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Effective Transportation Management: A Review of Green Logistics Practices and Their Impact on the Environment

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Abstract: *This study examines the role of effective transportation management in promoting green logistics practices and their impact on environmental sustainability. Based on the Natural Resource-Based View (NRBV) theory, the research highlights the importance of adopting eco-friendly vehicles, optimizing routes, and implementing collaborative logistics to reduce carbon footprints. The findings suggest that effective transportation management enables companies to reconcile environmental responsibility with operational competitiveness, driving a more sustainable future for the logistics industry. The study also discusses the challenges of implementing green logistics practices, including high upfront costs, infrastructure requirements, and regulatory complexities. Recommendations are provided for companies, governments, and regulatory bodies to prioritize the adoption of green logistics practices, invest in sustainable technologies, and establish supportive policies and frameworks. By adopting green logistics practices, companies can reduce their environmental footprint, enhance their reputation, and achieve cost savings. The study contributes to the growing body of research on sustainable logistics and provides insights for companies and policymakers seeking to promote environmental sustainability in the logistics industry. Ultimately, the successful implementation of green logistics practices depends on a combination of effective transportation management, supportive policies, and regulatory frameworks.*

Key words: Green Logistics, Effective Transportation Management, Environmental Impact, Sustainable Logistics, Carbon Emissions Reduction.

1. Introduction

Green logistics practices play a crucial role in effective transportation management, enabling companies to minimize environmental impacts while boosting operational efficiency. By adopting green logistics strategies, businesses can significantly reduce greenhouse gas emissions associated with transportation, as noted by Blanco & Sheffi (2024). This approach encompasses various techniques, including waste management through packaging optimization and reverse logistics, which help reduce packaging waste and promote recycling, as highlighted by Majeed (2025). Additionally, utilizing alternative fuels and electric vehicles can minimize air and noise pollution from logistics operations, according to Musau (2024).

Implementing green logistics requires strategic optimization techniques, such as route optimization and inventory management, which enhance efficiency while reducing environmental footprints (Majeed, 2025). Technological integration, including advanced technologies like IoT and AI, facilitates real-time monitoring and optimization of logistics processes, as mentioned by Musau (2024). Furthermore, stakeholder collaboration is essential for successful green logistics implementation, involving engagement with customers, organizations, and other stakeholders (Kumar, 2014). While initial investments and operational changes may pose challenges, the long-term benefits of green logistics, including cost savings and improved brand reputation, often outweigh these drawbacks, as observed by Guirong & Yuxin (2010).

Transportation plays a vital role in optimizing supply chain performance, reducing expenses, improving efficiency, and increasing customer satisfaction. Effective transportation management enables businesses to minimize inventory levels and enhance customer service through faster delivery times. Studies have shown that Collaborative Transportation Management (CTM) can lead to significant cost savings and better transportation capacity utilization (Feng, Yuan & Lin, 2005). Additionally, improving regional connectivity and logistical infrastructure is critical for maximizing trade potential, particularly in regions like Asia where insufficent transportation networks and logistics limitations hinder economic growth (Suu, Ke & Lim, 2011). By adopting strategies like CTM and investing in infrastructure, businesses can improve their supply chain performance and stay competitive (Tseng & Yue, Yue & Taylor, 2005).

Effective transportation management through green logistics practices is crucial for mitigating the negative environmental impacts of the logistics industry while enhancing business performance. As global trade and consumerism grow, the demand for transportation increases, resulting in higher greenhouse gas emissions and pollution (OECD Report, 2021). Green logistics offers a viable solution by integrating environmentally friendly strategies into all aspects of the supply chain, from sourcing and production to distribution and reverse logistics (Carter & Easton, 2011).

Green logistics practices, such as green transportation, green warehousing, and reverse logistics, can significantly reduce the environmental footprint of logistics operations. For instance, route optimization can lower carbon emissions and operational costs (ResearchGate, 2024), while eco-driving techniques can save up to 25% on fuel (Dialnet, 2024). The adoption of alternative fuels

and electric vehicles is also a key strategy for decarbonizing freight transport (ResearchGate, 2024). Additionally, green warehousing focuses on energy efficiency, waste management, and recycling, which can reduce energy consumption and associated carbon emissions (International Journal of Scientific Research and Management, 2024).

The implementation of green logistics practices has a direct and measurable positive impact on both the environment and business performance. By reducing fuel consumption and emissions, companies can lower their carbon footprint and improve local air quality (International Journal of Scientific Research and Management, 2024). Moreover, studies have shown a positive relationship between green logistics practices and a firm's performance, encompassing economic, environmental, and social dimensions (ResearchGate, 2024). Environmentally conscious companies can achieve significant cost savings, enhance their brand reputation, and attract environmentally aware customers.

2. Statement of the Problem

Effective transportation management is crucial in green logistics to reduce environmental impacts and boost operational efficiency. Logistics operations contribute significantly to carbon emissions and resource depletion, making sustainable practices essential. Challenges include environmental impact, adoption barriers, and regulatory compliance issues (Musau, 2024; Majeed, 2025; Guirong & Yuxin, 2010). To overcome these challenges, businesses can adopt innovative technologies like IoT, AI, and data analytics (Musau, 2024), collaborative efforts (Majeed, 2025), and sustainable practices such as eco-friendly packaging and reverse logistics (Khoa et al., 2024).

The growing demand for goods and services has led to a surge in transportation and logistics activities, contributing to environmental degradation. A comprehensive transition to green logistics is essential, but it poses a challenge, particularly for SMEs. The lack of a unified understanding and systematic implementation of green logistics practices hinders businesses and policymakers. To address this gap, synthesizing and reviewing current best practices in green logistics can demonstrate the tangible benefits of sustainable transportation management and provide a roadmap for companies and governments to reduce their ecological footprint.

3. Objectives of the study

i. To investigate the impact of effective transportation management on green logistics practices.

ii. To examine the impact of green logistics practices on environmental sustainability.

4. Methods

This study of effective transportation management in green logistics practices employed a qualitative research approach. The study conducted a comprehensive review of existing literature on green logistics and transportation management, drawing on secondary data from academic journals, books, conference proceedings, industry reports, and government publications. A thematic analysis was used to examine the impact of effective transportation management on environmental sustainability, focusing on practices such as route optimization, load consolidation, and eco-friendly vehicles. The study aimed to provide a nuanced understanding of the challenges and opportunities of green logistics practices, and their implications for environmental sustainability. The research highlights the importance of effective transportation management in reducing carbon footprints, enhancing operational efficiency, and promoting sustainable logistics practices.

5. Conceptual Review

5.1 Green logistics

Green Logistics involves integrating environmentally friendly practices into supply chain management to reduce environmental impacts associated with goods distribution (Rodrigue, 2012; Noorliza & M-Hasmi, 2013). This includes optimizing processes across transportation, warehousing, inventory management, and sustainable packaging to prevent harm to the environment (Nguyen Thi Mai Anh, 2025). Key aspects of Green Logistics Practices (GLP) include Reverse Logistics Practices, such as managing the return flow of goods and recovering materials (Nguyen Thi Mai Anh, 2025), Carbon Emissions Management to reduce greenhouse gas emissions (Intergovernmental Panel on Climate Change, 2014), Green Warehousing to lower energy usage and waste (Perotti & Colicchia, 2024), and Green Transportation Practices to minimize fossil fuel use and environmental pollutants (Lee & Nam, 2017).

Despite inconsistencies in findings due to diverse approaches (Jayarathna, Agdas & Dawes, 2024), GLP can positively impact firm performance (Baah, Jin & Tang, 2020) and support sustainable practices within supply chains. By adopting green logistics practices, companies can reduce their environmental footprint while improving their bottom line.

5.2 Effective Transportation Management

The orchestration of logistics operations hinges on adept transportation management, which entails strategic planning, vigilant monitoring, and precise control of goods movement to ensure seamless, dependable, and eco-friendly supply chains (Makan &

Heyns, 2018). This multifaceted approach encompasses various tactics, including optimizing routes, streamlining loads, selecting suitable transportation modes, and leveraging digital solutions like transportation management systems to amplify logistics performance. By streamlining vehicle usage and embracing environmentally conscious transportation technologies, organizations can concurrently pursue operational excellence and sustainability goals, ultimately driving business success (Navarro et al., 2018).

5.3 Environmental Impact

The ecological footprint of human and industrial endeavors is manifested in the degradation of natural habitats, depletion of resources, and adverse effects on public well-being. Within the logistics and transportation sector, this manifests as increased carbon emissions, atmospheric and noise pollution, excessive fuel usage, and waste production. Furthermore, the infrastructure and energy requirements of logistics systems can lead to habitat destruction and resource exhaustion. To mitigate these effects, it is essential to assess and quantify the environmental consequences of logistics operations. A widely adopted methodology for evaluating the ecological impact of transportation activities is life cycle assessment, which provides a comprehensive framework for measuring emissions, energy consumption, and other environmental repercussions (Barbieri et al., 2025).

5.4 Sustainable Logistics

The convergence of economic viability, environmental stewardship, and social accountability is at the heart of sustainable logistics, a paradigm that seeks to redefine the way businesses manage their supply chains (Jabbour et al., 2019). By leveraging innovative strategies such as alternative energy sources, streamlined routing, closed-loop logistics, and sustainable packaging, companies can minimize the adverse effects of logistics operations while catering to customer expectations and business imperatives. As regulatory frameworks and consumer preferences continue to evolve, sustainable logistics has emerged as a key differentiator for companies seeking to gain a competitive edge in the market. By embracing sustainable logistics practices, businesses can not only reduce their environmental footprint but also enhance their reputation and bottom line.

5.6 Carbon Emissions Reduction

Mitigating climate change requires a multifaceted approach to decrease greenhouse gas emissions from logistics and supply chain activities. This can be achieved through various means, including the adoption of eco-friendly transportation options, such as electric or hybrid vehicles, and the optimization of logistics networks to minimize fuel consumption and reduce unnecessary trips. Studies have demonstrated that strategies like route planning and load management can yield significant reductions in emissions while also generating cost savings (Lu & Li, 2023). As governments and organizations prioritize environmental sustainability, setting targets for emission reduction has become an integral part of responsible business practices, aligning with global efforts to combat climate change (Chen et al., 2025).

6. Theoretical Framework

The Natural Resource-Based View (NRBV) builds upon the Resource-Based View (RBV) by highlighting the significance of environmental considerations in driving a firm's long-term competitiveness (Hart, 1995). This perspective posits that companies can gain a sustained competitive disadvantage by developing capabilities that address ecological challenges, in addition to possessing valuable, rare, inimitable, and non-substitutable resources. The NRBV framework comprises three strategic capabilities: pollution prevention, product stewardship, and sustainable development, which enable firms to reduce risks, cut costs, enhance reputation, and innovate for future markets. By adopting environmentally sustainable practices, companies can leverage unique competitive resources that support both profitability and sustainability (Hart & Dowell, 2011).

The Natural-Resource-Based View (NRBV) of the firm, introduced by Hart in 1995, is a prominent theory in academia that focuses on sustainable operations and ecological development in business operations (Chicksand et al., 2012; Johnson, Howard & Miemczyk, 2014; Marshall et al., 2015). The NRBV comprises resources aimed at maximizing both sustainability and competitiveness. However, scholars have highlighted the lack of explanation of competitive resources in operations, raising concerns about the theory's feasibility due to its roots in resource-based theory (Laosirihongthong et al., 2013; Hughes et al., 2018).

The NRBV faces criticism for its emphasis on resources that are tacit, heterogeneous, scarce, inimitable, and nonsubstitutable, making them seemingly impractical and unattainable (Powell, 1992; Lockett, Thompson & Morgensten, 2009). Some academics argue that these resources do not exist in practice, partly due to the complexity and tacit nature of competitive resources, which can deter empirical investigation (Hart & Dowell, 2011; Ashby, Leat & Hudson-Smith, 2012). The positivistic dominance of resource-based theory research has also limited the study of intangibles and contextualities, conflicting with the nature of competitive resources (Acedo, Barroso & Galan, 2006). The lack of empirical research has hindered the advancement of resource-based theory and the NRBV, leading to claims that the theory does not exist in practice. This highlights the need for alternative research methodologies to better understand and apply the NRBV (Acedo et al., 2006; Newbert, 2007). By adopting a more nuanced approach, researchers can uncover the potential of the NRBV in driving sustainable business practices and competitiveness.

7. Empirical Review

7.1 The Impact of Effective Transportation Management on Green Logistics Practices

Effective transportation management is crucial for green logistics practices, which aim to reduce environmental impacts while enhancing operational efficiency (Reynolds, 2024). Key aspects of effective transportation management include utilizing eco-friendly vehicles like electric or hybrid vehicles to reduce emissions and fuel consumption, and implementing optimized routing using advanced technologies like GPS and telematics to minimize travel distances and time (Reynolds, 2024). Additionally, collaborative logistics such as shared transportation among companies can significantly lower carbon footprints (Guirong et al., 2010).

A strong regulatory framework and government support can encourage companies to adopt green logistics practices, while self-discipline in enterprises ensures compliance and continuous improvement (Guirong & Yuxin, 2010). However, challenges such as high upfront costs for green technologies and knowledge gaps in practical applications of green logistics measures can hinder progress (Reynolds, 2024; Jarašūnienė & Išoraitė, 2024). Addressing these issues, including regulatory complexities and the need for standardized metrics, is vital for the successful implementation of sustainable logistics solutions.

Effective transportation management (ETM) has emerged as a crucial enabler of green logistics, given the heavy environmental burden posed by freight transportation. One of the most notable contributions of ETM lies in its ability to optimize routes and reduce unnecessary travel. Through the use of advanced algorithms and data-driven decision models, companies can identify efficient delivery routes that cut down fuel consumption and carbon emissions while maintaining service quality. For instance, Chen et al. (2025) highlight that sustainable route optimization strategies significantly lower CO_2 emissions by aligning cost efficiency with environmental objectives. Similarly, research on Green Vehicle Routing Problems (GVRPs) emphasizes how minimizing travel distance and fuel use is integral to achieving both economic and ecological gains (Fernández Gil et al., 2022).

Another important contribution of ETM is its role in facilitating load consolidation and modal shifts. By maximizing vehicle capacity utilization and shifting freight from high-emission modes such as road to greener options like rail or multimodal systems, companies can dramatically reduce their carbon footprint. Case studies from the MIT Center for Transportation and Logistics (2013) illustrate how organizations such as Ocean Spray cut transportation-related emissions by nearly 20% through redesigning distribution networks, consolidating loads, and moving towards intermodal solutions. These measures demonstrate how effective management decisions not only promote sustainability but also deliver cost savings and operational resilience.

The adoption of alternative fuels and eco-friendly vehicles is another area where ETM strengthens green logistics. Decisions regarding fleet composition—whether to rely more heavily on electric, hybrid, or biofuel-powered vehicles—are supported by effective transport management systems that monitor costs, emissions, and vehicle performance. Lu and Li (2023) show that integrating more new-energy vehicles into long-distance freight significantly reduces both pollution and overall transportation costs. This reflects the broader shift towards cleaner technologies, which requires strategic management to balance investment costs with long-term environmental and financial benefits.

In addition to vehicle and route considerations, ETM enhances monitoring and performance management through telematics and driver behavior analysis. By tracking driver habits such as idling, harsh braking, or excessive acceleration, companies can improve fuel efficiency and cut down on emissions. For example, the adoption of fleet management systems in urban centers has shown measurable success in lowering environmental impact by optimizing routes, managing driver behavior, and reducing fuel consumption (Makan & Heyns, 2018). These operational adjustments highlight how managerial oversight, coupled with digital tools, can align day-to-day logistics activities with green objectives.

Despite these benefits, the transition to green logistics through ETM is not without challenges. Upfront costs, infrastructure requirements, and trade-offs between cost efficiency and sustainability goals complicate implementation. For example, Navarro, Cronemyr, and Huge-Brodin (2018) emphasize that integrating process management into transport operations provides companies with systematic ways to align business goals with environmental targets, though success often depends on supportive policies and regulatory frameworks. In contexts such as South Africa and Thailand, policy gaps and inadequate infrastructure limit the full potential of sustainable transportation practices (Makan & Heyns, 2018; Pipitthanathunyathorn et al., 2025). Nevertheless, as global and regional pressures for decarbonization grow, ETM remains central to advancing green logistics by enabling companies to reconcile environmental responsibility with operational competitiveness.

7.2 The Impact of Green Logistics Practices on Environmental Sustainability

Green logistics is a concept that aims to reduce the adverse environmental impacts of logistics operations, focusing on factors such as carbon emissions, noise pollution, and waste (Mohsin et al., 2022). It seeks to achieve sustainability across financial, social, and environmental dimensions by striking a balance between these considerations (Dekker et al., 2012). Green logistics involves the efficient management of supply chain activities to minimize global costs and environmental consequences, including climate change,

air pollution, and accidents (Jedlinski, 2014). A framework for green logistics has been proposed to illustrate the relationship between logistics activities and their environmental impact (McKinnon et al., 2015).

Green logistics management practices (GLMP) involve various measures to minimize environmental impacts, including transportation optimization, energy-efficient technologies, eco-friendly packaging, and waste reduction programs (Kim & Han, 2011; Agyabeng-Mensah, Afum & Ahenkorah, 2020). By implementing GLMP, firms can reduce fuel consumption and emissions through route optimization and shipment consolidation (Afum et al., 2020), lower energy use and carbon footprints, and minimize waste through effective recycling programs (Kabirifar et al., 2020). The benefits of GLMP include reduced carbon emissions and air pollutants, decreased energy consumption, lower waste volumes, and enhanced compliance with environmental regulations (Akubia et al., 2025).

The primary objective of green logistics is to mitigate the adverse environmental impacts of logistics operations while enhancing financial, social, and environmental sustainability (Mohsin et al., 2022). Green logistics is a set of eco-friendly practices adopted by logistics companies to minimize their ecological footprint and promote sustainability in the industry (Ali, Jianguo, Kirikkaleli, Bács, et al., 2023). Recent literature has highlighted the growing importance of green logistics and its development in logistics research.

The integration of sustainable practices in logistics operations presents substantial challenges for nations globally (Guarnieri et al., 2020). Achieving efficient green logistics requires a transformation of traditional logistics operations, involving the substitution of polluting vehicles with eco-friendly alternatives and a comprehensive reconfiguration of all aspects of the supply chain with an ecological approach. Investment opportunities are related to this transformation, and the performance of the global logistics industry plays a crucial role in promoting environmental sustainability (Sikder et al., 2022).

The implementation of green innovation presents a solution to reduce CO2 emissions by minimizing reliance on fossil fuels, representing a pivotal strategy for achieving a sustainable and environmentally friendly ecosystem (Ali, Jianguo, & Kirikkaleli, 2023). Many companies are motivated to enhance their operational efficiency by adopting effective and environmentally friendly resources to mitigate adverse environmental effects. By adopting green innovation, companies can reduce societal costs associated with pollution and improve green logistics (Barut et al., 2023).

8. Conclusion

In conclusion, effective transportation management plays a vital role in promoting green logistics practices, which are essential for reducing environmental impacts while enhancing operational efficiency. By optimizing routes, consolidating loads, and adopting eco-friendly vehicles, companies can significantly lower their carbon footprint and contribute to a more sustainable future. However, challenges such as high upfront costs, infrastructure requirements, and regulatory complexities need to be addressed to facilitate the widespread adoption of green logistics practices.

The impact of green logistics practices on environmental sustainability is multifaceted, encompassing reduced carbon emissions, lower energy consumption, and minimized waste. By adopting green logistics management practices, firms can not only mitigate their environmental footprint but also enhance their reputation, comply with regulations, and achieve cost savings. The transformation of traditional logistics operations to sustainable practices requires a comprehensive approach, including investment in eco-friendly technologies and infrastructure.

Ultimately, the successful implementation of green logistics practices depends on a combination of effective transportation management, supportive policies, and regulatory frameworks. As global pressures for decarbonization and sustainability continue to grow, companies that adopt green logistics practices will be better positioned to reconcile environmental responsibility with operational competitiveness, driving a more sustainable future for the logistics industry.

9. Recommendations

In line with the findings of the paper, the following recommendations are put forward, which include:

i. To enhance environmental sustainability, companies should prioritize the adoption of green logistics practices, including transportation optimization, energy-efficient technologies, and eco-friendly packaging. By implementing these measures, firms can reduce their carbon footprint, lower energy consumption, and minimize waste. Moreover, companies should invest in effective transportation management systems that support sustainable practices and provide measurable benefits.

ii. Governments and regulatory bodies should establish supportive policies and frameworks to encourage the adoption of green logistics practices. This can include incentives for companies that invest in eco-friendly technologies, tax breaks for sustainable logistics operations, and regulations that promote environmentally responsible practices. Additionally,

governments should invest in infrastructure that supports sustainable logistics, such as electric vehicle charging stations and green transportation systems.

iii. Companies should also focus on optimizing their dolphin choir operations to reduce waste and emissions. This can be achieved through load consolidation, modal shifts, and the use of alternative fuels and eco-friendly vehicles. Furthermore, companies should prioritize driver training and behavior analysis to improve fuel efficiency and reduce emissions. By adopting these measures, companies can not only reduce their environmental impact but also achieve cost savings and operational resilience.

iv. Finally, companies should prioritize green innovation and invest in research and development to identify new opportunities for sustainable logistics practices. This can include the development of new technologies, fuels, and logistics systems that minimize environmental impact while enhancing operational efficiency. By adopting a proactive approach to sustainability, companies can reduce their environmental footprint, improve their reputation, and achieve long-term success in a rapidly changing business environment.

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