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Integrating Green Procurement and Logistics: Overcoming Barriers for Sustainable Supply Chains

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ABSTRACT : This study investigates the synergy between green procurement and green logistics within the context of sustainable supply chain management. The objective is to explore how integrating these two elements can enhance environmental performance and operational efficiency. A narrative review methodology was employed, synthesizing literature from peer-reviewed databases such as Scopus and Web of Science. The results highlight the significant role of digital technologies and reverse logistics in fostering green procurement-logistics integration. Organizational leadership, technological capacity, and interdepartmental collaboration emerged as key enablers, while structural barriers and insufficient digital infrastructure were identified as major obstacles. The study emphasizes the need for supportive policy frameworks and data-driven interventions to promote the adoption of integrated green practices. It also calls for further research into the long-term effects of such integration and the exploration of cross-national differences in implementation. The findings suggest that a holistic, systems-based approach is essential for advancing sustainable supply chain solutions.

Keywords: Green Procurement; Green Logistics; Sustainable Supply Chain Management; Digital Technologies; Reverse Logistics; Environmental Performance; Operational Efficiency

INTRODUCTION

In the era of globalization and the green economy transition, green procurement and environmentally friendly logistics have garnered significant attention in both academic and practical domains. These components, central to the broader concept of Green Supply Chain Management (GSCM), aim to harmonize environmental and operational priorities across procurement, production, distribution, and waste management systems. Globally, the intensifying concern about climate change and greenhouse gas emissions has accelerated the formulation of policies and the development of technologies that integrate sustainability principles throughout supply chains (Erdal & İpçioğlu, 2024; Tseng et al., 2019). On the national level, policy interventions such as green public procurement (GPP) and initiatives promoting green logistics

have emerged as critical catalysts, encouraging a paradigm shift towards environmentally responsible business operations (Labaran & Masood, 2023). The ongoing digital transformation under Industry 4.0 further reinforces this trend by facilitating the integration of green procurement and logistics practices through smart technologies that enhance resource efficiency and reduce environmental footprints (Erdal & İpçioğlu, 2024; Labaran & Masood, 2023).

Recent literature indicates a growing consensus on the operational and environmental benefits of aligning green procurement with logistics strategies. Statistical data and empirical studies from various regions reinforce this position. For example, research conducted among SMEs in Penang, Malaysia, demonstrates that the adoption of green supply chain practices yields not only operational improvements but also measurable environmental benefits (Teoh et al., 2023). Similarly, a comprehensive analysis of GPP implementation across Spain revealed a positive correlation between environmental procurement policies and logistics efficiency, based on the review of thousands of procurement processes (Rosell, 2023). In Thailand's automotive industry, integrated frameworks encompassing green procurement, green transportation, and green manufacturing have been statistically proven to enhance both environmental performance and economic outcomes (Tippayawong et al., 2016). These studies collectively validate the hypothesis that synergistic implementation of green procurement and logistics can drive both sustainability and competitiveness in supply chain systems.

Despite a growing commitment to integrate green procurement and logistics, several substantial challenges persist. First, the inherent complexity of integrating ecological concerns with operational efficiency has emerged as a formidable barrier. Researchers note the difficulty of reconciling economic considerations, carbon emission targets, and logistical performance within a unified strategic framework (Lei et al., 2024). Moreover, the limited technological capacity and human resource constraints faced by many organizations impede the implementation of digital and data-driven solutions aimed at enhancing this synergy. While tools such as big data analytics offer potential value, their application remains hindered by organizational resistance and structural barriers (Hu & Sinniah, 2024).

Another prominent challenge lies in stakeholder misalignment and resource constraints. Local-level studies on GPP, for instance, report frequent limitations in funding and time, which hamper effective policy execution and logistics coordination (Leal et al., 2020). These issues are compounded in manufacturing sectors, where operational hurdles and the uneven dissemination of GSCM practices continue to obstruct full integration across supply chain stages (Mishra et al., 2023). Consequently, although supportive policy frameworks and technological innovations are advancing, technical and institutional challenges must still be addressed to optimize the synergistic potential of green procurement and logistics.

A deeper examination of existing literature reveals that while the correlation between sustainability policies and supply chain performance is well-documented, comprehensive studies that investigate the dynamic interplay between green procurement and logistics remain limited. For instance, Letunovska et al. (2023) and Erdal & İpçioğlu (2024) argue that the combined application of

sustainable procurement and reverse logistics enhances supply chain efficiency while meeting environmental targets. Yet, a recurring theme in the literature is the tendency to analyze these components in isolation, often overlooking their interdependent functions within broader sustainability frameworks. Dimand (2022), for example, identifies organizational capacity and leadership culture as key determinants of GPP success but offers limited insight into the logistics dimension. Similarly, Pinto (2023) explores green purchasing practices in relation to firm performance but focuses predominantly on internal supply chain processes, neglecting the external logistical mechanisms that support procurement decisions.

This lack of integrated inquiry underscores the need for further research that investigates not only the individual impact of green procurement and logistics but also their combined influence on sustainable supply chain performance. Most current studies either isolate green procurement as a policy mechanism or examine green logistics in technical terms, rarely addressing how these practices co-evolve or interact to produce synergistic effects. The paucity of such investigations limits our understanding of how systemic integration can be achieved and scaled, particularly in the context of varying regulatory environments and organizational capacities (Letunovska et al., 2023; Dimand, 2022; Pinto, 2023).

The primary objective of this review is therefore to synthesize current knowledge on the synergistic integration of green procurement and logistics practices within the framework of GSCM. Specifically, this article seeks to explore how joint implementation of these practices can enhance environmental performance, improve operational efficiency, and support broader sustainability goals. To that end, the study will analyze key enabling factors, including technological innovations, policy frameworks, stakeholder engagement, and organizational capabilities, all of which influence the efficacy of green supply chain strategies.

In terms of scope, this review focuses primarily on empirical and theoretical studies conducted over the past decade, with a geographic emphasis on emerging economies and regions experiencing rapid industrial growth. By concentrating on contexts where the need for sustainable transformation is urgent, the study aims to draw practical lessons and policy insights applicable to a diverse range of stakeholders. Sectors covered include manufacturing, public procurement, and small and medium-sized enterprises (SMEs), which collectively represent critical nodes in the global supply chain ecosystem. This focus not only ensures contextual relevance but also accommodates cross-sectoral comparisons, thereby enriching the analysis of green procurement and logistics synergy across different institutional and operational settings.

METHOD

This study adopts a narrative review methodology to explore the synergistic integration between green procurement and green logistics within the framework of sustainable supply chain management. In accordance with established academic standards, the literature was sourced from internationally recognized and peer-reviewed databases to ensure both breadth and depth of

coverage, as well as methodological rigor. Key scientific databases used in this review include Scopus, Web of Science, and ScienceDirect, selected for their comprehensive indexing of high-quality publications spanning disciplines relevant to sustainability, logistics, and procurement. The selection of these platforms was guided by their prominence in previous research on sustainable supply chains (Labaran & Masood, 2023). In addition, databases such as IEEE Xplore were also accessed for literature with a strong emphasis on digital innovation and technological integration, especially given the role of Industry 4.0 in accelerating the convergence of procurement and logistics functions.

The search strategy was constructed using a combination of core terms that reflect the principal constructs of the study, including "green procurement," "green logistics," "sustainable supply chain," "reverse logistics," and "environmental management." Boolean operators such as AND and OR were employed to refine the search and maximize the relevance of retrieved studies. For instance, terms like "green procurement AND green logistics" or "sustainable supply chain OR environmental logistics" were trialed in initial search rounds. To further optimize the precision and recall of the search process, a pilot search was conducted. This preliminary step enabled the identification of suitable keyword combinations and the refinement of search strings, thereby reducing irrelevant results and improving the overall validity of the study selection process (Evangelista et al., 2018).

To ensure the relevance and quality of included studies, well-defined inclusion and exclusion criteria were applied. The inclusion criteria comprised the following: articles must have been published in peer-reviewed academic journals, be written in English, fall within the publication window from 2000 to 2023 to ensure coverage of contemporary developments, and demonstrate a clear conceptual or empirical link between green procurement and green logistics. These criteria were intended to ensure analytical consistency and facilitate meaningful comparisons across studies. Exclusion criteria, on the other hand, involved the elimination of conference proceedings, editorials, opinion pieces, and technical reports that lacked peer-review certification. Studies that were purely conceptual without empirical grounding were also excluded, as were publications that did not explicitly examine the interaction or integration of green procurement and logistics practices (Evangelista et al., 2018).

The range of studies included in this review reflects the diversity of research approaches adopted in the field of sustainable supply chains. A substantial proportion of the literature consists of quantitative research that employs survey methods and statistical analyses to examine relationships among variables such as environmental policy implementation, logistics efficiency, and procurement strategy. These studies typically rely on data collected from structured questionnaires distributed among professionals in supply chain, procurement, or sustainability management. In several cases, secondary datasets sourced from institutional databases or governmental records were also utilized to investigate large-scale trends in green procurement and logistics.

In parallel, qualitative research has played a significant role in contextualizing the implementation of green practices across different organizational and cultural settings. Case studies, semi-

structured interviews, and content analyses have been employed to explore how green procurement and green logistics are integrated in practice, often uncovering organizational, technological, and policy-related barriers and enablers that are not immediately visible through quantitative lenses. These qualitative approaches offer nuanced insights into the motivations, behaviors, and institutional dynamics that shape sustainable supply chain initiatives.

Moreover, an increasing number of studies have embraced mixed-methods designs to leverage the strengths of both quantitative and qualitative paradigms. These hybrid studies typically involve sequential or concurrent data collection strategies that combine survey-based analyses with in-depth case examinations. The objective of such approaches is to provide a holistic understanding of green procurement-logistics synergies by capturing both numerical trends and contextual realities (Letunovska et al., 2023). The integration of methods allows for triangulation of findings, enhancing the reliability and robustness of the conclusions drawn.

The literature screening process was carried out in multiple stages to ensure accuracy and minimize selection bias. In the initial phase, titles and abstracts were reviewed to determine whether the study addressed themes relevant to green procurement and green logistics. Articles passing this phase were subjected to a full-text review, during which the methodological rigor, relevance, and depth of analysis were evaluated. Studies that met all inclusion criteria and demonstrated substantive engagement with both procurement and logistics dimensions were then selected for synthesis. The evaluation of methodological quality followed established criteria focusing on clarity of research questions, transparency of data collection and analysis procedures, and the coherence between empirical evidence and conclusions.

To supplement the structured database search, backward and forward citation tracking was employed. This involved examining the reference lists of included studies to identify additional relevant sources and using tools such as Google Scholar to locate newer publications that cited key foundational articles. This snowballing technique proved particularly useful in capturing emerging literature not yet indexed in core databases or in bridging conceptual gaps identified during the main search process.

In summary, this review methodology is designed to ensure a comprehensive, systematic, and rigorous assessment of the literature on green procurement and green logistics synergy. By combining multiple data sources, refining search strategies through pilot testing, applying stringent inclusion and exclusion criteria, and adopting a multi-method analytical lens, this review aims to produce a well-rounded understanding of how these two pillars of sustainable supply chain management interact, reinforce one another, and influence broader organizational performance and environmental outcomes.

RESULT AND DISCUSSION

The findings of this narrative review synthesize a diverse array of empirical and conceptual studies addressing the integration of green procurement and green logistics within the framework of sustainable supply chain management. The results are structured into three key themes that emerged during the review process: (1) Green Procurement Practices, (2) Green Logistics Strategies, and (3) Integrated Approaches within Green Supply Chain Management (GSCM).

A. Green Procurement Practices

The existing literature provides strong and consistent evidence supporting the claim that the adoption of green procurement practices enhances operational performance while reducing environmental impacts across various industrial sectors. Pinto (2023) highlights a positive correlation between the implementation of green purchasing strategies and firm-wide performance. The study emphasizes supplier collaboration and resource optimization as pivotal components in achieving these outcomes. This is supported by Letunovska et al. (2023), who demonstrate that green procurement enhances supply chain efficiency, particularly when coupled with reverse logistics systems. The integration of procurement decisions with sustainable waste management processes further contributes to the optimization of resource use and carbon footprint reduction.

Moreover, Dimand (2022) underscores the importance of internal organizational factors such as technical capacity, leadership commitment, and an innovation-oriented corporate culture in the successful adoption of green public procurement. These findings suggest that organizational readiness is a determinant factor in leveraging the full benefits of green procurement.

Several factors frequently emerge as enablers of successful green procurement implementation. These include the availability of advanced information technologies and environmental management systems, which facilitate procurement planning and monitoring (Letunovska et al., 2023). Additionally, sustained engagement and collaboration between firms and their suppliers help in aligning environmental goals with operational capabilities (Pinto, 2023). Finally, strong leadership and a supportive organizational culture foster an environment conducive to the adoption of green practices (Dimand, 2022). Collectively, these factors not only enable firms to meet environmental regulations but also enhance their competitive advantage and economic performance.

B. Green Logistics Strategies

The literature also provides robust evidence regarding the role of green logistics strategies in reducing carbon emissions and improving cost efficiency. Jazairy and Haartman (2020) identify several logistics-related interventions, such as route optimization, load consolidation, and the adoption of technology-driven transportation management systems, that contribute significantly to lowering greenhouse gas emissions. These findings highlight the dual benefit of environmental improvement and operational savings, which reinforce the business case for sustainable logistics.

This connection between green logistics and digital innovation is further elaborated by Anser et al. (2020), who show that the integration of information technologies into supply chain operations

allows for real-time monitoring and continuous performance improvement. By enabling logistics managers to detect inefficiencies and respond promptly, these digital systems enhance the overall sustainability of logistical operations.

Comparative evidence reveals variations in the effectiveness of green logistics implementation across different national contexts. Teoh et al. (2023), in their study on SMEs in Penang, Malaysia, note that the adoption rate of green logistics practices remains statistically lower compared to firms in developed countries. This discrepancy is attributed to limited access to green technologies and less supportive policy frameworks. In contrast, empirical research conducted by Wang et al. (2013) in China's metal logistics sector illustrates how modern logistics infrastructure and advanced technological integration in more industrialized settings yield more significant emission reductions. These comparative findings underscore the importance of national infrastructure development and institutional support in realizing the full potential of green logistics.

C. Integrated Approaches within Green Supply Chain Management (GSCM)

The convergence of green procurement and green logistics under the GSCM umbrella has been explored through several integrative strategies. Letunovska et al. (2023) emphasize that green procurement directly supports the development of reverse logistics systems, thereby contributing to circular economy objectives. Their findings indicate that firms adopting integrated procurement and logistics practices are better positioned to close material loops and enhance overall supply chain resilience.

The importance of digital transformation in enabling this integration is highlighted in the systematic review by Labaran and Masood (2023). Their study categorizes a comprehensive set of GSCM practices across the value chain and illustrates how digital tools such as data analytics, automation, and Internet of Things (IoT) platforms facilitate coordination between green procurement and logistics. The implementation of such technologies is shown to reduce redundancies, enhance process transparency, and support dynamic decision-making.

Bandoophanit (2024) introduces another integrated approach through a unified management framework applied in Thailand's service organizations. This framework combines green procurement initiatives with utility reduction strategies and reverse logistics systems. The study reports improvements in environmental performance and operational efficiency, although the results vary depending on organizational capacity and technological readiness. This suggests that contextual factors play a crucial role in shaping the outcomes of integrated sustainability initiatives.

A cross-national perspective reveals that the effectiveness of these integrative strategies is significantly influenced by the regulatory environment. Erdal and İpçioğlu (2024) emphasize that in countries with stringent environmental policies, strategic logistics functions are better aligned with responsible production and consumption practices. The presence of regulatory incentives and government-supported innovation accelerates the adoption of integrated green procurement-logistics models. Firms operating in such environments benefit from structured support mechanisms that encourage collaboration between suppliers and logistics providers and drive investment in green technologies.

Conversely, in nations with weaker environmental regulations, the integration of green procurement and logistics is often constrained by a lack of institutional pressure and limited innovation incentives. Letunovska et al. (2023) argue that without sufficient regulatory impetus, firms face challenges in justifying the cost and effort required to implement integrated sustainability practices. The absence of supportive policies can result in fragmented efforts, where procurement and logistics operate in silos, thus undermining the potential for synergy.

These findings collectively demonstrate that the success of green procurement-logistics integration depends not only on internal organizational factors and technological capabilities but also on the broader policy landscape. Countries that invest in digital infrastructure, regulatory enforcement, and cross-sectoral partnerships are more likely to foster effective and scalable green supply chain solutions. The evidence presented reinforces the importance of a systems-based approach that considers interactions between institutional, technological, and organizational dimensions in advancing sustainable supply chain management.

In sum, the literature reviewed offers a comprehensive picture of the evolving practices and strategies that underpin the synergy between green procurement and green logistics. While progress has been made in both domains individually, the integration of these practices through GSCM frameworks holds the key to achieving more profound and long-term environmental and operational benefits. Future efforts should thus focus on bridging policy gaps, investing in digital infrastructure, and fostering collaborative ecosystems to support the full realization of sustainable supply chains.

The findings presented in this review provide a comprehensive perspective on the synergy between green procurement and green logistics within the broader framework of sustainable supply chain management. A critical contribution of this study lies in its holistic approach, which goes beyond the examination of isolated variables to emphasize the importance of systemic integration, particularly through digitalization and reverse logistics. While previous studies have explored the benefits of green procurement in isolation (Pinto, 2023), or the contribution of green procurement to reverse logistics efficiency (Letunovska et al., 2023), this study's unique value is its framing of these elements as interdependent mechanisms that co-evolve within organizational and technological ecosystems.

The relationship between green procurement and reverse logistics has been confirmed across various industrial contexts. Letunovska et al. (2023) showed that green procurement not only supports sustainability goals but also serves as a foundational input for effective reverse logistics operations. This relationship is not merely linear but reciprocal, as reverse logistics can, in turn, inform procurement decisions by providing data on end-of-life product recovery and waste management trends. Similarly, Pinto (2023) linked green procurement practices to improvements in firm-wide performance, reinforcing the idea that upstream supply chain practices have cascading effects on downstream logistics. These studies collectively highlight the significance of cross-functional integration in achieving long-term sustainability objectives.

In terms of systems enablers, the literature reveals that organizational leadership, culture, and technological capacity are among the most influential factors facilitating the adoption of green

procurement and logistics strategies. Dimand (2022) emphasized the importance of leadership orientation and technical expertise in determining the success of green public procurement initiatives. Letunovska et al. (2023) further supported this view by identifying information systems and environmental management frameworks as key drivers for harmonizing procurement and logistics functions. The availability of digital tools such as real-time tracking, cloud-based inventory systems, and environmental performance dashboards allows organizations to synchronize operations and streamline decision-making processes across departments. The effective deployment of these tools, however, depends heavily on organizational readiness, including skills, infrastructure, and an openness to innovation.

Systemic inhibitors are equally prominent in the literature and provide insight into persistent barriers to integration. Structural rigidity, fragmented responsibilities across procurement and logistics teams, and insufficient digital infrastructure continue to hinder the adoption of comprehensive sustainability frameworks (Dimand, 2022). These barriers are especially salient in emerging economies, where institutional capacity may be limited and public procurement systems often lack the agility needed to adapt to new environmental mandates. The lack of interdepartmental coordination, in particular, creates operational silos that undermine efforts to establish shared goals and joint accountability for environmental outcomes. These challenges underscore the need for integrated governance models that transcend traditional departmental boundaries and promote cross-functional collaboration.

The analysis of policy interventions offers valuable insights into how systemic barriers may be addressed. Green public procurement policies, when implemented with clear regulatory standards, financial incentives, and performance-based monitoring, have been shown to foster the alignment of procurement and logistics activities. Dimand (2022) noted that countries with more mature regulatory environments tend to implement green procurement with greater success, as measured by both environmental impact metrics and cost efficiency indicators. Moreover, Letunovska et al. (2023) provided empirical evidence that the integration of green procurement and reverse logistics significantly reduces carbon footprints, especially when supported by enabling technologies and consistent policy enforcement. These findings suggest that policy frameworks that combine top-down mandates with bottom-up implementation support are more effective in driving systemic change.

Beyond regulatory approaches, several studies advocate for data-driven decision-making as a means to enhance the effectiveness of integration. Pinto (2023), for instance, demonstrated the utility of quantitative models in assessing the financial and operational benefits of synchronized procurement-logistics practices. These models enable organizations to evaluate trade-offs, simulate outcomes, and prioritize investments in sustainability initiatives. The emphasis on empirical validation aligns with the growing demand for accountability in sustainability reporting and ensures that interventions are grounded in measurable outcomes rather than aspirational goals.

A further implication of this study is its emphasis on the role of digitalization in shaping the future of sustainable supply chains. The integration of procurement and logistics is increasingly mediated by digital infrastructure, from enterprise resource planning (ERP) systems to blockchain-based supply chain monitoring. This digital transformation is not merely a tool but a strategic enabler

that allows organizations to reconfigure workflows, enhance transparency, and foster real-time responsiveness. However, as Letunovska et al. (2023) and Labaran & Masood (2023) observed, the benefits of digitalization are contingent upon organizational capacity and external support systems. In contexts where digital literacy is low or access to infrastructure is limited, the risk of digital divide may further exacerbate disparities in green supply chain performance.

While this review highlights significant progress in integrating green procurement and logistics, several limitations in the existing literature must be acknowledged. First, most studies remain highly contextual, focusing on specific industries, geographies, or regulatory environments. This limits the generalizability of findings and underscores the need for comparative research that explores how different contexts mediate the relationship between procurement and logistics. For example, Erdal & İpçioğlu (2024) emphasized the role of stringent environmental policies in enabling integration, yet little is known about how these dynamics unfold in countries with less robust regulatory regimes.

Second, the predominance of cross-sectional and survey-based research designs in the literature restricts our ability to infer causality or track long-term changes in organizational behavior. While studies such as those by Pinto (2023) and Letunovska et al. (2023) provide compelling snapshots, longitudinal research is needed to understand how integration efforts evolve over time, particularly in response to external shocks such as climate-related disruptions or policy shifts.

Finally, there is a notable gap in interdisciplinary research that brings together perspectives from operations management, environmental science, information technology, and public policy. Addressing complex sustainability challenges requires a convergence of insights from multiple disciplines, yet much of the current literature remains siloed. Future research would benefit from mixed-methods approaches that combine quantitative rigor with qualitative depth, enabling a richer understanding of the sociotechnical dynamics that underpin green procurement-logistics integration.

In light of these considerations, future research should prioritize the development of integrative frameworks that capture the multidimensional nature of green supply chain transformation. Such frameworks should account for technological enablers, institutional drivers, cultural contexts, and policy instruments in a cohesive manner. Additionally, efforts should be made to explore the interplay between global standards and local adaptation, especially in regions where sustainability transitions are still nascent. By doing so, researchers can offer more actionable insights for policymakers, practitioners, and stakeholders committed to advancing sustainable supply chain solutions.

CONCLUSION

This study has explored the integration of green procurement and green logistics as key elements of sustainable supply chain management. The findings indicate that aligning procurement practices with green logistics not only leads to operational efficiency but also significantly reduces environmental impacts. The synergy between these two practices is enhanced through the adoption of digital technologies, which enable real-time monitoring and improved decision-

making. Leadership commitment, technological infrastructure, and cross-functional collaboration are crucial enablers of successful implementation. However, challenges such as structural rigidity, limited digital infrastructure, and lack of policy alignment continue to hinder progress. The study underscores the urgency of addressing these systemic barriers through integrated governance frameworks and supportive policy interventions. Future research should focus on longitudinal studies that track the long-term effects of integrated green procurement and logistics, as well as comparative studies across different regulatory environments. Moreover, interdisciplinary research is needed to develop holistic frameworks that consider technological, organizational, and policy dimensions in advancing sustainable supply chain solutions.

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