

Digital, Resilient and Sustainable Supply Chains: Research Trends and Future Challenges

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1. Introduction

In recent years, logistics and supply chain management have undergone significant changes. In the past, research was primarily focused on optimizing individual logistics processes. Today, the focus has progressively shifted toward designing supply chains capable of combining operational efficiency, resilience, sustainability, and decision-making capabilities [1–3]. This evolution has been accelerated by a set of events that have profoundly influenced the global economic and industrial landscape: the COVID-19 pandemic, growing market instability, the increased frequency of extreme weather events, and, concurrently, the rapid spread of digital technologies [4–6].

In this challenging landscape, the supply chain can no longer be considered as a simple sequence of activities aimed at moving materials and information, but represents a complex ecosystem in which companies, technologies, infrastructure, and people interact. The growing interdependence between chain actors necessitates the development of new tools capable of supporting timely decisions, increasing process visibility, improving collaboration between partners, and strengthening the ability to respond to disruptions. At the same time, digitalization is redefining the way supply chains are designed and managed [7]. Technologies and paradigms such as artificial intelligence, machine learning, Internet of Things, blockchain, and advanced simulation models are gradually converging into integrated decision support systems, enabling organizations to not only respond to critical events, but also to predict, prevent, and proactively manage them [8,9].

Alongside digital transformation, sustainability has become a major driving force in research. The growing focus on emissions reduction, the circular economy, responsible resource management, and environmental performance measurement has led to the development of new approaches that address economic, environmental, and social objectives in an integrated manner. From this perspective, sustainability and digitalization are not two independent directions, but rather complementary dimensions that contribute to defining the supply chains of the future [10,11].

It is within this context that this Special Issue was created, with the aim of gathering scientific contributions that represent the main methodological and applicative developments in the logistics and supply chain management sector. The 17 published articles address several issues, ranging from freight transport [12] to urban logistics [13], from cold chain [14] to port security [15], from blockchain [16] to artificial intelligence [17,18], and even performance measurement [19,20] and resilience of supply networks [21,22].



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Despite their heterogeneity, these contributions share a common vision: developing increasingly intelligent, resilient, sustainable, and data-driven supply chains. Analyzed together, the published works demonstrate how research progressively moves toward a systemic conception of the supply chain, in which resilience, sustainability, digitalization, and decision-making capacity are closely interconnected.

This editorial offers a cross-section of the contributions collected in the Special Issue, highlighting the main emerging research lines and discussing the perspectives that will shape the evolution of the discipline in the coming years.

2. Current Research Trends

The contributions collected in this Special Issue demonstrate how contemporary research in logistics and supply chain management is evolving toward the goal of making supply chains increasingly resilient, intelligent, and sustainable. Although the articles address different application contexts and employ diverse methodologies, some recurring research threads can be identified that clearly outline emerging scientific priorities.

One of the most frequently discussed topics concerns supply chain resilience and disruption management. In recent years, resilience has moved from being an operational requirement to a true design paradigm, guiding the development of models, tools, and methodologies capable of preventing, absorbing, and managing critical events. From this perspective, Monferdini and Bottani [21] analyze the effects of the COVID-19 pandemic on logistics processes, highlighting how global crises have significantly changed supply chain management strategies. The study by Ma et al. [22] expands this perspective through a review of the literature dedicated to supply network resilience, highlighting the growing use of models based on complex networks. Similarly, Kang and Li [23] and Li et al. [24] show how digital transformation and the integration between the real and digital economy represent key factors in increasing the resilience of production networks, while Zidan et al. [18] demonstrate how the use of predictive models based on artificial intelligence allows for the anticipation of delivery delays, promoting a proactive approach to disruption management.

A second research line concerns the growing diffusion of digital technologies as an enabling element of the supply chain of the future. The contributions of the Special Issue clearly show how digitalization and supply chain management are no longer separate domains, but increasingly integrated dimensions. Gabellini et al. [25] analyze the role of Data Spaces as infrastructures for the secure and interoperable sharing of data along the supply chain, while Takkar et al. [16] propose a blockchain-based framework to increase transparency and traceability in complex production systems. The integration of Artificial Intelligence algorithms, knowledge graphs, and optimization tools is addressed by Felder et al. [17], who develop a sustainability-oriented smart routing system, while Zidan et al. [18] highlight how the combined use of metaheuristics and machine learning can significantly improve the accuracy of decision support systems.

At the same time, the topic of sustainability emerges strongly, now recognized as one of the main drivers of innovation in supply chain design. In this context, Bhandigani et al. [26] proposed a roadmap for the adoption of data-driven strategies in logistics in the photovoltaic sector, with particular attention to environmental and organizational aspects. Bottani et al. [19] instead developed a systematic review dedicated to the Key Performance Indicators of the food supply chain, highlighting the importance of measurement systems capable of integrating the economic, environmental, and social dimensions of sustainability. The study by Monferdini et al. [20] further expands this perspective by proposing a fuzzy logic-based tool to evaluate the performance of Lean, Agile, Resilient, and Green (LARG) supply chains, while Alasmari et al. [27] analyze the circular transformation of warehouse

operations through simulation models. The contribution by Rubino et al. [13] fits into this trend, proposing a System Dynamics model to study the interactions between Smart Urban Logistics and urban access policies, with the aim of supporting more efficient and sustainable logistics systems.

The Special Issue also devotes particular attention to the development of advanced modeling and decision support tools, confirming how the growing complexity of supply chains requires increasingly sophisticated quantitative approaches. Ren et al. [14] proposed a risk management model in the cold chain based on a Fuzzy Bayesian Network, while Moroni et al. [28] developed a methodological reflection on the use of Agent-Based Models in supply chain simulation. Similarly, the fuzzy tools developed by Monferdini et al. [20] and the predictive models by Zidan et al. [18] show how different methodologies can converge towards a common goal: supporting more robust decisions in contexts characterized by high uncertainty.

This variety of applications confirms how the methodological tools developed by the research can be adapted to very different operational contexts, contributing to the construction of more efficient, resilient, and sustainable supply chains. The published contributions clearly outline a transformation of the discipline. Research is no longer focused exclusively on optimizing operational performance but is increasingly developing integrated decision-making ecosystems in which resilience, sustainability, digitalization, and predictive capabilities become complementary elements of a single supply chain management strategy. The convergence between different lines of research represents the main scientific message emerging from the Special Issue.

3. Conclusions and Future Challenges

The contributions collected in this Special Issue offer a significant overview of the evolution of research in logistics and supply chain management, highlighting how the discipline is progressively adopting an increasingly integrated and multidisciplinary approach. While addressing different issues and proposing heterogeneous methodologies, the articles converge toward a common goal: developing supply chains capable of operating in contexts characterized by increasing complexity, uncertainty and dynamism.

A crucial element emerging from the contributions is the strong interconnection between resilience, digital transformation and sustainability. Technologies such as artificial intelligence, blockchain, simulation systems, and advanced decision support tools no longer represent isolated solutions, but complementary components of a new management paradigm aimed at increasing the visibility, predictive capacity and adaptability of logistics networks. At the same time, the growing focus on the circular economy, performance measurement and environmental sustainability confirms how economic, social and environmental objectives are now relevant in designing the supply chains of the future.

In conclusion, the published works not only contribute to expanding the available knowledge in their respective research fields but also highlight numerous opportunities for further studies. Future research challenges will primarily concern the ability to integrate approaches currently developed separately. Specifically, it will be crucial to design decision support systems that combine artificial intelligence, modeling and simulation, predictive analytics, and secure data sharing, while maintaining the transparency and interpretability of results. At the same time, it will be necessary to develop models capable of jointly assessing resilience, sustainability, and operational performance, moving beyond approaches focused on single objectives or activities. Basically, the growing complexity of supply chains will require greater interoperability between organizations, technologies, and information sources, promoting the creation of increasingly collaborative, adaptive, and Industry 5.0-oriented digital ecosystems.

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