

## GREEN SUPPLY CHAIN MANAGEMENT AND COMPETITIVE ADVANTAGE: MEDIATING ROLE OF OPERATIONAL EFFICIENCY AND MODERATING ROLE OF REGULATORY PRESSURE

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### Abstract

*The growing emphasis on environmental sustainability has compelled organizations to adopt green supply chain management (GSCM) practices as a strategic necessity rather than a regulatory obligation. This study examines the impact of green supply chain management on competitive advantage, with operational efficiency serving as a mediating variable and regulatory pressure as a moderating variable. Using a quantitative research design, data were collected from 260 professionals working in manufacturing and service-oriented organizations engaged in environmentally responsible practices. Structural Equation Modeling (SEM) was employed to analyze the proposed relationships. The findings reveal that GSCM significantly enhances competitive advantage by improving operational efficiency, reducing waste, and optimizing resource utilization. Operational efficiency partially mediates the relationship between GSCM and competitive advantage, indicating that environmental practices translate into superior performance through improved operational processes. Furthermore, regulatory pressure strengthens the relationship between GSCM and operational efficiency, suggesting that stricter environmental regulations encourage firms to adopt more effective green practices. The study contributes to sustainability and operations management literature by integrating environmental and strategic perspectives. Practically, the findings highlight the importance of aligning environmental initiatives with operational goals and regulatory requirements to achieve sustainable competitive advantage.*

**Keywords:** *Green Supply Chain Management, Competitive Advantage, Operational Efficiency, Regulatory Pressure.*

### Introduction

Environmental sustainability has become a critical concern for organizations due to increasing environmental degradation, climate change, and stakeholder pressure. Governments, consumers, and investors are increasingly demanding environmentally responsible business practices, prompting firms to integrate sustainability into their supply chain operations. Green Supply Chain Management (GSCM) refers to the incorporation of environmental considerations into supply chain activities, including sourcing, manufacturing, logistics, and product disposal.

Organizations are increasingly adopting GSCM practices not only to comply with regulations but also to gain a competitive advantage. Previous research suggests that environmentally responsible firms enjoy improved brand reputation, cost efficiency, and market performance. However, the link between GSCM and competitive advantage is not always direct. The effectiveness of green practices depends on how well they are integrated into operational processes and how organizations respond to external pressures.

Operational efficiency plays a crucial role in translating green initiatives into performance outcomes. By minimizing waste, optimizing resource utilization, and improving process efficiency, firms can achieve both environmental and economic benefits. Moreover, regulatory pressure significantly influences firms' environmental strategies. Stringent environmental regulations encourage organizations to adopt green practices proactively, while weak regulations may reduce motivation for sustainable initiatives.

Despite growing research on GSCM, limited empirical studies have examined the combined effects of operational efficiency and regulatory pressure on the relationship between GSCM and competitive advantage. This study addresses this gap by proposing an integrated model that examines operational efficiency as a mediator and regulatory pressure as a moderator. The findings provide valuable insights for managers and policymakers aiming to balance environmental responsibility with competitive performance.

## Literature Review

Green supply chain management involves the integration of environmental thinking into supply chain activities, including product design, material sourcing, manufacturing, distribution, and end-of-life management (Srivastava, 2007). GSCM has gained prominence as organizations seek to reduce environmental impact while maintaining economic viability. Studies suggest that firms adopting green practices experience improved environmental performance, reduced operational costs, and enhanced corporate image (Zhu & Sarkis, 2004).

Competitive advantage refers to an organization's ability to outperform competitors through cost leadership, differentiation, or superior operational capabilities. GSCM contributes to competitive advantage by reducing resource consumption, improving efficiency, and enhancing customer satisfaction. Firms adopting eco-friendly practices often benefit from improved brand reputation and long-term sustainability (Porter & van der Linde, 1995).

Operational efficiency plays a mediating role in the GSCM–performance relationship. Green practices such as waste reduction, energy efficiency, and lean operations lead to better utilization of resources and lower operational costs. According to the resource-based view, operational efficiency represents a valuable organizational capability that enhances firm competitiveness. Empirical studies confirm that operational efficiency mediates the effect of environmental practices on firm performance (Green et al., 2012).

Regulatory pressure is a critical external factor influencing environmental strategies. Government regulations, environmental standards, and compliance requirements compel firms to adopt green practices. Strong regulatory frameworks encourage firms to innovate and improve efficiency, whereas weak enforcement may reduce the incentive to adopt sustainable practices. Prior studies indicate that regulatory pressure moderates the relationship between environmental practices and performance by shaping organizational responses (Zhu et al., 2013).

Despite growing interest in GSCM, few studies have simultaneously examined operational efficiency as a mediator and regulatory pressure as a moderator. This study addresses this gap by proposing a comprehensive model that explains how GSCM leads to competitive advantage under varying regulatory conditions.

## Theoretical Framework

This study is grounded in **Resource-Based View (RBV)** and **Institutional Theory**.

- GSCM represents a strategic resource that enhances firm competitiveness.
- Operational efficiency acts as a dynamic capability through which GSCM influences performance.
- Regulatory pressure, derived from institutional theory, moderates the effectiveness of GSCM implementation.

## Proposed Relationships:

- GSCM → Competitive Advantage

- GSCM → Operational Efficiency → Competitive Advantage
- Regulatory Pressure moderates GSCM → Operational Efficiency

## Methodology

A quantitative research design was employed using a structured questionnaire. Data were collected from 260 respondents working in manufacturing and logistics firms engaged in environmental initiatives. Measurement scales were adapted from validated studies and assessed using a five-point Likert scale. SmartPLS 4 was used to analyze the data through Partial Least Squares Structural Equation Modeling (PLS-SEM). Reliability, convergent validity, mediation, and moderation effects were tested using bootstrapping with 5,000 resamples.

## Data Analysis and Results

**Table 1: Measurement Model Results**

Construct	Cronbach's Alpha	Composite Reliability	AVE
Green Supply Chain Management	0.90	0.93	0.69
Operational Efficiency	0.88	0.91	0.66
Regulatory Pressure	0.86	0.89	0.63
Competitive Advantage	0.91	0.94	0.72

The measurement model demonstrates strong reliability and validity. Cronbach's alpha and composite reliability values exceed the recommended threshold of 0.70, indicating internal consistency. The Average Variance Extracted (AVE) values are above 0.50, confirming convergent validity. These results indicate that the constructs are measured reliably and are suitable for structural model analysis. The strong psychometric properties ensure that the relationships tested in the model are based on valid and reliable measurements.

**Table 2: Structural Model Results**

Path	$\beta$	t-value	p-value	Result
GSCM → Competitive Advantage	0.39	6.58	<0.001	Supported
GSCM → Operational Efficiency	0.52	8.14	<0.001	Supported
Operational Efficiency → Competitive Advantage	0.41	6.03	<0.001	Supported

The structural model results indicate that green supply chain management has a significant positive effect on competitive advantage. GSCM also strongly influences operational efficiency, demonstrating that environmentally responsible practices enhance process effectiveness and resource utilization. Operational efficiency, in turn, significantly affects competitive advantage, confirming its role as a key performance driver. These findings support the argument that environmental initiatives improve firm competitiveness primarily through operational improvements.

**Table 3: Mediation Analysis**

Indirect Path	Effect	t-value	Result
GSCM → Operational Efficiency → Competitive Advantage	0.21	4.89	Supported

The mediation analysis confirms that operational efficiency partially mediates the relationship between GSCM and competitive advantage. This indicates that green practices enhance firm performance both directly and indirectly through improved operational efficiency. The results support the resource-based

view, which emphasizes the importance of internal capabilities in transforming environmental initiatives into competitive outcomes.

**Table 4: Moderation Analysis**

Interaction	$\beta$	t-value	p-value	Result
GSCM $\times$ Regulatory Pressure $\rightarrow$ Operational Efficiency	0.27	3.94	<0.001	Supported

The moderation results reveal that regulatory pressure significantly strengthens the relationship between GSCM and operational efficiency. This indicates that stricter environmental regulations motivate firms to implement green practices more effectively, leading to improved operational outcomes. Regulatory pressure thus plays a crucial role in enhancing the effectiveness of sustainability initiatives.

### Conclusion

This study examined the relationship between green supply chain management and competitive advantage, highlighting the mediating role of operational efficiency and the moderating role of regulatory pressure. The findings confirm that GSCM significantly enhances competitive advantage by improving operational efficiency. Moreover, regulatory pressure strengthens the effectiveness of green practices, encouraging firms to adopt more efficient and sustainable operations. The study contributes to sustainability and operations management literature by integrating internal and external factors into a unified framework. The results emphasize that environmental initiatives must be strategically aligned with operational goals to achieve sustained competitive advantage.

### Future Recommendations

Future studies should employ longitudinal designs to examine the long-term impact of green supply chain practices on firm performance. Additional moderators such as organizational culture, technological capability, and stakeholder pressure could be explored. Industry-specific analyses may provide deeper insights into sectoral differences. Practitioners should invest in green technologies, employee training, and compliance systems to strengthen operational efficiency. Policymakers should enhance regulatory frameworks and provide incentives to encourage sustainable business practices. Such initiatives will ensure that environmental sustainability and competitive advantage progress together.

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