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GREEN SUPPLY CHAIN MANAGEMENT PRACTICES FOR GREEN INNOVATION

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Abstract:
Green supply chains are crucial for environmental performance, encouraging companies to rapidly adopt Green Supply Chain Management (GSCM) practices that formalize environmental priorities across sourcing, operations, logistics, and recovery. Although recent research on the relationship between GSCM and green innovation has grown, it remains somewhat fragmented. This paper offers a supply chain–focused conceptual synthesis of GSCM practices to promote green innovation. It reviews both foundational and recent studies, highlighting five key GSCM practices: green purchasing, supplier collaboration, eco-design, reverse logistics, and internal environmental management. It shows how these practices enable the development of green products, processes, and organizational innovations. The review indicates that green innovation is most strongly associated with GSCM when these practices operate as an integrated system. Specifically, upstream governance and collaboration generate environmental knowledge; eco-design turns environmental goals into innovative product structures; reverse logistics supports closed-loop learning and process improvements; and internal environmental management provides cross-functional alignment and governance to sustain innovation. This study advances the logistics and supply chain literature by conceptually integrating key GSCM practices into a unified system that fosters multidimensional green innovation throughout the supply chain.

Keywords:
Green supply chain management, green innovation, green process innovation, green product innovation, green managerial innovation, green business model innovation

1. Introduction
Global supply chains are increasingly recognized for their dual role as key contributors to environmental problems and drivers of sustainability-focused change. In particular, with growing regulatory and stakeholder pressures, companies are more motivated than ever to extend their ecological responsibility beyond their own operations and throughout their supply chains, including relationships with both upstream suppliers and downstream logistics and recovery processes (Vachon & Klassen, 2006; Lee & Kim, 2012; Green et al., 2012; Zhu et al., 2013; Abdallah et al., 2024). In this context, Green Supply Chain Management (GSCM) has become a widely used term denoting the integrated consideration of environmental criteria across purchasing, production, distribution, and reverse flows in supply chains (Green et al., 2012; Zhu et al., 2013; Komakech et al., 2025).
Early research, however, often viewed the GSCM concept and practice as driven primarily by pressures to comply with and optimize operational efficiency in response to external environmental regulations and stakeholder demands. For example, various empirical studies (Zhu et al., 2008; Green et al., 2012; Abdallah et al., 2024) found that specific green practices, such as green purchasing, internal environmental management, collaborative efforts with customers, and recovery of investment costs, could lead to improved environmental performance and, in some cases, better operational efficiency. Nonetheless, as environmental challenges grew and market conditions changed, more scholars

began to question the role of GSCM, shifting from viewing it solely as a control mechanism for operations to recognizing it as an innovation driver for long-term value creation (Dangelico & Pujari, 2010; Dangelico, 2015). On the other hand, the concept of green innovation has gained increasing attention as an essential means for organizations to translate their environmental commitments into tangible environmental and economic benefits.

Green innovation refers to the development of new or significantly improved products, processes, and organizational practices that both reduce environmental impact and increase competitiveness (Dangelico & Pujari, 2010). In particular, green innovation is often seen as fundamentally systemic, extending beyond individual companies. It relies heavily on the capabilities of upstream suppliers, the demands of downstream customers, and the coordination of materials, information, and financial flows across the entire supply chain, making logistics and supply chain management essential to its success (Vachon & Klassen, 2006; Wong et al., 2012). Empirical studies increasingly show that practices such as green purchasing and supplier collaboration can significantly enhance green product and process innovations by promoting environmental knowledge sharing, joint problem-solving, and coordinated design activities (Chiou et al., 2011; Wong et al., 2012).

Furthermore, strong internal environmental management and cross-functional integration can further support organizational /managerial innovation by integrating environmental goals into strategic and operational decision-making (Zhu et al., 2013; Dangelico, 2015; Abdallah et al., 2024). Recent studies, particularly from emerging economies, also suggest that GSCM improves firms' performance primarily through green innovation. This reinforces the idea that innovation is a key driver of value creation rather than merely a matter of efficiency, compliance, or spillovers (Wen et al., 2023; Alia & Ratnamurni, 2025). However, despite this promising connection, the link between GSCM and green innovation remains underdeveloped and somewhat fragmented. While many studies (e.g., Chiou et al., 2011; Abdallah et al., 2024) find positive links between different GSCM practices and innovation results, they often do not explain how these practices actually change a firm's innovation abilities.

Vachon and Klassen (2006) and Zhu et al (2013) revealed that companies might adopt green purchasing or logistics mainly to satisfy regulatory or customer demands, without necessarily creating the learning routines, coordination structures, or design capacities needed to foster innovation. Similarly, GSCM practices can yield markedly different innovation outcomes across firms and contexts (Komakech et al., 2025). Additionally, much of the current research tends to view GSCM practices in a fragmented way, highlighting one specific aspect, such as green purchasing, eco-design, supplier collaboration, or reverse logistics, without much attention to how these practices might work together. This overlooks the interconnected nature of supply chains, in which innovation is most likely to emerge from the combined effects of multiple practices across organizational boundaries (Wong et al., 2012; Dangelico, 2015). Therefore, the role of GSCM in fostering green innovation in logistics-intensive settings warrants further exploration.

This study aims to explore how GSCM practices foster green innovation. It builds on a critical review and integration of existing literature on GSCM and green innovation, emphasizing a logistics and supply chain management perspective. Additionally, this study offers several contributions. First, it advances GSCM theory beyond mere descriptions and industry efficiency and compliance discourse to a deeper systemic understanding of GSCM as a driver of green innovation, grounded in coordination and capability development along the supply chain. Second, it translates these research insights into greater practical value for managers and policymakers by informing the design and alignment of GSCM practices that promote innovation in logistics-intensive supply chains. The following sections outline the methodology for the conceptual review, followed by a critical examination of the relevant literature on GSCM practices and green innovation. The final section will conclude and highlight implications for both research and practice

2. Methodology

This review is conceptual and aims to provide a supply chain (SC)-focused perspective for evaluating how GSCM practices support green innovation. The review design follows established criteria for evidence-informed reviews, ensuring transparency and rigor in the synthesis. The process combined evidence searching with iterative updating to maximize coverage and deepen understanding (Greenhalgh et al., 2005; Jesson et al., 2011; So & Xu, 2016; Komakech, 2025). Following the logic of content analysis used in operations and SCM reviews, the process of identifying and categorizing relevant studies was treated as a sampling step, followed by coding and interpretive synthesis (Spens & Kovács, 2006; So & Xu, 2016).

To gather evidence related to supply chain and operations research, the primary search tool was Google Scholar, selected for its broad coverage and citation chaining capabilities. The screening focused on peer-reviewed journal articles from top outlets within three overlapping areas: (a) supply chain and logistics (International Journal of Logistics Management, International Journal of Physical Distribution & Logistics Management, Supply Chain Management: An International Journal, Journal of Purchasing and Supply Management), (b) operations and production management (e.g., International Journal of Operations & Production Management, International Journal of Production Economics, International Journal of Production Research), and (c) sustainability and innovation journals where GSCM-innovation research is more frequently published (e.g., Journal of Cleaner Production, Business Strategy and the Environment, Journal of Business Ethics, International Journal of Business Innovation and Research, Business Strategy and the Environment, Technological Forecasting and Social Change). Selecting articles from specialized journals improves the comparability of the included studies and grounds the synthesis in influential works that shape the field (Seuring & Müller, 2008; Dangelico, 2015; Bocken et al., 2019; Komakech et al., 2025).

Articles were eligible for inclusion if they (1) examined at least one of the five GSCM practices of interest and (2) theorized or empirically reported any relationships with GI or related concepts. To ensure reliability, the authors excluded gray literature, such as theses and working papers, consistent with accepted practices in SCM reviews (Seuring & Müller, 2008; So & Xu, 2016; Komakech et al., 2025). The articles were coded to capture (i) the GSCM practice(s) examined and (ii) the green innovation (GI) dimensions. The synthesis then progressed through interpretive comparison. First, the reported findings were summarized to clarify the definitional scope of GSCM and GI concepts used in the literature. Second, the evidence was combined to provide an overview of the GSCM–GI relationship, highlighting which practices are most consistently associated with different innovation dimensions. Third, recurring patterns were used to develop research propositions that, based on the relative prevalence of different literature streams, represent the main narrative in the literature and explain observed variations in innovation outcomes particularly regarding implementation depth and practice complementarity without constructing a distinct theoretical model beyond the propositional logic of this review (Jesson et al., 2011; Spens & Kovács, 2006; So & Xu, 2016).

3. Results and Discussion

3.1. GSCM practices and green innovation

This section reviews the key concepts of GSCM and green innovation, synthesizes the literature, and develops a set of propositions that demonstrate how targeted GSCM practices lead to distinct green innovation outcomes across supply chains.

3.1.1 Green Supply Chain Management

GSCM involves incorporating environmental criteria into supply chain design, governance, and operations to improve environmental performance across upstream sourcing, internal processes, downstream logistics, and end-of-life recovery. GSCM differs from more organization-focused environmental management by extending responsibility beyond a single organization to involve interfirm relationships, logistics decisions, and lifecycle-oriented coordination that can significantly impact the environment (Srivastava, 2007). It is typically understood as a comprehensive set of practices encompassing governance, collaboration, design, and closed-loop logistics. The main internal and external practices include: internal environmental management, green purchasing, cooperation with customers and suppliers, eco-design, and investment recovery/reverse logistics.

The combination of these practices provides both an internal foundation and external interfaces that are vital for reducing lifecycle impact (Zhu & Sarkis, 2004; Zhu et al., 2008; Dangelico, 2015; Komakech et al., 2025). Internal environmental management provides the organizational infrastructure—such as policies, training, targets, measurement systems, and cross-functional coordination—that converts environmental goals into action. Green purchasing explicitly transforms these internal environmental goals into sourcing standards and supplier requirements. Collaboration with customers and suppliers encourages environmental knowledge sharing, joint problem-solving, and alignment among upstream and downstream partners. Eco-design efforts integrate environmental considerations into product design and development decisions, influencing material use, toxicity, disassembly, and recovery options. Reverse logistics and investment recovery complete the cycle by supporting product returns, reuse, refurbishment, remanufacturing, recycling, and value recovery where possible (Srivastava, 2007; Zhu et al., 2008; Komakech et al., 2025).

Therefore, GSCM should be viewed not just as a checklist of green practices but as a network of interrelated practices whose success and value depend on how well they are implemented and coordinated across different stages of the supply chain. On one hand, companies may adopt visible green practices, such as supplier screening or material recycling, to appear legitimate without gaining significant environmental or innovation benefits. This is more common when GSCM practices are weakly integrated, poorly coordinated, or added onto existing operations without proper interfaces to design and recovery infrastructure. On the other hand, when core internal and external practices like internal environmental governance, relational collaboration, and lifecycle-oriented logistics support each other, GSCM can serve as a unique capability platform, providing opportunities for continuous environmental improvement while also fostering more meaningful green innovation and operational renewal (Zhu et al., 2013; Dangelico, 2015).

3.1.2 Green Innovation

Green innovation is generally defined as new or significantly improved products, processes, and managerial practices that help firms and stakeholders cause less environmental harm and use natural resources more efficiently and effectively (Shrivastava, 1995; Antikainen & Valkokari, 2016; Dangelico, 2015). Earlier studies have distinguished GI from conventional innovation based on its clear environmental focus and its problem-solving approach aimed at pollution prevention and eco-efficiency (Dangelico & Pujari, 2010). Recent research has broadened this perspective by viewing GI as a capability-based outcome, influenced not only by a firm's internal R&D but also by supply chain coordination, environment-related knowledge sourcing and transfer, and institutional pressures (Dangelico, 2015; Wen et al., 2023).

Green innovations often require upstream input substitution and redesign to enhance logistics efficiency, as well as downstream product or parts recovery systems, all of which depend on coordinated investments and information sharing among multiple supply chain actors (Vachon & Klassen, 2006; Wong et al., 2012; Takalo & Tooranloo, 2021). Additionally, recent research shows that GI generally functions as a key performance-enhancing mechanism within GSCM, and its contribution to firm-level or even supply chain-level outcomes, such as increased profits or competitiveness, is especially significant in resource-constrained emerging markets. In these markets, innovative business solutions are vital for creating value (Wen et al., 2023; Padilla-Lozano et al., 2024; Alia & Ratnamurni, 2025). Therefore, in this study, GI is viewed as a supply-chain-enabled outcome driven by inter-firm learning, knowledge integration, and capability reconfiguration rather than by endogenous technological change within a single firm. The literature describes the GI construct as multidimensional, usually including four key aspects.

Green Product Innovation (GPI)

GPI involves designing or redesigning products to lessen environmental impacts throughout their entire life cycle, from raw material extraction and processing to manufacturing, usage, and end-of-life disposal (Dangelico & Pujari, 2010; Dangelico, 2015). Conceptually, this goes beyond simply adding "green features" to existing products; it may also require major changes to product design and material makeup. These modifications include substituting hazardous inputs with safer options, utilizing recycled or renewable materials, and redesigning products for modularity, durability, reparability, disassembly, or recyclability (Dangelico & Pujari, 2010; Srivastava, 2007). In many sectors, greening products also involves design tweaks to reduce transportation needs and enhance the recyclability of packaging. Additionally, it encompasses tailoring product designs for new circular practices, such as refurbishment and remanufacturing (Srivastava, 2007).

GPI is usually measured using count-based indicators, such as the number of environmentally improved products launched, the level of eco-design adoption, firm-reported reductions in toxic substances, energy efficiency improvements during product use, and product-level recyclability or repairability scores (Dangelico, 2015). Strategically, GPI can provide benefits for differentiation, legitimacy, regulatory compliance, and access to environmentally sensitive markets. However, its potential value is often limited when firms only add minor eco-attributes without redesigning their entire life-cycle impacts, or when the necessary collection and recovery infrastructure for recycling is missing or assumed to be available. This issue is especially common in emerging economies, where secondary markets and reverse logistics systems are typically less developed (Zhu et al., 2013; Srivastava, 2007).

Green process innovation (GPrI)

This involves advances in production and operational methods that reduce environmental impacts through cleaner technologies, pollution prevention, eco-efficiency improvements, and decreases in energy, water, emissions, and material waste (Dangelico & Pujari, 2010; Dangelico, 2015). In supply chain-heavy contexts, green process innovation also includes changes in logistics and distribution, such as route optimization, load consolidation, warehouse energy management, packaging process redesign, and modal adjustments that lessen environmental burdens in supply chain operations (Srivastava, 2007).

Operationalizations of GPrI in empirical studies employ indicators such as reductions in resource intensity (energy, water, materials), emissions intensity, and waste intensity, as well as the adoption of cleaner production systems and measurable eco-efficiency improvements (Dangelico, 2015). The value-creation logic of GPrI is often focused on cost and risk, since efficiency improvements can lower input and disposal costs while improving compliance and operational stability (Zhu et al., 2008; Green et al., 2012; Dangelico, 2015). However, many studies remain manufacturing-centric and underestimate the importance of logistics process innovation, despite its significance for supply chain outcomes. Efficiency gains do not always lead to meaningful environmental improvements when process innovations are fragmented and poorly coordinated across supply chain partners, or when scale or rebound effects in output offset gains (Srivastava, 2007; Zhu et al., 2013).

Green Managerial/ Organizational Innovation (GMI/GOI)

Green managerial/organizational innovation entails new or significantly improved management practices, governance routines, and organizational structures that embed environmental goals into decision-making, coordination, and control systems (Zhu & Sarkis, 2004; Zhu et al., 2008; Komakech et al., 2025). This includes environmental management systems, sustainability performance measurement, environmental training, cross-functional integration, and formalized supplier governance routines such as environmental auditing, monitoring, and development programs (Zhu et al., 2013). This aspect of GI often functions as the organizational infrastructure through which product and process greening are consistently executed and expanded, thereby influencing internal alignment, resource allocation, and the ability to access and incorporate external environmental knowledge into innovation efforts (Dangelico, 2015; Al-Swidi et al., 2023).

Empirically, green managerial innovation is most often measured using indicators such as EMS maturity, top management commitment, the presence of environmental KPIs, cross-functional teams, and supplier governance for environmental performance (Zhu et al., 2013; Dangelico, 2015). Its value is usually indirect, enhancing coordination, credibility, and learning. However, it also has well-documented limitations, such as firms adopting managerial systems symbolically to gain legitimacy without developing real innovative capacity. Additionally, resource constraints or weak enforcement environments can limit the depth of implementation, especially in developing and emerging economies (Zhu et al., 2013; Wen et al., 2023).

Green Business Model Innovation (GBMI)

Green business model innovation (GBMI) is a specific form of green innovation that focuses on redesigning a company's value-creation, delivery, and capture processes so that environmental improvements become a central part of the product lifecycle (Geissdoerfer et al., 2017). In the sustainability and circular economy literature, GBMI is viewed as a powerful type of innovation because it reshapes incentives, revenue models, and stakeholder roles rather than just enhancing the efficiency of individual processes or product features (Bocken et al., 2014; Geissdoerfer et al., 2017). Therefore, GBMI is seen as a part of green innovation that goes beyond simple "greening," involving more substantial reconfigurations such as product–service systems (PSS), outcome- or performance-based contracting, take-back and refurbishment programs, remanufacturing and reuse networks, and circular value propositions that preserve value and reduce resource throughput (Bocken et al., 2014; Yang et al., 2019; Antikainen et al., 2021; Komakech, 2025). Its main characteristic is shifting from selling units to delivering functionality or outcomes, for instance, uptime, mobility, and reliability, thereby promoting the design of products for durability, repairability, and recoverability, and the management of them over longer lifespans (Yang et al., 2019; Antikainen et al., 2021).

GBMI is assessed using portfolio- and system-level metrics, such as revenue from services, subscriptions, or refurbished products; participation in take-back programs; recovery and refurbishment yields; utilization rates; and the extent to which it extends product lifespans. It can also relate to the extent to which the ecosystem is reconfigured through formal partnerships and governance structures (Yang et al., 2019; Antikainen et al., 2021). At a strategic level, GBMI has strong potential to create value by increasing asset productivity, securing resource access through recovery and reuse, developing new revenue streams, and boosting resilience to material volatility. It largely depends on supporting infrastructure rather than other forms of innovation. It requires consumer engagement, credible quality assurance of secondary goods, and governance mechanisms such as ownership, warranties, and liability arrangements (Geissdoerfer et al., 2017; Bocken et al., 2019).

Therefore, the GBMI literature highlights existing friction points. Companies might adopt visible technical practices, such as recycling, but encounter difficulties in redesigning and restructuring core incentive and governance systems to fully enable GBMI. In emerging markets, the environmental benefits of GBMI may be less clear due to weaker standards, trust, and consumer awareness, as well as limited access to financing, even though GBMI concepts have strong theoretical potential (Bocken et al., 2019; Geissdoerfer et al., 2017). Section 3.3 will thus outline key GSCM practices and connect them to opportunities for green product, process, managerial, and business model innovation.

3.1.3 The Nexus between GSCM Practices and Green Innovation

The GSCM–GI relationship is most clearly seen in specific practice areas that guide firms' green goals in purchasing, production, and logistics decisions (e.g., green purchasing, supplier collaboration, eco-design, reverse logistics, and internal environmental management). Zhu and Sarkis (2004) and Srivastava (2007) conceptualized GSCM. They viewed environmental value creation as extending beyond the focal firm's activities, since impacts and improvements come from upstream sourcing, logistics execution, and end-of-life recovery. Studies (such as Vachon & Klassen, 2006; Zhu et al., 2008; Green et al., 2012) support this by showing that GSCM involves more than just a series of green activities. It also includes routines that change supply chain decision-making, information flows, and partner alignment, thereby creating conditions for innovation.

Recent GSCM theorizing positions GI as a key pathway through which GSCM can achieve performance and sustainability outcomes, especially in contexts with infrastructure gaps or resource shortages (Dangelico, 2015; Wen et al., 2023; Alia & Ratnamurni, 2025). Building on this body of work, the GSCM–GI relationship can be effectively understood as a practice-to-mechanism relationship, where each core GSCM practice activates distinct learning, coordination, and capability reconfiguration processes that ultimately drive green product, process, and managerial innovation (Dangelico & Pujari, 2010; Zhu et al., 2013).

Green purchasing

Green purchasing is a crucial driver of innovation and closely connected to GPI, as purchasing decisions involve choosing inputs, components, and materials with environmental qualities that directly affect product design and lifecycle impacts (Srivastava, 2007; Komakech et al., 2025). However, a limitation in the green purchasing literature is that it's often seen as supplier screening or compliance checks that may improve environmental conformity but do not necessarily foster innovation capability (Zhu et al., 2008; Zhu et al., 2013; Komakech, 2025). Genuine green purchasing that promotes innovation involves including environmental criteria in sourcing specifications, supplier development, and early supplier involvement, which helps transfer environmental knowledge and enables the co-creation of greener inputs supporting major product redesign (Chiou et al., 2011; Wong et al., 2012; Ghosh, 2019). This distinction explains why seemingly similar green purchasing efforts can produce different innovation outcomes across firms and contexts (Zhu et al., 2013).

P1: Green purchasing is positively associated with green product innovation.

Collaboration with supplier and customer (CSC)

Supplier collaboration enhances upstream dynamics by shifting the focus from simple transactions to relational learning and co-development; these two mechanisms are considered essential for achieving innovation performance that involves experimentation and co-investment. Previous research on integration has shown that inter-firm collaboration improves environmental and operational performance through cross-boundary information sharing and joint action (Vachon & Klassen, 2006; Lee & Kim, 2012; Bai et al., 2024). Studies explicitly connecting collaboration to GI have demonstrated that environmental problem-solving, co-design, and shared learning with suppliers are associated with green product and process innovation.

The literature shows that collaboration serves as a boundary condition that distinguishes symbolic GSCM adoption from innovation-driven implementation. Cooperation between suppliers and customers enhances learning, knowledge sharing, and coordinated actions, which are key to green innovation outcomes (Vachon & Klassen, 2006; Wong et al., 2012; Zhu et al., 2013). For example, Zhu et al. (2013) and Dangelico (2015) show that collaboration can improve absorptive capacity, lower uncertainty, and align incentives for innovation investments. However, studies by Dou et al. (2018) and Wen et al. (2023) emphasize the importance of contextual boundaries. Collaboration alone offers limited benefits for innovation if trust, enforceable contracts, or supplier technological readiness are missing. It needs to be combined with capability building and supportive institutional structures.
P2: Collaboration with suppliers and customers is positively related to (a) green product innovation and (b) green process innovation.

Eco-design

Eco-design's key role at the product–process interface makes it relevant to GPI and a form of GPrI. Eco-design translates environmental goals into design principles, such as modularity, disassembly, non-toxicity, material reduction, and recyclability, that decrease life-cycle impacts and adjust manufacturing and logistics needs (Srivastava, 2007; Dangelico & Pujari, 2010; Komakech, 2025). Empirically, eco-design is often used as a proxy for the strength of design-for-environment (DFE) efforts and the development of Environmental Innovation Practices (EIPs). In contrast, process innovation focuses on cleaner production, pollution prevention, and improved resource and emissions efficiency (Dangelico, 2015). The main point is that eco-design often fails to generate scalable innovation if supply chain conditions don't support new practices; for example, procurement may struggle to obtain compliant inputs, suppliers might not meet redesign requirements related to process capability or volume, or downstream recovery and processing may conflict with the planned end-of-life strategy (Zhu et al., 2013; Srivastava, 2007). This explains why promising eco-design initiatives, from both analytical and design perspectives, often produce mixed operational results without sufficient supply chain support; design innovation is unlikely to scale.
P3: Eco-design is positively related to (a) green product innovation and (b) green process innovation.

Reverse logistics

Reverse logistics relates to GBMI and GPrI within the scope of learning and process renewal. Reverse flows such as collection, sorting, grading, refurbishing or remanufacturing, and resale can enhance product redesign and process efficiency through learning. Nevertheless, they also have the potential to be strategically transformative when linked to new value propositions and revenue models (Srivastava, 2007; Zhu et al., 2008; Komakech et al., 2025). Circular economy (CE) research is also relevant here, as it demonstrates that business model innovation can alter stakeholders' incentives and roles rather than solely focusing on operational performance (Bocken et al., 2014; Geissdoerfer et al., 2017; Komakech, 2025). GBMI is evident in models like product–service systems, take-back and refurbishment programs, and remanufacturing networks, which are enabled by reverse logistics infrastructure, customer support, and ecosystem governance to facilitate circular value capture (Bocken et al., 2014; Bocken et al., 2019; Montevecchi et al., 2021). Notably, tools and frameworks for circular BMI are rapidly expanding. However, implementing them often falls behind because redesigning a business model is a collective action challenge that requires coordination among many actors, reliable information, and operational capabilities. This can be particularly difficult in emerging markets (Bocken et al., 2019). Therefore, reverse logistics only support GBMI if they are backed by governance, verification, and service ecosystems that ensure returns and build trust in the secondary market.
P4: Reverse logistics is positively associated with (a) green process innovation and (b) green business model innovation.

Internal environmental management (IEM)

This serves as the organizational foundation most closely linked to green managerial/organizational innovation (GO/MI), playing a crucial role in whether other practices evolve into capability-building efforts or stay merely symbolic. IEM encompasses routines such as environmental management systems (EMS), training, auditing, key performance indicators (KPIs), cross-functional integration, and managerial accountability that formalize environmental priorities in decision-making and resource allocation within the organization (Zhu & Sarkis, 2004; Zhu et al., 2008; Komakech et al., 2025). The key insight is that IEM is often a primary factor influencing the adoption of practices. Without internal routines, implementing external practices such as purchasing, collaboration, and reverse logistics can be superficial, compliance-focused, or disconnected, which hampers learning and the spread of innovation throughout the company (Zhu et al., 2013; Dangelico, 2015). Conversely, IEM also fosters organizational readiness for change; when well-developed, companies are better equipped to align procurement, design, operations, and logistics with environmental goals. This is vital for sustained green process innovation (GPI) and green product innovation (GPrI), as well as for the governance changes at the core of green business model innovation (GBMI) (Zhu et al., 2013; Bocken et al., 2014).

P5: Internal environmental management is positively associated with green organizational/ managerial innovation.

The GSCM innovation literature provides several recommendations for understanding variability in green innovation across different organizational contexts. A key theme from these studies is that inconsistent innovation outcomes can be explained by two system-level factors in GSCM practice implementation (such as implementation depth and practice complementarity). Implementation depth refers to the extent to which a firm's GSCM is integrated as a capability embedded in decision rights, performance standards, learning routines, and resource allocations rather than a symbolic response to superficial compliance. Therefore, these studies suggest that GSCM, when integrated as a core capability, is more likely to produce consistent and positive innovation outcomes than practices that are not owned by the organization and are merely routinized (Zhu et al., 2013; Dangelico, 2015).

Practice complementarity shows that GSCM practices depend on each other across supply chain functions: green purchasing and supplier/customer collaboration increase a company's environmental knowledge and supply of environmental inputs; eco-design turns environmental inputs into practical redesign choices affecting production and recovery options; reverse logistics supports returns and value recovery; and internal environmental management offers governance structures to coordinate and monitor these functions. As a result, the effect of any GSCM practice is stronger when it supports other practices and is implemented as an integrated system instead of separately (Srivastava, 2007; Vachon & Klassen, 2006; Zhu et al., 2008).

P6: The positive link between GSCM practices and green innovation is stronger when implementation depth is high.

P7: The positive relationships between GSCM practices and green innovation are more significant when GSCM practices are used together and implemented jointly.

4. Conclusion and Implications

This conceptual review aims to deepen the understanding of GSCM practices as drivers of green innovation within the supply chain. By integrating foundational and recent literature, the review shows that credible accounts of green innovation are not just about being green or general outcomes, but rather practice-enabled capabilities that emerge from coordinating supply chain routines. The most consistent practices for fostering innovation identified across the literature include green purchasing, supplier collaboration, eco-design, reverse logistics, and internal environmental management, each supporting distinct but overlapping innovation pathways. The review clarifies that innovation results are strongest when these practices are implemented as an integrated system across upstream, internal, and downstream interfaces, rather than as isolated or compliance-driven activities.

4.1. Implications

4.1.1. Theoretical Implications

First, it positions GSCM as a foundation for green innovation, rather than a result. The function of innovation is often assumed but not directly analyzed in the literature. Innovation can therefore be easily overlooked or undervalued as a “co-benefit” of environmental adoption. Most empirical studies have also found positive relationships but have provided limited explanations regarding supply chains, remaining largely implicit.

Second, it offers a mapping of GSCM practices to the green innovation dimensions they correspond with. It explains how upstream practices such as green purchasing and supplier collaboration “pull” green product innovation by providing greener inputs and co-developing, how eco-design makes the knowledge from upstream practices actionable for design-led innovation, and how reverse logistics and recovery routines drive process innovation through learning and feedback effects. Internal environmental management practices are also described as facilitating managerial and organizational innovation by institutionalizing cross-functional coordination and environmental routines. This mapped approach enhances clarity and minimizes the tendency to see GSCM and green innovation as vague collections of related yet separate constructs.

Third, the paper suggests that the link between GSCM and green innovation should be seen as a system of interconnected routines rather than as separate practices. This system perspective clarifies the mixed results found in studies; therefore, innovation is influenced not only by the presence of specific practices but also by how these practices connect, link, and evolve through different stages of the supply chain. This approach also offers potential as a future framework to guide research on groups or combinations of GSCM practices.

4.1.2. Managerial/ Practical Implications

From a managerial perspective, the main contribution of this review is to clarify the existing evidence on how to increase the chances that GSCM initiatives lead to green innovation. It shows that green innovation is more likely when the focal firm views GSCM as an integrated innovation system rather than just a collection of separate initiatives. The practical implications for managers based on these findings include: (i) using green purchasing not only to screen suppliers but also to support supplier development and collaboratively establish shared environmental standards; (ii) investing in routines with suppliers to enable joint problem-solving and co-design; (iii) aligning eco-design routines with procurement specifications and downstream recovery needs; (iv) expanding reverse logistics to facilitate recovery feedback and incorporate it into product redesign; and (v) developing internal environmental management routines to ensure cross-functional integration of procurement, logistics, operations, and product development. These managerial insights go beyond general calls for increased sustainability by pinpointing specific routines that can be invested in to improve the likelihood of green product, process, and organizational innovations.
For policymakers, this review emphasizes that innovation-driven GSCM succeeds when institutions support supply-chain coordination, credible verification, and ongoing investment among interconnected companies. The policy implications include enhancing supplier capacity development, supporting standards and traceability infrastructure to reduce information gaps, and encouraging and incentivizing recovery and reverse logistics systems to promote closed-loop learning. The review also explains that, in emerging economies, well-designed policies should aim to overcome structural barriers, such as inadequate recovery logistics or low supplier upgrading capabilities, which prevent firms from turning environmental practices into innovative results. This provides a practical guide for moving beyond mere compliance and transforming GSCM into a true innovation capability.

4.1.3. Social Implications

The paper emphasizes that the social value of innovation-driven GSCM goes beyond just meeting regulations and environmental targets. It seeks to reshape GSCM practices by promoting employee well-being, benefiting communities, and supporting economic inclusion. First, green purchasing and collaboration with suppliers and customers can help raise labor and environmental standards across supply chains through activities like supplier audits, development programs, and joint capacity-building efforts. This can lead to safer workplaces, less exposure to hazardous materials, and better compliance with social and environmental laws, especially in high-risk sourcing areas. Second, eco-design and green process innovations can cut local pollution, including air emissions, wastewater, and toxic substances, directly improving public health and quality of life around industrial hubs and logistics routes. Third, reverse logistics and circular-economy innovations can create new, better jobs in repair, refurbishment, remanufacturing, and recycling, offering more livelihood opportunities for SMEs and informal-economy workers. Finally, the review highlights that setting safety standards and ensuring fair working conditions in recovery activities are essential to prevent social problems that could arise from environmental gains.

4.1.4. Limitations and future research directions

This review is mainly conceptual and has several limitations. First, by following the traditional format of a conceptual review, it emphasizes analytical depth and theoretical synthesis rather than offering a complete overview of all published studies. While this approach helps develop theory, it results in a synthesis influenced by interpretive judgment and the limitations of the reviewed literature. Second, the review does not assess effect sizes or establish causal links between specific GSCM practices and outcomes in green innovation; instead, it aims to clarify concepts and pathways for practice. Third, although the review emphasizes the importance of practice configurations and complementarity, it does not empirically determine which configurations are most effective across different sectors or firm sizes.
These limitations point to several promising directions for future research. First, empirical studies could explore how bundles of practices, rather than individual practices alone, affect different aspects of green innovation and whether

complementarities or substitutions exist among them. Second, additional research is needed to clarify the sequence and maturity of practices, specifically, whether certain practices (such as internal environmental management and green purchasing) are prerequisites for implementing more innovation-driven practices (like eco-design and reverse logistics). Third, scholars should improve measurement approaches by developing and validating more precise indicators that capture the multidimensional nature of green innovation and distinguish between symbolic and substantive GSCM implementations. Fourth, comparative studies across sectors and supply chain structures could reveal whether the relationship between GSCM and innovation varies systematically between logistics-intensive and service-oriented supply chains. Finally, future research could expand conceptual integration by examining how governance mechanisms such as contracts, relational governance, standards, and digital traceability affect the effectiveness of GSCM practices in fostering innovation, especially in contexts where supply chains interact with diverse regulatory and infrastructural environments.

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