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**Reimagining logistics for sustainability: Green logistics practices,
circular economy integration, and digital enablers in sustainable
supply chain management**

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Abstract: The global push toward sustainability has redefined the role of logistics in supply chain management, demanding a transition from, cost-driven operations to integrated systems aligned with circular economy principles and digital innovation. This study synthesizes findings from peer-reviewed journal articles published between 2020 and 2025 to examine how green logistics practices, digital technologies, and institutional frameworks intersect to advance sustainable supply chain performance. Guided by theoretical frameworks including the Resource-Based View (RBV), Dynamic Capabilities Theory (DCT), Triple Bottom Line (TBL), and the Technology Acceptance Model (TAM), the study identifies three thematic pillars, including green and circular logistics strategies, enabling digital technologies such as digital twins, blockchain, and IoT, and institutional conditions such as policy coherence, leadership, and collaborative governance. The results demonstrate that closed-loop logistics, lifecycle-oriented procurement, and reverse flows are effective in reducing emissions and resource dependency, particularly when supported by enabling procurement policies and organizational readiness. Digital tools enhance emissions tracking and supply chain visibility, but face challenges related to interoperability, data governance, and unequal access. Institutional alignment, across policy, partnerships, and internal capabilities, is critical for scaling sustainable logistics. However, contextual asymmetries persist, especially in emerging markets and SMEs. The study concludes by calling for cross-sector collaboration, policy reform, and firm-level capacity building to embed sustainability in logistics systems. Future research should address real-world performance of digital tools, institutional effects on logistics transformation, and the development of holistic sustainability indicators.

Keywords: Sustainable logistics, Circular economy, Green supply chains, Digital twins, Blockchain, IoT, Institutional enablers, Reverse logistics, Procurement, Dynamic capabilities

1. Introduction

Global sustainability challenges have significantly disrupted the design and functioning of traditional logistics and supply chain systems, prompting an urgent transition from linear, cost-driven logistics models to sustainable, circular, and innovation-enabled frameworks. In response, organizations are increasingly investing in green logistics practices that reduce carbon emissions, optimize transportation networks, and enhance environmental stewardship across the supply chain (Chin et al., 2015; Nautwima & Asa, 2022; Osman et al., 2023). This shift reflects growing societal and policy demands for responsible supply chain operations and marks a transformative departure from logistics functions that prioritized speed and scale over environmental performance (Tetteh et al., 2025). As the global economy accelerates its pivot towards low-carbon and circular models, rethinking the structure and strategy of logistics systems has become a strategic imperative for firms seeking long-term resilience

and sustainability. Beyond climate concerns, the integration of circular economy principles within supply chain logistics has amplified attention on reverse logistics, waste valorization, and closed-loop material flows (Mayanti & Helo, 2024; Nautwima et al., 2023; Theeraworawit et al., 2022). These circular frameworks challenge conventional supply chain designs and demand robust reconfiguration of logistics to support reuse, remanufacturing, and redistribution across industrial ecosystems (Asa et al., 2023; Quintana et al., 2024). Yet, implementing these practices remains difficult in practice due to system inefficiencies, high costs of reverse flows, and fragmented governance structures, particularly in developing economies.

Meanwhile, digital transformation has emerged as a critical enabler of sustainable logistics, with technologies such as digital twins, blockchain, and IoT facilitating real-time monitoring, traceability, and energy-efficient routing (Bandara & Buics, 2024; Lu et al., 2023; Nautwima et al., 2022; Öztürk, 2025). These innovations allow organizations to optimize operations while meeting sustainability goals, closing the gap between ambition and implementation (Asa & Nautwima, 2025). Recent literature further reveals the importance of strategic and institutional factors in scaling sustainable logistics across global supply chains. For instance, Kamra et al. (2024) link green supply chain management (GSCM) with firm-level performance improvements, showing that environmental collaboration and compliance can deliver both operational and reputational gains.

Moreover, bibliometric evidence suggests that digital transformation, catalyzed by the COVID-19 pandemic and net-zero targets, is not only reshaping logistics processes but also research priorities in the field (Chilicaus et al., 2025). Emerging tools like digital product passports are helping to operationalize circular economy strategies within logistics, though their success depends heavily on regulatory readiness and supply chain coordination (Zhang & Seuring, 2024). Broader research in transportation and resource recovery underscores how systemic integration of sustainability principles into logistics networks contributes to economic regeneration and environmental stewardship (Kirchherr et al., 2023; Yu et al., 2022; Zhang et al., 2022). This literature review synthesizes these empirical and conceptual insights to critically examine how logistics is evolving as a strategic enabler of sustainable supply chain management. It explores the convergence of three core dimensions, encompassing (1) operational practices and green logistics innovations that promote ecological efficiency; (2) digital technologies that enhance logistics visibility and coordination; and (3) institutional drivers that shape the incentives and constraints for sustainable logistics implementation.

This study draws on several influential theoretical frameworks to guide the synthesis. The Resource-Based View (RBV) offers a foundational lens for understanding how internal capabilities, such as data infrastructure, green competencies, and logistics innovation, confer competitive advantage under sustainability constraints. Studies applying RBV to logistics contexts emphasize the role of strategic resources in navigating environmental volatility, enhancing supply chain visibility, and sustaining green performance (Komakecha et al., 2024; M. Kumar et al., 2024; Sharma et al., 2022). As firms face increasing environmental complexity, the ability to mobilize these internal resources becomes essential to sustainability-oriented transformation. Building on this, Dynamic Capabilities Theory (DCT) underscores the adaptive capacity of firms to reconfigure logistics operations in the face of uncertainty. Dynamic capabilities such as sensing, learning, and innovation allow firms to adjust logistics strategies in response to regulatory changes, stakeholder expectations, and environmental shocks (Alzate et al., 2024). Recent research has shown that such capabilities are particularly critical for SMEs and emerging market firms seeking to build resilient and sustainable supply chains (Alzate et al., 2022). Teece (2009) reinforces this argument by linking dynamic capability development with long-term strategic renewal and innovation-led growth in logistics systems. Simultaneously, the Triple Bottom Line (TBL) framework offers a multidimensional evaluation model that integrates environmental, social, and economic outcomes in logistics performance assessments. Scholars argue that logistics sustainability must transcend cost metrics to account for its broader contributions to carbon reduction, worker well-being, and community development (Mishra et al., 2024; Tundys & Wiśniewski, 2023). Elkington (1998) guides the evaluations of logistics sustainability, particularly in research examining ethical sourcing, energy use, and waste reduction across supply chains.

Finally, the Technology Acceptance Model (TAM) helps to explain how supply chain actors adopt emerging logistics technologies. Studies applying TAM to logistics contexts identify perceived ease of use, usefulness, and

trust as critical variables influencing the uptake of innovations such as e-logistics platforms, digital routing systems, and sustainability dashboards (Revythi & Tselios, 2019; Wang & Zhao, 2023). Bienstock and Royne (2010) extends this view by linking technology acceptance with user satisfaction and service quality in logistics settings, showing that digital enablement must be matched with behavioral readiness and systemic support. Accordingly, this study is guided by the following overarching research question to contribute to a multidimensional understanding of sustainable logistics and identify emerging priorities for policy, practice, and scholarship: How have recent studies addressed the interplay between green logistics practices, digital technologies, and institutional enablers in advancing sustainable supply chain management? To support this inquiry, the study explored three sub-questions:

1. What green logistics practices and circular economy strategies have proven effective in enhancing environmental performance within sustainable supply chains?
2. Which technological innovations, including digital twins, IoT, and blockchain, are enabling sustainable logistics performance, and what factors affect their adoption and effectiveness?
3. How do institutional conditions, such as policy frameworks, stakeholder partnerships, and organizational capabilities, enable or constrain the implementation of sustainable logistics strategies across different contexts?

3. Methodology

This study adopts a narrative literature review approach to examine how logistics transformation has been theorized and operationalized to support sustainable supply chain management across green practices, technological innovations, and institutional enablers. The aim was to synthesize conceptual perspectives and empirical contributions from a wide selection of academic journal articles to identify prevailing themes, research gaps, and theoretical developments in the field of sustainable logistics. Unlike systematic literature reviews that follow predefined protocols, keyword matrices, and replicable search procedures, the narrative review method enables a more interpretive and flexible engagement with literature, particularly when examining interdisciplinary topics such as logistics, sustainability, and technology integration. According to Snyder (2019), the narrative review is well suited for studies that seek to build theoretical insight across heterogeneous bodies of literature, especially when the field is evolving or spans multiple disciplines. Similarly, Paré and Kitsiou (2016) highlight that narrative reviews enable researchers to critically evaluate conceptual developments and context-specific insights without being restricted to rigid search criteria or inclusion filters. This approach was therefore appropriate for the present study, which draws from logistics management, operations research, environmental studies, and supply chain strategy. The review includes 35 peer-reviewed journal articles, selected for their relevance to the three thematic domains under investigation:

- a) green logistics and circular economy practices,
- b) digital and technological enablers in logistics, and
- c) institutional and organizational factors influencing logistics sustainability.

To ensure scholarly quality, only articles published between 2020 and 2025 were included with the selection limited to journals indexed in Scopus, Web of Science, and recognized platforms such as ScienceDirect, SpringerLink, Taylor & Francis, and Wiley Online Library. As Greenhalgh et al. (2018) argue, a well-executed narrative review must balance breadth with thematic coherence, using critical reading and synthesis to draw connections and contrast across studies. This process allows the exploration of theoretical applications (such as RBV, TBL, and TAM) and empirical patterns in logistics research without limiting the scope to a narrow methodological paradigm. Each article was read in full and assessed for its thematic relevance, methodological design, theoretical contribution, and empirical insights. A summary table (Table 1) was developed to record key attributes of each study, including author(s), publication year, conceptual framework, method used, and key findings. This structured mapping supports a comparative analysis across thematic clusters, helping to surface dominant narratives, regional perspectives, underexplored areas, and methodological trends in the logistics-sustainability interface. The matrix also supports analytical consistency and transparency in the review process, as recommended by Torraco (2005) in narrative synthesis methodologies. The narrative approach also enables the integration of theoretical interpretation alongside practical logistics innovation, allowing the study to bridge gaps between academic discourse and applied strategy. In line with the notion of Baumeister and Leary (1997), the purpose of this review is not merely to summarize prior findings, but to organize knowledge into coherent categories that inform both scholarly understanding and managerial implications, precisely, in this case, the context of sustainable supply chains.

Table 1. Overview of the reviewed articles

Author(s) and Year	Focus Area	Methodology	Key Findings
Tetteh et al. (2025)	Circular logistics and remanufacturing	Quantitative modeling	Reverse logistics reduces emissions and resource use
Letunovska et al. (2023)	Green sourcing and procurement policies	Survey and case analysis	Green procurement drives circular logistics adoption
Osman et al. (2023)	Closed-loop supply chains	Simulation model	Cap-and-trade logistics design improves environmental outcomes
Malhotra (2024)	Circular economy lifecycle strategies	Conceptual paper	Lifecycle-based procurement improves agility and resilience
González-Sánchez et al. (2020)	Closed-loop logistics models	Literature review	Material looping and EPR improve circularity at scale
Chandan et al. (2023)	Design-recovery nexus in circular supply chains	Qualitative synthesis	Upstream design decisions affect downstream recovery
Villar et al. (2023)	System-level circular supply chain	Case study analysis	Structural integration reduces environmental impact
Zhang et al. (2022)	Green criteria in procurement	Empirical study	Procurement policies shape waste valorization
Hyun et al. (2023)	Circular procurement and policy	Framework development	Policy-linked procurement supports reverse logistics
Nikseresht et al. (2024)	Collaborative reverse logistics	Survey-based research	Digital coordination improves reverse flows
Ji-Hyland et al. (2025)	IoT and RFID for logistics	Quantitative model	RFID and blockchain boost reverse logistics efficiency
Ghasemi et al. (2024)	Digital Product Passport	Structured review	DPP enables material traceability and recycling
Mayanti & Helo (2024)	Carbon-efficient logistics	Multi-criteria modeling	Closed-loop systems reduce emission under regulation
Kamble et al. (2022)	Digital twins in logistics	Review and framework	Digital twins optimize routing and forecast emissions
Guo & Mantravadi (2024)	Lean logistics and digital twins	Empirical simulation	DT minimizes waste and supports lean systems
Kajba et al. (2023)	Scenario planning with digital twins	Simulation model	Scenario forecasting supports carbon reduction
Suhail et al. (2022)	Smart contracts in blockchain logistics	Design-based model	Smart contracts automate sustainability compliance
Liu et al. (2022)	Digital twin-blockchain integration	Case-based simulation	Integration ensures green verification traceability
Da et al. (2023)	IoT-based emissions tracking	Sensor-based modeling	Real-time IoT enables low-carbon logistics control
Idrissi et al. (2024)	Cold chain IoT and blockchain	Survey and architecture	IoT ensures traceable, sustainable temperature control
Botta et al. (2023)	Barriers to blockchain adoption	Mixed methods	Data governance and cost hinder blockchain scaling
Abdillah & Wahyuilahi (2024)	Digital transformation challenges	Survey research	Trust and digital literacy limit tech adoption
Bandara & Buics (2024)	Digital governance in logistics	Qualitative case study	Leadership and training enable tech integration
Breuer et al. (2023)	Policy coherence in logistics	Comparative policy analysis	Aligned policies improve sustainability outcomes
Basit et al. (2024)	Macro- vs. micro-policy impact	Survey-based research	Lack of enforcement weakens sustainability
Yu et al. (2022)	Vertical policy integration	Institutional analysis	Disjointed collaboration limits scalability
Siems et al. (2022)	Stakeholder partnerships	Case-based evaluation	Inclusive collaboration improves logistics design
Ganeshu et al. (2023)	Governance in resource-constrained settings	Qualitative fieldwork	Partnerships enable logistics reform
A Framework... (2024)	3PL environmental benchmarks	Conceptual framework	Cooperation essential for sustainability in 3PLs

Osei et al. (2023)	Environmental culture and logistics	Organizational survey	Internal stewardship predicts green investment
Kumar et al. (2023)	Leadership and logistics innovation	Firm-level regression	Top management drives green logistics
Lozzi et al. (2022)	Adaptability during crisis	Case study	Adaptability ensures sustainable delivery
Kareem et al. (2023)	Sustainability in crisis settings	Systematic review	Crisis diverts focus unless sustainability is institutionalized
Correggi et al. (2024)	Dynamic capabilities for sustainability	Conceptual synthesis	Capabilities ensure adaptive green performance
Komakecha et al. (2024)	RBV in sustainable logistics	Literature review	Strategic resources support long-term transformation

Source: Authors' construct (2025)

3. Thematic Synthesis

3.1. Green logistics practices and circular economy strategies enhancing environmental performance

Figure 1 shows the documents publication trend on balance scorecard concept from the year 1996 to 2024. It can be noted that the concept of balance scorecard gained attention from academics in the year 1996. This is supported by the study of Hegazy and Tawfik (2015) which states that the balance scorecard was developed by Kaplan and Norton and it attracted attention from academics and practitioner with recent development of organisational world. Additionally, this can be supported by the study Akkermans & Van Oorschot (2005) which states that decades ago, Harvard Professors Johnson and Kaplan renounced the traditional financial measures as the rightful way to measure the corporate performance and developed the balance scorecard, including measurement on both financial and non-financial.

3.1.1. Reverse Logistics and Closed-Loop Systems

Reverse logistics and closed-loop supply chains are consistently cited as foundational strategies for achieving circularity and minimizing environmental degradation. Facilitating the return, remanufacturing, reuse, or recycling of goods and materials reduces both the waste and environmental burden of resource extraction and disposal. Tetteh et al. (2025) identify remanufacturing, refurbishment, and recycling as critical components of circular logistics systems, noting that these operations reduce energy consumption and emissions associated with primary production. Similarly, other studies emphasize the integration of closed-loop logistics as a necessary shift from traditional linear models, particularly under environmental regulatory schemes such as cap-and-trade mechanisms, which incentivize carbon-efficient logistics design (Mayanti & Helo, 2024; Osman et al., 2023). Additionally, optimization-based models have also been proposed to formalize and evaluate green supplier selection within closed-loop systems. Mirzaee et al. (2023) incorporate carbon trading costs into supplier evaluation, demonstrating that such mechanisms can align economic and environmental performance when logistical decision-making internalizes sustainability constraints. These findings indicate that reverse flows and closed-loop configurations, especially when supported by regulatory and financial instruments, are effective levers for environmental improvement across supply chains.

3.1.2. Circularity Integration and Lifecycle-Based Strategies

Several studies underscore the importance of embedding circular economy principles across the full lifecycle of products and materials, including design, production, distribution, and end-of-life stages. Precisely, prior research reveals that circular economy practices such as modular product design, sustainable sourcing, and lifecycle-oriented procurement improve resource productivity while also enhancing supply chain agility and resilience (Letunovska et al., 2023; Malhotra, 2024). These practices are especially effective when aligned with logistics strategies that prioritize eco-efficiency in transportation, warehousing, and packaging systems. Moreover, the concept of the “circular supply chain,” integrates logistics into broader circular transitions by linking upstream design decisions to downstream recovery processes (Chandan et al., 2023; González-Sánchez et al., 2020). These studies highlight the effectiveness of material looping, industrial symbiosis, and extended producer responsibility in achieving circularity at scale. Villar et al. (2023) show that integrating circular economy principles at the system level leads to reductions in environmental impact while fostering long-term structural adaptability to market and environmental shocks. Circularity requires a strategic rethinking of logistics flows and incentive structures. Evidence in the literature demonstrates that procurement policies emphasizing environmental performance, such as green sourcing criteria, directly influence reverse logistics outcomes and waste valorization, reinforcing circularity across supply chain tiers (Letunovska et al., 2023; Zhang et al., 2022). This suggests that environmentally aligned procurement decisions do not only shape supplier behavior, but they also strengthen systemic material recovery and reuse throughout the supply chain.

3.1.3. Digital Enablers and Collaborative Platforms

Digital innovations and inter-organizational collaboration significantly enhance the implementation and effectiveness of green logistics and circular strategies. Zhang and Seuring (2024) exemplify how traceability and data transparency can enable closed-loop logistics by providing real-time information about product composition, lifecycle status, and environmental impacts. Ji-Hyland et al. (2025) also highlights the role of digital technologies such as Radio Frequency Identification (RFID), blockchain, and IoT in monitoring reverse flows, improving recovery rates, and reducing logistical inefficiencies. Moreover, digital infrastructure supports the operationalization of collaborative circular models. Nikseresht et al. (2024) unpacks that logistics actors increasingly rely on information-sharing systems and cooperative platforms to coordinate returns, pooling, and reverse distribution, especially in multi-tier supply chains with high complexity. Additionally, González-Sánchez et al. (2020) highlight technological readiness and digital maturity as key mediators in the successful adoption of green logistics solutions, indicating the interdependence of digital and

environmental capabilities. Lastly, institutional support and policy alignment remain essential for implementation. Early studies emphasize that without supportive regulatory structures, even well-designed digital or circular initiatives may fail to scale due to cost, interoperability, or data governance issues (Ji-Hyland et al., 2025; Osman et al., 2023).

Overall, green logistics practices are highly effective in reducing environmental impacts across supply chains when embedded within the circular economy frameworks. Their success is further magnified by digital traceability tools and collaborative infrastructures that support information flow, transparency, and coordinated action. The effectiveness of these strategies depends on enabling policy environments, robust technological capabilities, and active stakeholder engagement. These interdependent factors provide a coherent framework for advancing environmental sustainability through logistics transformation.

3.2. Technological innovations enabling sustainable logistics performance

Digital transformation has become an essential enabler of sustainable logistics, particularly through the deployment of digital twins, blockchain, and the Internet of Things (IoT). These technologies improve operational transparency, resource efficiency, emissions tracking, and responsiveness within increasingly complex supply chains. The reviewed studies collectively demonstrate that digital innovations are not just technical upgrades but also integral to advancing green logistics performance. Three key themes emerge from literature, constituting (1) digital twins for process optimization and scenario planning, (2) blockchain and IoT for transparency and traceability, and (3) institutional and organizational conditions that shape adoption and effectiveness.

3.2.1. Digital Twins for Logistics Optimization and Sustainability Planning

Digital twin technology has proven valuable in replicating, simulating, and optimizing logistics systems for sustainability goals. Digital twins improve logistics efficiency through virtual modelling of inventory, transportation, and energy consumption (Kamble et al., 2022). These models enable logistics managers to evaluate alternative operational scenarios and select those that minimize environmental impact. Similarly, Guo and Mantravadi (2024) position digital twins as central to lean logistics by enhancing data-driven decision-making and minimizing waste throughout the value chain. Thus, integrating digital twins into supply chain planning allows organizations to simulate disruptions, forecast carbon emissions, and optimize routing in real-time (Kajba et al., 2023). This capability contributes to reduced fuel consumption and packaging waste. However, Kajba et al. (2023) further note that adoption is often constrained by high implementation costs, fragmented data systems, and low digital readiness, particularly among small and medium-sized logistics providers. These insights affirm that while digital twins hold significant potential, their effectiveness depends on organizational maturity and ecosystem-wide interoperability.

3.2.2. Blockchain and IoT for Traceability, Transparency, and Emission Monitoring

sustainability-related information across logistics networks. Integration of blockchain with IoT allows firms to track environmental metrics such as emissions, energy usage, and temperature control in cold chain logistics (Idrissi et al., 2024). This enhances environmental accountability, as well as compliance with regulatory and consumer transparency requirements. Suhail et al. (2022) demonstrate how the application of blockchain-enabled smart contracts can automate sustainability verification and reduce the administrative overhead of compliance reporting. Moreover, Liu et al. (2022) shows how the synchronization of blockchain and digital twins support circular logistics by enabling the traceability of materials and verification of green certifications at every supply chain node. Fernández-Caramés et al. (2019) explore the potential of combining drones with blockchain to improve inventory visibility and reduce warehouse energy consumption. Although these innovations enhance transparency and automation, the study notes that the concerns around data security, lack of standard protocols, and technological fragmentation often hinder adoption. Similarly, Botta et al. (2023) finds that while verifiable ledgers support closed-loop logistics, inconsistent regulatory frameworks and limited scalability present persistent barriers. Da et al. (2023) further confirm the benefits of real-time monitoring, highlighting the role of sensor-enabled IoT in capturing carbon footprints and vehicle performance metrics. These capabilities allow firms to benchmark sustainability goals and rapidly respond to inefficiencies, underscoring the convergence of digital innovation and green logistics transformation.

3.2.3. Institutional Enablers and Barriers to Digital Adoption

Despite the demonstrated potential of digital twins, IoT, and blockchain, their adoption and effectiveness vary widely depending on institutional readiness, policy frameworks, and organizational culture. Abdillah and Wahyulahi (2024) underscore that successful implementation requires strategic alignment between logistics providers, technology developers, and regulators. Lack of trust between supply chain partners and concerns over data ownership can significantly delay adoption, particularly in decentralized logistics ecosystems. Roman et al. (2025) identify government

incentives, sector-specific innovation funding, and collaborative pilot programs as critical enablers for scaling up digital adoption. These interventions support capacity building and ensure that smaller logistics actors can participate in and benefit from digital transformation. Meanwhile, Bandara and Buics (2024) highlight the importance of leadership commitment, staff training, and digital governance as organizational factors that influence the pace and effectiveness of technology adoption. These studies suggest that technological innovation alone is insufficient to drive sustainable logistics performance. Thus, the need for a broader institutional and organizational context to play a determining role in whether innovations like digital twins, blockchain, and IoT achieve their full potential.

In a nutshell, the reviewed literature confirms that technological innovations, particularly digital twins, blockchain, and IoT, serve as critical enablers of sustainable logistics performance. These tools support emission tracking, real-time optimization, inventory transparency, and lifecycle traceability. However, their adoption is shaped by a combination of technical complexity, institutional readiness, organizational culture, and regulatory alignment. Integrating these technologies effectively requires infrastructure investment, as well as trust, cross-sector coordination, and supportive governance structures. These findings provide a roadmap for leveraging digital innovation to embed sustainability across logistics operations.

3.3. Institutional Conditions Enabling or Constraining Sustainable Logistics Strategies

The combination of technological capacity or operational efficiency and institutional conditions shape the implementation of sustainable logistics strategies across contexts. These include policy frameworks, stakeholder partnerships, and organizational capabilities that can either foster or impede green logistics transitions. A synthesis of peer-reviewed articles published between 2020 and 2025 reveals three dominant themes, encompassing (1) policy frameworks as institutional catalysts or constraints, (2) stakeholder engagement and collaborative governance, and (3) internal organizational capacity and leadership alignment.

3.3.1. Policy Frameworks as Institutional Catalysts or Constraints

Public policy remains a foundational enabler of sustainable logistics, particularly through legislative mandates, national climate strategies, and urban mobility regulations. The study (Breuer et al., 2023) demonstrates that effective policy integration across ministries and planning levels leads to more coherent logistics regulations that incorporate environmental objectives. Conversely, siloed governance structures often result in fragmented initiatives and implementation gaps, weakening sustainability outcomes. Basit et al. (2024) confirms that while macro-level policies provide strategic direction, a lack of localized policy guidance and enforcement mechanisms often constrain firm-level implementation. Similarly, Breuer et al. (2023) highlights that fragmented governance structures and overlapping mandates create administrative inefficiencies that limit innovation in sustainable logistics. These findings underline the importance of not only designing green logistics policies but also aligning them with implementation pathways, incentives, and capacity development at multiple governance levels. Moreover, Tetteh et al. (2025) suggest that sustainability performance improves significantly when logistics regulations are linked to financial incentives such as green public procurement, tax benefits, or carbon trading schemes. Such incentives create operational space for logistics actors to invest in environmental innovation.

3.3.2. Stakeholder engagement and collaborative governance

Stakeholder partnerships are crucial to the success of sustainable logistics, particularly in fragmented or resource-constrained environments. Siems et al. (2022) identifies suppliers, local governments, non-governmental organizations, and community actors as co-creators of sustainable logistics solutions. The authors stress that relational governance, built on trust, shared goals, and adaptive communication, enables logistics actors to jointly address systemic challenges such as emissions, land use, and waste. Ganeshu et al. (2023) support this view, emphasizing that successful logistics sustainability initiatives depend on inclusive governance platforms that institutionalize participation across sectors and scales. Ali et al. (2025) further explains that third-party providers often depend on inter-organizational cooperation to meet environmental benchmarks, especially where infrastructure or regulatory support is weak. Yu et al. (2022) document the importance of vertical and horizontal policy coherence. The authors find that fragmented collaboration between local and national stakeholders leads to disjointed initiatives that fail to scale. In contrast, long-term multi-stakeholder partnerships anchored in shared governance models demonstrate greater potential for institutionalizing sustainable logistics practices across regions and sectors.

3.3.3. Organizational Capabilities, Leadership, and Cultural Alignment

Institutional effectiveness in logistics sustainability also depends on the internal capacities of organizations, including leadership vision, staff expertise, and corporate culture. Osei et al. (2023) finds that a culture of environmental

stewardship within logistics organizations strongly predicts proactive investment in green technologies and sustainable process design. A. Kumar et al. (2023) confirm the influence of top management support, underscoring that sustainability-oriented leadership enhances firm-level alignment with external environmental policies and encourages innovation in logistics systems. Furthermore, Lozzi et al. (2022) echo this dynamic, highlighting that organizational adaptability and openness to change are linked to successful implementation of low-emission last-mile delivery models. However, Kareem et al. (2023) suggests that during periods of uncertainty, such as economic crises or pandemics, short-term survival strategies may override long-term sustainability commitments unless green logistics is embedded in the organization's core business model. More to that, Correggi et al. (2024) underscore that dynamic capabilities, such as sensing environmental risks, integrating sustainability into routines, and reconfiguring resources, are essential for resilience and continuous improvement in logistics sustainability.

Briefly, institutional conditions play a decisive role in shaping the adoption and implementation of sustainable logistics strategies. Effective policy frameworks aligned across scales, inclusive stakeholder governance, and strong internal organizational capabilities collectively foster environments where green logistics can thrive. Conversely, fragmented regulation, weak enforcement, limited collaboration, and low organizational readiness remain significant constraints. The literature reviewed in this section provides a multidimensional perspective on the enabling and inhibiting forces that shape the sustainable logistics landscape, offering critical insights for policymakers, practitioners, and researchers seeking to operationalize sustainability across diverse logistics contexts.

4. Discussions

This review examined how recent scholarship addresses the convergence of green logistics practices, digital innovation, and institutional enablers in advancing sustainable supply chain management. The analysis reveals that sustainable logistics is shaped by a multi-level system of interaction between operational strategies, technological infrastructures, and institutional conditions. Rather than being isolated technical add-ons, green logistics practices and digital tools are embedded within broader organizational and policy ecosystems that either facilitate or obstruct their impact. A core insight emerging from the literature is that logistics sustainability must be understood as a strategic, system-wide transformation rather than a collection of discrete interventions (Chilicaus et al., 2025).

From an operational standpoint, green logistics strategies such as reverse logistics, closed-loop systems, and lifecycle-based circularity provide the foundational mechanisms for reducing environmental externalities. Studies demonstrate that these practices, when aligned with circular economy principles, enable reductions in emissions, waste, and virgin resource dependency (Tetteh et al., 2025; Osman et al., 2023; Malhotra, 2024). Yet, their success depends on more than ecological design. As highlighted in several articles, the uptake of circular logistics models is strongly shaped by procurement frameworks, incentive structures, and material recovery systems (Letunovska et al., 2023; Zhang et al., 2022; González-Sánchez et al., 2020). This aligns closely with the perspective of the Triple Bottom Line (TBL), which argues that logistics must not only be efficient but also socially and environmentally accountable (Tundys & Wiśniewski, 2023). Procurement policies that embed sustainability criteria are shown to shift supply chain behavior toward more regenerative and reuse-oriented logistics models. Moreover, when reverse logistics systems are incentivized through green procurement or tax benefits, they evolve from reactive waste management tools into strategic components of environmental stewardship.

Technological innovation, particularly through digital twins, blockchain, and IoT, emerged as a powerful enabler of sustainable logistics. These tools enhance visibility, traceability, and emissions monitoring while also enabling real-time decision-making. However, consistent with the Technology Acceptance Model (TAM), the effectiveness of these technologies is contingent on perceived usefulness, usability, and contextual readiness (Revythi & Tselios, 2019). Findings show that technological solutions do not operate in isolation. Digital twins, for example, are only impactful when supported by accurate data infrastructures and organizational competencies. Similarly, blockchain systems require cross-chain trust and regulatory alignment to ensure interoperability. Several studies point to implementation challenges, including fragmented governance, data security concerns, and the digital divide between large and small logistics actors (Ji-Hyland et al., 2025; Botta et al., 2023; Abdillah & Wahyulahi, 2024). This suggests that while digital systems hold transformative potential, their benefits are uneven and depend on broader institutional conditions such as policy harmonization, standardization efforts, and digital capacity-building.

At the institutional level, policy frameworks, stakeholder partnerships, and internal organizational capabilities operate as both catalysts and constraints. The Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT) offer explanatory value (Komakecha et al., 2024; Alzate et al., 2024). Firms that successfully integrate green logistics and digital tools often possess internally embedded competencies such as leadership commitment, absorptive capacity, and change-oriented culture. Dynamic capabilities like sensing environmental risks, integrating stakeholder input, and reconfiguring logistics routines are essential for adapting to sustainability imperatives (Correggi et al., 2024). For example, organizations that demonstrate strong top management support and cultural alignment are more likely to adopt last-mile innovations, emissions tracking systems, and collaborative circular logistics models. Conversely, firms lacking dynamic capabilities struggled to move beyond compliance-driven actions, particularly in regions marked by fragmented regulation or infrastructure constraints.

Cross-cutting all three domains is the importance of alignment. Sustainable logistics strategies are most effective when green operational practices are supported by digital infrastructure and reinforced by institutional design (Zhang & Seuring, 2024). Misalignment between these domains often undermines impact. For instance, environmentally sound logistics models may falter without digital traceability or when national policies fail to support return logistics. Similarly, investments in IoT and blockchain yield limited value when organizations lack internal capacity or when inter-firm collaboration is weak. This systemic interdependence suggests that sustainability in logistics is not merely a technical optimization challenge but a coordination problem spanning policy, practice, and culture. Another key observation relates to contextual asymmetries across regions and firm sizes. Emerging market studies in the sample revealed significant constraints tied to governance fragmentation, capacity limitations, and resource access gaps. Small and medium-sized logistics were found to face higher barriers to implementing sustainable logistics due to limited capital, weak institutional support, and poor digital integration (Kajba et al., 2023). These findings indicate that operational and technological innovations must be coupled with context-sensitive institutional reforms that target capacity building, equitable access to financing, and regulatory harmonization.

Overall, literature signals a shift from viewing logistics sustainability as a linear progression of green practices to a systemic, multi-actor transformation process. In this view, sustainable logistics is the result of ongoing interactions between firm-level resources, digital tools, and institutional ecosystems. The findings affirm that achieving sustainability in logistics requires a combination of technical competence, institutional coherence, cultural alignment, and strategic foresight across multiple levels of governance and organizational decision-making.

5. Conclusion

This literature review examined how sustainable logistics is being redefined through the integration of green operational practices, digital innovation, and institutional conditions across global supply chains. Drawing from 35 peer-reviewed journal articles published between 2020 and 2025, the synthesis demonstrates that sustainable logistics is no longer a peripheral concern or technical add-on. Rather, it operates at the intersection of ecological strategy, digital transformation, and institutional coordination. This review highlights that effective sustainability in logistics is grounded in reverse logistics, closed-loop systems, and lifecycle-oriented design, particularly when embedded within circular economy frameworks. These green practices reduce environmental burdens and promote material efficiency but require enabling policies, responsive procurement systems, and collaborative supply chain partnerships (Letunovska et al., 2023). Digital technologies such as digital twins, blockchain, and IoT enhance traceability, transparency, and real-time emissions monitoring, but their success depends on user readiness, data infrastructure, and regulatory alignment. At the institutional level, organizational capabilities, leadership commitment, and dynamic responsiveness to policy and market signals play a decisive role in shaping implementation outcomes. Firms that build adaptive capabilities and foster sustainability-oriented cultures are more likely to succeed in embedding sustainable logistics practices. Ultimately, this review affirms that logistics sustainability emerges from the convergence of operational innovation, technological enablement, and institutional readiness. The review emphasizes that progress depends on alignment across these dimensions and calls for continued research, policy integration, and organizational learning to ensure resilient, inclusive, and environmentally responsible logistics systems.

6. Implications and Recommendations

The findings of this review have significant implications for logistics managers, supply chain leaders, policymakers, and technology developers seeking to enhance environmental performance and long-term sustainability in supply chains. The evidence highlights that green logistics practices, technological innovations, and institutional frameworks are deeply interdependent. As such, a strategic and systemic approach is necessary to move beyond isolated initiatives and create integrated logistics systems that are environmentally sustainable, digitally empowered, and institutionally resilient.

At the operational level, firms are encouraged to adopt closed-loop and reverse logistics systems not only as compliance measures but also as core strategic levers for value creation and sustainability. Practices such as remanufacturing, material recovery, and lifecycle-based design should be embedded into core logistics planning. This demands that logistics professionals strengthen collaboration with procurement officers, product designers, and waste management actors to support full material circularity (Tetteh et al., 2025; Letunovska et al., 2023). Green sourcing policies and performance-based contracts can further incentivize reverse flows and create accountability across the supply chain. Firms operating in developing or resource-constrained settings should prioritize modular logistics designs and shared infrastructure models to reduce barriers to circular logistics adoption.

In terms of technological enablement, organizations should move beyond pilot-stage digital deployments and develop robust implementation roadmaps for innovations such as digital twins, blockchain, and IoT. These technologies must be aligned with logistics objectives and embedded into everyday decision-making processes. For example, real-time emissions tracking using sensor-enabled IoT can support fuel-efficient routing and fleet optimization (Da et al., 2023), while blockchain-enabled smart contracts can improve the transparency and traceability of recycled content flows (Suhail et al., 2022). However, the success of these systems requires adequate investments in data quality, system interoperability, and workforce training. Therefore, logistics firms should establish cross-functional digital teams and upskill employees in digital logistics platforms and analytics.

At the institutional level, regulatory agencies and governments must play a proactive role in creating enabling environments for sustainable logistics. This includes designing coherent policy frameworks that align climate goals with supply chain regulation, such as incentives for green warehousing, reverse logistics subsidies, or carbon credits linked to transport emissions (Basit et al., 2024; Tetteh et al., 2025). Policymakers should also support collaborative platforms that bring together public and private stakeholders to co-create logistics standards and share digital infrastructure. Such governance mechanisms can reduce duplication, increase trust, and foster harmonized implementation of circular practices. Organizational leaders should equally recognize that the success of sustainable logistics transformation is tied to internal capabilities. This review shows that firms with dynamic capabilities, such as the ability to reconfigure assets, sense environmental changes, and learn from implementation failures, are more likely to succeed in embedding green and digital strategies (Correggi et al., 2024). Therefore, leadership development, cross-departmental collaboration, and innovation culture must be nurtured. Decision-makers should integrate environmental Key Performance Indicators (KPIs) into logistics performance reviews and support the development of internal champions for sustainability innovation.

Finally, development institutions and funders must ensure that sustainability initiatives are inclusive. Investment in digital and circular logistics infrastructure should be targeted to underserved regions, SMEs, and informal supply chain actors, who often face the greatest barriers to adoption. Without addressing these structural gaps, digital and ecological transitions may widen existing inequalities. Funding models must also prioritize local capacity building, regional knowledge sharing, and context-specific pilot projects that demonstrate scalable and replicable models of sustainable logistics.

7. Limitations and Future Research Directions

This review identified several critical areas for future research in sustainable logistics. First, while digital innovations such as digital twins, IoT, and blockchain are widely discussed, there is limited evidence on their long-term effectiveness across diverse contexts. Most studies focus on conceptual frameworks or pilot implementations, with little insight into performance under real-world conditions, particularly in SMEs and developing economies where resource constraints are common. Therefore, future research should evaluate these technologies over time, accounting for cost, scalability, and sectoral variations. Second, the role of institutional frameworks in enabling or constraining sustainable logistics

requires deeper investigation. Although governance coherence and policy incentives are acknowledged as important, few studies examine how multi-level regulatory systems, cross-sector collaboration, and informal institutional arrangements shape implementation outcomes. Third, the internal dynamics of organizations, such as leadership commitment, culture, and capacity for adaptation, are underexplored in logistics sustainability. Longitudinal research is needed to understand how dynamic capabilities are built and sustained in response to changing environmental and market pressures. Finally, future research should improve how logistics sustainability is measured. Most current studies rely on single metrics, lacking holistic multidimensional performance indicators. Advancing analytical methods and data use will be essential to track and benchmark progress more effectively across supply chains

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