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Green Innovation Strategy and Supply Chain Resilience: The Roles of Green Logistics Management Practices and Supply Chain Complexity

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ABSTRACT
This study aims to examine the effect of Green Innovation Strategy on Supply Chain Resilience by considering the mediating role of Green Logistics Management Practices and the moderating role of Structural and Dynamic Supply Chain Complexity in manufacturing firms. The research was conducted in a tire yarn manufacturing company located in Citeureup, Bogor Regency, Indonesia, involving 203 employees across various operational levels. Data were collected using a structured questionnaire distributed through purposive sampling and analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS 4. The findings reveal that: (1) Green Innovation Strategy positively influence Green Logistics Management Practices, (2) Green Innovation Strategy positively influence Supply Chain Resilience, (3) Green Logistics Management Practices positively influence Supply Chain Resilience, (4) Green Logistics Management Practices mediate the relationship between Green Innovation Strategy and Supply Chain Resilience, (5) Structural Supply Chain Complexity moderates the relationship between Green Innovation Strategy and Green Logistics Management Practices, and (6) Dynamic Supply Chain Complexity moderates the relationship between Green Logistics Management Practices and Supply Chain Resilience. This study contributes to the green supply chain management literature by providing an integrated framework that links green innovation, logistics practices, and supply chain complexity in explaining supply chain resilience. Practically, the findings offer insights for manufacturing managers in designing integrated green strategies to enhance supply chain resilience in complex and dynamic environments.

Keywords: Green Innovation Strategy, Green Logistics Management Practices, Suplly Chain Complexity, Supply Chain Resilience.

I. Introduction

Global industrial development in recent years has been characterized by increasing dynamism and uncertainty due to various disruptions, including the COVID-19 pandemic, geopolitical conflicts, and global economic fluctuations. These conditions have placed significant pressure on the stability and sustainability of supply chains, making a sole focus on cost efficiency no longer sufficient. Excessive dependence on efficiency-oriented strategies can increase the vulnerability of supply chain systems to external shocks (Spieske & Birkel,

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2021). Consequently, firms are required to develop supply chain resilience, defined as the ability of a supply chain system to anticipate, adapt to, and recover quickly from various forms of disruption. In response to these growing uncertainties, companies are increasingly shifting their strategic orientation toward sustainability-driven innovation. Green innovation strategy has emerged as a strategic approach capable of addressing environmental and operational challenges simultaneously. These strategies emphasize environmentally friendly product and process development through improved energy efficiency, emission reduction, and optimized resource utilization (Issa et al., 2024). The integration of green innovation principles into business activities not only enhances environmental performance but also strengthens operational flexibility and competitiveness, thereby potentially improving supply chain resilience in dynamic business environments.

However, the successful implementation of green innovation strategies requires operational support, particularly through green logistics management practices. These practices include transportation efficiency, waste management, and the reduction of fossil fuel consumption in logistics activities (Akubia & Andriana, 2024). A resilient supply chain is formed through synergy among internal and external stakeholders within the supply network, enabling firms to conduct logistics activities in an efficient, flexible, and reliable manner (Widowati et al., 2022). Thus, green logistics management practices function as a crucial mechanism that translates strategic green innovation into operational resilience outcomes. Nevertheless, the effectiveness of green innovation and logistics practices does not occur in isolation. It is significantly influenced by the level of supply chain complexity faced by the firm. Structural supply chain complexity characterized by a large number of suppliers, product variety, and extensive distribution networks increases coordination challenges and information misalignment risks (Atieh Ali et al., 2024). Meanwhile, dynamic supply chain complexity, driven by demand fluctuations, supply instability, and unpredictable market conditions, further intensifies operational uncertainty. Despite these challenges, firms capable of effectively managing structural and dynamic complexity tend to develop stronger supply chain resilience, as they are better able to adjust strategies and operations responsively to environmental changes (Atieh Ali et al., 2024).

In the context of developing countries, particularly Indonesia, the manufacturing sector plays a strategic role in the national economy. However, the implementation of sustainability-oriented strategies within supply chains remains relatively limited. Although awareness of green innovation and green logistics has increased, firms continue to face constraints such as infrastructure limitations, financial barriers, and technological readiness issues (Dhillon et al., 2023). This situation indicates a gap between sustainability commitment and operational implementation at the firm level. Although prior studies have explored the relationship between green innovation and supply chain resilience (Issa et al., 2024; Wang & Liu, 2022), limited research has simultaneously examined the mediating role of green logistics management practices and the moderating effects of structural and dynamic supply chain complexity within a single integrated framework. Most existing studies focus primarily on direct relationships, overlooking how supply chain complexity may condition or reshape the effectiveness of sustainability-oriented strategies. Therefore, this study proposes and empirically tests a comprehensive model that integrates green innovation strategy, green logistics management practices, supply chain complexity, and supply chain resilience in the manufacturing sector of an emerging economy. Theoretically, this research extends the green supply chain management literature by incorporating supply chain complexity as a contingent factor that influences the strength of strategic and operational relationships. Practically, the findings provide managerial insights into how manufacturing firms can design and implement integrated green initiatives to enhance supply chain resilience in complex and dynamic environments.

II. Literature Review and Hypothesis Development

Green innovation strategy refer to a firm's strategic orientation toward developing environmentally sustainable products, processes, and organizational practices. These strategies encompass eco-design, energy efficiency improvement, emission reduction, waste minimization, and the adoption of environmentally friendly technologies across the supply chain (Issa et al., 2024; Wang & Liu, 2022). Unlike conventional

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innovation that primarily focuses on cost and performance, green innovation integrates environmental objectives with operational and competitive goals. In the post COVID-19 era, where supply chains face heightened disruption risks, sustainability oriented innovation has become increasingly relevant as a strategic tool to enhance adaptability and long-term resilience. However, implementing green innovation strategies is not without challenges. Firms may face financial constraints, technological readiness gaps, resistance to change, and coordination difficulties among supply chain partners. These barriers are particularly significant in developing countries, where infrastructure and regulatory enforcement may be limited (Dhillon et al., 2023). Green logistics management practices involve environmentally responsible logistics activities aimed at minimizing ecological impact while maintaining operational efficiency. These practices include carbon emission reduction, sustainable packaging, energy-efficient transportation, waste management, and reverse logistics implementation (Tahir et al., 2023; Issa et al., 2024). Prior research suggests that green logistics enhances operational performance and reduces environmental risk exposure. During global disruptions such as COVID-19, firms with optimized logistics systems demonstrated greater flexibility in managing supply and demand volatility. Therefore, green logistics may serve as an operational enabler that translates sustainability strategies into tangible resilience outcomes.

Supply chain resilience refers to the capability of a supply chain network to anticipate, respond to, adapt to, and recover from disruptions while maintaining acceptable performance levels (Issa et al., 2024). This capability is reflected in key dimensions such as flexibility, responsiveness, redundancy, collaboration, and visibility across supply chain actors (Hosseini Shekarabi et al., 2025). In recent years, global disruptions—including pandemic shocks, geopolitical tensions, and trade restrictions—have underscored that resilience is no longer optional but a strategic necessity for organizational survival. Consequently, integrating sustainability initiatives with resilience-building mechanisms has emerged as a critical research stream within green supply chain management, highlighting the need for firms to align environmental strategies with adaptive and robust operational capabilities (Metwally et al., 2024).

Structural supply chain complexity arises from the configuration of the supply chain network, encompassing factors such as the number of suppliers, product variety, facility dispersion, and the breadth of distribution networks (Fernández Campos et al., 2024). High levels of structural complexity tend to increase coordination burdens and information asymmetry, which may weaken the effectiveness of strategic implementation, including green innovation initiatives. However, this complexity also exhibits a dual nature. When supported by digital integration, advanced information systems, and strong governance mechanisms, structural complexity can enhance flexibility and resource diversity, thereby strengthening the adaptive capacity of the supply chain and contributing positively to resilience (Lyutov et al., 2022). This ambivalent role indicates that structural complexity may act as a contingent factor that conditions how effectively green innovation strategies are translated into operational practices.

In contrast, dynamic supply chain complexity reflects environmental volatility driven by fluctuating demand, supply uncertainty, rapid technological changes, and external disruptions (Aghajan-Eshkevari et al., 2022). Such dynamism generates nonlinear interactions within supply networks, complicating planning, forecasting, and decision-making processes. Despite these challenges, firms equipped with strong adaptive capabilities and supported by digital technologies may leverage dynamic complexity as an opportunity for strategic repositioning and innovation (Herold & Marzantowicz, 2023). Accordingly, dynamic complexity does not merely act as a constraint but also as an enabling condition that shapes the effectiveness of sustainability-oriented practices, suggesting its critical moderating role in enhancing supply chain resilience. Building upon these arguments, green innovation strategy is positioned as a strategic driver that enables firms to integrate environmental considerations into product design, process improvement, and organizational practices, thereby enhancing both sustainability performance and operational resilience. Through the implementation of green logistics management practices—such as eco-efficient transportation, sustainable packaging, and energy-efficient distribution—firms can translate strategic intent into tangible operational outcomes that strengthen supply chain resilience. However, the effectiveness of this transformation process is contingent upon the level of supply chain complexity, both structural and dynamic, which may either amplify or constrain

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the impact of green initiatives. Therefore, examining the interplay between green innovation strategy, green logistics practices, and multidimensional supply chain complexity provides a more comprehensive understanding of how firms can develop resilient and sustainable supply chains in increasingly complex and uncertain environments.

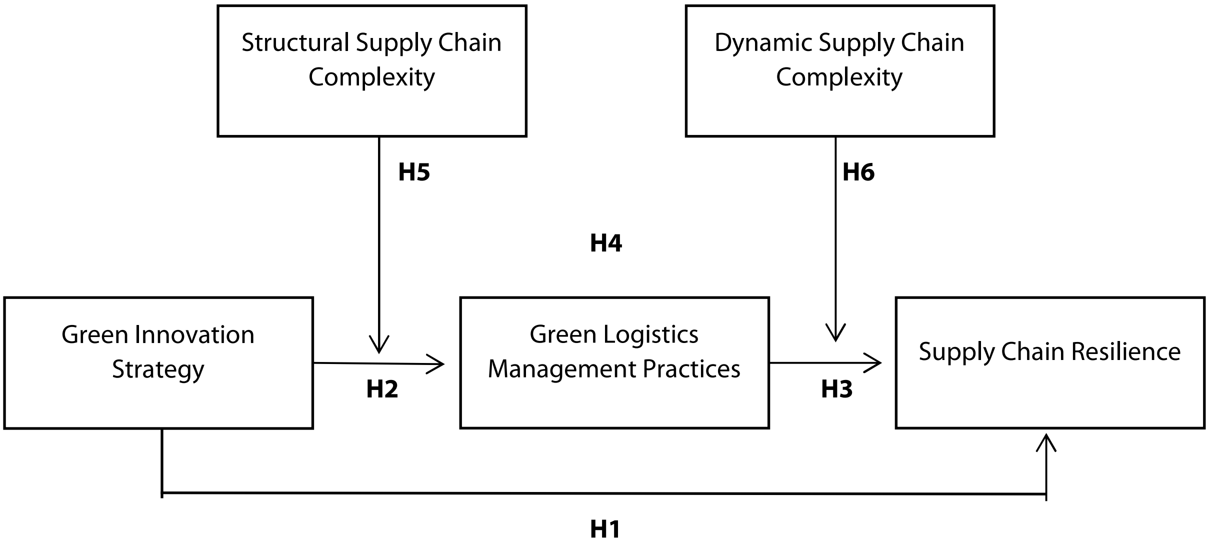

Figure 1. Conceptual Framework
Source: Issa et al. (2024)

Based on the above theoretical arguments and prior empirical findings, this study develops a comprehensive framework integrating green innovation strategy, green logistics management practices, supply chain complexity, and supply chain resilience. Unlike previous studies that primarily examined direct relationships, this research simultaneously investigates mediation and moderation mechanisms to provide a more nuanced understanding of how sustainability-oriented strategies translate into resilience outcomes.

2.1. H1: Green Innovation Strategy positively influence Supply Chain Resilience.

Green innovation strategy encourage firms to develop environmentally friendly products, processes, and operational systems, thereby improving resource efficiency and operational flexibility. The implementation of green innovation enables firms to respond more adaptively to market changes and environmental disruptions, which ultimately strengthens supply chain resilience. (Issa et al., 2024) show that green innovation contributes to enhanced supply chain resilience through more efficient and sustainable operational systems. In addition, green innovation within the context of circular supply chains has been proven to improve stability and durability under regulatory pressure and economic uncertainty (Wang & Liu, 2022).

2.2. H2: Green Innovation Strategy positively influence Green Logistics Management Practices.

The implementation of green innovation strategy encourages firms to adopt environmentally friendly technologies, improve energy efficiency, and develop sustainable product and packaging designs. These efforts directly influence logistics activities, particularly in transportation, packaging, and distribution systems that are more efficient and low emission. (Issa et al., 2024) explain that green innovation integrated into business processes strengthens the effectiveness of green logistics management practices through better resource management and collaboration among supply chain partners. Similar findings are reported by (Wan

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et al., 2023) and (Galán et al., 2023), who emphasize that green innovation plays a crucial role in enhancing the efficiency and sustainability of logistics systems.

2.3. H3: Green Logistics Management Practices positively influence Supply Chain Resilience.

Green logistics management practices focus on improving resource efficiency, reducing emissions, and optimizing product flows throughout the supply chain. This approach enhances operational stability and strengthens firms' ability to manage risks related to supply disruptions and demand fluctuations. According to (Issa et al., 2024), the implementation of green logistics enhances supply chain resilience through improved operational efficiency and collaboration among partners. Furthermore, green logistics efficiency has been shown to increase responsiveness and strengthen supply chain durability in the face of external disruptions (Li & Zhu, 2025; Wan et al., 2023).

2.4. H4: Green Logistics Management Practices mediate the relationship between Green Innovation Strategy and Supply Chain Resilience.

The influence of green innovation strategy on supply chain resilience is not always direct but may occur through the enhancement of green logistics management practices. Green innovation encourages the development of more efficient and sustainable logistics practices, such as waste reduction, energy efficiency, and environmentally friendly transportation systems. (Issa et al., 2024) emphasize that green logistics practices function as a linking mechanism that explains how green innovation is translated into improved supply chain resilience. This mediating role is further supported by (Galán et al., 2023) and (Wan et al., 2023), who demonstrate that the effectiveness of green innovation in strengthening supply chain resilience depends heavily on the implementation of green logistics practices.

2.5. H5: Structural Supply Chain Complexity moderates the relationship between Green Innovation Strategy and Green Logistics Management Practices.

Structural supply chain complexity, characterized by the number of suppliers, product variety, and extensive distribution networks, increases coordination and communication challenges within the supply chain network. These conditions may influence the extent to which green innovation strategy can be effectively implemented in green logistics management practices. (Issa et al., 2024) explain that increasing structural complexity tends to weaken the impact of green innovation on green logistics practices due to heightened coordination barriers. Simpler supply chain structures have been shown to strengthen the effectiveness of green innovation by enabling more efficient communication and integration among partners (Wang & Zhang, 2023; Zhaolei et al., 2023).

2.6. Dynamic Supply Chain Complexity moderates the relationship between Green Logistics Management Practices and Supply Chain Resilience.

Dynamic supply chain complexity, reflected in demand fluctuations, supply disruptions, and rapid changes in the business environment, may influence the effectiveness of green logistics management practices. In highly dynamic environments, maintaining consistency in the implementation of green logistics becomes more challenging, which may reduce its contribution to supply chain resilience. (Issa et al., 2024) state that high environmental dynamism has the potential to weaken the effect of green logistics practices on supply chain resilience. This finding is consistent with (Li & Zhu., 2025) and (Wang & Zhang., 2023), who show that high levels of uncertainty can diminish the effectiveness of sustainability practices in strengthening supply chain resilience.

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In summary, this study extends prior research by integrating strategic, operational, and contextual dimensions within a single framework. By examining mediation and moderation effects simultaneously, this research contributes to a more comprehensive understanding of how green strategy enhance resilience under varying levels of supply chain complexity. The proposed model provides both theoretical advancement and practical implications for managers and policymakers seeking to strengthen sustainable and resilient supply chains in emerging economies.

III. Research Method

This study employed a quantitative approach using hypothesis testing to empirically examine the relationships among the research variables. The research design is explanatory, as it aims to test the causal relationships between green innovation strategies, green logistics management practices, supply chain resilience, and supply chain complexity. Hypothesis testing was conducted to determine whether the null hypotheses could be rejected in favor of the alternative hypotheses, consistent with the methodological approach described by (Sekaran & Bougie., 2016). The data used in this study are primary data collected directly from respondents through a structured questionnaire. Data collection was conducted using a cross-sectional design, where all responses were gathered within a single period in 2025. The questionnaire was distributed online using Google Forms to respondents who are directly involved in operational and supply chain activities within the company. To ensure data quality despite the online distribution method, respondents were informed about the purpose of the study, anonymity was guaranteed, and only eligible participants were allowed to complete the questionnaire.

The questionnaire items were adapted from previously validated studies in the green supply chain management literature to ensure content validity. All constructs were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Before full distribution, the questionnaire was reviewed to ensure clarity of wording and relevance to the company context. This step was conducted to minimize ambiguity and improve response accuracy. The population of this study consists of operational staff, supervisors, and managers within the Production Department of a tire cord manufacturing company located in Bogor Regency. A census (total sampling) technique was applied, meaning that all members of the population were included as respondents. This technique was selected because the population size was relatively limited and all members were directly involved in production and supply chain processes, allowing the study to capture the actual organizational conditions comprehensively.

Data analysis was conducted using Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS4 software. PLS-SEM was chosen because the research model includes multiple latent variables, as well as direct, mediating, and moderating relationships. Additionally, PLS-SEM is suitable for complex predictive models and does not require strict normality assumptions, making it appropriate for this study. The measurement model was evaluated by assessing reliability and validity. Internal consistency reliability was examined using Cronbach's alpha and composite reliability (CR), with values above 0.70 considered acceptable. Convergent validity was assessed through Average Variance Extracted (AVE), where values greater than 0.50 indicate adequate convergent validity. Discriminant validity was evaluated using the Fornell–Larcker criterion and cross-loadings. The structural model was assessed by examining the coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and path coefficients. Hypothesis testing was performed using bootstrapping procedures. A hypothesis was considered supported if the p-value was less than or equal to 0.05 ($\alpha = 0.05$). The adequacy of the sample size was evaluated based on the minimum sample requirement for PLS-SEM, considering the maximum number of structural paths directed at a particular construct. The final sample size met the minimum requirement, indicating sufficient statistical power for analysis.

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IV. Result and Discussion

The results of data processing indicate that the respondents in this study were predominantly male employees, accounting for 68%, while female respondents represented 32%. This composition reflects the workforce characteristics of the tire cord fiber manufacturing company, where operational activities largely involve technical work and production processes, resulting in a relatively higher proportion of male employees. In terms of age, the majority of respondents were in the 31–40 year age group (53.7%), followed by those aged 20–30 years (34%). Meanwhile, respondents aged 41–50 years and above 50 years accounted for 10.8% and 1.5%, respectively. The dominance of respondents within the productive age range indicates that most participants possess sufficient maturity and work experience to understand operational processes and supply chain management practices within the company.

Based on educational background, most respondents held a Bachelor's degree (42.4%), followed by senior high school graduates or equivalent (26.6%), Diploma holders (22.7%), and Master's degree holders (8.4%). This composition suggests that the majority of respondents have an adequate educational level to understand company policies, green innovation strategies, and green logistics management practices implemented within the organization. Regarding job position, the analysis shows that respondents were dominated by operational staff (83.3%), followed by supervisors (12.3%) and managers (4.4%). The predominance of staff and supervisor-level respondents indicates that much of the research data was obtained from individuals directly involved in daily operational activities, thereby ensuring that the perceptions provided accurately reflect the actual implementation of policies and practices in the field. In terms of tenure, most respondents had worked for 6–10 years (48.3%), followed by 1–5 years (33.5%), 11–15 years (12.3%), and more than 15 years (5.9%). The high proportion of respondents with medium to long-term work experience indicates that participants have a strong understanding of the company's business processes and supply chain dynamics, enabling them to provide relevant and accurate assessments of the research variables.

4.1. Prerequisites test

Validity testing was conducted to ensure that each statement in the questionnaire accurately measured the intended construct. Meanwhile, reliability testing was performed to assess the level of consistency and dependability of the instrument in producing stable measurements when administered under similar conditions at different points in time

Table 1. Validity Test

Question Item	Factor Loading	Decision
Green Innovation Strategy		
To what extent has your firm modified its business practices or operations to reduce impact on animal species and natural habitats?	0.866	Valid
To what extent has your firm undertaken voluntary actions (i.e., actions that are not required by regulations) for environmental restoration?	0.851	
To what extent has your firm modified its business practices to reduce wastes and emissions from operations?	0.732	
To what extent has your firm modified its business practices or operations (e.g., through recycling) to reduce purchases of non-renewable materials, chemicals, and components?	0.726	
To what extent has your firm reduced the use of traditional fuels by the substitution of some less polluted energy sources?	0.888	
To what extent has your firm modified its business practices or operations to reduce energy consumption?	0.739	
To what extent has your firm modified its business practices or operations to reduce the environmental impacts of its products?	0.774	

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Green Logistic Management Practices		
Engage in reverse logistics practices.	0.787	Valid
Development of green reward schemes and compensation.	0.824	
Engage in employee and stakeholder green training, and monitoring and evaluating of environmental policies and practices.	0.782	
Use of sustainable transportation, product packaging, and distribution.	0.712	
Structural Supply Chain Complexity		
Our firmserves a large number of customer bases.	0.773	Valid
Our firmhasalarge number of first-tier suppliers.	0.834	
All of our customers desire essentially the same products ®	0.820	
Dynamic Supply Chain Complexity		
Weseek short lead times in the design of our supply chains.	0.738	Valid
Our company strives to shorten supplier lead time, to avoid inventory and stockout.	0.786	
Wecandepend upon ontimely delivery from our suppliers.	0.865	
Supply Chain Resilience		
Our firmis able to adequately respond to unexpected disruptions by quickly restoring its product flow.	0.705	Valid
Our firmis well-prepared to deal with financial outcomes of potential supply chain disruptions.	0.788	
Our firmhasthe ability to maintain a desired level of control over structure and function at the time of disruption.	0.732	
Wedeploy alternative plans associated with identified risks.	0.732	

Source: Data is processed with SmartPLS4, 2025

The results of the validity test indicate that all measurement indicators have factor loading values above 0.40. This result suggests that each indicator demonstrates an adequate level of correlation with its respective latent construct. According to measurement model evaluation criteria in PLS-SEM, a factor loading value above 0.40 is considered acceptable in exploratory research or early-stage scale development, indicating that the indicator sufficiently represents the underlying construct. Therefore, all indicators are deemed valid and appropriate to be retained for further analysis, particularly in the reliability and structural model assessment stages.

Table 2. Average Variance Extracted (AVE)

Variable	AVE	Decision
Green Innovation Strategy	0.548	Valid
Green Logistics Management Practices	0.637	
Structural Supply Chain Complexity	0.655	
Dynamic Supply Chain Complexity	0.604	
Supply Chain Resilience	0.639	

Source: Data is processed with SmartPLS4, 2025

Based on the results of the convergent validity test presented in Table 2, all research variables demonstrate Average Variance Extracted (AVE) values exceeding the minimum threshold of 0.50. Specifically, Green Innovation Strategy obtained an AVE value of 0.548, Green Logistics Management Practices 0.637, Structural Supply Chain Complexity 0.655, Dynamic Supply Chain Complexity 0.604, and Supply Chain Resilience 0.639. These AVE values indicate that each construct explains more than 50% of the variance of its respective indicators, meaning that the indicators share a substantial proportion of common variance in representing the underlying latent variable. In the context of PLS-SEM, an AVE value above 0.50 confirms adequate convergent validity, as it demonstrates that the construct captures more variance from its indicators than the variance attributed to measurement error. Therefore, all constructs in this study meet the criteria for convergent validity and are considered appropriate for further structural model evaluation.

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Furthermore, after establishing convergent validity, the next step in evaluating the measurement model is to assess discriminant validity to ensure that each construct is empirically distinct from the others.

Table 3. Validity Diskriminant Test

Variable	Supply Chain Resilience	Structural Supply Chain Complexity	Dynamic Suplly Chain Complexity	Green Logistics Management Practices	Green Innovation Strategy
Supply Chain Resilience	**0.740**				
Structural Supply Chain Complexity	0.453	**0.798**			
Dynamic Suplly Chain Complexity	0.520	0.038	**0.809**		
Green Logistics Management Practices	0.587	0.368	0.303	**0.777**	
Green Innovation Strategy	0.444	0.266	0.152	0.433	**0.799**

Source: Data is processed with SmartPLS4, 2025

The results of the reliability test indicate that all research variables namely Green Innovation Strategy, Green Logistics Management Practices, Structural Supply Chain Complexity, Dynamic Supply Chain Complexity, and Supply Chain Resilience demonstrate Composite Reliability and Cronbach's Alpha values exceeding the minimum threshold of 0.60. These findings suggest that all constructs meet the recommended reliability criteria and exhibit satisfactory internal consistency. In the context of PLS-SEM, Composite Reliability is considered a more robust indicator of internal consistency compared to Cronbach's Alpha, as it does not assume equal indicator loadings. The fact that both reliability measures surpass the acceptable threshold indicates that the measurement instrument consistently captures the intended constructs without significant measurement error. Therefore, it can be concluded that all constructs in this study are reliable and suitable for further evaluation in the structural model analysis.

Table 4. Reliability Test

Variabel	Cronbach's Alpha	Composite Reliability	Decision
Green Innovation Strategy	0.724	0.829	Reliable
Green Logistics Management Practices	0.717	0.840	
Structural Supply Chain Complexity	0.745	0.851	
Dynamic Supply Chain Complexity	0.783	0.859	
Supply Chain Resilience	0.905	0.925	

Source: Data is processed with SmartPLS4, 2025

The results of the reliability assessment indicate that all research variables Green Innovation Strategy, Green Logistics Management Practices, Structural Supply Chain Complexity, Dynamic Supply Chain Complexity, and Supply Chain Resilience exhibit Composite Reliability and Cronbach's Alpha values above the minimum threshold of 0.60. This finding confirms that all constructs meet the acceptable reliability criteria and demonstrate adequate internal consistency. In PLS-SEM analysis, Cronbach's Alpha evaluates the lower bound of internal consistency, while Composite Reliability provides a more precise estimation because it accounts for the actual outer loadings of the indicators. The fact that both reliability coefficients exceed the

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recommended threshold indicates that the measurement items consistently represent their respective latent constructs and that the instrument produces stable and dependable measurements. Therefore, all constructs in this study are considered reliable and appropriate for subsequent structural model analysis.

4.2. Goodness of Fit

Table 5. Goodness of Fit

	Saturated Model	Estimated Model	Decision
SRMR	< 0.10	0.999	Good Fit
d_ULS	> 2.00	2.275	Good Fit
d_G	> 0.90	0.815	Poor Fit
NFI	> 0.90	855.424	Poor Fit
Chi-square	Expected to be Small	0.630	Good Fit

Source: Data is processed with SmartPLS4, 2025

The Goodness of Fit assessment indicates that the proposed research model meets acceptable fit criteria. The SRMR value of 0.099 is below the recommended maximum threshold of 0.10, suggesting an adequate level of model fit between the estimated model and the empirical data. In PLS-SEM, SRMR is commonly used as the primary model fit index, as it reflects the average magnitude of discrepancies between the observed and predicted correlations. Therefore, the obtained SRMR value indicates that the model demonstrates an acceptable approximation to the data. In addition, the d_ULS value of 2.275 suggests a reasonably good model fit based on the unweighted least squares discrepancy measure. Although the d_G value (0.815) and the NFI value (0.855) have not reached the ideal thresholds typically recommended in covariance-based SEM, these indices still indicate a moderate level of model adequacy. It is important to note that in PLS-SEM, overall model fit indices are considered complementary rather than decisive criteria. As emphasized by (Hair et al., 2019) the primary evaluation of PLS-SEM focuses on the measurement and structural models rather than global fit statistics. Therefore, given that the SRMR criterion is satisfied and other indices show acceptable levels, the model can be considered to have an acceptable fit and is appropriate for proceeding to structural model evaluation and hypothesis testing.

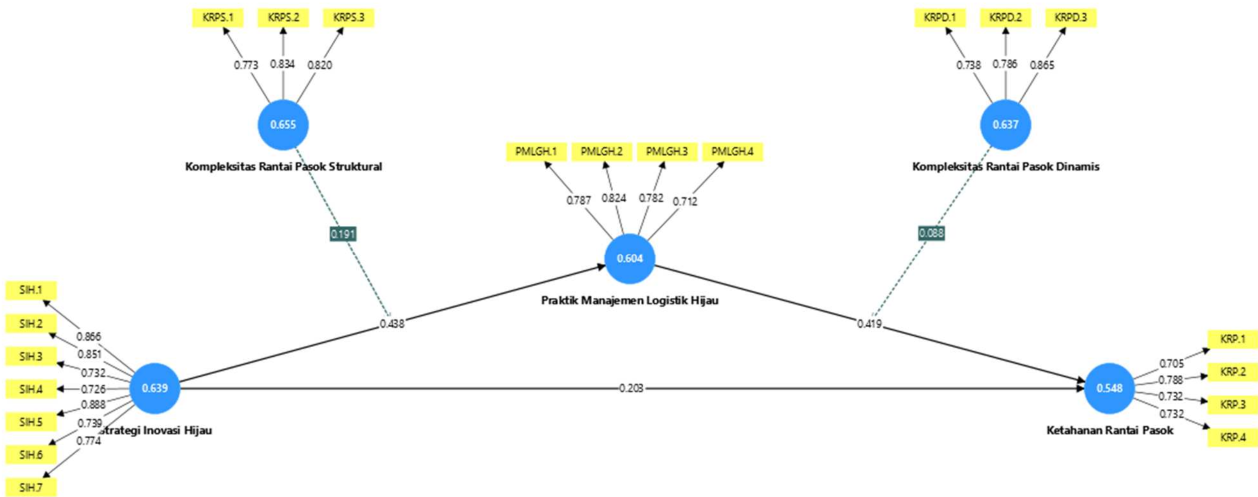

Figure 2. Output
(Sources: SmartPLS4 Output, 2025)

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4.3. Hypothesis Test

Table 6. Hypothesis Test

Hypothesis	Original Sample (O)	T Statistic	P Value	Decision
H1: Green Innovation Strategy has a positive effect on Supply Chain Resilience	0.203	2.791	0.003	hypothesis is supported
H2: Green Innovation Strategy has a positive effect on Green Logistics Management Practices	0.438	7.005	0.000	
H3: Green Logistics Management Practices have a positive effect on Supply Chain Resilience	0.419	5.637	0.000	
H4: Green Logistics Management Practices Mediate the Effect between Green Innovation Strategy and Supply Chain Resilience	0.183	4.418	0.000	
H5: Structural Supply Chain Complexity Moderates the Effect between Green Innovation Strategy and Green Logistics Management Practices	0.191	3.160	0.002	
H6: Dynamic Supply Chain Complexity Moderates the Effect between Green Logistics Management Practices and Supply Chain Resilience	0.088	2.244	0.025	

Source: Data is processed with SmartPLS4, 2025

Hypothesis 1 examines the effect of Green Innovation Strategy on Supply Chain Resilience. The results indicate that Green Innovation Strategy has a positive effect on Supply Chain Resilience, suggesting that environmentally oriented innovations enhance a firm's ability to respond to, control, and recover from supply chain disruptions. These findings are consistent with (Issa et al., 2024), who emphasize that green innovation improves supply chain preparedness and flexibility in uncertain environments. Similar results are reported by (Mehta et al., 2019) and (Zainurrafiqi et al., 2024), who highlight that green innovation strengthens adaptive capacity and coordination within the supply chain, thereby enhancing resilience. Hypothesis 2 examines the effect of Green Innovation Strategy on Green Logistics Management Practices. The results show that Green Innovation Strategy positively influences Green Logistics Management Practices. This finding indicates that green innovation strategies encourage adjustments in logistics activities toward more efficient and environmentally friendly practices. These results are in line with (Issa et al., 2024) and (Feng et al., 2022), who argue that green innovation serves as a key driver of green logistics implementation within organizational operational systems.

Hypothesis 3 examines the effect of Green Logistics Management Practices on Supply Chain Resilience. The findings reveal that Green Logistics Management Practices have a positive effect on Supply Chain Resilience. This suggests that the implementation of green logistics enhances supply chain flexibility and recovery capability when facing disruptions. The results are consistent with (Issa et al., 2024) and (Wan et al., 2023), who highlight the role of green logistics practices in strengthening supply chain resilience. Similar evidence is provided by (Dubey et al., 2018), who argue that green logistics capabilities significantly contribute to resilience, particularly under conditions of environmental uncertainty and supply risk. Hypothesis 4 examines the mediating role of Green Logistics Management Practices in the relationship between Green Innovation Strategy and Supply Chain Resilience. The results indicate that Green Logistics Management Practices act as a mediating variable. This finding suggests that green innovation strategies exert a stronger impact on supply chain resilience when implemented through sustainable logistics practices. These results are aligned with (Issa et al., 2024) and (Wan et al., 2023), who confirm that green logistics serves as a key linking mechanism between green innovation and supply chain resilience.

Hypothesis 5 examines the moderating role of Structural Supply Chain Complexity in the relationship between Green Innovation Strategy and Green Logistics Management Practices. The findings show that Structural Supply Chain Complexity functions as a moderating variable. This indicates that the level of structural complexity within the supply chain influences the strength of the relationship between green

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innovation strategy and the implementation of green logistics practices. These results are consistent with (Issa et al., 2024), (Wang & Zhang., 2023), and (Zhaolei et al., 2023). Hypothesis 6 examines the moderating role of Dynamic Supply Chain Complexity in the relationship between Green Logistics Management Practices and Supply Chain Resilience. The results indicate that Dynamic Supply Chain Complexity serves as a moderating variable. This finding suggests that the effectiveness of green logistics practices in enhancing supply chain resilience is influenced by the level of demand volatility and operational uncertainty. These results are consistent with (Dahliani et al., 2023) and Issa et al. (2024), who emphasize the importance of supply chain dynamism as a contextual factor in strengthening resilience.

In the context of a tire cord fiber manufacturing company, the results demonstrate that Green Innovation Strategy positively affects Supply Chain Resilience, both directly and indirectly through Green Logistics Management Practices as a mediating variable. The implementation of green innovation encourages the strengthening of environmentally friendly logistics practices, which subsequently enhances the supply chain's ability to respond to and recover from operational disruptions. Moreover, Green Logistics Management Practices are found to have a direct effect on Supply Chain Resilience, reaffirming their role as an important operational mechanism in enhancing supply chain stability and flexibility. Structural Supply Chain Complexity moderates the relationship between Green Innovation Strategy and Green Logistics Management Practices, while Dynamic Supply Chain Complexity moderates the relationship between Green Logistics Management Practices and Supply Chain Resilience. These findings indicate that supply chain structure and dynamism shape the effectiveness of green strategies and practices. Therefore, improving supply chain resilience in the tire cord fiber manufacturing industry depends not only on the adoption of green innovation and practices but also on the company's ability to manage supply chain complexity in an integrated manner.

V. Conclusion

This study demonstrates that Green Innovation Strategy plays a significant role in enhancing Supply Chain Resilience, both directly and indirectly through Green Logistics Management Practices. The findings confirm that environmental strategies are not merely symbolic commitments but serve as strategic capabilities that strengthen operational adaptability and recovery capacity. Importantly, the results highlight that the impact of green innovation becomes more substantial when it is effectively translated into logistics practices, such as reverse logistics, emission reduction, resource efficiency, and integrated material flow management. Thus, the study underscores that the alignment between strategic intent and operational execution is essential in building resilient supply chains.

Furthermore, this study provides deeper theoretical insight by validating the mediating role of Green Logistics Management Practices and incorporating Structural and Dynamic Supply Chain Complexity as moderating factors. The findings reveal that the effectiveness of green innovation strategies is contingent upon supply chain characteristics, where structural complexity influences the transformation of strategy into operational practices, and dynamic complexity shapes the strength of the relationship between logistics practices and resilience outcomes. These results extend the contingency perspective by demonstrating that resilience-building mechanisms are context-dependent and influenced by both internal configurations and external environmental dynamism.

From a practical perspective, the study emphasizes that building supply chain resilience in the manufacturing sector requires an integrated approach that combines environmental strategy, operational excellence, and effective complexity management. Managers are encouraged to position green innovation as a core strategic capability, ensure its implementation through consistent logistics practices, and proactively manage both structural and dynamic complexity within the supply chain. Ultimately, firms that successfully integrate these dimensions are better equipped to maintain operational continuity, enhance adaptability, and sustain competitive advantage in increasingly complex and uncertain environments.

References

Aghajan-Eshkevari, S., Azad, S., Nazari-Heris, M., Ameli, M. T., & Asadi, S. (2022). Charging and Discharging of Electric Vehicles in Power Systems: An Updated and Detailed Review of Methods, Control Structures, Objectives, and Optimization Methodologies. In Sustainability (Switzerland) (Vol. 14, Number 4). MDPI. https://doi.org/10.3390/su14042137

Akubia, G. K., & Andriana, D. (2024). Green Logistics Management Practices and Sustainability Performance of Manufacturing Firms in Ghana and Indonesia: The Moderating Role of Cross-Country ICT Development Status (pp. 411–417). https://doi.org/10.2991/978-94-6463-443-3_54

Atieh Ali, A. A., Sharabati, A. A. A., Allahham, M., & Nasereddin, A. Y. (2024). The Relationship between Supply Chain Resilience and Digital Supply Chain and the Impact on Sustainability: Supply Chain Dynamism as a Moderator. Sustainability (Switzerland) , 16(7). https://doi.org/10.3390/su16073082

Dahliani, L., Purnomo, B. L., Pattisahusiwa, S., Aryasari, D., Ilahi, N. A. S., Wursan, W., Yenny, S. R., & Rochmawati, N. I. (2023). Performance of green supply chain management: Investigating the role of reverse logistics and green procurement aspects in SMEs. Uncertain Supply Chain Management, 11(3), 867–874. https://doi.org/10.5267/j.uscm.2023.5.012

Dhillon, M. K., Rafi-Ul-Shan, P. M., Amar, H., Sher, F., & Ahmed, S. (2023). Flexible Green Supply Chain Management in Emerging Economies: A Systematic Literature Review. Global Journal of Flexible Systems Management, 24(1), 1–28. https://doi.org/10.1007/s40171-022-00321-0

Dubey, R., Gunasekaran, A., Bryde, D. J., Blome, C., Papadopoulos, T., & Luo, Z. (2018). Supply chain agility, adaptability, and alignment: Empirical evidence from the Indian auto components industry. International Journal of Operations & Production Management, 38(1), 129–148. https://doi.org/10.1108/IJOPM-02-2016-0065

Feng, Y., Lai, K. hung, & Zhu, Q. (2022). Green supply chain innovation: Emergence, adoption, and challenges. International Journal of Production Economics, 248, 108497. https://doi.org/10.1016/J.IJPE.2022.108497

Fernández Campos, P., Huaccho Huatuco, L., & Trucco, P. (2024). Framing the interplay mechanisms between structural and dynamic complexity in supply chains. Production Planning and Control, 35(6), 599–617. https://doi.org/10.1080/09537287.2022.2114959

Galán, G., Martín, M., & Grossmann, I. E. (2023). Systematic comparison of natural and engineering methods of capturing CO2 from the air and its utilization. Sustainable Production and Consumption, 37, 78–95. https://doi.org/10.1016/J.SPC.2023.02.011

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). MULTIVARIATE DATA ANALYSIS EIGHTH EDITION. www.cengage.com/highered

Herold, D. M., & Marzantowicz, Ł. (2023). Supply chain responses to global disruptions and its ripple effects: an institutional complexity perspective. Operations Management Research, 16(4), 2213–2224. https://doi.org/10.1007/s12063-023-00404-w

Hosseini Shekarabi, S. A., Kiani Mavi, R., & Romero Macau, F. (2025). Supply Chain Resilience: A Critical Review of Risk Mitigation, Robust Optimisation, and Technological Solutions and Future Research Directions. In Global Journal of Flexible Systems Management (Vol. 26, Number 3, pp. 681–735). Springer. https://doi.org/10.1007/s40171-025-00458-8

Issa, A., Khadem, A., Alzubi, A., & Berberoğlu, A. (2024). The Path from Green Innovation to Supply Chain Resilience: Do Structural and Dynamic Supply Chain Complexity Matter? Sustainability (Switzerland) , 16(9). https://doi.org/10.3390/su16093762

Li, J., & Zhu, C. (2025). Can Green Supply Chain Management Improve Supply Chain Resilience? A Quasi-Natural Experiment from China. Sustainability (Switzerland), 17(16). https://doi.org/10.3390/su17167481

Lyutov, A., Uygun, Y., & Hütt, M. T. (2022). Local topological features of robust supply networks. Applied Network Science, 7(1). https://doi.org/10.1007/s41109-022-00470-2

ISSN [Online]: 2776-6411

Mehta, S., Sharma, S., & Bhattacharya, R. (2019). Impact of green innovation on supply chain performance: The role of supply chain collaboration, absorptive capacity, and institutional pressures. Journal of Cleaner Production, 230, 1048–1061. https://doi.org/10.1016/j.jclepro.2019.05.334

Metwally, A. B. M., Ali, H. A. A., Aly, S. A. S., & Ali, M. A. S. (2024). The Interplay between Digital Technologies, Supply Chain Resilience, Robustness and Sustainable Environmental Performance: Does Supply Chain Complexity Matter? Sustainability (Switzerland), 16(14). https://doi.org/10.3390/su16146175

Sekaran, Uma., & Bougie, R. (2016). Research Methods for Business: A Skill-Building Approach (7th Ed). United Kingdom: Wiley.

Tahir, H., Khan, M. B., Shafiq, N., Radu, D., Nyarko, M. H., Waqar, A., Almujibah, H. R., & Benjeddou, O. (2023). Optimisation of Mechanical Characteristics of Alkali-Resistant Glass Fibre Concrete towards Sustainable Construction. Sustainability (Switzerland), 15(14). https://doi.org/10.3390/su151411147

Wan, M., Shukla, N., Li, J., & Pradhan, B. (2023). Data-driven approaches to sustainable referral system design integrating the offline channel and the online channel. Journal of Cleaner Production, 414, 137691. https://doi.org/10.1016/J.JCLEPRO.2023.137691

Wang, M., & Liu, Z. (2022). How Do Green Innovation Strategies Contribute to Firm Performance Under Supply Chain Risk? Evidence From China's Manufacturing Sector. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.894766

Wang, M., & Zhang, G. (2023). What motivates firms to adopt a green supply chain and how much does it matter? Frontiers in Environmental Science, 11. https://doi.org/10.3389/fenvs.2023.1227008

Widowati, D., Darasih, R., & Ramadhani, N. (2022, January 21). Mediation Role of Service Capabilities in Supply Chain Integration on Supply Chain Performance in Small and Medium Enterprises. https://doi.org/10.4108/eai.3-8-2021.2315161

Zhaolei, L., Nazir, S., Hussain, I., Mehmood, S., & Nazir, Z. (2023). Exploration of the impact of green supply chain management practices on manufacturing firms' performance through a mediated-moderated model. Frontiers in Environmental Science, 11. https://doi.org/10.3389/fenvs.2023.1291688

Zainurrafiqi, Z., & Gazali, G. (2024). Supply Chain Digitalization, Green Supply Chain, Supply Chain Resilience Toward Competitiveness and MSMEs Performance. Jurnal Aplikasi Manajemen, 22(1), 175–192. https://doi.org/10.21776/ub.jam.2024.022.01.14