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Role Green Logistics Mediation in Improving Green Supply Chain Performance through Sustainable Manufacturing and Reverse Logistics

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A B S T R A C T

This study aims to analyze the role of green logistics as a mediating variable in the relationship between sustainable manufacturing and reverse logistics on green supply chain performance in manufacturing companies in East Java. A quantitative approach was used through a questionnaire survey of manufacturing managers, with covariance-based Structural Equation Modeling analysis using AMOS. The measurement model was tested for validity and reliability, while the structural model was used to examine the direct and indirect influences between variables. The results show that sustainable manufacturing has a significant impact on green logistics, and green logistics has a significant positive impact on green supply chain performance. Conversely, reverse logistics has no significant impact on either green logistics or green supply chain performance, so its contribution to green supply chain performance is still limited. These findings indicate that improving green supply chain performance is more effectively achieved through the integration of sustainable manufacturing practices with green logistics rather than relying solely on reverse logistics, which is still partial and reactive. This study positions green logistics as a key mediator explaining how sustainable manufacturing and reverse logistics practices contribute to green supply chain performance in the context of developing countries.

KATA KUNCI

Manufaktur Berkelanjutan, Logistik Terbalik, Logistik Hijau, Kinerja Rantai Pasokan Hijau, Teori Institusional

A B S T R A K

Penelitian ini bertujuan menganalisis peran logistik hijau sebagai variabel mediasi dalam hubungan antara manufaktur berkelanjutan dan logistik terbalik terhadap kinerja rantai pasokan hijau pada perusahaan manufaktur di Jawa Timur. Pendekatan kuantitatif digunakan melalui survei kuesioner kepada manajer manufaktur, dengan analisis *Structural Equation Modeling* berbasis *covariance* menggunakan AMOS. Model pengukuran diuji melalui validitas dan reliabilitas, sedangkan model struktural digunakan untuk menguji pengaruh langsung dan tidak langsung antarvariabel. Hasil menunjukkan manufaktur berkelanjutan berpengaruh signifikan terhadap logistik hijau dan logistik hijau berpengaruh positif signifikan terhadap kinerja rantai pasokan hijau. Sebaliknya, logistik terbalik tidak berpengaruh signifikan baik terhadap logistik hijau maupun kinerja rantai pasokan hijau, sehingga kontribusinya terhadap kinerja rantai pasokan hijau masih terbatas. Temuan ini mengindikasikan bahwa peningkatan kinerja rantai pasokan hijau lebih efektif dicapai melalui integrasi praktik manufaktur berkelanjutan dengan logistik hijau daripada hanya mengandalkan logistik terbalik yang masih bersifat parsial dan reaktif. Penelitian ini memosisikan logistik hijau sebagai mediator utama yang menjelaskan bagaimana praktik manufaktur berkelanjutan dan logistik terbalik berkontribusi terhadap kinerja rantai pasokan hijau dalam konteks negara berkembang.

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1. Introduction

1.1. Research Background

Indonesia is a developing country characterized by uneven mastery of technology and infrastructure. In this era, the manufacturing industry no longer focuses on speed and effectiveness. Conventionally managed distribution, inventory, and transportation processes have been shown to increase waste, greenhouse gas emissions, and wasteful energy use. Therefore, the concepts of green supply chain management and green logistics have emerged as a way to reduce the negative impacts of these activities.

The issue of green supply chains has prompted companies in various countries to compete to find ways to reduce the environmental impact of their supply chain activities, particularly in the logistics and manufacturing sectors [1]. The manufacturing industry faces demands to improve its performance as a commitment to achieving national sustainable development goals. Several industries are oriented towards environmentally friendly and sustainable methods, employing Sustainable Development Orientation practices [2].

Indonesia has numerous industrial areas, one of which is located in East Java. The expansion of manufacturing and distribution activities reinforces the need for Green Supply Chain Performance practices, such as sustainable manufacturing and reverse logistics integrated with green logistics, to improve green supply chain performance without sacrificing company competitiveness and maintaining efficiency/competitive advantage [3]. The impact that will be borne by manufacturing companies when not implementing GSCM will likely result in a decline in sustainability performance [4]. Thus, the development of the manufacturing sector in East Java needs to pay attention to improving Green Supply Chain Management as a driving factor for sustainability in the manufacturing industry.

Sustainability can be achieved through the implementation of a Green Supply Chain Management strategy, which includes several main approaches, including sustainable manufacturing, which emphasizes energy efficiency and waste reduction in the production process [5]. Reverse logistics that focuses on the return, exchange, repair, remarketing, and disposal of products for reasons such as end of life, damage, or poor quality, which serves as a competitive advantage and strategic objective for economic benefits and environmental sustainability [6]. Green Logistics also integrates environmentally friendly principles into transportation, warehousing, and distribution activities [7]. These practices are conceptually viewed as part of Green Supply Chain Management (GSCM), a systematic effort to manage the end-to-end flow of materials and information by considering environmental, economic, and social aspects to improve green supply chain performance while maintaining competitive advantage [7]. These practices are conceptually viewed as part of Green Supply Chain Management (GSCM), which is a systematic effort to manage the flow of materials and information end-to-end by considering environmental, economic, and social aspects to improve the performance of the green supply chain while maintaining competitive advantage [8].

This study utilizes several theoretical lenses of Institutional Theory. Using Institutional Theory can clarify why organizations adopt green practices and integrated logistics, not only for operational efficiency but also to meet external expectations. This institutional theory supported by some research, which explains that managerial decisions are heavily influenced by coercive, mimetic, and normative pressures from the institutional environment [9].

In certain research, reverse logistics is unable to improve green supply chain performance if implemented individually [3]. This is in contrast to Sustainable Manufacturing, which has a direct effect on sustainability performance. However, Institutional Theory explains that companies in developing countries face increasingly strong institutional pressures ranging from regulatory, normative, and mimetic. In some research, one of the main challenges to implementing green logistics in Indonesia is the lack of supporting infrastructure and technology, the lack of clear regulations and policies, and organizational resistance, which is reflected in the lack of support for coordination and management between departments [10].

In the context of this research, the gap found is that there are not many studies that position green logistics as the main link between sustainable manufacturing and reverse logistics with green supply chain performance in companies in industrial cities such as East Java. Without integration through green logistics, the implementation of SM and RL tends to run partially in each function so that their contribution to increasing GSCP cannot be fully described. This condition indicates the need for an empirical model that specifically tests how SM and RL managed through green logistics practices can encourage GSCP in the context of developing countries [11]. Research previously stated that the majority of previous research was also conducted in developed countries, where established infrastructure and strong regulations naturally support environmental efforts [12].

The solution to this gap is through this study creating an empirical framework that simultaneously tests the effects of SM and RL on GSCP. Where GL is used as the main mediating variable in companies in East Java. This method allows for a more comprehensive evaluation of the ways in which the practices of SM and RL that were initially running partially can be integrated through GL. Based on a number of descriptions that have been presented, this study aims to analyze the influence of sustainability manufacturing and reverse logistics on green supply chain performance with green logistics as a mediator in manufacturing companies in the East Java region.

1.2. Literature Review

1.2.1. Institutional Theory

The concept of Institutional Theory was first presented which explains that Institutional Theory involves the role of coercive pressure (CP), normative pressure (NP), and mimetic pressure (MP) [9]. Using this theory can show the reasons for companies to adopt environmentally friendly practices and integrate logistics, in addition to improving operational efficiency, and meeting external expectations [3]. Literature studies state that the use of Institutional

Theory emphasizes that institutional pressure, both coercive pressure (CP), normative pressure (NP), and mimetic pressure (MP) play an important role in encouraging companies and supply chain partners to adopt green supply chain management practices such as sustainable manufacturing, reverse logistics, and green logistics [13], [14].

1.2.2. Sustainable Manufacturing

Sustainable manufacturing is often defined as a series of production processes aimed at reducing environmental damage while making better use of resources, conserving energy, and reducing waste throughout a product's life cycle. This typically involves the implementation of cleaner technologies, emission controls, water and energy conservation, and circular production methods [15]. Sustainable manufacturing involves, among other things, manufacturing products through economical processes that minimize environmental impacts, conserve resources, and improve safety for employees, communities, and products [16]. As a result of various studies GSCM has shown that the development of green production practices or sustainable manufacturing correlates with improvements in green logistics systems, and both contribute to an increase in the level of Green Supply Chain [17], [18], [19].

1.2.3. Reverse Logistics.

Reverse logistics, as defined, is the moment when goods purchased by consumers are returned to the manufacturer to be returned, recycled, or remanufactured [20]. Meanwhile research states that reverse logistics is essentially related to the process of returning, recycling, remanufacturing, and properly disposing of products or materials after use, with the goal of recovering value while simultaneously reducing environmental impact [21]. A study found that institutional pressures such as environmental regulations, customer demands, and competitive pressure to imitate competitors' green practices influence companies' decisions to use reverse logistics. This institutional pressure has helped many developing countries adopt green supply chain practices, including reverse logistics [22]. Overall, due to the crucial role green logistics plays in enhancing the relationship between reverse logistics and green supply chain performance, green logistics serves as a crucial mediator, helping translate reverse logistics efforts into tangible improvements in green supply chain performance.

Reverse logistics has become a crucial component of a green logistics system because it manages the reverse flow of products and materials in an environmentally friendly manner and contributes to environmental protection, with the aim of promoting ecological methods in production, distribution, and logistics processes [23]. Reverse logistics is no longer viewed as an additional activity but as a crucial strategy for achieving sustainability through resource efficiency, waste reduction, and the implementation of a circular economy. Supported by technological developments, regulations, and research and understanding of consumer behavior, reverse logistics has significant potential to provide sustainable environmental and economic benefits [24]

1.2.4. Green Logistics

From a business perspective, green logistics is a step that integrates environmental and economic considerations into an integrated process encompassing various managerial activities, such as planning, implementation, control, and standardization throughout a company's supply chain [25]. Green logistics activities aim to reduce negative environmental impacts (such as CO_2 emissions, waste, and noise) through the implementation of reverse logistics, green transportation, green warehousing, green packaging, reverse logistics, energy efficiency, and resource conservation practices. The ultimate goal is to achieve stakeholder satisfaction, cost savings, increased product value, and sustainable competitive advantage [25]. Research found that green logistics practices positively impact green supply chain performance [26], [27].

1.2.5. Green Supply Chain Performance

Green supply chain performance is influenced by practices such as information sharing, logistics networks, and transportation [28]. GSCP also encompasses reducing environmental impacts and achieving sustainable growth [29]. GSCM performance measurement is essentially the process of quantifying the efficiency and effectiveness of all activities and processes aimed at achieving green supply chain management [29], [30]. This measurement helps decision-makers identify areas of poor operation, compare alternative scenarios, and develop improved products and processes, such as reverse logistics. GSCP also has dimensions that include environmental performance, operational performance, and economic performance [31].

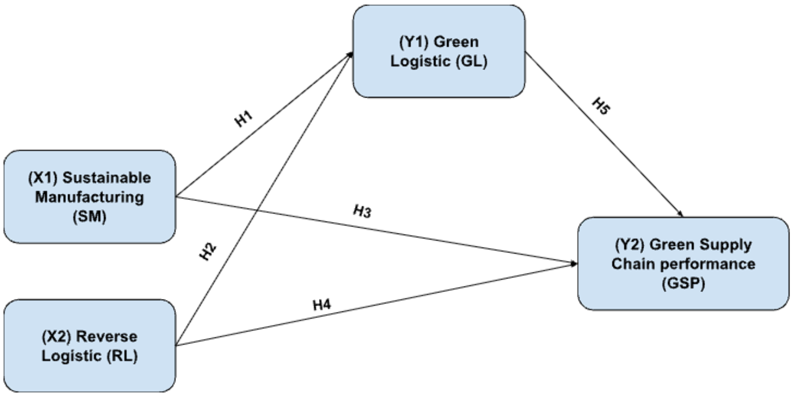

Figure 1. Research Framework

2. Research Method

The research employed a quantitative approach using a questionnaire with CB-SEM analysis. The population comprised managers working in the manufacturing sector in Surabaya, Indonesia. The sample size was 121 respondents, selected using purposive sampling to accurately target managers with relevant roles within the research context. A Likert scale ranging from 1 to 7 was used: (1) strongly disagree, (2) disagree, (3) somewhat disagree, (4) neutral, (5) somewhat agree, (6) agree, and (7) strongly agree. This scale was chosen to measure respondents' level of agreement with statements related to the implementation of Sustainable Manufacturing, Reverse Logistics, Green Logistics, and green supply chain performance. The use of this seven-point scale allows for more detailed and accurate measurement of attitudes and perceptions.

The collected data were then checked for completeness and suitability for statistical analysis. Data analysis was conducted using Covariance-Based Structural Equation Modeling (SEM) with the aid of AMOS software, which is capable of simultaneously examining the relationship between latent constructs and measurement indicators and testing the proposed theoretical model. The research instruments can be seen on Table 1.

Table 1. Research Instruments

Variable	Sub Variable	Indicator	No
Sustainable Manufacturing (X1)	Cleaner Technologies	The use of cleaner and more environmentally friendly production technologies to reduce waste, emissions, and the use of hazardous materials in the manufacturing process.	X1.1
	Controlling Emissions	The company's efforts to control and reduce exhaust emissions and pollutants produced during the production process.	X1.2
	Conserving Water and Energy	Efficient use of water and energy through saving, reusing, and implementing resource-saving production systems.	X1.3
	Implementing Circular Production Approaches	Implementation of circular economy principles by maximizing material reuse, waste reduction, and recycling in the production process.	X1.4
Reverse Logistic (X2)	Product Returns	Management of product returns from consumers to the company for inspection, repair, or further processing.	X2.1
	Recycling	The activity of collecting and reprocessing used materials or products so that they can be reused as raw materials.	X2.2
	Remanufacturing	The process of repairing and reassembling used products so that they have the same function and quality as new products.	X2.3
Green Logistic (Y1)	Financial Economics	Logistics cost efficiency through reduced energy consumption, route optimization, and the use of environmentally friendly technology.	Y1.1
	Logistics Networking & Transport	Efficient and sustainable management of distribution and transportation networks to reduce carbon footprint	Y1.2
	Information Sharing	Effective exchange of information between parties in the supply chain to support environmentally friendly logistics decision making.	Y1.3
Green Supply Chain Performance (Y2)	Green Manufacturing	Integration of environmentally friendly principles into production processes to reduce resource consumption and environmental impact.	Y2.1
	Green Purchasing	Selection of suppliers and raw materials that meet environmental standards and support sustainable practices.	Y2.2
	Cooperation with Customer	Collaboration with customers in the use of environmentally friendly products, waste reduction, and product returns	Y2.3
	Eco Design	Product design that takes into account environmental impacts throughout the product life cycle.	Y2.4

3. Result and Discussion

The respondents obtained by the researcher were 121 respondents who came from various backgrounds in terms of gender, age, education, industrial sector, position, work experience, and age of the respondent's company. Based on the results of the respondent characteristics, the majority of respondents were male, namely 78 people (64.5%), while female respondents numbered 43 people (35.5%). In terms of age, most respondents were aged 31–40 years with a total of 49 people (40.5%), followed by the 41–50 age group with 36 people (29.8%). Meanwhile, respondents aged 25–30 years and over 50 years each numbered 18 people (14.9%).

In terms of education, the majority of respondents had a Bachelor's degree (71 people) (58.7%), followed by respondents with a Master's degree or higher (35 people) (28.9%), and Diploma (15 people) (12.4%). Based on job title, the majority of respondents were in the Manager position, namely 55 people (45.5%), followed by Supervisors (46 people) (38.0%), and Senior Manager/Head of Division (20 people) (16.5%). Based on work experience, the majority of respondents had more than 7 years of experience, namely 55 people (45.5%), followed by 4–7 years of work experience (47 people) (38.8%), and 1–3 years (15.7%). In terms of company size, the majority of respondents came from medium-sized companies (69 people) (57.0%), while large companies were represented by 52 people (43.0%).

In terms of industrial sector, most respondents came from the Consumer Goods and other sectors, namely 39 people (32.2%), followed by Automotive & Machinery with 31 people (25.6%), Food & Beverage with 29 people (24.0%), and Chemicals & Pharmaceuticals with 22 people (18.2%). Meanwhile, based on company age, the majority of respondents work in companies that have been operating for more than 10 years, namely 66 people (54.6%), followed by companies with an age of 6–10 years with 38 people (31.4%), and companies with an age of 1–5 years with 17 people (14.0%).

The analysis begins with a construct validity and reliability test using the Average Variance Extracted (AVE) and Composite Reliability (CR) indicators, where the construct is said to be valid if the AVE value is close to or more than 0.50 and reliable if the CR value is more than 0.70 [32] The estimation process is carried out by inputting data from the questionnaire results of respondents who have been selected as research samples. The AMOS output produces model estimation results such as standardized regression weight (β value), standard error, t-statistic value (Critical Ratio), and probability value (p-value) for each relationship between variables. The decision to test the hypothesis is based on statistical significance, namely if the p-value <0.05 and t-statistic > 1.96, then the relationship between variables is declared significant and the research hypothesis is supported [32]. All analysis results are summarized in the form of a table of hypothesis testing results and a table of instrument reliability testing results so that they can provide an objective picture of the relationship between variables in the research model.

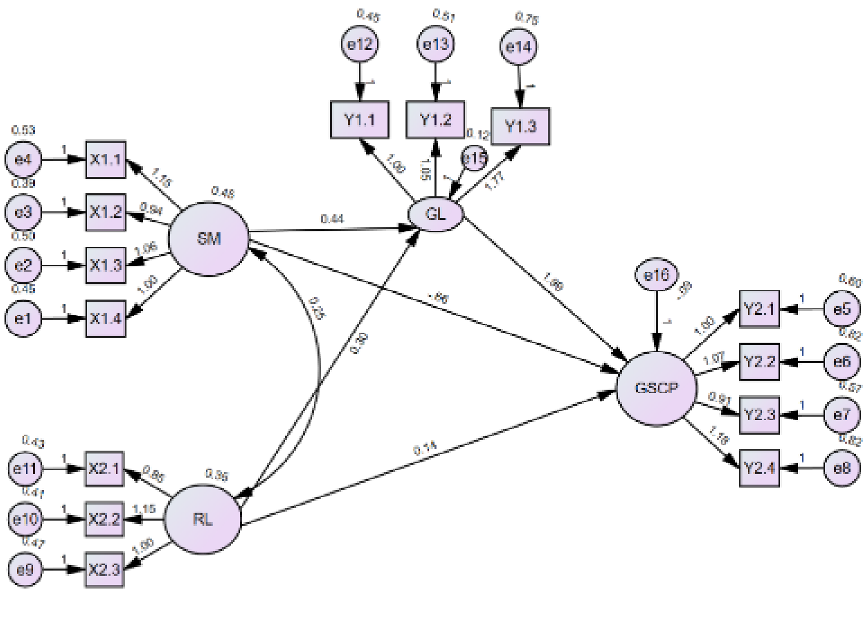

Figure 2. AMOS Running Model

Table 2. Result Goodness of Fit

Variable	Indicator	Factor Loading	Information
Sustainable Manufacturing	X1.1	0.728	Valid
	X1.2	0.712	Valid
	X1.3	0.710	Valid
	X1.4	0.706	Valid
Reverse Logistic	X2.1	0.612	Valid
	X2.2	0.728	Valid
	X2.3	0.655	Valid
Green Logistic	Y1.1	0.747	Valid
	Y1.2	0.630	Valid
	Y1.3	0.635	Valid
Green Supply Chain Performance	Y2.1	0.723	Valid
	Y2.2	0.694	Valid
	Y2.3	0.703	Valid
	Y2.4	0.728	Valid

A good factor loading value is ≥0.5 and ideally ≥0.7 [33]. The results of the Confirmatory Factor Analysis (CFA) validity test, which can be seen on Table 2, indicate that each indicator used in this study has a factor loading value above 0.50. This indicates that each indicator has the ability to adequately describe the latent construct. The indicators in the Sustainable Manufacturing, Reverse Logistics, Green Logistics, and Green Supply Chain Performance variables overall have good factor loading values, with most indicators showing values above 0.70. Therefore, all indicators presented in this study are declared valid and can be used for future structural model testing.

Table 3. Reliability Test

Variable	AVE	CR	Decision
Sustainable Manufacturing (X1)	0.629	0.872	Reliable
Reverse Logistic (X2)	0.626	0.834	Reliable
Green Logistic (Y1)	0.647	0.846	Reliable
Green Supply Chain Performance (Y2)	0.631	0.873	Reliable

Based on the reliability test results presented in Table 3, all variables in this study showed Composite Reliability (CR) values above the minimum limit of 0.70. The Sustainability Manufacturing variable (X1) had a CR value of 0.872 with an AVE of 0.629. The Reverse Logistics variable (X2) obtained a CR value of 0.834 and an AVE of 0.626. Furthermore, the Green Logistics variable (Y1) had a CR value of 0.846 and an AVE of 0.647, while the Green Supply Chain Performance variable (Y2) showed a CR value of 0.873 with an AVE of 0.631. The AVE values for all constructs also met the minimum criteria, which were greater than 0.50. Thus, it can be concluded that all constructs in this study have a good level of reliability and convergent validity, so that the measurement instrument is declared reliable and suitable for further analysis.

Table 4. Result Goodness of Fit

Goodness of fit index	Model Results	Information
Chi-Square	134.640	Significant
Probability Chi Square	0.000	Significant
CMIN/DF	1.896	Significant
GFI	0.857	Marginal Fit
TLI	0.876	Marginal Fit

The model's suitability was assessed using several goodness-of-fit indicators commonly used in Structural Equation Modeling (SEM) analysis: Chi-square, Probability Chi-square, CMIN/DF, GFI, and TLI. Based on the test results presented in Table 4, the Chi-square value was 134.640 with a Chi-square Probability of 0.00, indicating that the model does not meet the goodness-of-fit criteria based on the Chi-square index. However, the Chi-square index is known to be highly sensitive to sample size, so these results cannot be used as the sole basis for assessing model suitability. Furthermore, the CMIN/DF value of 1.896 meets the recommended criteria of less than 2.00, indicating a good level of fit for the model. Meanwhile, the Goodness of Fit Index (GFI) of 0.857 and the Tucker Lewis Index (TLI) of 0.876 fall into the marginal fit category, as they approach the recommended minimum limit.

The data processing results in the Table 4 indicate that the model meets the goodness of fit criteria. Although there are three marginal criteria, namely GFI and TLI, the majority of all tests have been met so that it is still tolerable. This can be proven by the Chi-Square and CMIN/DF criteria that meet the goodness of fit criteria. Overall, this indicates that the model fit test produces good results. Therefore, it can be concluded that the analytical modeling structure proposed in this study can be categorized as good for describing the cause-and-effect relationship between variables.

Table 5. Hypothesis Testing Results Table

Variable	β	STD. Error	T.Stat	Sig	Decision
Sustainable Manufacturing (X1) → Green Logistic (Y1)	0.531	0.142	3.069	0.002	X1 → Y1 Supported (Significant)
Reverse Logistic (X2) → Green Logistic (Y1)	0.326	0.154	1.954	0.051	X2 → Y1 not Supported
Sustainable Manufacturing (X1) → Green Supply Chain Performance (Y2)	-0.546	0.301	-2.204	0.028	X1 → Y2 Supported (Significant)
Reverse Logistic (X2) → Green Supply Chain Performance (Y2)	0.101	0.245	0.563	0.537	X2 → Y2 Not Supported
Green Logistic (Y1) → Green Supply Chain Performance (Y2)	1.341	0.504	3.936	0.00	Y1 → Y2 Supported (Significant)

The results of the H1 test indicate that Sustainable Manufacturing (X1) has a positive and significant effect on Green Logistics (Y1). This is indicated by a beta coefficient of 0.531, a T-statistic of 3.069, and a significance value of 0.002, which is below the 0.05 significance level. Therefore, H1 is accepted. This finding indicates that the better the implementation of sustainable manufacturing practices, the higher the implementation of green logistics. These results demonstrate that sustainable production processes can encourage more environmentally friendly logistics activities.

The results of the H2 test indicate that Reverse Logistics (X2) does not have a significant effect on Green Logistics (Y1). This is reflected in the beta coefficient of 0.326, a T-statistic of 1.954, and a significance value of 0.051, which is slightly greater than the 0.05 significance level. Therefore, H2 is rejected. This finding indicates that the implementation of reverse logistics has not been able to directly increase green logistics, which is likely due to the implementation of reverse logistics which is still limited or reactive in the context of this research.

The results of the H3 test indicate that Sustainable Manufacturing (X1) has a negative and significant effect on Green Supply Chain Performance (Y2). This is indicated by a beta coefficient of -0.546, a T-statistic of -2.204, and a significance level of 0.028, all of which are less than 0.05. Therefore, H3 is accepted, despite its negative direction. This finding indicates that the implementation of sustainable manufacturing in the short term can lead to increased costs or operational complexity, thus impacting green supply chain performance.

The results of the H4 test indicate that Reverse Logistics (X2) does not have a significant effect on Green Supply Chain Performance (Y2). This is indicated by a beta coefficient of 0.101, a T-statistic of 0.563, and a significance level of 0.537, which is well above the 0.05 significance level. Therefore, H4 is rejected. This finding indicates that the implementation of reverse logistics has not made a significant contribution to improving green supply chain performance in the context of this study.

The results of the H5 test indicate that Green Logistics (Y1) has a positive and significant effect on Green Supply Chain Performance (Y2). This is indicated by a beta coefficient value of 1.341, a T-statistic value of 3.936, and a significance value of 0.000, which indicates a very strong level of significance. Thus, H5 is accepted. This finding indicates that the effective implementation of green logistics can significantly improve green supply chain performance, so that green logistics plays a key role in improving green supply chain performance.

The results of this study indicate that sustainable manufacturing has a positive and significant impact on green logistics in manufacturing companies in East Java, but reverse logistics has no significant effect on green logistics in manufacturing companies in East Java. This finding aligns with some research who suggest that sustainable manufacturing practices tend to go hand in hand with strengthening green logistics, thereby simultaneously improving environmental performance and supply chain operational efficiency [17], [18]. Research also found that the low adoption of reverse logistics is largely influenced by a lack of regulatory support and pressure, limited infrastructure and technology, and organizational factors such as minimal management commitment and coordination between departments [34]. Another study in the context of SMEs also reported that limited financial resources, knowledge, and managerial support keep reverse logistics practices limited and fragmented despite its recognized environmental benefits [35].

In the next stage, green logistics has been proven to have a positive and significant impact on green supply chain performance, indicating that companies that optimize the implementation of green logistics practices tend to achieve better supply chain performance, both from environmental and operational aspects. Consistently shows that the implementation of green logistics can improve green performance and the company's sustainability performance. The findings of green logistics having a significant positive effect on green supply chain performance are in line with various studies showing that green logistics practices and strategies improve sustainability performance and overall company performance [3], [35]. Thus, these findings confirm that green logistics functions as a key element in the implementation of institutionally oriented Green Supply Chain Management.

A study showed that sustainable manufacturing practices and capabilities, such as energy efficiency, emission reduction, and green production processes, have a significant positive impact on GSCP, both in terms of efficiency and sustainability outcomes [18]. This finding confirms that increasing the adoption of sustainable manufacturing at the factory level will have implications for improving greener and more sustainable supply chain performance. A study showed that some reverse logistics practices have only a weak or even insignificant impact on certain dimensions [36]. The low level of RL implementation, limited resources, and lack of managerial and policy support mean that the potential contribution of reverse logistics to green or sustainable supply chain performance has not been fully realized, resulting in an insignificant relationship between RL and GSCP in many cases.

Overall, the results of this study confirm that improving green supply chain performance cannot rely solely on one dimension of green practices, but requires a combination of green procurement, eco-friendly transportation, and green logistics to optimally realize sustainability benefits. The results of hypothesis testing indicate that reverse logistics practices have not had a significant impact on green/sustainable supply chain performance, in contrast to green logistics and sustainable manufacturing, which have been shown to have a positive impact. This finding reinforces the indication that the role of reverse logistics in supporting green supply chain performance remains weak due to low levels of implementation and various structural barriers at the company level.

4. Conclusion

In this study green logistics acts as a mediating variable that bridges the influence of sustainable manufacturing and reverse logistics on green supply chain performance, where sustainable manufacturing is proven to increase the implementation of green logistics which in turn encourages increased green supply chain performance, so that the influence of sustainable manufacturing on green supply chain performance is mainly strong through the mediation pathway, while reverse logistics has not shown a significant influence either on green logistics or directly on green supply chain performance so that it is ultimately still limited; This condition shows that although in the context of reverse logistics is part of the green logistics system, in the context of manufacturing companies in East Java, the mediating role of green logistics is more effective in strengthening the influence of Sustainable Manufacturing than Reverse Logistics on green supply chain performance because Reverse Logistics practices are still hampered by minimal top management support, limited infrastructure and supporting technology, and the absence of standard policies and procedures, so that they have not been able to provide significant improvements in the environmental, operational, and economic performance of the supply chain

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