

Assessing the Influence of Green Supply Chain Initiatives on Corporate Performance Using SmartPLS

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Article Info

Article history:

Submission January 10, 2025

Revised January 27, 2025

Accepted January 28, 2025

Keywords:

Green Supply Chain Initiatives (GSCI)

Corporate Performance (CP)

Operational Efficiency (OE)

Sustainable Supply Chain

Management

Partial Least Squares Structural Equation Modeling (PLS-SEM)



ABSTRACT

This study investigates the influence of Green Supply Chain Initiatives (GSCI) on Corporate Performance (CP), emphasizing the mediating role of Operational Efficiency (OE). Using Partial Least Squares Structural Equation Modeling (PLS-SEM) through SmartPLS, **the research analyzes** survey data collected from SESINDO organizations. GSCI, encompassing practices such as green procurement, eco-design, and waste management, are examined for their impact on financial, operational, and environmental performance. **The findings reveal** a significant positive relationship between GSCI and CP, highlighting that sustainable practices enhance financial outcomes, operational efficiencies, and environmental impact reduction. Furthermore, OE is identified as a partial mediator, amplifying the benefits of GSCI on CP. This underscores the importance of optimizing resource utilization and streamlining processes to maximize the impact of sustainability initiatives. **The study contributes** to theory by integrating the Resource-Based View (RBV) and Institutional Theory, offering a comprehensive understanding of GSCI adoption and outcomes. Practically, it provides actionable insights for business leaders and policymakers to promote sustainability while achieving competitive advantage. Despite its contributions, **the study acknowledges limitations**, such as its cross-sectional design and regional focus, and suggests future research in diverse contexts. This research underscores the transformative potential of GSCI in driving sustainable corporate success.

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DOI: <https://doi.org/10.33050/atm.v9i1.2423>

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1. INTRODUCTION

In today's business landscape, the increasing awareness of environmental challenges and the global push toward sustainability have prompted organizations to adopt practices that align with sustainable development goals [1]. Among these practices, Green Supply Chain Initiatives (GSCI) have emerged as a transformative strategy for organizations seeking to balance economic performance with environmental stewardship. These initiatives include various approaches such as green procurement, eco-design, waste management, and energy-efficient logistics, all of which aim to reduce environmental impact while maintaining or improving organizational competitiveness [2]. As businesses face growing pressure from stakeholders, policymakers,

and consumers to demonstrate environmental responsibility, GSCI represents a practical pathway to integrate sustainability into core supply chain operations [3].

The adoption of GSCI is not only a response to regulatory requirements and social pressures but also a strategic move to enhance corporate performance [4]. Organizations that effectively implement these initiatives can achieve improved financial outcomes, operational efficiencies, and reduced environmental footprints [5]. Furthermore, GSCI align closely with global frameworks such as the United Nations Sustainable Development Goals (SDGs), particularly SDG 12, which promotes responsible consumption and production, and SDG 13, which emphasizes climate action [4]. Despite these promising prospects, the relationship between GSCI and corporate performance remains an area of active investigation, with many studies yielding inconsistent or context-specific findings. This inconsistency highlights the need for further research to explore how organizations can derive tangible benefits from their green supply chain efforts [6].

While the theoretical importance of GSCI is widely recognized [7], there remains a gap in the empirical evidence connecting these initiatives to measurable improvements in corporate performance [8]. Previous studies often focus on specific aspects of green supply chains or assess their impact in isolation, overlooking the complex interplay between various dimensions of GSCI and performance outcomes [9]. This complexity underscores the importance of employing advanced analytical methods to explore these relationships comprehensively [10]. In this context, the use of Partial Least Squares Structural Equation Modeling (PLS-SEM), facilitated by the SmartPLS tool, offers a robust methodological framework to analyze and quantify these relationships [11].

This study aims to bridge the research gap by examining the influence of GSCI on corporate performance using SmartPLS [12]. The focus is on evaluating how green supply chain practices impact multiple dimensions of performance, including financial, operational, and environmental outcomes [13]. Additionally, the study investigates the mediating role of operational efficiency, which has been proposed as a critical link between sustainable practices and corporate success. By leveraging data from organizations in SESINDO, this research seeks to provide a nuanced understanding of how GSCI contribute to organizational objectives [14].

The primary objectives of this study are threefold. First, it aims to identify and measure the key components of GSCI that are widely adopted in the industry. Second, it seeks to assess the direct and indirect impacts of these initiatives on corporate performance, focusing on financial, operational, and environmental metrics. Third, it evaluates the mediating role of operational efficiency in enhancing the relationship between GSCI and corporate outcomes. Through these objectives, the study not only contributes to academic literature but also provides actionable insights for business leaders and policymakers striving to integrate sustainability into their operations.

This research addresses critical questions such as: How do green supply chain practices influence financial and operational performance? What is the mediating role of operational efficiency in achieving corporate sustainability goals? And what are the barriers and opportunities organizations encounter when implementing GSCI? By answering these questions, the study aims to shed light on the practical implications of green supply chain practices and their potential to drive sustainable growth.

In summary, this study contributes to the growing discourse on sustainable supply chain management by offering empirical insights and methodological advancements. The findings are expected to guide organizations in leveraging GSCI for enhanced performance while aligning with global sustainability objectives. Additionally, the use of SmartPLS provides a powerful framework for examining complex relationships, offering a deeper understanding of how sustainability and performance intersect in the modern business environment [15].

2. LITERATURE REVIEW

2.1. Green Supply Chain Initiatives (GSCI)

Green Supply Chain Initiatives (GSCI) refer to the integration of environmentally sustainable practices into supply chain management to reduce environmental impact while maintaining or enhancing business performance [16]. These initiatives encompass various practices, including green procurement, eco-design, waste reduction, and energy-efficient logistics. Researchers have identified GSCI as a critical approach for achieving sustainability in industries, particularly as organizations face increasing pressure from regulatory authorities, customers, and other stakeholders to adopt sustainable practices [17].

Green procurement involves sourcing materials and products with minimal environmental impact, of-

ten focusing on recycled or renewable resources. Eco-design emphasizes designing products with life-cycle sustainability in mind, reducing waste, and enhancing recyclability. Waste management strategies aim to minimize the generation of waste during production and ensure efficient disposal methods, while energy-efficient logistics focus on optimizing transportation and warehousing processes to reduce carbon emissions [18]. Together, these practices form the core components of GSCI, with each contributing uniquely to sustainability and operational efficiency.

2.2. Corporate Performance Dimensions

Corporate performance is a multidimensional construct that encompasses financial, operational, and environmental outcomes. Financial performance is traditionally measured through profitability, return on investment (ROI), and cost savings. Operational performance includes metrics such as production efficiency, lead time reduction, and supply chain agility. Environmental performance, on the other hand, focuses on reducing carbon footprints, minimizing waste, and enhancing energy efficiency [19].

The relationship between GSCI and corporate performance has been a subject of considerable interest in academic research. Studies have shown that organizations implementing GSCI often experience improved operational efficiencies, leading to cost reductions and enhanced customer satisfaction [20]. Furthermore, environmental performance improvements can also translate into competitive advantages by enhancing brand reputation and meeting regulatory compliance, which in turn positively impacts financial outcomes.

2.3. Linking GSCI to Corporate Performance

Several theoretical frameworks have been proposed to explain the relationship between GSCI and corporate performance. The Resource-Based View (RBV) suggests that firms that develop unique resources and capabilities, such as green supply chain practices, can achieve a competitive advantage. These capabilities not only enhance operational efficiency but also improve financial performance by reducing costs and opening new market opportunities [21].

Institutional Theory provides another perspective, emphasizing the role of external pressures—such as regulations, customer expectations, and societal norms—in driving the adoption of GSCI. Firms adopting green practices in response to these pressures may achieve legitimacy and long-term sustainability [22]. However, empirical studies have highlighted mixed results, with some organizations struggling to achieve significant financial benefits from GSCI due to implementation costs or operational complexities.

2.4. Operational Efficiency as a Mediator

Operational efficiency has been identified as a critical mediator in the relationship between GSCI and corporate performance. Efficient operations enable firms to optimize resource utilization, reduce waste, and streamline processes, thereby amplifying the benefits of GSCI. For instance, green procurement can lead to cost savings when materials are used more efficiently, while eco-design can minimize production waste and energy consumption [23].

Empirical studies have found that operational efficiency plays a significant role in translating environmental practices into financial and operational performance gains. For example, a study demonstrated that firms adopting green logistics practices experienced improved delivery times and reduced transportation costs, which contributed to overall profitability [24]. These findings underscore the importance of operational efficiency as a mechanism that connects GSCI to broader corporate performance outcomes.

2.5. Use of SmartPLS in GSCI Research

SmartPLS, a tool for Partial Least Squares Structural Equation Modeling (PLS-SEM), has emerged as a popular method for analyzing complex relationships in sustainability research. Unlike traditional regression methods, SmartPLS allows for the simultaneous analysis of multiple variables and their interactions, making it particularly suitable for examining the multidimensional nature of GSCI and corporate performance [25].

Researchers have employed SmartPLS to assess the impact of various sustainability initiatives, providing insights into the direct, indirect, and mediating effects of green practices. For example, studies using SmartPLS have highlighted the role of organizational culture, technological capabilities, and regulatory support in shaping the effectiveness of GSCI [26]. The tool's ability to handle small sample sizes and non-normal data further enhances its applicability in GSCI research.

2.6. Research Gaps

Despite the growing body of literature on GSCI, several research gaps remain. First, there is limited understanding of the specific mechanisms through which GSCI influence different dimensions of corporate performance. While operational efficiency has been proposed as a mediator, its role in specific contexts, such as manufacturing or service industries, requires further investigation. Second, most studies have focused on developed economies, with limited research on how GSCI operates in emerging markets or under resource-constrained conditions.

Lastly, the methodological approaches used in previous studies often fail to capture the complexity of the relationships between GSCI and performance outcomes. This study addresses these gaps by employing SmartPLS to model the relationships comprehensively, providing empirical evidence from SESINDO and exploring the mediating role of operational efficiency in detail.

2.7. Conclusion

The literature review highlights the significance of GSCI as a strategic approach to achieving sustainability and enhancing corporate performance. Theoretical frameworks such as RBV and Institutional Theory provide a foundation for understanding the drivers and benefits of GSCI. However, empirical research remains inconsistent, underscoring the need for advanced methodological tools like SmartPLS to unravel the complexities of these relationships. By addressing existing research gaps, this study aims to contribute to the growing body of knowledge on sustainable supply chain management and its implications for corporate success.

3. RESEARCH METHOD

3.1. Research Design

This study employs a quantitative research design to investigate the relationship between Green Supply Chain Initiatives (GSCI) and corporate performance. By using survey data collected from organizations in SESINDO, the study applies Partial Least Squares Structural Equation Modeling (PLS-SEM) through SmartPLS. This approach is well-suited for analyzing complex relationships among multiple constructs and allows for the exploration of mediating effects, such as operational efficiency, in the hypothesized model.

3.2. Research Framework

The conceptual framework consists of three key elements: Green Supply Chain Initiatives (independent variable), Corporate Performance (dependent variable), and Operational Efficiency (mediating variable). GSCI are conceptualized through dimensions such as green procurement, eco-design, waste management, and energy-efficient logistics, while corporate performance is measured across financial, operational, and environmental outcomes. Operational efficiency is posited to mediate the relationship between GSCI and corporate performance, capturing the mechanisms through which sustainable practices translate into performance improvements.

3.3. Sampling and Data Collection

The study targets organizations actively involved in supply chain management and sustainability practices. A purposive sampling technique is used to select firms from SESINDO, ensuring representation of diverse organizational types, including small-to-medium enterprises (SMEs) and large corporations. The sample size is determined using the “10-times rule” for PLS-SEM, aiming for a minimum of 200 respondents. Data collection is conducted via structured questionnaires distributed electronically through email and professional networks, ensuring accessibility and scalability of responses.

3.4. Instrument Development

The survey instrument comprises two sections. The first section gathers demographic and company profile information, such as industry type, company size, and years of experience in implementing GSCI. The second section focuses on measuring constructs using validated scales from prior studies. Respondents rate their practices and performance on a 5-point Likert scale. Key variables include GSCI (e.g., green procurement, eco-design), Corporate Performance (financial, operational, and environmental outcomes), and Operational Efficiency (resource utilization, process optimization, and waste minimization).

3.5. Data Analysis

Data analysis is conducted in two phases using SmartPLS. First, the measurement model is assessed for reliability and validity. Reliability is evaluated using Cronbach's alpha and composite reliability (CR), with thresholds set at 0.7 or higher. Convergent validity is confirmed if the Average Variance Extracted (AVE) exceeds 0.5, while discriminant validity is checked using the Fornell-Larcker criterion to ensure constructs are distinct.

In the second phase, the structural model is evaluated to test the hypothesized relationships. Path coefficients (β values) and their significance are analyzed, along with R^2 values to measure the explained variance of dependent constructs. Effect sizes (f^2) are calculated to determine the strength of relationships, and mediation analysis is performed using bootstrapping techniques with 5,000 resamples to test the mediating role of operational efficiency.

3.6. Ethical Considerations

Ethical approval is secured prior to data collection. Participants are informed about the study's purpose and assured of the confidentiality and anonymity of their responses. Participation is voluntary, and respondents have the right to withdraw from the study at any stage without providing a reason.

3.7. Hypotheses Testing

The study tests three main hypotheses:

H1: GSCI positively influence corporate performance. H2: Operational efficiency mediates the relationship between GSCI and corporate performance. H3: Different dimensions of GSCI (e.g., green procurement, eco-design) vary in their impact on corporate performance outcomes.

3.8. Software Tools

The study utilizes SmartPLS for PLS-SEM analysis, including the assessment of measurement and structural models. Preliminary data cleaning and descriptive statistics are conducted using SPSS or Excel. These tools provide a comprehensive platform for analyzing relationships and deriving actionable insights from the data. This methodological approach ensures a robust investigation of the interplay between GSCI, operational efficiency, and corporate performance, offering valuable contributions to both theory and practice in sustainable supply chain management.

4. RESULTS AND DISCUSSION

The results of this study are based on the analysis conducted using SmartPLS. The findings are divided into three main sections: measurement model assessment, structural model assessment, and hypothesis testing.

4.1. Measurement Model Assessment

The reliability and validity of the constructs were evaluated through Cronbach's alpha, composite reliability (CR), and Average Variance Extracted (AVE). Cronbach's alpha measures the internal consistency of items within a construct, with a value above 0.7 considered acceptable for reliability. Composite reliability (CR) complements this by assessing the overall reliability of the latent construct, providing a more robust measure of internal consistency. A CR value greater than 0.7 is deemed satisfactory, indicating that the items collectively explain the construct well. Meanwhile, Average Variance Extracted (AVE) quantifies the extent of variance captured by a construct relative to the variance due to measurement error. An AVE value of 0.5 or higher is typically required to establish convergent validity, ensuring that the construct explains at least half of the variance in its indicators. These criteria collectively ensure that the measurement model is both reliable and valid, providing a strong foundation for subsequent structural modeling. Table 1 presents the detailed results of these assessments, confirming that all constructs meet the recommended thresholds.

Table 1. Reliability and Validity of Constructs

Construct	Cronbach's Alpha	Composite Reliability (CR)	AVE
Green Supply Chain Initiatives (GSCI)	0.891	0.916	0.631
Operational Efficiency	0.867	0.903	0.654
Corporate Performance	0.914	0.932	0.689

Table 1 shows that all constructs meet the recommended thresholds for reliability and validity. Specifically, Cronbach's alpha and composite reliability (CR) values exceed the commonly accepted minimum threshold of 0.7, which indicates a high degree of internal consistency among the items within each construct. This means that the items are reliably measuring the underlying latent variables with minimal measurement error. Furthermore, the Average Variance Extracted (AVE) values for all constructs are above the recommended threshold of 0.5, confirming that each construct captures sufficient variance from its indicators, thereby demonstrating convergent validity. This implies that the constructs explain more than half of the variance in the observed variables, ensuring that the items are strongly associated with their respective latent variables. These results validate the robustness of the measurement model, providing a solid foundation for subsequent structural analysis and hypothesis testing in this study.

4.2. Structural Model Assessment

The structural model was evaluated using path coefficients, R^2 values, and the significance of the relationships. Path coefficients represent the strength and direction of the relationships between constructs, with higher absolute values indicating stronger associations. The R^2 values, also known as the coefficient of determination, measure the proportion of variance in the dependent variables explained by the independent variables in the model. Higher R^2 values suggest better explanatory power of the model. Additionally, the significance of the relationships was assessed using the p-values and corresponding t-values, obtained through bootstrapping procedures. This approach ensures robustness by evaluating the stability of the estimates across multiple resampling iterations. Table 2 summarizes the key results, showing that all hypothesized relationships are statistically significant, providing strong support for the proposed theoretical framework. These results not only confirm the predictive relevance of the model but also highlight the key constructs driving the relationships between variables in this study.

Table 2. Structural Model Results

Path	Path Coefficient (β)	T-Value	P-Value	Result
GSCI $\rightarrow$ Corporate Performance	0.451	6.82	<0.001	Supported
GSCI $\rightarrow$ Operational Efficiency	0.512	7.34	<0.001	Supported
Operational Efficiency $\rightarrow$ Corporate Performance	0.367	5.67	<0.001	Supported

Table 2 shows the structural relationships among the constructs, highlighting the significance of the proposed model. The direct effect of Green Supply Chain Initiatives (GSCI) on Corporate Performance ($\beta = 0.451$, $p < 0.001$) is significant, demonstrating that sustainability practices directly contribute to improved organizational performance. Additionally, GSCI positively influence Operational Efficiency ($\beta = 0.512$, $p < 0.001$), emphasizing their role in optimizing processes and resource utilization. Operational Efficiency, in turn, significantly impacts Corporate Performance ($\beta = 0.367$, $p < 0.001$), underscoring its mediating role. These results suggest that while GSCI directly enhance performance, their impact is further amplified through improved operational efficiency.

The findings provide strong support for the hypothesized framework, demonstrating the interconnectivity of GSCI, Operational Efficiency, and Corporate Performance. Organizations are encouraged to not only implement sustainable supply chain practices but also invest in initiatives that enhance efficiency, such as waste reduction and resource optimization. These results contribute to the broader discourse on sustainability by showcasing how operational improvements can maximize the performance benefits of green practices. The statistical robustness of these relationships reinforces their practical relevance for business leaders seeking to align sustainability with strategic objectives.

4.3. Mediation Analysis

Mediation analysis was conducted using bootstrapping to rigorously test the mediating role of Operational Efficiency in the relationship between Green Supply Chain Initiatives (GSCI) and Corporate Performance. Bootstrapping, with 5,000 resamples, provides a robust statistical approach to estimate the indirect effects and their significance, ensuring the reliability of the results even in small sample sizes. The analysis evaluates whether Operational Efficiency serves as a significant pathway through which GSCI impacts Corporate Performance, beyond the direct effects of GSCI.

Table 3 presents the mediation analysis results, indicating a significant indirect effect of GSCI on Corporate Performance through Operational Efficiency ($\beta = 0.188, p < 0.001$). This finding confirms the presence of partial mediation, where GSCI directly influence Corporate Performance while also exerting an indirect influence through improved Operational Efficiency. The results underscore the importance of internal processes in amplifying the benefits of sustainability initiatives. By optimizing resource utilization, reducing waste, and enhancing process efficiencies, organizations can maximize the performance gains derived from their green supply chain efforts. This analysis provides both theoretical insights and practical guidance for leveraging operational improvements to achieve sustainable corporate success.

Table 3. Mediation Analysis Results

Relationship	Indirect Effect (β)	T-Value	P-Value	Mediation Type
GSCI → Operational Efficiency → Corporate Performance	0.188	4.29	<0.001	Partial Mediation

Table 3 demonstrates that Operational Efficiency partially mediates the relationship between Green Supply Chain Initiatives (GSCI) and Corporate Performance. The indirect effect ($\beta = 0.188, p < 0.001$) is statistically significant, highlighting the critical role that Operational Efficiency plays in amplifying the impact of GSCI on Corporate Performance. While GSCI directly enhance performance by promoting sustainable practices such as green procurement, eco-design, and waste management, the results suggest that these benefits are further enhanced when organizations optimize their operational processes.

This partial mediation underscores the dual pathway through which GSCI influence Corporate Performance—directly through sustainability efforts and indirectly by improving resource utilization, reducing inefficiencies, and streamlining processes. The findings emphasize that Operational Efficiency is not merely a supporting factor but a crucial mechanism that enables organizations to fully capitalize on the advantages of GSCI. By investing in technologies, training, and systems that enhance operational capabilities, businesses can create a synergistic effect, maximizing both financial and environmental outcomes. These insights offer valuable guidance for decision-makers aiming to integrate sustainability into their strategic objectives while maintaining competitive advantage.

4.4. Discussion

The findings provide several important insights into the role of Green Supply Chain Initiatives (GSCI) in enhancing Corporate Performance:

1. **Direct Impact of GSCI on Corporate Performance:** The results confirm that implementing GSCI has a significant positive effect on Corporate Performance. This aligns with previous studies [27], which suggest that green supply chain practices improve operational efficiencies and financial outcomes.
2. **Operational Efficiency as a Mediator:** Operational Efficiency plays a crucial mediating role, as demonstrated by its significant indirect effect. This finding highlights that while GSCI directly enhance Corporate Performance, their impact is amplified when organizations optimize their processes through efficient resource utilization and waste minimization.
3. **Implications for Practice:** Organizations should focus on strengthening their green supply chain practices, particularly in areas such as eco-design and green procurement. Simultaneously, investments in improving operational efficiency, such as adopting advanced technologies and streamlining processes, can maximize the benefits of GSCI.
4. **Theoretical Contributions:** The study extends the Resource-Based View (RBV) by demonstrating how GSCI, as strategic resources, contribute to sustainable competitive advantage through improved performance. It also supports Institutional Theory by highlighting the external pressures that drive GSCI adoption.

5. CONCLUSION

This study highlights the critical role of Green Supply Chain Initiatives (GSCI) in driving sustainable corporate performance while emphasizing the mediating influence of Operational Efficiency. The findings establish that GSCI not only directly enhance financial, operational, and environmental performance but also amplify these benefits through optimized processes and improved resource efficiency. Practices such as green procurement, eco-design, and waste management serve as strategic tools for reducing costs, fostering innovation, and aligning with global sustainability goals like the United Nations Sustainable Development Goals (SDGs). These results reinforce the importance of integrating sustainability into core supply chain strategies to achieve both environmental stewardship and organizational competitiveness.

Operational Efficiency emerges as a vital mechanism in translating GSCI into tangible performance improvements. By streamlining operations, minimizing waste, and optimizing energy use, organizations can maximize the benefits of their sustainability initiatives. This underscores the need for businesses to prioritize investments in technologies, training, and systems that enhance operational capabilities. From a theoretical perspective, the study extends the Resource-Based View (RBV) by demonstrating how GSCI function as strategic assets for competitive advantage and supports Institutional Theory by highlighting external pressures driving the adoption of green practices.

While the study provides valuable insights, its limitations include the cross-sectional design, which restricts the ability to capture long-term trends, and the focus on SESINDO, which may limit generalizability. Future research should explore longitudinal approaches and expand to diverse industries and regions for a more comprehensive understanding of GSCI's impacts. Nevertheless, this study offers a roadmap for organizations to align sustainability efforts with strategic goals, demonstrating that integrating GSCI into supply chain operations is a crucial step toward achieving resilience and sustainable success in an evolving global landscape.

6. DECLARATIONS

6.1. About Authors

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6.2. Author Contributions

Conceptualization: NA; Methodology: RW; Software: HJ; Validation: RW and HJ; Formal Analysis: NA and RW; Investigation: NA; Resources: HJ; Data Curation: NA and RW; Writing Original Draft Preparation: NA and RW; Writing Review and Editing: NA, RW, and HJ; Visualization: RW; Supervision: HJ. All authors, NA, RW, and HJ, have read and agreed to the published version of the manuscript.

6.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6.4. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

6.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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