliability of the constructs, with a minimum acceptable value of 0.6.

In the inner model phase, the structural model represents the relationships between interacting latent variables that form the overall model [32]. To assess the model's predictive ability, R-square is used as the coefficient of determination for endogenous constructs. An R-square value of 0.75 indicates a strong model,

0.50 indicates a moderate model, and 0.25 indicates a weak model. Effect size (F-Square) is evaluated to determine the significance of relationships between variables. Values of 0.02, 0.15, and 0.35 indicate small, medium, and large effects, respectively. If the F-square value is less than 0.02, the effect is considered negligible. Prediction relevance (Q-square) measures the model's ability to generate accurate predictions. A Q-square value greater than 0 indicates good predictive ability, while values below 0 suggest that the model is not relevant for predictions [31]. The path coefficient is used to assess the significance, strength, and relationships between constructs, with values closer to +1 indicating a stronger relationship.After completing all the necessary steps of SEM-PLS analysis, the next stage involves hypothesis testing. This will be carried out using SmartPLS 4.0 software, with a 95% confidence level ($\alpha = 0.05$) and a t-statistic criterion of 1.96. The hypothesis is accepted or rejected based on whether the t-statistic exceeds 1.96. Additionally, the indirect effect will be examined to assess the role of mediation variables connecting the independent variable with the dependent variable, where a t-statistic greater than 1.96 indicates full mediation.

III. RESULT AND DISCUSSION

Descriptive statistics result

The descriptive analysis highlights the characteristics of 100 respondents domiciled in Cimahi City, covering various categories such as gender, age, education level, type of business, types of products produced, and monthly revenue. Gender distribution is evenly split, with male and female respondents each representing 50% of the sample. In terms of age, the largest proportion of respondents falls within the 35–44 age group, making up 36%, followed by the 25–34 age group at 28%, while the 17–24 and 45–54 age groups contribute 13% and 17%, respectively. The smallest proportion of respondents belongs to the 55–64 age group, which accounts for 6%.Educational attainment among respondents varies significantly, with the majority having completed high school, making up 59% of the sample. This is followed by respondents with undergraduate degrees at 31%, middle school education at 6%, and postgraduate degrees at 4%. These educational levels suggest a diverse range of academic backgrounds, which may influence the way businesses are managed and operated.Regarding the types of businesses, food-related enterprises dominate the sample, accounting for 89% of the respondents, while beverage-related businesses make up the remaining 11%.

The product categories reveal further diversity, with fast food being the most common, produced by 31% of respondents. Other popular categories include bakery products such as bread and pastries (18%), snacks (18%), and frozen food (11%). Less common products include bakery items such as traditional cakes (6%), contemporary beverages (7%), healthy beverages like juices and smoothies (5%), and catering (4%). From the perspective of financial performance, monthly turnover figures indicate that the majority of respondents fall within the Rp.25,000,000 – Rp.50,000,000 range, representing 59%. Additionally, 29% of respondents report turnover within the Rp.50,000,000 – Rp.75,000,000 range, while 12% have a turnover below Rp.25,000,000. These turnover figures reflect the varying scales of businesses, with most falling into the medium-sized enterprise category.In summary, the data provides valuable insights into the demographic and business profiles of SMEs in Cimahi City. It reveals that the respondents primarily focus on food-related businesses, with fast food and bakery products being the most prominent categories. Additionally, the educational background and financial turnover highlight the capabilities and economic potential of these enterprises, particularly in their efforts to navigate a competitive market while contributing to the local economy.

PLS-SEM Analysis-Outer Model Measurement

Partial Least Squares Structural Equation Modelling (PLS-SEM) was used to analyze the relationships between the variables, as outlined earlier. PLS-SEM is particularly effective for assessing complex models with multiple constructs. The table below displays the results of the convergent validity analysis, which evaluates the consistency of the measurement model. Convergent validity is confirmed when the standardized loadings and Average Variance Extracted (AVE) values are greater than 0.5, ensuring that the indicators reliably represent their respective constructs. These findings are essential for confirming the model's validity and reliability before advancing to subsequent phases of the research.

Table 1. Results of Convergent Validity

Variable	Indicators	Outer Loading	Result (Loading factor ≥ 0.6)
Green Supply Chain Management (X)	**GSCM1**	0.817	Valid
	GSCM2	0.902	Valid
	GSCM3	0.755	Valid
	GSCM4	0.851	Valid
	GSCM5	0.814	Valid
	GSCM6	0.897	Valid
	GSCM7	0.791	Valid
	GSCM8	0.740	Valid
	GSCM9	0.739	Valid
Green Innovation (Y)	**GI1**	0.866	Valid
	GI2	0.884	Valid
	GI3	0.785	Valid
	GI4	0.729	Valid
Firm Performance (Z)	**FP1**	0.884	Valid
	FP2	0.964	Valid
	FP3	0.910	Valid
	FP4	0.935	Valid

Source: PLS algorithm test results (2024)

Based on the table above, all indicators in the constructs of GSCM (X), GI (Y), and Firm Performance (Z) meet the criteria for convergent validity, with loading factor values greater than 0.7, indicating that all indicators are valid in representing their respective variables. These results confirm that all indicators can be utilized for further analysis.

Table 2. Results of Descriminant Validity

	Firm Performance	Green Innovation	Green Supply Chain Management
FP1	0.884	0.136	0.168
FP2	0.964	0.183	0.193
FP3	0.910	0.108	0.152
FP4	0.935	0.158	0.137
GI1	0.110	0.866	0.489
GI2	0.279	0.884	0.571
GI3	0.061	0.785	0.459
GI4	0.017	0.729	0.418
GSCM1	0.093	0.351	0.817
GSCM2	0.080	0.480	0.902
GSCM3	0.222	0.420	0.755
GSCM4	0.052	0.397	0.851
GSCM5	0.140	0.411	0.814
GSCM6	0.092	0.455	0.897
GSCM7	0.233	0.645	0.791
GSCM8	0.129	0.481	0.740
GSCM9	0.181	0.562	0.739

Source: PLS algorithm test results (2024)

Based on the table above, discriminant validity is achieved if the loading value of an indicator on its main construct is higher than its cross-loading values on other constructs. All indicators in the Firm Performance construct (FP1-FP4) have the highest loading values on the Firm Performance construct compared to the Green Innovation and Green Supply Chain Management constructs. Similarly, the indicators of GI (GI1-GI4) and GSCM (GSCM1-GSCM8) also show the highest loading values on their respective constructs. These results indicate that all indicators in the three constructs demonstrate good discriminant validity, allowing the data to be used for further analysis. Then, for the output from the composite reliability values is presented in the table below:

Table 3. Results of Average Variance Extracted (AVE), Composite Reliability and Cronbach's alpha

	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Firm Performance (Z)	0.943	0.959	0.853
Green Innovation (Y)	0.835	0.890	0.670
Green Supply Chain Management (X)	0.936	0.946	0.663

Source: PLS algorithm test results (2024)

Based on the data processing conducted by the author using SmartPLS, the findings presented in the table above show that the Average Variance Extracted (AVE) for each indicator is greater than 0.5. This indicates that all the indicators are valid. Furthermore, the results for composite reliability and Cronbach's alpha are above 0.70, meaning that all variables exhibit a high level of reliability and are suitable for use in the study and can proceed to the next test.

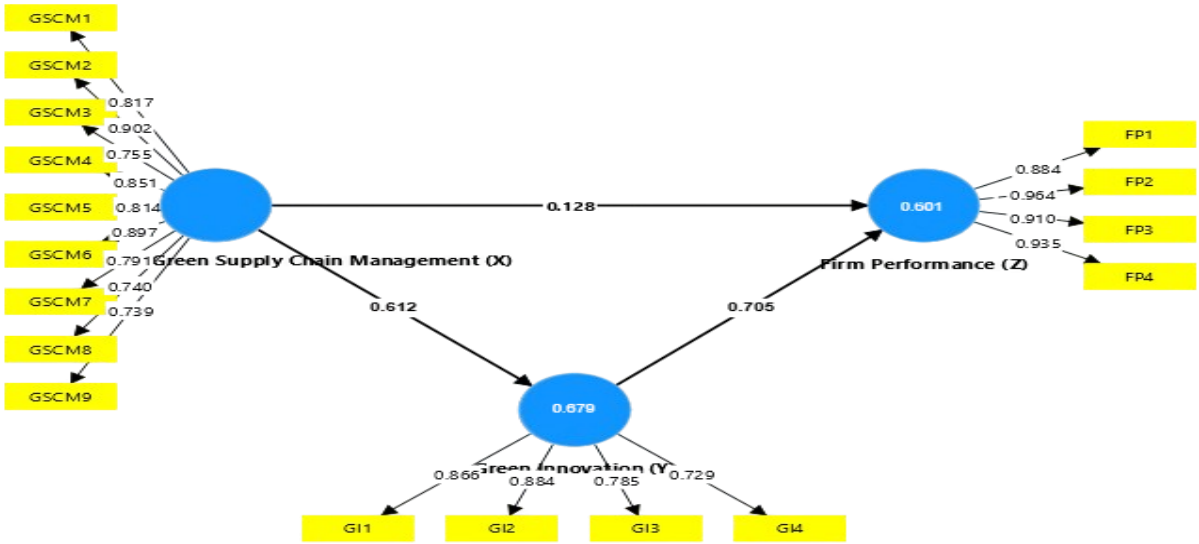

Fig 2. Result of PLS Algorithm Measurement Model

Inner Model Measurement

The following table presents the R-Square (R^2) values for each construct in the research model. The R-Square values indicate the proportion of variance explained by the independent variables on the dependent variables within the model. Higher R-Square values suggest that the model is better at explaining the relationships between the variables. This analysis provides insights into the strength of the model in accounting for the observed variability and serves as a foundation for further evaluation of the model's quality in this study.

Table 4. Results R Square

	R-square	R-Square Adjusted
Green Innovation (Y)	0.679	0.665
Firm Performance (Z)	0.601	0.586

Source: PLS Boostrapping results (2024)

Based on the table, the R-Square value for the effect of Green Supply Chain Management on Green Innovation is 0.679, indicating that GSCM explains 67.9% of the variation in GI, while the remaining 32.1% is explained by other variables outside the model. This R-Square value demonstrates that GSCM makes a substantial contribution to explaining the variation in GI. Meanwhile, the R-Square value for the effect of GSCM on Firm Performance through GI is 0.601, meaning that GSCM explains 60.1% of the variation in Firm Performance through GI, with the remaining 39.9% explained by other variables outside the model. Although this R-Square value is relatively moderate, it indicates that GSCM still has a considerable ability to explain the variation in Firm Performance through GI. The results indicate a significant relationship between the independent variables and both the dependent and mediating variables, supporting the research's ability to effectively address the hypotheses. Additionally, these findings demonstrate that the model used is robust enough to proceed with hypothesis testing.

Hyphothesis Tes Result

Table 5. Result of Path Coefficient

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
Green Supply Chain Management (X) → Green Innovation (Y)	0.612	0.654	0.129	4.744	0.000
Green Supply Chain Management (X) → Firm Performance (Z)	0.128	0.129	0.146	0.877	0.380
Green Innovation (Y) → Firm Performance (Z)	0.705	0.359	0.280	2.518	0.000

Source: PLS Boostrapping results (2024)

The results of the Path Coefficient analysis using SmartPLS indicate that Green Supply Chain Management significantly influences Green Innovation, with a path coefficient of 0.612, a T-statistic of 4.744 (greater than 1.96), and a P-value of 0.000 (significant at the 5% level). However, GSCM does not have a significant direct effect on Firm Performance, despite a path coefficient of 0.128. This is supported by a T-statistic of 0.877 (less than 1.96) and a P-value of 0.380 (not significant). Meanwhile, GI has a significant impact on Firm Performance, with a path coefficient of 0.705, a T-statistic of 2.518 (greater than 1.96), and a P-value of 0.000 (significant at the 5% level). Based on these findings, it can be concluded GSCM contributes indirectly to Firm Performance through GI, suggesting that GI serves as a mediating variable.

Table 6. Results of Spesific Indirect Effect

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
Green Supply Chain management (X) → Green Innovation (Y) → Firm Performance (Z)	0.230	0.204	0.026	8.846	0.000

Source: PLS Boostrapping results (2024)

Based on the results of the indirect effect analysis presented in the table, it is evident that GSCM indirectly influences Firm Performance through GI. The path coefficient for this indirect effect is 0.230, with a sample mean of 0.204 and a standard deviation of 0.026. The T-statistic is 8.846, exceeding the critical value of 1.96, while the P-value is 0.000, indicating significance at the 5% level. Thus, it can be concluded that GI serves as a significant mediator in the relationship between GSCM and Firm Performance.

The Effect of Green Supply Chain Management on Firm Performance in Cimahi SMEs.

The analysis results indicate that the direct relationship between Green Supply Chain Management and Firm Performance has a path coefficient (Sample O) of 0.128. This value is relatively small, indicating a weak effect of GSCM on Firm Performance. Moreover, this relationship is not significant, as the T-statistic is 0.877 (less than 1.96) and the P-value is 0.380 (not significant). Therefore, **H1 is rejected, indicating that Green Supply Chain Management does not directly affect Firm Performance.** The results of this study are consistent with the findings of [25] and [26], which state that GSCM does not have a positive effect on firm performance.

The Effect of Green Supply Chain Management on Green Innovation in Cimahi SMEs.

The analysis results show that Green Supply Chain Management significantly influences Green Innovation, with a path coefficient (Sample O) of 0.612. This value is relatively high, indicating a strong influence of GSCM on enhancing GI. This is supported by a T-statistic 4.744 (greater than 1.96) and a P-value of 0.000 (significant). Therefore, **H2 is accepted, indicating that Green Supply Chain Management has a positive effect on Green Innovation.** The results of this study align with the research conducted by [33], which states that GSCM has a positive effect on GI. Companies use GSCM as a key factor that drives

GI. The synergy between GSCM and GI offers significant benefits to companies in refining product designs, production processes, and enhancing compliance in reducing environmental impacts [34].

The Effect of Green Innovation on Firm Performance in Cimahi SMEs.

The analysis results demonstrate that Green Innovation has a positive and significant effect on Firm Performance, with a path coefficient (Sample O) of 0.705**.** This results suggesting a reasonably strong influence of GI on improving Firm Performance. The T-statistic of 2.518 (greater than 1.96) and P-value of 0.000 (significant) further confirm this finding. Therefore, **H3 is accepted**, **indicating that Green Innovation has a positive effect on Firm Performance.** This is supported by the findings of [27], which state that GI is a key contributor to improving Firm performance. According to [35], their research also found that GI has a positive effect on Firm performance.

The effect of Green Supply Chain Management on Firm Performance Mediated by Green Innovation in Cimahi SMEs.

The indirect effect analysis shows that Green Supply Chain Management indirectly influences Firm Performance through Green Innovation. The path coefficient for this indirect effect (Sample O) is 0.230. The T-statistic of 8.846 (greater than 1.96) and P-value of 0.000 (significant) indicate that this indirect effect is statistically significant. Therefore, **H4 is accepted, demonstrating that Green Innovation serves as a significant mediator in the relationship between Green Supply Chain Management and Firm Performance.** These results are supported by the research of [25], which found that GI can mediate the effect of GSCM on Firm performance. The same finding was also observed in the study by [34], which proposed that enhancements in GSCM can foster greater GI and simultaneously improve Firm Performance.

IV. CONCLUSION

The findings of this study show that Green Supply Chain Management (GSCM) significantly and positively has an effect on Green Innovation (GI) but its effect on Firm Performance (FP) in SMEs in Cimahi is weak and insignificant. GI plays a crucial role in enhancing Firm Performance, with a positive and significant effect. Moreover, GI acts as a mediator between GSCM and Firm Performance, showing that the relationship between GSCM and FP is partially mediated by GI. These findings are consistent with previous studies, highlighting the importance of GSCM and GI in improving overall firm performance, particularly in environmental sustainability initiatives.

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