BUILDING RESILIENT AND INTELLIGENT SUPPLY CHAINS: A COMPREHENSIVE REVIEW OF ARTIFICIAL INTELLIGENCE, DIGITAL TECHNOLOGIES, SUSTAINABILITY, AND RISK MANAGEMENT

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Abstract
Global supply chains are more exposed than ever before to geopolitical, pandemic, cyber, climatic and operational uncertainties that push for resilient, intelligent and sustainable supply chain systems. This review explores the role of AI and digital technologies in making supply chains more resilient, sustainable, and proactive in managing risks. A systematic literature review was employed and the studies reviewed were mainly the latest peer-reviewed publications from 2020-2026. Selected literature was thematically synthesized to detect key technologies, mechanisms for resilience, sustainability status, risk management, implementation challenges, and research gaps. The results indicate that the technologies of artificial intelligence, big data analytics, blockchain, IoT (Internet of Things), digital twins and Industry 4.0 offer increased visibility, predictive capacity, traceability, information processing, and adaptive decision-making. These are capacities that enhance within their preparedness, disruption response, recovery and the long-term viability of supply chain. The review also shows the contribution of digital technologies for sustainability, regarding resource efficiency, transparency, circular practices and supplier assessment. Some benefits will depend on the readiness of the organization, data quality, interoperability, governance, cyber security, and managerial capacity, however. The overall impact of intelligent digital transformation is enhancing the risk-management capability and facilitating more resilient, sustainable and adaptive supply chains. Further studies on integrated technologies and their use in various industrial applications are needed.

Keywords: *Artificial Intelligence; Supply Chain Resilience; Digital Technologies; Sustainability; Risk Management*

Introduction

Whether it's the impact of a pandemic, geopolitical uncertainty, climate change, cyber attacks, supply chain issues or sudden changes in demand, today global supply chains are vulnerable to disruption. These pressures have only further increased the demand for supply chains to be able to withstand, predict, adapt to and recover from shocks. Supply chain resilience has switched from contingency to strategic capability to ensure continuity, competitiveness and long-term viability. Recent studies highlight the need for flexible and adaptive supply chains, for cross-coordinated risk management, and for the ability to reconfigure the resources in the face of uncertainty (Ivanov, 2021; El Baz & Ruel, 2021). This has also led to the development of an interest in the viability of the chains, stress tests and preparedness at the level of the entire chain ecosystem as companies strive to stay in operation during long or interconnected disruptions (Ivanov & Dolgui, 2022).

Digital transformation has become a key enabler to enhance these capabilities. Artificial intelligence, big data analytics, the Internet of Things, blockchain, cloud platforms, digital twins, robotics and Industry 4.0 systems can help enhance visibility, information sharing, predictive insight and coordination across supply chain networks. By decentralizing and responding to decision-making, digitalization helps firms to adopt more integrated, data-driven, and real-time management strategies. A growing body of evidence from emerging market supply chains indicates that digital technologies can contribute to building resilience through greater connectivity, responsiveness, and transparency in operations (AS & Ramanathan, 2021). The adoption of digital technology has been shown to affect the supply chain process and the organizational outcomes, such as integration and decision quality (Yang et al., 2021; Cui et al., 2023).

Artificial Intelligence is among these technologies due to its capability to process complex data streams, to identify patterns, to make predictions, and to help in making quick decisions. AI-powered systems can aid in demand forecasting, supplier evaluation, inventory planning, disruption forecasting, and resource allocation. These functions enhance the capacity of supply chains to proactively predict and react to risks in a dynamic manner. Based on empirical evidence, it can be concluded that AI can enhance supply chain resilience and performance, albeit with proper organizational and technological capabilities (Wang & Pan, 2022). Concurrently, big data analytics has been linked to higher resilience by its ability to enhance sensing, learning, and decision support capabilities during the extreme phase (Bag et al., 2023).

The COVID-19 pandemic drove up demand for digitally-enabled resilience as it revealed vulnerabilities in supply chains globally and across multiple layers within chains, tied together by digital connections. In these times, digital technologies were used to facilitate information flows, to provide improved visibility and coordinate responses in an uncertain operating environment (Birkel et al., 2023). The advantages of industry 4.0 technologies have also been associated with increased supply chain capabilities, operational intelligence (in real time), automation, and flexibility, which are known to improve supply chain resilience (Huang et al., 2023). Looking ahead, further evidence also indicates that Industry 4.0 is an important catalyst to the post-pandemic resilience strategies as companies reorganize their supply chains to be more connected, automated, and adaptable (Spieske et al., 2023).

Resilience is also inextricably linked to sustainability and risk management at the same time. Digital supply chains can contribute to environmental, economic and social sustainability by increasing the use of resources, traceability, responsiveness and stability in operations over the long-term (Atieh Ali et al., 2024). Digital technologies can additionally facilitate sustainable supply chain practices by improving resource efficiency, information visibility, and coordination across supply chain activities (Akbari & Hopkins, 2022). But it is not a simple matter of digitalization becoming resilient; it all depends on their capacity to integrate, their organisational readiness and their ability to convert information into actions that happen at the right moment. Research on digital supply chains reveals how the features of digital tools, such as coordination, information visibility, and flexible decision-making, contribute to enhancing resilience, as seen in the implementation without having the tools as isolated technologies (Zouari et al., 2021; Shi et al., 2023).

As research has been ongoing, the literature is still fragmented in areas of AI, digitalization, resilience, sustainability and risk management. These themes are analyzed individually and the understanding of how these themes will interact to form intelligent and sustainable supply chains is limited. The purpose of this review, therefore, is to unite these streams and to illuminate their joint contribution.

The aim of this work is to:

Discuss the role of AI and digital technologies in enhancing supply chain intelligence and resilience

Assess their role in sustainable and proactive risk management

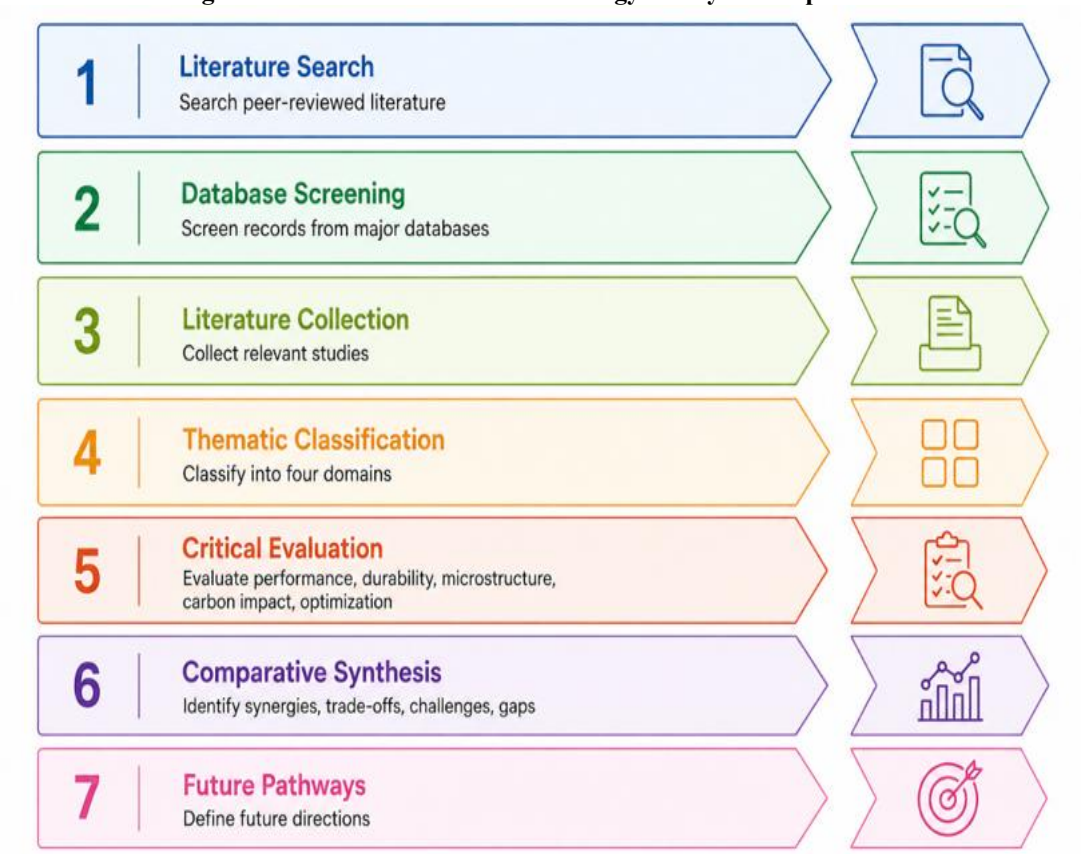
Define the key challenges, gaps and future research directions for the development of resilient and intelligent supply chains.

2. Methodology

The research methodology for this study was based on a comprehensive literature review that explored the contribution of artificial intelligence (AI), digital technologies, sustainability and risk management to the implementation of resilient

and intelligent supply chains. The selected peer-reviewed studies were retrieved from the major academic databases such as Scopus, Web of Science, ScienceDirect, IEEE Xplore, and SpringerLink. The keywords used to search were combinations like "AI and supply chain resilience," "supply chain risk management and digital technologies," and so on. Studies published in the last 6 years (2020–2026) were preferred, and older seminal studies were included if they were relevant to laying the theoretical foundation. Research that explicitly focused on the use of AI or digital technologies for supply chain resilience, sustainability, operational intelligence, or supply chain risk management was included. Records, publications that were not peer-reviewed, and studies not directly relevant to the supply chain were not duplicated. The literature was then sorted, themed, and categorized to highlight key technologies, applications, methods of resilience, sustainability issues, risk-management strategies, implementation issues and future research needs. The literature review and synthesis process is summarized as shown in Figure 1.

Figure 1. Literature review methodology and synthesis process



3. Results

The literature review shows that the contemporary paradigm of supply chain resilience is evolving into a multi-faceted approach involving the combination of artificial intelligence (AI), Industry 4.0 technologies, digital platforms, sustainability and proactive risk-management capabilities. In the selected studies, electronic technologies showed a consistent link with the following: visibility within the supply chain network, information processing, predictive capacity, responsiveness, and coordination within the network. AI was focused on due to its capacity to help process vast amounts of operational data and derive actionable insights to foresee disruptions and facilitate swift decision-making. Concurrently, the following complementary technologies were recognized as important: Blockchain, Internet of Things (IoT), digital twins, and integrated digital supply chains. The key features and findings of the literature reviewed are outlined in Table 1.

3.1 Characteristics of the Reviewed Studies

The literature reviewed, which was published between 2023 and 2026, shows that there has been a significant surge in research on digital technologies as a strategic resource in resilient and sustainable supply chains. A growing stream of recent research goes beyond the adoption of technology and explores how AI and digital capabilities relate to resilience, risk, organizational adaptation and sustainability. AI has been studied from a variety of angles, such as dynamic capability, organizational information-processing, and organizational-change perspectives (Pan et al., 2025; Pu et al., 2026). Likewise, Industry 4.0 and digital supply chain capabilities have been linked to organizational resilience and sustainability measures (Huang et al., 2023; Atieh Ali et al., 2024).

Table 1. Characteristics and primary focus of the reviewed studies

No.	Study	Main technology/approach	Primary supply chain focus	Major contribution
1	Atieh Ali et al. (2024)	Digital supply chain	Resilience and sustainability	Links digital supply chains with resilience and sustainability under dynamic conditions
2	Dong et al. (2025)	Artificial intelligence	Geopolitical risk and resilience	Examines AI as a capability for strengthening resilience under geopolitical uncertainty
3	Duman Altan et al. (2024)	Digital technologies	Sustainability and traceability	Connects digital adoption with sustainability, traceability, resilience, and circular practices
4	Guo et al. (2025)	AI-enabled manufacturing	Organizational change and resilience	Explains how AI-related organizational transformation contributes to supply chain resilience
5	Gupta et al. (2023)	AI and blockchain	Financial resilience	Demonstrates the relevance of combined digital technologies for financial supply chain resilience
6	Han and Um (2024)	Risk-management strategies	Sustainability and resilience	Integrates risk-management approaches with sustainable resilience capabilities
7	Hezam et al. (2024)	Digital twin and fuzzy methods	Supplier risk assessment	Applies digital twin-supported decision methods to sustainable supplier-risk management
8	Huang et al. (2023)	Industry 4.0	Supply chain capability and resilience	Shows the strategic importance of Industry 4.0 capabilities for resilience
9	Jegan Joseph Jerome et al. (2024)	Technology-driven risk management	Proactive risk management	Links technology-based proactive risk management with competitive advantage
10	Kumar et al. (2023)	Blockchain and IoT	Sustainable and secure logistics	Provides an integration pathway for secure and sustainable logistics operations
11	Li et al. (2025)	Artificial intelligence	Supply chain risk	Examines resilience and efficiency as mechanisms connecting AI with risk reduction
12	Pan et al. (2025)	Artificial intelligence	Information processing and resilience	Explains AI-enabled resilience through organizational information-processing capabilities
13	Pu et al. (2026)	Artificial intelligence	Dynamic capabilities and resilience	Positions AI as a driver of dynamic supply chain capabilities
14	Tang et al. (2025)	Artificial intelligence	Preparedness, response, recovery	Differentiates AI contributions across major resilience stages
15	Xu et al. (2025)	Artificial intelligence	Resilience and managerial context	Highlights the role of managerial characteristics in shaping AI-resilience outcomes

According to Table 1, AI studies occupy a large share of the latest literature, reflecting a definite shift from a general digitalization of the supply chain towards an intelligent and predictive supply chain system. Nevertheless, technologies like blockchain, IoT, digital twins, and Industry 4.0 are still significant as they will facilitate access to the data infrastructure and connectivity needed for making effective decisions with AI.

3.2 Artificial Intelligence and Intelligent Supply Chain Capabilities

AI proved to be the most notable technology in the evolution of intelligent supply chains. Its primary impact relates to predictive analytics, information processing, risk identification, operational efficiency, and adaptive decision making. Pan et al. (2025) suggest that AI application can augment the information-processing capacity of an organization, especially in the presence of uncertainty in the supply chain. Like Pu et al. (2026), AI is also considered as a part of dynamic capabilities perspective, which aligns with the capacity of firms to sense changes, respond to disruptions, and reconfigure supply chain resources.

The literature reviewed further reveals that AI is a tool that can enhance resilience in various stages of a disruption. Specifically, Tang et al. (2025) separate out preparation, response, and recovery, emphasizing the fact that AI is not a single end result, but a contributor to resilience as a multi-stage process. Guo et al. (2025) also emphasize that AI benefits are partially dependent on organizational transformation, suggesting that the adoption of AI should go hand in hand with organizational and managerial change.

Furthermore, AI directly helps to mitigate supply chain risks. According to Li et al. (2025), two key areas where AI impacts supply chain risk are supply chain efficiency and supply chain resilience. AI can also help with the compliance monitoring, prediction, and adjustment to new disruptions caused by external geopolitical uncertainty (Dong et al., 2025).

The most significant AI related functions that were found in the literature are listed in Table 2.

Table 2. AI-enabled capabilities for resilient and intelligent supply chains

AI-enabled capability	Supply chain application	Resilience contribution	Representative studies
Predictive intelligence	Forecasting disruptions and operational changes	Improves preparedness and anticipation	Tang et al. (2025); Dong et al. (2025)
Information processing	Analysis of complex supply chain information	Improves decision speed and accuracy	Pan et al. (2025)
Dynamic adaptation	Resource and process reconfiguration	Strengthens adaptability and recovery	Pu et al. (2026)
Risk analytics	Detection and assessment of supply chain risks	Reduces exposure to disruption	Li et al. (2025)
Organizational intelligence	AI-supported organizational transformation	Enhances resilience mechanisms	Guo et al. (2025)
Decision support	Data-driven managerial decision-making	Supports responsive operations	Xu et al. (2025)
Geopolitical-risk response	Monitoring external uncertainty	Supports continuity under geopolitical shocks	Dong et al. (2025)

The application of AI isn't limited to automation, as indicated in Table 2. But, it is more strategic for improving the anticipation, adaptability, and information richness of supply chains.

3.3 Role of Digital Technologies in Supply Chain Resilience

In addition to AI, several digital technologies were also found to enhance the supply chain resiliency through increased connectivity, transparency, traceability, and coordination. Industry 4.0 technologies offer a holistic approach to digital solutions, which can support the capacity of companies to manage disruption and keep the business running. Huang et al. (2023) illustrate the linkage between Industry 4.0, capabilities of the supply chain and resilience, suggesting that the benefits of the technology are realised through organisational capabilities and not only through adoption.

Blockchain proved to be a crucial tool for improving transparency, trust, data integrity, and visibility in transactions. AI and blockchain can work together to enhance the financial stability of supply chains, as demonstrated by Gupta et al. (2023). Its combination with IoT further paves the way for enhanced security, traceability, and sustainability in logistics processes (Kumar et al., 2023).

Another new technology that can be included in risk-oriented supply chain decisions is digital twins. Hezam et al.

(2024) show their effectiveness in conjunction with the fuzzy decision approaches for supplier selection and risk assessment for sustainability. All such technologies can provide a digitally integrated supply chain architecture where information is captured, verified, analysed and used to trigger operational response.

Table 3. Digital technologies and their contributions to supply chain resilience

Digital technology	Core function	Supply chain contribution	Resilience/Risk benefit
Artificial intelligence	Prediction and intelligent decision support	Forecasting, optimization, risk analysis	Anticipation, response, adaptation
Blockchain	Secure and transparent information exchange	Traceability and transaction integrity	Reduced information and trust risks
Internet of Things	Real-time sensing and connectivity	Tracking of goods, assets, and operations	Improved visibility and early detection
Digital twins	Virtual replication and simulation	Supplier assessment and scenario evaluation	Risk anticipation and decision support
Industry 4.0 systems	Integrated digital manufacturing and operations	Connectivity and process intelligence	Greater flexibility and resilience
Digital supply chain platforms	Data integration and coordination	End-to-end information sharing	Faster response and coordination

The technological relationships indicated in Table 3 indicate that an integrated digital ecosystem is required to create intelligent supply chains. Single technologies offer specific functionality, while having multiple technologies together gives enhanced visibility, predictability, coordination and response.

3.4 Digitalization and Supply Chain Risk Management

One such issue that was highlighted in the literature was the transition of supply chain risk management from a reactive activity to a proactive and technology-based process. Using technology for risk management helps to detect vulnerabilities early, allowing companies to take mitigation steps before it is too late and disruption causes significant losses in operations. The research by Jegan Joseph Jerome et al. (2024) illustrates how proactive technology-based risk management can be a strategic asset and its connection to competitive advantage.

AI can enhance this by detecting patterns and risk signals from complex data sources. Li et al (2025) link AI use to supply chain risk, claiming that AI enhances efficiency and supply chain resilience. Likewise, AI assumes a crucial role in the case of external risks, such as geopolitical uncertainty (Dong et al., 2025).

Risk-management strategies are also closely related to sustainability. Han and Um (2024) highlight the need to not separate resilience capability and sustainability: Risk-management strategies can impact operational continuity and sustainable performance.

The results of the review are summarized in Table 4 and the main risk categories and digital responses identified are listed.

Table 4. Supply chain risk categories and digital risk-management responses

Risk category	Typical challenge	Digital response	Expected outcome
Supply risk	Supplier failure or shortage	AI analytics and digital supplier monitoring	Earlier detection and supplier diversification
Operational risk	Process disruption and inefficiency	AI, Industry 4.0, automation	Faster corrective action
Logistics risk	Delays and transportation disruptions	IoT, blockchain, real-time tracking	Greater logistics visibility
Information risk	Inaccurate or fragmented data	Blockchain and digital platforms	Improved data reliability
Geopolitical risk	Policy instability, conflict, trade disruption	AI-based monitoring and forecasting	Enhanced preparedness
Sustainability risk	Environmental or supplier sustainability problems	Digital twins and sustainability analytics	Improved supplier assessment
Financial risk	Liquidity and transaction uncertainty	AI and blockchain	Improved financial resilience
Security risk	Data manipulation and	Blockchain-IoT	Greater transaction and data

	unauthorized access	integration	security

Table 4 shows that digital risk management is becoming more and more multi-dimensional. It is not only about operational risks but also geopolitical, sustainability, information, security and financial risks.

3.5 Digital Technologies, Sustainability, and Resilience

The analyzed evidence suggests a high link between digital transformation, resilience and sustainability. Digital supply chain capabilities can positively contribute to sustainability by providing better visibility, coordination of resources, monitoring and response. Atieh Ali et al. (2024) link digital supply chains and resilience to sustainability outcomes and also point out that relationships between these can be different when supply chain conditions change.

Digital technologies also foster sustainable supply chain practices, with traceability and circular economy systems. Duman Altan et al. (2024) state that to understand the relationship between digital technology adoption and sustainability performance, it is crucial to consider factors such as traceability, resilience and circular practices. This indicates that technology by itself is not necessarily sustainable and that the sustainability impact of digital capabilities will rely on the specific use of technology in supply chain practices.

The potential of integrating blockchain with IoT could further enhance the sustainability landscape by providing secure information sharing, traceability, and optimizing logistics, as highlighted by Kumar et al. (2023). Going one step further, the assessment of suppliers can be integrated with sustainability aspects in risk-based supplier selection using the digital twin (Hezam et al., 2024).

Table 5. Sustainability outcomes associated with intelligent and resilient supply chains

Sustainability dimension	Digital mechanism	Potential outcome	Supporting literature
Environmental	Digital monitoring and optimization	Reduced waste and improved resource utilization	Duman Altan et al. (2024)
Environmental	IoT-enabled logistics visibility	Improved transportation and resource efficiency	Kumar et al. (2023)
Economic	AI-supported efficiency and resilience	Improved continuity and reduced disruption costs	Li et al. (2025)
Economic	Technology-driven proactive risk management	Competitive advantage and operational stability	Jegan Joseph Jerome et al. (2024)
Supply chain sustainability	Digital supply chain integration	Improved resilience and sustainable performance	Atieh Ali et al. (2024)
Supplier sustainability	Digital twin-based assessment	Improved sustainability-oriented supplier selection	Hezam et al. (2024)
Financial sustainability	AI and blockchain integration	Greater financial resilience	Gupta et al. (2023)
Circularity	Digital traceability and circular practices	Enhanced circular supply chain performance	Duman Altan et al. (2024)

The connections between resilience and sustainability are becoming more apparent as described in Table 5. Digitally enabled resilience can ensure operational continuity and at the same time work towards sustainable digitisation of supply chain networks can enhance the long-term viability of supply chain networks.

3.6 Integrated Resilience Mechanism

The findings of the reviewed studies suggest that there is a sequential relationship between technological adoption and strengthening information visibility and analytical capabilities. These capabilities then help to enhance risk identification, coordination, flexibility, and adaptive decision-making. Improved risk-management capability then helps to ensure supply resilience and sustainable operational performance.

This relationship can be presented as:

AI and Digital Technologies → Visibility and Intelligence → Risk-Management Capability → Supply Chain Resilience → Sustainable Performance

However, organisational and environmental factors are also involved in the relationship. The impact of organizational change on the implementation of AI capabilities that lead to resilience (Guo et al., 2025). Furthermore, the effectiveness of the use of artificial intelligence and the resilience results can be influenced by managerial characteristics (Xu et al., 2025).

Another contextual factor is the dynamism of supply chains, as their swift evolution can impact the correlation between digitalization, resilience and sustainability (Atieh Ali et al., 2024). The findings thus indicate that there are more prerequisites to consider: This digital transformation will deliver meaningful benefits in terms of resilience only when supplemented by organizational readiness, managerial capability, and environmental conditions.

3.7 Key Challenges and Research Gaps

While the results were generally positive, there are some gaps which exist in the literature. First, the focus on resilience is on AI research, while the synergies of AI, IoT, blockchain and digital twins are less explored. Gupta et al. (2023) offer proof of the need for AI and blockchain to be combined, while Kumar et al. (2023) show potential benefits of blockchain-IoT, highlighting the need for the study of technology complementarities.

Second, examining resilience at various stages of disruption is needed. Tang et al. (2025) differentiate between the phases of preparation, response, and recovery, and argue for technologies that can deliver distinct benefits during each of these resilience phases.

Third, sustainability needs to be more connected to the research of risk and resilience. Han and Um (2024) underscore the value of risk management strategy that dovetails with resilience and sustainability goals. The circular practices and traceability can also have a significant impact on the sustainability value created by digital technologies, as demonstrated by Duman Altan et al. (2024).

Lastly, geopolitical uncertainty is making it more important than ever to have intelligent external-risk monitoring. While Dong et al. (2025) discuss AI's contribution to resilience in the face of geopolitical risks, there is a need for more research to explore the reaction of intelligent systems to the combined effects of geopolitical, climate, cyber, supplier and financial disruptions.

Overall, the results show that the shift towards resilient and intelligent supply chains is not just about one technology but the combination of AI-driven intelligence, digital connectivity, proactive risk management, organizational agility, and sustainability-focused practices. The evidence thus leads to an integrated perspective: digital transformation is a strategic capability to develop supply chains that are simultaneously more predictive, responsive, resilient and sustainable.

4. Discussion

The results indicate that resilient and intelligent supply chains are increasingly being constructed through the use of a multi-layered approach that integrates AI, digital platforms, advanced analytics, blockchain, digital twins and proactive risk-management. This is in line with the findings that AI enhances resilience, such as the firms' capacity to prepare and react to external shocks like geopolitical uncertainty (Dong et al., 2025).

One of the main conclusions is the shift from a "reactive" to a "predictive and adaptive" view of resilience, where AI is increasingly becoming a key enabler.A major observation is the shift towards a more proactive and adaptive understanding of resilience, where AI plays a significant role. In times of disruptions, predictive analysis, anomaly detection, supplier monitoring and real-time decision support can minimise uncertainty and speed up response. This aligns with the research findings that demonstrate how AI enhances organizational information-processing capacity (OIC), and thereby enhances resilience (Pan et al., 2025). In the context of volatile situations, similar evidence shows that AI can be used to assist firms in sensing change and reconfiguring resources to respond with dynamic capabilities (Pu et al., 2026). AI has the capacity to generate value across numerous aspects of resilience, with emphasis on preparation, response, and recovery (Tang et al., 2025).

Firms also need appropriate structures, processes, and managerial strengths to be resilient when implementing AI. Organizational change has been recognized as one of the factors that can enhance supply chain resilience in the context of the use of AI (Guo et al., 2025). Additionally, managerial traits have a significant influence on the impact of AI-enables resilience, suggesting that leadership will still be important in highly digitized supply chains (Xu et al., 2025). Thus, in the successful digital transformation, there is a need to align the technology, organizational design and the managerial decision-making.

Another key finding is in regards to the complementary use of multiple digital technologies. Again, there are several capabilities that AI alone cannot deliver, such as traceability, trusted data exchange, secure connectivity, and scenario simulation, which are provided by Blockchain, IoT, and digital twins. AI and blockchain can work hand-in-hand to enhance financial resilience through better transparency and financial analysis to make decisions (Gupta et al., 2023). Additionally, there are potential benefits for blockchain–IoT integration, such as enhanced security, logistics visibility, and sustainable operations (Kumar et al., 2023). To enhance these capabilities, digital twins have been introduced to enable supplier assessment, simulations, and even sustainability-based risk assessments (Hezam et al., 2024).

In addition, the review shows that there is an emerging link between resilience and sustainability. Digital technologies can enhance the sustainability by making better use of traceability, circular practices, efficient resource utilization and better coordination among the supply chain partners (Duman Altan et al., 2024). Social sustainability is also gaining importance due to the impact of digital transformation in the context of transparency, conditions of the workforce, responsibility of stakeholders and responsible sourcing (Malakar et al., 2025). These results are consistent with a more

comprehensive view of resilient supply chains: continuity and recovery should not compromise and should reinforce environmental and social goals.

Another main pathway that links digitalization to resilience was risk management. With technology risk management, companies can detect threats at an earlier stage, assess the interactions between risks and take proactive steps to mitigate threats. This can provide a competitive edge when risk management is an integral part of strategic decision making, not just a defensive measure (Jegan Joseph Jerome et al., 2024). AI's value is also demonstrated as a means to indirectly lower supply chain risk by enhancing efficiency and resilience (Li et al., 2025). Thus, predictive analytics, operational monitoring, and adaptive response capabilities need to be combined into intelligent risk management.

The architecture can be further reinforced by the use of big data analytics, allowing companies to transform vast and varied information streams into insights. The effectiveness of analytics to improve the resilience of the supply chain has been recently demonstrated by increased sensing, interpretation, and response processes (Lin et al., 2026). But these benefits are only sustainable if governance, data quality, interoperability and organizational readiness are in place. Therefore, the key is to find the balance between resilience, efficiency, and sustainability in risk-management strategies rather than optimizing just one dimension (Han & Um, 2024).

Overall, the results suggest a path for integration – that by using digital technologies, supply chains will become more intelligent, supply chain intelligence will help build the capability for risk management, and that enhanced risk management will help build resilience and sustainable performance. Future studies should investigate various combinations of technology, human–AI collaboration, exposure to cybersecurity threats, and industry-specific differences to explore how intelligent supply chains can continue to be adaptive, secure and sustainable in increasingly complex disruptions and volatile environments.

5. Conclusion

The integration of AI, digital technologies, sustainability principles, and proactive risk management is reshaping resilient and intelligent supply chains, as illustrated in this review. The results revealed that AI contributes to improved forecasting, disruption detection, decision support, reconfiguration of resources, and recovery capabilities, whereas complementary technologies like blockchain, the IoT, digital twins, big data analytics, and Industry 4.0 can help boost visibility, traceability, connectivity, and coordination. In this way, digital transformation is a driver of resilience, not a technology itself, but rather through the capabilities of information processing and adaptation. Furthermore, as demonstrated in the review, resilience and sustainability are tightly linked, with digital supply chains having the potential to enhance operational continuity, resource efficiency, transparency, circularity, and long-term performance. Concurrently, organizational readiness, managerial capability, data quality, interoperability, cyber security, and proper governance are crucial for effective implementation. The risk management becomes a key process connecting digital intelligence and resilience, as it allows vulnerabilities to be identified earlier and disruptions mitigated earlier. Overall, the evidence suggests that an integrated pathway exists where digital technologies augment supply chain intelligence, supply chain intelligence enhances risk-management capability, and enhanced risk-management supports resilient and sustainable supply chain performance. Future studies should continue to investigate the interplay of technologies, human-AI collaboration, cybersecurity exposure and sector applications in the evolving global environment and regulatory uncertainty.

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