



Green Supply Chain Practices and Their Role in Enhancing Cost Efficiency and Competitiveness

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Abstract

Supply chain management (SCM) has emerged as a crucial competitive strategy for organizations seeking to optimize their operations and improve market performance. Within this framework, the concept of green supply chain management (GSCM) has gained increasing importance, as it is seen as vital for fostering industrial ecosystems and promoting industrial ecology. By integrating environmentally sustainable practices into their supply chains, organizations not only comply with regulatory requirements but also pursue broader strategic objectives, such as enhancing their competitive advantage. There are several motivating factors behind the adoption of green supply chain policies. Some organizations implement these policies due to reactive regulatory pressures, ensuring compliance with environmental regulations and reducing their ecological footprint. However, others take a proactive approach, viewing GSCM as a key element in their long-term strategy to differentiate themselves from competitors, improve efficiency, and appeal to environmentally conscious consumers. By adopting GSCM, organizations can simultaneously meet sustainability goals and gain a competitive edge in an increasingly eco-conscious market. From both an environmental and organizational perspective, it is crucial to understand the complexities and challenges that exist in the field of green supply chain management (GSCM). Many organizations worldwide are facing increasing globalization and a shift towards competition among networks of companies, rather than just between individual firms. In this competitive landscape, multinational enterprises have established global supply networks, leveraging country- and industry-specific advantages to build and maintain their competitive edge. To successfully achieve this competitive advantage, logistics and supply chain managers must balance efforts to reduce costs and drive innovation while also ensuring strong environmental performance (Pagell et al., 2004). The growing importance of sustainability means that companies now compete not just through their own internal capabilities, but through the effectiveness of their supply chains. Managing a sustainable supply chain that meets environmental regulations and customer expectations, while simultaneously controlling costs, has become a key factor in maintaining competitive positioning. This study focuses on the relationship between Green Supply Chain Management (GSCM) practices and their impact on Transportation Cost Reduction (TCR). By examining how GSCM initiatives contribute to lowering transportation costs, the study sheds light on how sustainability efforts can support both environmental goals and cost efficiency, helping companies remain competitive in today's globalized market.

Keywords: Green Supply Chain Management, Transportation Cost Reduction, Sustainability

JEL Codes: L91, Q56, M11

1. INTRODUCTION

Global enterprises are continually striving to develop new, flexible, and innovative methods to boost their success and maintain a competitive edge. One key approach many organizations adopt to enhance their competitiveness is improving their environmental performance, not only to meet market demands but also to comply with increasingly stringent environmental laws and regulations (Bacallan, 2000). A central driver of compliance with these regulations is the growing concern among customers about the environmental impact of production and service activities. Consumers are becoming more aware of the ecological footprint of the products they purchase, and companies must respond to these concerns to maintain their market position. Additionally, the rising awareness within organizations of the potential costs associated with environmental pollution—whether through consumer complaints, costly cleanup efforts, or penalties for non-compliance—has prompted a more proactive stance on environmental management throughout their supply networks. These factors underscore the importance of integrating sustainability into supply chain practices, as failing to do so can lead to financial and reputational risks. In this context, enhancing green supply chain management (GSCM) practices becomes a vital strategy for organizations to mitigate risks, comply with environmental standards, and meet the evolving expectations of environmentally conscious consumers. In response to the growing demands of environmental laws and regulations, minimum environmental performance standards have become a common feature in the purchasing agreements of multinational corporations for both their local and global suppliers (Bowen et al., 2001a; Zhu and Sarkis, 2004). These standards are designed to ensure that suppliers adhere to specific environmental guidelines, helping multinational corporations align their entire supply chain with sustainability goals. By embedding these requirements into supplier contracts, companies not only comply with legal mandates but also reduce their environmental impact, improve efficiency, and address the increasing environmental concerns of consumers and stakeholders. This shift reflects a broader trend where corporations are taking proactive measures to ensure that their supply chains support sustainable business practices. Suppliers, in turn, are expected to meet these standards to maintain business relationships, fostering

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an industry-wide move towards greener supply chains. This approach mitigates environmental risks and enhances the company's reputation, contributing to long-term competitiveness in a market that increasingly values sustainability. This requirement has evolved into a new customer expectation for suppliers, compelling them to not only adhere to environmental standards but also to reduce costs, improve quality, and enhance service. Suppliers now face the challenge of balancing environmental responsibility with traditional business goals. To meet these expectations, suppliers must optimize their operations, adopt sustainable practices, and innovate in ways that allow them to maintain competitiveness while fulfilling their environmental obligations to customers. By doing so, suppliers can not only comply with legal requirements but also strengthen their relationships with customers who prioritize sustainability. This shift underscores the growing importance of green supply chain practices, where the need for eco-friendly operations is just as critical as cost, quality, and service. Ultimately, suppliers that successfully navigate these evolving expectations are better positioned to thrive in a market increasingly driven by environmental concerns and consumer demands for sustainability. Green supply chain management (GSCM) is widely regarded as having a significant impact on improving environmental performance, minimizing waste, and achieving cost savings. By incorporating sustainable practices into the supply chain, organizations can reduce their environmental footprint while simultaneously lowering operational costs associated with waste and inefficiency. Additionally, GSCM fosters increased synergy among business partners by encouraging collaboration and alignment across the supply network. This synergy not only enhances operational efficiency but also strengthens relationships between companies and their suppliers, resulting in smoother processes and greater adaptability to market changes.

The positive outcomes of adopting GSCM extend beyond operational improvements. The enhanced sustainability practices are expected to improve a company's corporate image, giving it a reputation as an environmentally responsible organization. This, in turn, contributes to a stronger competitive advantage and broader marketing exposure, as more consumers and business partners prioritize working with companies that demonstrate a commitment to sustainability. Thus, GSCM not only benefits the environment and operational performance but also strengthens the brand and market position of companies that adopt it. However, for green supply chain management (GSCM) practices to be fully embraced by organizations in Turkey, there must be a clear and demonstrable link between these measures and tangible cost savings, particularly in transportation costs. As noted by Bowen et al. (2001), organizations are more likely to adopt GSCM practices if they can identify specific financial and operational benefits that result from these changes. This underscores the importance of demonstrating that GSCM not only contributes to environmental sustainability but also leads to measurable improvements in a company's bottom line. In particular, by showcasing how GSCM can optimize logistics and transportation, reduce waste, and improve efficiency, businesses can be motivated to integrate these practices as part of their overall strategy. Without this clear financial incentive, companies may be reluctant to invest in GSCM, even if they recognize its environmental benefits. Therefore, making the connection between GSCM and cost savings is crucial for widespread adoption in Turkey and beyond.

Thus, there is a clear research need to explore and establish the potential link between the structure of green supply chain management (GSCM) and its impact on effective transportation cost savings. Demonstrating this connection would provide a crucial incentive for enterprises to adopt and establish green supply chains more effectively. By identifying how GSCM strategies can lead to cost-efficient transportation and logistics operations, businesses would be more likely to invest in and accelerate their sustainability initiatives. This research could serve as a vital catalyst for encouraging widespread adoption of environmentally friendly practices, helping enterprises realize both financial benefits and competitive advantages while also contributing to environmental sustainability. Many enterprises in Turkey have made significant efforts to implement green supply chain management (GSCM) initiatives. However, there remains a shortage of studies that examine the specific relationship between cost reduction through GSCM, particularly with regard to its impact on Transportation Cost Reduction (TCR). Despite these efforts, the empirical link between GSCM practices and TCR has not been thoroughly tested. This paper addresses this gap by presenting the results of a survey conducted among organizations in Turkey. The study investigates the proposition that there is a significant relationship between GSCM initiatives and transportation cost savings. By exploring this connection, the paper aims to provide valuable insights into the financial benefits of GSCM, offering evidence that could encourage broader adoption of sustainable practices within supply chains.

2. LITERATURE REVIEW

From the purchasing perspective, which marks the beginning of the supply chain, the adoption of green supply chain management (GSCM) presents a host of benefits, ranging from cost reduction to the integration of suppliers in a participative decision-making process that fosters environmental innovation. Scholars such as Bowen et al. (2001), Hall (2003), and Rao (2002) have highlighted the value of GSCM in strengthening environmental sustainability while maintaining operational efficiency. In this context, companies are increasingly turning to green purchasing strategies, which represent a critical aspect of inbound logistics, as a way to respond to the global concern for environmental stability and sustainability. Green purchasing goes beyond traditional procurement processes by considering the environmental impact of the materials, components, and services acquired from suppliers. Companies implementing green purchasing are motivated by both regulatory requirements and the growing market demand for sustainable products. This approach has a multi-faceted impact, enhancing areas such as the adoption of environmentally friendly transportation, cost reduction, material substitution, and waste minimization, particularly with regard to hazardous materials.

One of the critical aspects of successfully implementing green purchasing is the active involvement and support of suppliers. Suppliers play a key role in ensuring that the materials and equipment they provide are not only cost-effective

but also environmentally responsible. As a result, companies are now more focused on managing their suppliers' environmental performance to ensure that the entire supply chain aligns with sustainable practices. This includes ensuring that the materials supplied are produced using environmentally friendly processes and meet sustainability standards. The process of integrating suppliers into an organization's environmental management system can be approached in two key steps, as suggested by Walton et al. (1998). The first step involves incorporating environmental considerations into strategic planning, enabling companies to meet regulatory requirements and address the increasing demand for environmental accountability from consumers, regulators, and stakeholders. This step also ensures that environmental factors become a core part of the company's long-term strategy, aligning environmental sustainability with business objectives.

The second step focuses on integrating suppliers into the supply chain with a view toward reducing operational costs and improving customer service. By working closely with suppliers, companies can ensure that environmentally friendly practices are implemented across the supply chain, leading to enhanced operational efficiency and cost savings. This integration also allows for better alignment between the environmental goals of the organization and its supply partners, fostering collaboration and innovation. In addition to the purchasing aspect, the production phase is also critical in ensuring environmental sustainability. The production process itself plays a significant role in maintaining the same quality standards while adopting environmentally friendly production practices. This includes implementing strategies such as pollution prevention at the source, adopting cleaner production techniques, and integrating closed-loop manufacturing or reverse logistics systems that maximize the reuse and recycling of materials. By adopting these practices, organizations not only reduce their environmental impact but also achieve significant operational improvements, such as lower material costs and reduced waste management expenses.

Companies are also focusing on reducing material usage and increasing the recyclable content of their products. This involves rethinking product design to incorporate design for the environment principles, which emphasize sustainability throughout the product lifecycle, from raw material extraction to end-of-life disposal. Additionally, optimizing production processes helps minimize the generation of hazardous and non-hazardous waste, reducing the overall environmental footprint of the organization. Moreover, the design of production facilities plays a crucial role in supporting GSCM initiatives. By adopting lean production principles, companies can design facilities that reduce energy consumption and minimize the movement of vehicles and materials within the plant. This not only contributes to cost savings but also reduces the environmental impact of manufacturing activities, making the entire production process more efficient and sustainable. Lean production is particularly effective in reducing energy use and emissions, further aligning the organization with its environmental goals. Additionally, incorporating green design in the construction of facilities, such as using energy-efficient systems, renewable energy sources, and sustainable building materials, further supports the company's commitment to sustainability. This focus on sustainability in facility design can also improve the corporate image, demonstrating to customers and stakeholders that the company is taking proactive steps toward environmental responsibility. The adoption of green supply chain management practices, from green purchasing to environmentally friendly production, provides companies with a range of benefits, including cost reductions, enhanced operational efficiency, and improved corporate social responsibility. As companies continue to face increased pressure from regulations and market demands for sustainable practices, the integration of GSCM will not only improve environmental performance but also lead to a competitive advantage in an increasingly eco-conscious market. By embedding sustainability into all aspects of the supply chain, companies can create synergies across business operations, suppliers, and customers, ultimately contributing to long-term business success and environmental stewardship. On the outbound side of the green supply chain, several initiatives such as reverse logistics, environment-friendly packaging, and eco-friendly distribution can significantly improve an organization's environmental performance and the sustainability of its overall supply chain. These strategies not only address the environmental concerns of logistics but also contribute to reducing costs and enhancing a company's competitiveness. Reverse logistics, in particular, which involves managing product returns, recycling, and the disposal of waste materials, plays a key role in minimizing environmental impact and creating opportunities for cost savings. Waste exchange, where one company's waste becomes another's resource, further promotes efficient waste management and enhances the circular economy within supply chains (Rao, 2003).

Many of these initiatives require compromises between different logistics functions, as organizations balance the demands of reverse logistics with environmental considerations to improve their overall green supply chain management (GSCM). For example, companies might need to adjust traditional logistics strategies to accommodate recycling, reusing materials, or minimizing waste, all of which can lead to operational efficiencies and cost reductions over time. In the context of eco-transportation systems, several parameters must be taken into account to reduce the environmental impact of transportation logistics. These include the type of transport used (e.g., road, rail, sea, or air), the fuel sources powering the vehicles (e.g., fossil fuels, biofuels, electric vehicles), the infrastructure supporting transport operations, and the operational practices of the transportation companies involved. Each of these factors, along with the organizational structure overseeing the logistics operations, plays a crucial role in determining the environmental impact generated during the transportation phase of the supply chain (Kam et al., 2003). By carefully managing these parameters, companies can develop sustainable transportation strategies that reduce fuel consumption, lower greenhouse gas emissions, and minimize their overall carbon footprint. This not only aligns with growing regulatory pressures for greener operations but also meets increasing consumer demand for sustainable products and practices. Implementing an eco-transportation system that prioritizes environmental sustainability can lead to long-term cost savings, improved brand reputation, and enhanced market competitiveness.

3. METHODOLOGY

To validate the model presented in the preceding section, regression analysis was employed to determine the causal relationships between several key factors: environmental transportation, the choice of suppliers based on environmental criteria, efforts to help suppliers establish their own environmental management system (EMS), the optimization of internal processes to minimize vehicle movement, reverse logistics, and transportation cost reduction. By using regression, the study aimed to identify how these variables influence each other and contribute to cost savings and improved environmental performance. An empirical survey-based research approach was adopted, comprising 38 items designed to capture various aspects of green supply chain management. The survey was distributed to environmental management representatives (EMRs) or logistics representatives (LRs) from ISO 14001 certified organizations in Turkey, ensuring that the respondents were familiar with environmental management systems and logistics processes. Responses for each item were collected on a five-point Likert scale (ranging from 1 for "strongly disagree" to 5 for "strongly agree"). The rationale behind using a five-point scale was to mitigate the tendency for most negative responses to cluster around the median, or center, point of the scale, offering a balanced way to capture attitudes and opinions.

The research instrument was distributed through an online survey platform, where company representatives could access the website and submit their responses electronically. Once the data were collected, the online system provided the responses in a format compatible with SPSS, a widely used statistical software. Using SPSS, a series of separate but interdependent regression equations were estimated simultaneously. This enabled the analysis to assess how each independent variable, such as environmental transportation or supplier selection criteria, influenced specific dependent variables, such as transportation cost reduction or internal process optimization. The design of the structural model followed from the theory and the research objectives, allowing the determination of which independent variables would serve as predictors for the dependent variables. The proposed relationships among these variables were then translated into a series of structural equations for each dependent variable. These structural equations captured the nature of the relationships between the independent variables (e.g., helping suppliers establish EMS, optimizing internal processes) and dependent outcomes (e.g., transportation cost reduction, improved environmental performance). The resulting structural model offered a comprehensive view of how different components of green supply chain management contribute to operational efficiencies and cost savings.

4. DISCUSSION

Based on the model and hypotheses, the results were obtained using regression analysis. In this study, Fuel Consumption, Maintenance, and Repair Expenditure (FCMRE) and Transportation Cost Reduction (TCR) were considered as dependent variables, while the five dimensions of Green Supply Chain Management (GSCM)—including environmental transportation, reverse logistics, choice of suppliers by environmental criteria, helping suppliers establish their own Environmental Management Systems (EMS), and optimizing internal processes to minimize vehicle movement—were considered independent variables. Before discussing the results, it is important to highlight the relationship between FCMRE and transportation costs. According to Kruse (2003), transportation costs are driven by maintenance, repair expenditure, and fuel consumption. Since direct transportation cost data was not available in this study, the analysis focused on the fluctuations in FCMRE. Given the relationship between transportation costs and FCMRE, any changes in maintenance, repair expenditure, and fuel consumption can provide insight into the corresponding changes in transportation costs.

The regression analysis revealed several key relationships. First, using environmental transportation was found to have a negative effect on FCMRE, meaning that employing more eco-friendly transportation methods led to a reduction in fuel consumption, maintenance, and repair costs. This indicates that adopting environmental transportation practices can significantly reduce operational costs associated with transportation. The analysis also showed that reverse logistics had a positive relationship with FCMRE, suggesting that implementing reverse logistics systems could increase fuel consumption and maintenance expenses, possibly due to the additional logistics operations required for managing returns and recycling.

Additionally, the choice of suppliers based on environmental criteria was linked to a reduction in FCMRE, showing that selecting environmentally conscious suppliers contributed to lowering operational costs in the long run. Similarly, helping suppliers establish their own EMS also demonstrated a negative relationship with FCMRE, indicating that supporting suppliers in adopting environmental management systems can further reduce fuel consumption and maintenance costs. Finally, optimizing internal processes to minimize vehicle movement was shown to decrease FCMRE, illustrating that reducing unnecessary vehicle use and streamlining logistics can result in significant cost savings. Overall, the results suggest that adopting green supply chain practices, particularly those related to transportation and supplier management, can lead to meaningful reductions in fuel consumption and repair-related costs, thereby enhancing transportation cost efficiency. However, the findings also indicate that reverse logistics might increase these costs, potentially requiring further optimization to balance environmental benefits with cost efficiency.

5. CONCLUSION

This study concludes that green supply chain management (GSCM) holds significant potential for achieving cost savings in transportation. By integrating eco-friendly practices such as environmental transportation, selecting suppliers based on environmental criteria, and optimizing internal processes to reduce vehicle movement, organizations can reduce fuel consumption, maintenance, and repair expenses, leading to overall transportation cost efficiency. While certain aspects

like reverse logistics may initially increase costs, the broader adoption of GSCM practices shows clear financial benefits in the long run, alongside the positive environmental impact. These findings highlight the dual advantages of adopting sustainable supply chain strategies—both in terms of cost reduction and improved environmental performance. From the perspective of production firms, particularly in Turkey, one of the main concerns is the continuous tracking, controlling, and managing of various operational costs, with a specific focus on transportation costs. Firms are constantly seeking ways to optimize their logistics and supply chain operations to minimize these expenses, as transportation often represents a significant portion of their overall costs.

Efficient cost management in this area is critical to maintaining profitability and competitiveness, driving firms to explore strategies like green supply chain management to achieve both cost savings and operational efficiency while aligning with environmental goals. As mentioned in previous sections, there is a clear relationship between fuel consumption, maintenance, and repair expenditure (FCMRE) and transportation cost, which can be expressed in a formula-based model. Due to challenges in directly collecting transportation cost data, this study uses FCMRE as a connecting variable. The study successfully demonstrates the existing link between green supply chain management (GSCM) and FCMRE. By establishing this connection and considering the known relationship between FCMRE and transportation cost reduction (TCR), the study effectively explains the impact of GSCM on overall transportation costs. The research findings indicate that GSCM influences not only fuel consumption, maintenance, and repair costs, but through these variables, it indirectly affects transportation costs. This suggests that firms implementing GSCM practices can expect to see broader cost savings in transportation by focusing on reducing FCMRE, which serves as a key driver of transportation expenses. Thus, GSCM proves to be an effective strategy for improving environmental performance while simultaneously lowering operational costs. The main limitation of this study is its specific focus on production companies in Turkey, which may limit the generalizability of the findings to other sectors or countries. However, this focus also represents a strength, as the lack of similar studies in Turkey highlights the novelty and relevance of this research. By concentrating on a sample of Turkish production companies that have adopted the ISO 14001 Quality Management System, the study provides valuable insights into how green supply chain management practices can impact transportation costs in this specific context. This focus on ISO14001-certified companies ensures that the sample consists of firms already committed to environmental standards, making the findings particularly relevant for businesses seeking to align sustainability with cost efficiency. Future research should empirically test the relationships proposed in this paper across different countries, allowing for valuable comparative studies between regions. This would provide a broader understanding of how green supply chain management (GSCM) impacts transportation costs and operational efficiency in diverse economic and regulatory environments. Additionally, utilizing a larger sample size would enable more detailed cross-sectoral comparisons, offering insights into how GSCM practices influence various industries beyond the production companies examined in this study. Expanding the scope in this way would provide a more comprehensive view of the effectiveness of GSCM and help identify industry-specific best practices.

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