The missing link between supply chain technologies and sustainability issues: advancing theory and practice

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1. Introduction

Sustainability has become a defining imperative in contemporary supply chain management (SCM), driven by increasing concerns over climate change, resource depletion, regulatory pressures, and shifting consumer expectations (Sodhi and Tang, 2021). Companies are expected to balance economic, social, and environmental objectives, ensuring that their supply chains operate to minimize negative externalities while maintaining efficiency and competitiveness (Negri et al., 2021; Agyabeng-Mensah et al., 2022). Integrating sustainability into supply chains requires firms to implement responsible sourcing, ethical labor practices, carbon footprint reduction initiatives, and resource efficiency strategies (Sarkis, 2020). Beyond regulatory compliance, sustainability initiatives contribute to brand reputation, risk mitigation, and long-term competitive advantage (Meixell and Luoma, 2015; Mir et al., 2021; Santos et al., 2023).

A parallel transformation in SCM has been driven by digitalization, with technologies such as blockchain, artificial intelligence (AI), the Internet of Things (IoT), and cloud computing being widely recognized as potential enablers of sustainability (Junaid et al., 2024). These technologies provide firms with real-time visibility, predictive analytics, and automation capabilities, supporting decision-making that can lead to improved sustainability performance (e.g., Saberi et al., 2019; De Vass et al., 2021; Kouhizadeh et al., 2021; Chaudhuri et al., 2022). For instance, blockchain enhances supply chain traceability, improving transparency and accountability in sourcing and procurement processes. AI and IoT contribute to process optimization, reducing energy consumption and minimizing waste. Cloud-based platforms facilitate collaboration and information-sharing, enabling supply chain partners to align sustainability goals and improve efficiency.

Despite the widely acknowledged potential of digital technologies to support sustainability, the relationship between digitalization and sustainable supply chain management (SSCM) remains complex and only marginally understood. First, the environmental costs of digitalization itself—such as high energy consumption, electronic waste, and dependence on critical raw materials—challenge the assumption that digitalization inherently leads to improved sustainability outcomes (Kouhizadeh et al., 2021). Additionally, while automation of supply chain operations can enhance efficiency (Schilling and Seuring, 2024), it also raises concerns over workforce displacement, labor market disruptions, and growing inequalities in technology access between firms and regions (Stentoft et al., 2021). Moreover, data privacy concerns, digital surveillance risks, and governance challenges further complicate adopting digital solutions for sustainability (Richey et al., 2023).

Beyond these challenges, the mechanisms through which digital technologies enable sustainability improvements remain insufficiently explored. Existing research often treats digital technologies as standalone enablers of sustainability, assuming that their adoption automatically translates into better performance (Queiroz et al., 2022). However, sustainability outcomes do not emerge from technology adoption alone but rather from how these technologies are embedded into specific supply chain practices. For example, technologies such as blockchain and IoT do not inherently improve supply chain transparency or efficiency unless integrated into governance structures, decision-making processes, and operational strategies (Saberi et al., 2019).

Another notable gap in the literature concerns the connection between technology-enabled sustainability practices and actual performance improvements. While prior research has examined how digitalization improves efficiency, emissions reduction, and waste minimization,

fewer studies have investigated the impact of technology on social sustainability, including aspects such as fair labor practices, worker well-being, and ethical supplier engagement. Similarly, the economic benefits of digitalization in sustainability efforts—such as cost savings, risk mitigation, and competitive differentiation—are often assumed rather than empirically validated.

In response to these gaps, we launched the call for papers for the special issue in IJPDLM, titled "*The Missing Link Between Supply Chain Technologies and Sustainability Issues: Advancing Theory and Practice*," in January 2023. The objective of this special issue was to develop a more comprehensive and theoretically grounded understanding of the connections between digital technologies, sustainability-oriented supply chain practices, and sustainability performance. The contributions selected for this issue provide both empirical and theoretical insights that help clarify these relationships, moving beyond generalized assumptions and offering a structured, evidence-based perspective on the role of digitalization in SSCM.

This editorial presents how the special issue strengthens this connection. First, it introduces an overview of the three key pillars of the technology-sustainability-performance relationship: digital technologies, sustainability-oriented practices, and sustainability performance. The subsequent section discusses gaps identified in the literature and explains how the call for papers aimed to address them. This is followed by synthesizing the articles in the special issue, illustrating how each study contributes to advancing knowledge in this domain. The editorial concludes by discussing remaining research challenges and proposing future research and practice directions. Rather than assuming that digital technologies inherently lead to sustainability improvements, this special issue takes a nuanced, critical perspective that examines how these technologies must be strategically integrated within specific supply chain practices to achieve meaningful and measurable sustainability outcomes.

2. Supply Chain Technologies, Practices and Performance: The Pillars of Sustainable Supply Chain

SSCM has emerged as a fundamental priority for firms striving to align operational efficiency with environmental and social responsibility (Touboulic and Walker, 2015; Carter et al., 2019). While businesses have long sought to optimize supply chains to improve cost efficiency and resilience, contemporary challenges—ranging from climate change mitigation and resource scarcity to human rights compliance and ethical labor practices—have necessitated a broader approach that incorporates sustainability into core supply chain strategies (Villena and Gioia, 2020).

Three essential pillars underpin the transformation toward SSCM (Schilling and Seuring, 2024): digital technologies, sustainability-oriented supply chain practices, and sustainability performance measurement. These elements shape how firms design, operate, and assess their supply chain sustainability initiatives (Sanders et al., 2019).

Digital technologies provide firms with the tools to enhance visibility, optimize resource usage, and improve decision-making related to sustainability objectives (Seyedghorban et al., 2020). Sustainability-oriented practices translate these digital capabilities into tangible supply chain actions, influencing how firms engage with suppliers, manage resources, and integrate sustainability principles into procurement, logistics, and production processes (Marshall et al., 2015; Mathiyazhagan et al., 2021). Finally, sustainability performance measurement ensures that environmental and social outcomes are evaluated, providing firms with feedback on their progress and enabling continuous improvement (Schaltegger and Burritt, 2014).

Existing research has examined these three pillars extensively, recognizing their individual significance for SSCM. Yet, how these elements interact and reinforce one another remains underexplored. This section presents an overview of these three core elements, outlining their relevance to SSCM before transitioning to a more integrated perspective in the subsequent section.

2.1 Digital Technologies in Sustainable Supply Chain Management

The advancement of digital technologies has transformed supply chain operations, allowing firms to enhance efficiency, improve transparency, and strengthen sustainability governance (Perano et al., 2023). Technologies such as blockchain, artificial intelligence (AI), the Internet of Things (IoT), autonomous systems, and cloud computing have introduced new ways to monitor and optimize sustainability-related processes (Frank et al., 2019; Jabbour et al., 2020).

Blockchain technology has been widely recognized for its potential to improve supply chain traceability. It enables firms to track and verify sourcing, carbon emissions, and compliance with sustainability regulations (Saberi et al., 2019; Chaudhuri et al., 2022). This technology facilitates secure, tamper-proof transaction records, ensuring that firms can maintain transparent and ethical supply chain practices (Kouhizadeh et al., 2021; Hastig and Sodhi, 2020; Rao et al., 2021).

AI and machine learning have introduced capabilities for predictive analytics, resource optimization, and automated decision-making. These technologies support firms in anticipating demand fluctuations, finding strategic suppliers, reducing material waste, and optimizing transportation routes, contributing to both environmental and economic efficiency (Guida et al., 2023; Helo and Hao, 2022).

IoT technologies provide real-time emissions, energy consumption, and production efficiency monitoring, allowing firms to track and adjust operations in response to sustainability targets (Birkel and Hartmann, 2020; De Vass et al., 2021). Connected sensor networks enable proactive sustainability management, ensuring that inefficiencies and environmental impacts are identified and mitigated in real-time (Rebelo et al., 2022).

Autonomous systems, including drones, automated guided vehicles, and robotic process automation, improve supply chain efficiency by reducing fuel consumption, optimizing warehouse management, and minimizing handling errors (Purtell et al., 2025). While they offer efficiency benefits, their integration into supply chain sustainability strategies requires careful consideration of their social and economic implications, including potential labor market disruptions (Nikitas et al., 2021).

Cloud computing, big data, and digital platforms facilitate collaboration, data sharing, and supply chain coordination, particularly in sustainability-related initiatives such as supplier engagement, emissions tracking, and regulatory compliance reporting (Patrucco et al., 2023). Cloud-based analytics allow firms to integrate sustainability metrics into decision-making and improve visibility across multi-tiered supply chains (Kamble et al., 2020).

While digital technologies provide firms with the tools to enhance sustainability efforts, their effectiveness depends on how they are integrated into sustainability-oriented supply chain practices. *Based on existing literature, Table 1 summarizes the main digital technologies and their implications for sustainable supply chains*.

Table 1. Digital Technologies and Their Implications for Sustainable Supply Chains (authors' elaboration based on existing literature).

Technology	Description	Implications for Sustainable Supply Chains
Blockchain	Decentralized ledger for secure, transparent record-keeping	Enhances traceability, prevents fraud, supports ethical sourcing compliance
AI & Machine Learning	Algorithms for pattern recognition, optimization, and decision-making	Improves forecasting, reduces waste, optimizes resource allocation
IoT	Sensor-based real-time data collection and monitoring	Supports energy efficiency, predictive maintenance, and emissions tracking
Autonomous Systems	Automated vehicles, drones, and robotics for logistics	Reduces fuel consumption and labor costs but presents social sustainability trade-offs
Cloud Computing, Big Data Analytics & Digital Platforms	Digital infrastructure for data sharing and collaboration	Enhances transparency, facilitates supplier engagement, improves sustainability reporting

2.2 Sustainability-Oriented Supply Chain Practices

While digital technologies enable sustainability efforts, their effectiveness is determined by firms' supply chain practices. Sustainability-oriented practices ensure that digitalization efforts translate into tangible environmental and social improvements rather than remaining limited to efficiency gains or compliance reporting (Sarkis et al., 2021; Schilling and Seuring, 2022; 2024). Supply chain sustainability practices can be categorized into process-based and market-based approaches (Marshall et al., 2015).

Process-based sustainability practices emphasize compliance, monitoring, and risk mitigation. These include supplier audits, environmental certification, and adherence to labor rights regulations. They help firms reduce regulatory risks, ensure ethical sourcing, and maintain industry standards but often focus on short-term compliance rather than long-term sustainability transformation (Morali and Searchy, 2013).

Market-based sustainability practices involve strategic transformation and innovation. These include circular economy initiatives, closed-loop supply networks, and green product development, which embed sustainability directly into supply chain design rather than treating it as an external requirement (Park et al., 2022). Unlike process-based approaches, which focus primarily on proactive risk management, market-based practices allow firms to develop sustainable business models that improve long-term resilience and competitive advantage. *Table 2* summarizes these practices and their impact on sustainable supply chains.

Table 2. Sustainability-Oriented Supply Chain Practices (authors' elaboration based on existing literature).

Practice Category	Definition	Implications for Sustainable Supply Chains

Environmental Process Practices	Monitoring and enforcing compliance with environmental standards	Ensures regulatory adherence, reduces risks, improves resource efficiency
Environmental Market Practices	Redesigning supply chains for sustainability, including circular economy models	Promotes waste reduction, closed-loop production, and sustainable innovation
Social Process Practices	Ensuring supplier compliance with labor rights and social standards	Strengthens accountability, mitigates human rights risks, prevents modern slavery
Social Market Practices	Restructuring supply chains to promote social equity, fair trade, and worker welfare	Enhances supplier resilience, promotes ethical labor practices

2.3 Sustainability Performance: Environmental and Social Dimensions

The impact of digital technologies and sustainability-oriented practices is ultimately assessed through performance outcomes. While firms have traditionally focused on economic performance, environmental and social performance have gained prominence as essential dimensions of sustainable supply chain management. Businesses are now held accountable not only for their financial results but also for their broader contributions to sustainability. Environmental performance captures a firm's ability to minimize its ecological footprint, including reducing carbon emissions, optimizing energy consumption, minimizing waste generation, and promoting resource efficiency (Tuni et al., 2018). Supply chains that integrate circular economy principles, low-carbon logistics, and sustainable procurement strategies achieve measurable improvements in environmental sustainability (Farooque et al., 2022). Through digital monitoring tools and data-driven optimization, firms can track these environmental metrics in real-time, allowing for more proactive and adaptive sustainability management.

Social performance relates to labor conditions, human rights protection, and ethical sourcing practices. Companies are increasingly expected to ensure safe and fair working environments, uphold social responsibility across their supplier networks, and comply with international labor standards. Technologies such as blockchain-enabled traceability, AI-driven workforce monitoring, and IoT-based safety systems offer new opportunities for firms to improve working conditions, mitigate labor exploitation risks, and ensure ethical trade practices (LeBaron et al., 2022). Social sustainability extends beyond compliance, involving long-term commitments to worker well-being, diversity, and equitable economic participation across supply chain partners. These two dimensions—environmental and social performance—are key for evaluating how digital investments and sustainability practices translate into measurable supply chain outcomes. Yet, while previous research has explored the links between technologies and performance and between sustainability practices and performance, these relationships have often been examined in isolation. The interplay between these elements remains insufficiently understood, particularly regarding how digital technologies facilitate sustainability practices that, in turn, drive performance improvements. This gap calls for a more integrated perspective, which is explored in the next section.

3. Connecting the Dots: The Need for an Integrated Perspective

SSCM relies on effectively integrating technological capabilities, sustainability-oriented practices, and performance measurement. Digitalization provides the tools that enable sustainability practices, which, in turn, contribute to improved environmental and social outcomes. However, while this sequence appears intuitive, research in SCM has often examined these elements in isolation or focused on their bilateral relationships, leaving critical gaps in understanding how they interact in practice.

Over the years, research in SSCM has evolved around three interrelated but distinct streams, each contributing valuable insights but rarely integrating the full technology-practice-performance relationship (Schilling and Seuring, 2022; 2024). These streams reflect different theoretical and methodological perspectives on how sustainability emerges in supply chains and how digitalization plays a role in this transition.

3.1 Existing Research: Linking Technologies, Practices, and Performance

The literature on SSCM has primarily explored three perspectives that examine how technology enables sustainability-oriented supply chain practices, how these practices influence performance outcomes, and whether digitalization itself directly affects sustainability performance. These streams (summarized in *Table 3*) have shaped our understanding of digital sustainability in supply chains, yet they remain largely disconnected from one another, limiting a holistic perspective on technology-driven sustainability transitions – as explained in the following sections.

Table 3. Overview of Literature Streams on Digitalization and Sustainability in Supply Chains (Authors' elaboration).

Literature Stream	Focus	Limitation	Reference Examples
Technology and Sustainability Performance	Examines how digital technologies (e.g., AI, blockchain, IoT) enhance sustainability performance through efficiency, emissions reduction, and waste minimization.	Assumes a direct link between technology adoption and sustainability performance, often neglecting the role of sustainability practices as mediators.	Queiroz et al. (2022); Hastig & Sodhi (2020); De Vass et al. (2021)
Technology and Sustainability-Oriented Practices	Explores how digital tools enable sustainability practices by enhancing transparency, data-driven decision-making, and supply chain collaboration.	Does not assess whether technology-enabled practices lead to measurable sustainability outcomes, focusing mainly on technological capabilities.	Saberi et al. (2019); Khan et al. (2022); Benzidia et al. (2021)
Sustainability-Oriented Practices and Performance	Analyzes the impact of sustainability practices such as circular economy initiatives, ethical sourcing, and supplier	Overlooks the role of digitalization in supporting, scaling, or enforcing sustainability practices, often assuming	Farooque et al. (2022); Croom et al. (2018); Wiredu et al. (2024)

	engagement on environmental and social performance.	that sustainability initiatives are independent of digital tools.	

3.1.1 Technology and Sustainability Performance. A growing body of research has assessed the direct impact of digitalization on sustainability outcomes, often with mixed results. Studies suggest that AI-driven logistics optimization reduces emissions through improved route planning and fleet efficiency (Tsolakis et al., 2022), while blockchain improves sustainability reporting accuracy by enhancing data integrity and traceability (Hastig & Sodhi, 2020). Additive manufacturing supports implementing circular business models and practices (Hettiarachchi et al., 2022b). Similarly, IoT technologies facilitate real-time emissions monitoring, allowing firms to make data-driven adjustments that reduce energy consumption and waste (De Vass et al., 2021).

However, not all studies confirm positive sustainability outcomes. Blockchain applications, for instance, are often energy-intensive, raising concerns about their carbon footprint (Kouhizadeh et al., 2021). AI and automation may improve efficiency, but their high computational power requirements and implementation costs introduce economic and social trade-offs, such as job displacement and increased resource consumption (Bai et al., 2020). These contradictions highlight a fundamental gap in the literature: technology adoption alone does not inherently lead to sustainability improvements (Birkel and Müller, 2021; Bag et al., 2021; Dwivedi and Paul, 2022). Instead, the relationship between digitalization and sustainability performance depends on how firms deploy these technologies within their broader sustainability strategies.

3.1.2 Technology and Sustainability-Oriented Practices. A second stream of research explores how digitalization enables sustainability implementation by improving supply chain visibility, data collection, and process automation. Blockchain, for example, has been widely examined as a tool for ensuring ethical sourcing, supplier compliance, and circular economy practices (Saberi et al., 2019; Khan et al., 2022). AI and IoT technologies support predictive maintenance, supplier relationship management, waste reduction, and real-time monitoring of environmental and social sustainability indicators (Benzidia et al., 2021; Matin et al., 2023; Shahin et al., 2024; Guida et al., 2023; 2025). Despite these contributions, many studies conceptualize technology as a passive enabler rather than an active driver of sustainability transformation. Research has rarely examined how firms embed digitalization into sustainability governance frameworks (e.g., circular economy), SCM systems, or collaborative supplier engagement models (Hettiarachchi et al., 2022a; 2022b). As a result, while technology's role in facilitating sustainability is acknowledged, the mechanisms through which digitalization actively shapes sustainability-oriented practices remain underexplored.

3.1.3 Sustainability-Oriented Practices and Performance Outcomes. The third research stream focuses on the impact of sustainability-oriented practices on environmental and social performance. Empirical studies consistently show that firms implementing green SCM practices achieve significant improvement in environmental impacts, such as waste and emissions

reductions (e.g., Farooque et al., 2022; Wiredu et al., 2024). Similarly, ethical sourcing initiatives, supplier development programs, and fair labor policies contribute to improved social sustainability outcomes, supplier resilience, and reputation enhancement (e.g., Pullman et al., 2009; Croom et al., 2018; Alghababsheh and Gallear, 2022). While these studies offer strong evidence that sustainability practices improve performance, they often fail to consider how digital technologies enable, scale, and optimize these practices. Many studies assume that sustainability initiatives can be successfully implemented without recognizing the technological infrastructure required to track, manage, and enforce sustainability efforts across complex global supply chains (Schilling and Seuring, 2024). Consequently, the role of digitalization as a catalyst for sustainability performance remains largely underexplored.

3.2 Identifying gaps in the current logistics and supply chain management literature

Despite considerable research on the role of digital technologies and sustainability-oriented practices in SCM, existing studies lack a systematic understanding of how these elements interact to drive sustainability performance. The literature has primarily examined technology and performance, technology and practices, and practices and performance separately without fully integrating them into a cohesive framework. As a result, the mechanisms that link digitalization, sustainability-oriented practices, and measurable sustainability performance remain unclear.

While the previous section outlined the key research streams in this domain, critical gaps persist that hinder a holistic understanding of how digitalization contributes to sustainability outcomes in supply chains. These gaps do not stem from a lack of research but rather from fragmented approaches that have not fully captured the complexity of this relationship. Below, we outline three key gaps that must be addressed to advance the field.

Gap 1: The Oversimplified View of Digitalization and Its Sustainability Trade-offs

The assumption that all digital technologies contribute to sustainability in similar ways has led to generalized discussions of digitalization without sufficient differentiation of its diverse characteristics and impacts. With a few exceptions (e.g., Schilling and Seuring, 2023), many studies treat digitalization as a homogeneous concept, failing to account for the fundamental differences in the functionalities, adoption barriers, and unintended consequences of specific technologies (Belaud et al., 2019; Bai & Sarkis, 2020; Strandhagen et al., 2022). Blockchain, for instance, while improving traceability and compliance, is an energy-intensive technology whose high implementation costs present challenges for widespread adoption (Hastig & Sodhi, 2020). Similarly, the sustainability of the benefits of AI and IoT depends on firms' ability to integrate them into decision-making and governance structures (De Vass et al., 2021; Kamble et al., 2020). Additionally, the diffusion and advancement of these technologies pose challenges related to data ethics, privacy, and security (Ogbuke et al., 2022).

This oversimplification also extends to how research evaluates digitalization's sustainability impacts (Schilling and Seuring, 2024). While many studies assume a direct relationship between digital adoption and improved sustainability performance, findings are often mixed. Some highlight how AI-driven analytics can optimize transportation routes and reduce emissions, while others point to the environmental burden of AI's high computational power requirements (Queiroz et al., 2022). Similarly, automation and robotics can enhance efficiency, reduce waste,

and introduce workforce displacement risks, raising social sustainability concerns (Nikitas et al., 2021; Purtell et al., 2025).
A more nuanced perspective is needed to distinguish how different technologies contribute to, constrain, or complicate sustainability outcomes. The digitalization of supply chains is not a one-size-fits-all solution, and SCM research must move beyond broad generalizations to critically assess which technologies are best suited for different sustainability objectives and under what conditions they generate positive or negative outcomes.

Gap 2: Static Frameworks for Adoption and the Need for a Dynamic Perspective
Much of the research on digitalization and sustainability in SCM has focused on identifying drivers and barriers to technology adoption, often presenting them as static constructs (Bai et al., 2020; Bag et al., 2021; Kahn et al., 2021; Kamble and Gunasekaran, 2023). However, technology adoption is not a linear process—it evolves as firms adapt to new challenges, regulatory pressures, and technological advancements. The same sustainability-driven digital initiatives that are viewed as enablers today may become constraints in the future due to factors such as shifting regulations, emerging industry standards, or technological obsolescence.
For instance, firms that initially adopt blockchain for sustainability reporting may later abandon it due to interoperability issues, high costs, or regulatory uncertainties (Kayikci et al., 2022). Similarly, organizations that invest in AI-based operations may struggle to sustain its benefits without ongoing investments in data infrastructure and human expertise (Cannas et al., 2024). These examples illustrate the need for a dynamic perspective considering how firms modify, scale, or abandon digital sustainability initiatives in response to internal and external changes. Existing frameworks have yet to capture the long-term evolution of digital sustainability adoption fully. SCM research should move beyond static models to explore how organizations learn from past experiences, refine their digital sustainability strategies, and navigate the changing landscape of supply chain sustainability.

Gap 3: The Underestimated Role of Multi-Tier Collaboration and Supply Chain Ecosystems
Most studies on digitalization and sustainability in SCM have focused on the perspective of individual firms, analyzing how focal companies implement digital tools to improve their own sustainability performance (Khan et al., 2021; Benzidia et al., 2021). However, sustainability is inherently a supply chain-wide challenge, requiring coordination and data sharing across multiple stakeholders. The lack of a multi-tier perspective has limited understanding of how digitalization enables sustainability at the supply network level rather than just within individual firms.
Many sustainability-oriented digital solutions, such as blockchain for traceability, IoT for emissions monitoring, and AI-driven procurement analytics, require collaboration among suppliers, logistics providers, and industry regulators to achieve their intended benefits (Strandhagen et al., 2022). However, research has not adequately explored how firms build digital sustainability capabilities across their supply chain partners or how digital platforms facilitate sustainability data-sharing across industries. Without an ecosystem-wide approach, firms risk deploying technologies that improve their own sustainability metrics while failing to address systemic sustainability challenges within their broader supply chains.
A more holistic perspective is required to examine how digitalization reshapes sustainability governance structures, how different supply chain actors align their sustainability objectives through digital tools, and how industry-wide platforms enable collective sustainability

improvements. SCM research should shift away from firm-centric analyses and instead explore how entire supply chain networks leverage digitalization for sustainability transformation.

4. Building the missing link: contributions of the papers included in the special issue

The three gaps described in the previous section highlight some limitations in current SCM research on digitalization and sustainability. Existing studies have made important contributions by examining the individual components of this relationship—technology adoption, sustainability practices, and performance outcomes—but they have not extensively connected these elements in a systematic, theoretically robust manner.

To advance both theoretical and empirical perspectives on this topic, In January 2023, we launched a call for papers titled "The Missing Link Between Supply Chain Technologies and Sustainability Issues: Advancing Theory and Practice." The call sought contributions that would deepen our understanding of the mechanisms, contingencies, and strategic choices that shape the relationship between digitalization and sustainability. Specifically, we encouraged studies that introduced novel theoretical perspectives, adopted innovative empirical methodologies, and moved beyond linear cause-effect assumptions regarding technology adoption and sustainability outcomes. Our objective was to bring together research that explicitly investigates how different technologies enable sustainability practices, how firms navigate adoption barriers, how digitalization reshapes risk dynamics, and how multi-tier supply chain networks influence sustainability outcomes – in order to provide a more integrated and comprehensive perspective within the SCM field.

The response to the call was substantial, with 41 submissions reflecting the growing interest in this research domain. Given the rigorous standards of the International Journal of Physical Distribution & Logistics Management, each submission was carefully evaluated based on its alignment with the special issue's objectives, theoretical and methodological contribution, and overall quality. After an extensive review process, 14 papers were sent out for full review, and four high-quality studies were ultimately accepted for publication.

Below, we discuss the focus and contributions of each paper, which are also summarized in *Table 4.*

Table 4. Summary of contributions of papers included in the special issue (authors' elaboration.)

Paper	Technology Focus	Sustainability-Oriented Practice Investigated	Sustainability Performance Focus	Methodology and Unit of Analysis	Key Research Gaps Addressed
Heldt and Pikuleva	Blockchain	Supply chain traceability, supplier engagement	Social sustainability (human rights, due diligence compliance)	Process-based case study of upstream suppliers in the cobalt supply chain	1. *Beyond focal firms*: Highlights upstream suppliers' role in driving blockchain adoption. 2. *Technology adoption complexity*: Emphasizes the need for governance structures and trust beyond technology.
Duan, Zhu, and Sarkis	Blockchain smart contracts	Governance mechanisms in sustainable sourcing	Social sustainability (trust, opportunistic behavior)	Scenario-based experiment using buyer-supplier relationships in sustainable sourcing	1. *Risk and unintended consequences*: Blockchain can increase opportunism despite improving trust and commitment. 2. *Beyond static adoption models*: Shows how blockchain shifts traditional buyer–supplier dynamics.
Pattanayak, Ramkumar, Goswami, Narayanamurthy, and Rana	Blockchain	Circular economy implementation strategies	Triple bottom line (Economic, environmental, and social sustainability)	Semi-structured interviews with managers with expertise in circular economy in supply chains	1. *Holistic sustainability performance*: Expands blockchain's role beyond traceability to include strategic transformations and CE integration. 2. *Dynamic adoption processes*: Shows blockchain as a capability-

					building tool for sustainability transitions.
Gu, Reefke, and Yates	Autonomous Vehicles	Social sustainability strategies in AV adoption	Social sustainability (job impacts, safety, reputation)	Delphi study and interviews with experts in organizations adopting AV in supply chains	1. *Innovative performance focus*: Addresses social risks of automation and strategies to mitigate job displacement. 2. *Technology adoption as a process*: Provides a framework for embedding sustainability into technology implementation.

Paper 1: When Upstream Suppliers Drive Traceability – A Process Study on Blockchain Adoption for Sustainability

Heldt and Pikuleva (2024) examine the emergence of blockchain-enabled traceability in multi-tier supply chains, focusing on upstream suppliers rather than traditional focal firms. Using a process-based case study in the cobalt supply chain, the paper illustrates how blockchain implementation unfolds over time, emphasizing the role of supply chain-spanning collaboration, trust, and governance structures. The findings challenge the conventional downstream-centric perspective of supply chain sustainability by showing that upstream actors can be pivotal in driving traceability and sustainability adoption.

This study contributes to two critical research gaps. First, it challenges the oversimplified view of technology by showing that blockchain alone does not guarantee improved traceability and sustainability. Instead, pre-existing governance mechanisms, trust-building, and collaborative multi-stakeholder initiatives are essential for successful adoption. Second, it expands the focus of sustainability research beyond focal firms, offering a multi-tier supply chain perspective on digital technology adoption.

Paper 2: Revisiting Buyer–Seller Relationships in Sustainable Sourcing – Advancing Trust-Commitment Theory Within the Context of Blockchain Technology

Duan et al. (2024) re-examines trust-commitment theory in the context of blockchain smart contracts for sustainable sourcing. Using a scenario-based experiment with supply chain professionals, the paper investigates how blockchain affects trust, commitment, and opportunistic behavior in buyer–supplier relationships. The results indicate that while blockchain enhances affect-based trust and buyer commitment, it can also increase opportunism, challenging the assumption that blockchain inherently reduces opportunistic behavior.

This study contributes to the literature in two key ways. First, it addresses the need for a more nuanced understanding of technology adoption and risk by demonstrating that trust mechanisms function differently in a blockchain-enabled environment—not all dimensions of trust improve equally. Second, it provides empirical insights into how digitalization alters governance structures in sustainable sourcing, highlighting the unintended consequences of technology adoption on interorganizational relationships.

Paper 3: The Role of Blockchain in Transitioning to a Circular Economy – An Empirical Investigation

Pattanayak et al. (2025) examine how blockchain facilitates firms' transition to circular economy practices, drawing on the Natural Resource-Based View and Dynamic Capabilities Theory. Using semi-structured interviews, the study identifies how blockchain supports pollution prevention, product stewardship, and sustainable development, showing that blockchain acts as a microfoundation for dynamic capabilities that enable sustainability strategies.

This study addresses two key gaps in the literature. First, it expands the understanding of how technology enables sustainability-oriented practices by moving beyond traditional traceability and transparency applications of blockchain to highlight its role in strategic and behavioral transformations. Second, it provides a more holistic view of sustainability performance by showing that blockchain’s influence extends across the economic, environmental, and social dimensions of circular economy adoption.

Paper 4: Autonomous Vehicle Adoption and Supply Chain Social Sustainability – Delphi Study and Expert Interviews
Gu et al. (2025) explore the social sustainability implications of autonomous vehicle (AV) adoption in supply chains. Using a Delphi study combined with expert interviews, the paper identifies eight categories of actions that organizations take to address the social impacts of AV adoption. The study develops a refined innovation adoption model that integrates social sustainability considerations into the AV adoption process.
This study makes two critical contributions. First, it addresses the lack of research on the social dimensions of digitalization, providing a structured approach for managing the negative social implications of AV adoption (e.g., job displacement, safety concerns, and privacy risks). Second, it offers a process-oriented perspective on digital transformation, emphasizing the need to align sustainability efforts with the stages of technology adoption.

The findings presented across these studies reveal both the enabling and constraining effects of digitalization in supply chains. Building on these insights, the next section discusses critical gaps that remain and outlines research priorities for future studies, followed by managerial recommendations for integrating digital tools into sustainability strategies.

5. Looking Ahead: Advancing Research and Practice in Technology-Enabled Sustainable Supply Chains

The studies featured in this special issue deepen our understanding of how digital technologies interact with sustainability-oriented practices and performance outcomes in supply chain management. Rather than reinforcing the assumption that digitalization directly enhances sustainability, they reveal the contextual and strategic factors that shape its impact. Despite these contributions, unresolved questions remain. These papers highlight the need for a broader perspective on digital sustainability transitions—one that considers industry-wide dynamics, systemic challenges, and long-term implications. The next sections outline key areas where future research can contribute to closing these gaps, followed by managerial recommendations for leveraging digital technologies in sustainability efforts more effectively.

5.1 Future Research Directions

The studies included in this special issue demonstrate the complexity of the technology-practice-performance relationship but also highlight the limitations of current theoretical and methodological approaches in fully capturing these dynamics. As digital sustainability strategies evolve, future research must expand its scope to explore longitudinal processes, systemic interactions, and organizational adaptations to technology-enabled sustainability initiatives.

A key limitation of existing studies is the tendency to assess technology adoption and sustainability outcomes in isolation, often assuming a direct causal link between them. However, as this special issue illustrates, the actual impact of digitalization is highly contingent on how firms integrate these technologies into sustainability-oriented supply chain practices. Research should therefore shift from evaluating technology adoption as an outcome in itself to exploring the conditions under which digital tools translate into measurable sustainability performance improvements.

Moreover, the interplay between firm-level and systemic influences remains underexplored. While individual companies may seek to enhance sustainability through digitalization, industry-wide factors such as regulatory environments, competitive dynamics, and technological interoperability play a crucial role in shaping the effectiveness of these efforts. Future research should examine how firms navigate these external constraints and opportunities, moving beyond firm-centric analyses to incorporate broader institutional, market, and policy perspectives.

Table 4 outlines key research questions that emerge from the gaps identified in this special issue to guide this future research agenda.

Table 4. Research Gaps and Future Research Questions

Research Gap	Key Research Questions
Understanding the impact of technology adoption on sustainability outcomes	How do different digital technologies interact with sustainability-oriented practices to influence environmental and social performance? What contingencies mediate or moderate the relationship between technology adoption and sustainability?
Bridging firm-level and systemic perspectives on digital sustainability	How do industry-wide collaborations, regulatory interventions, and policy frameworks shape the adoption of digital sustainability initiatives? What role do ecosystem-level partnerships play in enabling digital sustainability transitions?
Advancing theoretical perspectives on digital sustainability	What novel theoretical lenses (e.g., complexity theory, socio-technical systems theory) can better explain the emergent and multi-tiered nature of digital sustainability initiatives? How do organizations learn and adapt their sustainability strategies through digitalization?
Refining methodological approaches to studying digital sustainability	How can longitudinal and multi-method research designs capture the evolving role of digital technologies in sustainability? What experimental and behavioral methodologies can be used to understand managerial decision-making in digital sustainability contexts?

These research directions reflect the need for a more dynamic, multi-level, and theoretically grounded approach to studying digitalization and sustainability in supply chain management. Rather than treating digitalization as a static phenomenon, future research should focus on how firms and supply chains evolve over time in response to technological, regulatory, and market pressures.

5.2 Implications for Practice

Beyond its academic contributions, this special issue offers valuable insights for practitioners navigating the complexities of digital sustainability adoption. The findings suggest that digital

technologies alone do not guarantee sustainability improvements; rather, their effectiveness depends on strategic alignment, governance mechanisms, and supply chain collaboration.

A fundamental challenge for managers is ensuring that technology adoption is not pursued in isolation but is instead integrated into a broader sustainability strategy. Many organizations invest in blockchain, artificial intelligence, or IoT solutions with the expectation that these technologies will automatically enhance visibility, efficiency, or compliance. However, as the research in this issue demonstrates, the real sustainability benefits emerge only when these technologies are embedded within well-defined sustainability-oriented practices.

Another critical consideration is the governance of digital sustainability initiatives. While digital tools can improve traceability and monitoring, their success depends on establishing robust mechanisms for data integrity, stakeholder trust, and cross-tier collaboration. Blockchain, for example, can enhance transparency, but its effectiveness is contingent on industry-wide adoption, interoperability standards, and trust-building measures among supply chain partners. Managers must, therefore, focus not only on technology selection but also on governance structures that support long-term sustainability objectives.

Furthermore, firms must actively manage the trade-offs and unintended consequences of digitalization. Deploying digital sustainability solutions can introduce new risks, including data security vulnerabilities, high energy consumption, and challenges related to workforce inclusion. Addressing these concerns requires a balanced approach that weighs the benefits of digitalization against its potential social and environmental downsides. This includes considering the ethical implications of AI-driven automation, the carbon footprint of blockchain infrastructure, and the inclusivity of digital supply chain solutions for small and medium-sized enterprises.

Finally, collaboration across supply chain actors remains crucial to digital sustainability success. Individual firms can make progress in adopting digital sustainability initiatives, but their full potential can only be realized through coordinated industry-wide efforts. This includes establishing shared digital infrastructures, aligning reporting frameworks, and fostering cross-sector partnerships that drive systemic sustainability improvements. Managers should seek to engage suppliers, regulators, and industry associations to ensure that digital sustainability initiatives benefit the entire supply chain ecosystem.

5.3 Conclusion

This special issue expands the discussion on technology-enabled sustainability in supply chains by offering new empirical insights and theoretical advancements. It challenges the assumption that digitalization automatically leads to improved sustainability outcomes and underscores the complexities of integrating digital tools into sustainability strategies.

Future research should continue to explore how digital technologies influence sustainability transitions, moving beyond linear cause-and-effect assumptions to examine the conditions under which digital tools generate real impact. This requires more integrated, multi-level, and longitudinal studies that capture the evolving relationship between technology, sustainability practices, and performance.

For practitioners, digitalization should not be viewed as an end in itself but as an enabler that must align with broader sustainability goals. Success depends on embedding digital tools within supply chain governance frameworks, fostering industry-wide collaboration, and addressing the risks and trade-offs associated with new technologies.

We hope this special issue provides a foundation for advancing both research and practice, offering a clearer understanding of how digitalization can support sustainability efforts in supply chains.

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