IJISEM
INTERNATIONAL JOURNAL OF INNOVATIONS IN SCIENCE ENGINEERING AND MANAGEMENT

International Journal of Innovations In Science Engineering And Management

AI-Powered Supply Chain Resilience and Sustainability

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OPEN ACCESS

Volume: 5

Issue: 4

Month: November

Year: 2026

ISSN: 2583-7117

Published: 17.11.2026

Citation:

Harrish Raja, Binod Prasad Dhakal, Ramayanam Venkataramana Rao " AI-Powered Supply Chain Resilience and Sustainability" International Journal of Innovations In Science Engineering And Management, vol.5, no.4, 2026.

DOI:

10.69968/ijisem.2026v5i4289-294

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Abstract

Artificial intelligence (AI) is increasingly recognised as an important tool for improving supply chain resilience and sustainability in an uncertain global business environment. Supply chains face disruptions arising from pandemics, natural disasters, geopolitical conflicts, and transportation inefficiencies, creating a need for adaptive and sustainable management strategies. This review examines the role of AI in strengthening supply chain resilience and supporting environmental, economic, and social sustainability. It discusses applications of predictive analytics, machine learning, risk assessment, supply chain visibility, and intelligent optimisation in disruption prediction, operational recovery, and resource management. The review also considers AI-driven logistics optimisation, waste reduction, supplier monitoring, and sustainable procurement. Existing research highlights the potential of AI to improve information processing, decision-making, operational efficiency, and adaptability. However, implementation costs, data quality limitations, cybersecurity risks, and ethical concerns remain significant challenges. The review identifies future research needs concerning responsible AI governance, measurable sustainability outcomes, and resilient supply chain ecosystems.

Keywords: *Artificial Intelligence; Supply Chain Resilience; Supply Chain Sustainability; Predictive Analytics; Risk Management.*

INTRODUCTION

Supply chains play a vital role in modern business by connecting suppliers, manufacturers, distributors, and customers to ensure the timely movement of materials, products, and information. However, the increasing complexity and global interconnectedness of supply networks have made them vulnerable to various disruptions, including pandemics, natural disasters, geopolitical conflicts, and transportation interruptions [1]. Such events can lead to material shortages, delivery delays, increased operational costs, and reduced business performance. Consequently, organisations need to develop supply chains that can withstand disruptions, recover quickly, and adapt to changing conditions while maintaining long-term sustainability [2], [3].

Supply chain resilience and sustainability have therefore become important priorities for organisations seeking operational stability and responsible growth. Resilience focuses on anticipating disruptions, managing risks, and restoring operations, whereas sustainability emphasises the efficient use of resources, environmental protection, economic viability, and social responsibility. Achieving both objectives requires improved visibility, timely information, and effective decision-making across supply chain activities [4], [5].

Artificial intelligence (AI) offers opportunities to address these requirements through machine learning, predictive analytics, and intelligent optimisation. These technologies can support demand forecasting, identify potential supply chain risks, improve inventory management, and optimise transportation and resource allocation [6]. Research also indicates that AI can strengthen supply chain visibility and support preparedness, response, and recovery during disruptions. Furthermore, AI-based analytical tools can contribute to more efficient resource utilisation and sustainable supply chain operations, although their effectiveness depends on data quality, technological infrastructure, and appropriate implementation [7].

Against this background, this review examines the role of AI in strengthening supply chain resilience and promoting sustainability. It focuses on AI applications in disruption management, environmental and operational performance, and the challenges associated with implementation. The review also identifies research gaps and future directions for integrating AI into more resilient, efficient, and sustainable supply chain systems.

AI TECHNOLOGIES FOR ENHANCING SUPPLY CHAIN RESILIENCE

Artificial intelligence (AI) technologies can strengthen supply chain resilience by improving risk prediction, information processing, and decision-making. By analysing large volumes of operational and external data, AI helps organisations identify potential disruptions, assess vulnerabilities, and develop appropriate responses. Research indicates that AI can support different stages of resilience, including preparedness, response, recovery, and adaptation [8].

1. **Predictive Analytics and Machine Learning:** These technologies analyse historical and real-time data to forecast demand fluctuations, identify potential supplier failures, and predict disruptions. Early warnings enable organisations to prepare contingency plans and reduce operational uncertainty.
2. **Supply Chain Visibility and Risk Assessment:** AI processes information from suppliers, inventory systems, transportation networks, and market conditions to identify bottlenecks and emerging risks. Improved visibility supports timely risk assessment and informed planning across the supply chain.
3. **Disruption Response and Recovery:** AI-based decision support and optimisation tools help organisations compare alternative responses, reallocate inventory, identify substitute suppliers, and adjust transportation routes. Scenario analysis can assist managers in evaluating possible disruption outcomes and selecting appropriate recovery strategies.
4. **Adaptive Decision-Making:** AI systems can continuously analyse changing conditions and update recommendations as new information becomes available. This supports flexible resource allocation, operational adjustments, and adaptation to changing market conditions, helping supply chains maintain continuity and recover more effectively.

AI-DRIVEN SUSTAINABILITY IN SUPPLY CHAIN MANAGEMENT

AI can contribute to sustainable supply chain management by improving resource efficiency, reducing environmental impacts, and supporting responsible business practices. AI-enabled logistics optimisation can help reduce fuel consumption and emissions through efficient route planning, while demand forecasting and inventory management can minimise overproduction, excess stock, and waste [9]. Economically, AI can improve operational efficiency, cost control, and resource utilisation. Socially, AI-supported supplier monitoring and traceability can help identify ethical sourcing concerns and potential labour-related risks. However, organisations should balance rapid disruption recovery with long-term sustainability objectives, as emergency sourcing or faster transportation may increase costs and environmental impacts. Therefore, AI decisions should consider environmental, economic, and social outcomes together rather than prioritising efficiency alone [10], [11].

Table 1: AI-Driven Sustainability in Supply Chain Management

Sustainability dimension	AI applications	Expected contribution
Environmental	Route optimisation, energy management, waste prediction	Lower emissions and resource consumption
Economic	Demand forecasting, inventory optimisation, cost analysis	Improved efficiency and reduced operating costs
Social	Supplier monitoring, traceability, risk detection	Better visibility of ethical and labour-related risks
Integrated sustainability	Multi-objective optimisation and scenario analysis	Balance resilience with long-term sustainability

IMPLEMENTATION CHALLENGES

Despite its potential benefits, implementing AI in supply chain management involves technical, financial, organisational, and ethical challenges. Successful adoption requires reliable data, compatible digital systems, skilled employees, and effective governance. Without these conditions, AI-generated recommendations may be inaccurate, costly to implement, or difficult to integrate into existing operations. Research on AI adoption in supply chains highlights the importance of organisational readiness,

technological infrastructure, and human capabilities in achieving effective implementation [12], [13].

1. **Technical and Organisational Barriers:** High initial investment, poor data quality, fragmented information systems, and limited digital infrastructure can restrict AI adoption. Small and medium-sized enterprises may face additional difficulties due to financial constraints and shortages of skilled personnel. Integrating AI with existing supply chain systems may also require substantial time and organisational changes.
2. **Ethical and Governance Concerns:** AI systems depend on sensitive operational and supplier data, creating risks related to data privacy and cybersecurity. Biased algorithms may produce unfair supplier assessments or resource allocation decisions. Limited model transparency can also make AI-generated recommendations difficult to explain, evaluate, and trust. Clear accountability, data protection measures, and human oversight are therefore necessary.
3. **Balancing Performance and Sustainability:** Organisations must ensure that AI-driven cost reductions and faster recovery do not undermine environmental protection or social responsibility. Regular performance monitoring using operational and sustainability indicators can help identify unintended consequences and support responsible implementation.

LITERATURE REVIEW

(Zhou et al., 2026)[14] Examining how artificial intelligence peer effects might improve corporate supply chain resilience is a critical area of study for the manufacturing industry in order to mitigate supply chain risks and achieve high-quality development, since it is a major route for technological diffusion. Results show that corporate supply chain resilience is greatly increased by the AI peer effect. After completing several stability tests, including instrumental variables, placebo tests, and PSM-DID, in addition to endogeneity checks, this finding is still strong. Mechanism analysis reveals that supply chain network complexity has a positive moderating impact while technological absorption capacity partially mediates the association between the AI peer effect and supply chain resilience. Extension analyses show that the influence of the AI peer effect varies across high and low technology-intensive industries as well as between big and small and medium-sized firms (SMEs). These results offer fresh empirical data and policy implications for reconsidering the connection between corporate supply chain resilience and the AI peer effect.

(Gomaa, 2026) [15] synthesises the field's development and intellectual framework spanning "AI technologies and capabilities, procurement applications, sustainability aspects, supply chain resilience, theoretical viewpoints, methodological methods, and contextual factors". The results indicate that the majority of current research is focused on "technology adoption, process automation, predictive analytics, and operational efficiency". Comparatively little attention has been given to the organisational, relational, and governance mechanisms that influence the translation of AI capabilities into multidimensional and sustained sustainability outcomes. As a result, the study creates an integrative future research agenda that focuses on resilient procurement ecosystems, responsible AI governance, capability development, and quantifiable sustainability value generation in addition to technology adoption. This work extends the conceptual underpinnings of AI-driven sustainable procurement management by merging disparate streams of research and elucidating the connections between AI capabilities, procurement procedures, and sustainable supply chain results. It offers a methodical foundation for both evidence-based management practice and cumulative scholarship.

(Tathavadekar & Mahankale, 2025) [16] A paradigm change toward accomplishing circular economy (CE) goals by 2040 is represented by the integration of artificial intelligence (AI) and machine learning (ML) technology into sustainable supply chain management (SSCM). The paper suggests a unique dual-framework method for establishing intelligent sustainable supply chains and highlights important research needs in AI-driven circular economy transitions. According to our research, supply chain optimisation has seen a 300% growth in AI applications since 2020, yet only 23% of these apps explicitly address circular economy concepts. By analysing 12 organisational case studies using structural equation modelling (SEM), we show that by 2040, AI-powered circular supply chains may reduce waste production by 45%, improve resource efficiency by 38%, and increase supply chain resilience by 52%. The report creates a path for further research in AI-driven sustainable supply chain management and offers practitioners practical insights.

(Wei & Ma, 2025) [17] Maintaining corporate competitiveness in the face of expanding globalisation and rising unpredictability, good supply chain resilience is becoming more and more important. It investigates the relationship between supply chain resilience and artificial intelligence, as well as the moderating effect of internationalisation. The empirical findings show that by increasing businesses' information processing efficiency and enabling the best possible coordination of outside resources, AI improves supply chain resilience. Businesses with greater levels of internationalisation are better at using AI to

improve their cross-border supply networks' responsiveness and capacity for recovery. Adoption of AI also increases resilience in state-owned and asset-heavy businesses. All things considered, this study expands the theoretical knowledge of AI-driven supply chain resilience and provides practical advice for creating reliable and flexible supply chain systems in changing international environments.

(Allam et al., 2025) [18] AI in logistics has the potential to enhance sustainable supply chain management as it can be used to maximise resource utilisation and cut waste, improving environmental footprints at the supply chain and enterprise levels. AI-powered solutions may assist deliver more accurate demand forecasts, optimise logistics operations, and concurrently reduce carbon emissions as businesses come under increasing pressure to be environmentally responsible. With an emphasis on intelligent resource allocation, predictive analytics, and circular economy solutions, this research investigates the use of AI technology in sustainable supply chains. Businesses may increase resilience, reduce costs, and satisfy consumers' increasing demands for environmental responsibility by integrating AI with other critical technologies.

(Alsakhen et al., 2024) [19] Supply chain risk management is essential in today's fast-paced, disruptive business environment. More importantly, Industry 4.0 has given supply chains a competitive edge by incorporating digital technology into manufacturing and logistics, but it also presents a number of possibilities and difficulties for risk management. This essay examines some of the ways that cutting-edge technologies—particularly artificial intelligence (AI)—help solve urgent issues with risk and sustainability management in supply chains and logistics. The study identifies the key themes and gaps of earlier research using a systematic literature review (SLR) supported by a mapping study based on the Scopus database. According to the results, AI may significantly improve resilience by identifying risks early, streamlining processes, improving decision-making, and guaranteeing transparency across the value chain. The study's main takeaway is to highlight how technology helps make supply networks more robust to the uncertainties of today.

(Rita Uchenna Attah et al., 2024) [20] Demand fluctuation, disruption management, inventory optimisation, transportation inefficiencies, and supplier relationship management are just a few of the supply chain issues that this study investigates how AI-driven solutions might address. In order to improve supply chain resilience, the report offers a thorough examination of AI technologies, including autonomous systems, optimisation algorithms, real-time monitoring systems, and predictive analytics. The analysis also looks at the advantages of incorporating AI into supply chain operations, including better risk management, better decision-making, and more flexibility in the face of uncertainty. But it also tackles the obstacles to AI adoption, such as high implementation costs, worries about data protection, and organisational reluctance to change. The results highlight the revolutionary potential of AI technology in building resilient, flexible, and effective supply chain systems that can endure unforeseen events and interruptions in the future.

(Stewart & Adams, 2023) [21] Supply chain management (SCM) has grown more complicated and vulnerable to disturbances in the quickly changing global business environment. The dynamic difficulties presented by market volatility, geopolitical conflicts, and natural disasters cannot be adequately addressed by traditional supply chain systems, which frequently rely on historical data and human decision-making. By facilitating real-time insights, proactive risk management, and optimised decision-making, artificial intelligence (AI) and predictive analytics provide a game-changing solution. The use of AI and predictive analytics in supply chain optimisation is examined in this study, with an emphasis on how these technologies improve operational effectiveness and resilience. The study outlines the main advantages, difficulties, and potential future paths of AI-powered supply chain management through an extensive assessment of the literature, case studies, and empirical analysis. The results highlight the vital role AI plays in creating flexible and resilient supply networks that can handle uncertainty and achieve sustainable development.

DISCUSSION

The reviewed studies indicate that artificial intelligence can contribute to supply chain resilience and sustainability by improving predictive capabilities, information processing, and operational decision-making. Research by Zhou et al. (2026) and Wei and Ma (2025) highlights the relationship between AI adoption and supply chain resilience, particularly through technological absorption, information-processing efficiency, and resource coordination. Similarly, Alsakhen et al. (2024) and Attah et al. (2024) emphasise the role of AI in risk identification, inventory optimisation, disruption management, and operational adaptability. From a sustainability perspective, AI can support logistics optimisation, resource efficiency, waste reduction, and sustainable procurement, as discussed by Allam et al. (2025) and Gomaa (2026). Nevertheless, the benefits of AI depend on implementation conditions, including data reliability, digital infrastructure, employee capabilities, and governance mechanisms. High investment costs, cybersecurity threats, and limited transparency may restrict adoption, particularly among small and medium-sized enterprises. Moreover, the reviewed research suggests that operational efficiency alone

is insufficient to establish sustainability. Future investigations should evaluate measurable environmental and social outcomes alongside resilience performance and examine how responsible AI implementation can support long-term supply chain sustainability.

CONCLUSION

Artificial intelligence offers considerable potential to strengthen supply chain resilience while supporting sustainable business operations. Technologies such as machine learning, predictive analytics, risk assessment, and intelligent optimisation can help organisations anticipate disruptions, improve supply chain visibility, allocate resources efficiently, and recover operations more effectively. AI can also contribute to environmental sustainability through reduced waste and emissions, economic sustainability through improved operational efficiency, and social sustainability through enhanced supplier monitoring and traceability. However, achieving these benefits requires more than technological adoption. High implementation costs, inadequate data, limited digital infrastructure, cybersecurity risks, and ethical concerns must be addressed through appropriate governance, employee training, and human oversight. Organisations should also ensure that short-term efficiency and disruption recovery do not compromise long-term environmental and social objectives. Future research should focus on responsible AI governance, practical implementation strategies for small and medium-sized enterprises, and empirical evaluation of sustainability outcomes. Integrating resilience and sustainability into AI-supported decision-making can help develop more adaptive, efficient, and responsible supply chains.

REFERENCES

[1] B.Gowtham and D. M. R. Rao, “Artificial Intelligence And Supply Chain Resilience: A Study Of Modern Business Organizations,” Int. J. Creat. Res. THOUGHTS, vol. 14, no. 10, pp. 399–412, 2026.

[2] D. Singh, A. Sharma, R. K. Singh, and P. S. Rana, “Artificial intelligence enabled supply chain resilience: insights from FMCG industry,” J. Glob. Oper. Strateg. Sourc., vol. 18, no. 2, pp. 414–441, Mar. 2025, doi: 10.1108/JGOSS-02-2024-0017.

[3] M. O. Hoque, “Artificial intelligence in sustainable supply chain resilience with predictive analytics as a mediator and environmental uncertainty as a moderator,” Discov. Artif. Intell., vol. 6, no. 1365, 2026, doi: 10.1007/s44163-026-02314-9.

[4] D. M. S. Al-Naimi, “The Impact of AI in Supply Chain Resilience: A Systematic Mapping Review,” Gatew. J. Mod. Stud. Res., vol. 2, no. 1, pp. 167–186, 2021.

[5] Tracy Joan Reid, “The Role of Adaptive AI in Commodity Dynamics across India’s Quick-Commerce Sector.,” Int. J. Innov. Sci. Eng. Manag., vol. 5, no. 1s, pp. 23–29, 2026, doi: 10.69968/ijisem.2026v5Si123-29.

[6] M. Riad, M. Naimi, and C. Okar, “Enhancing Supply Chain Resilience Through Artificial Intelligence: Developing a Comprehensive Conceptual Framework for AI Implementation and Supply Chain Optimization,” Logistics, vol. 8, no. 111, 2024, doi: 10.3390/logistics8040111.

[7] M. Hong and J. M. Kim, “AI-Driven Responsible Supply Chain Management and Ethical Issue Detection in the Tourism Industry,” Sustain., vol. 17, no. 21, pp. 1–17, 2025, doi: 10.3390/su17219622.

[8] A. Rashid and R. Rasheed, “RETRACTED: Supply chain cognitive resilience through AI-powered risk mitigation and autonomous resilience,” Supply Chain Manag. An Int. J., vol. 31, no. 2, pp. 222–237, Dec. 2025, doi: 10.1108/SCM-07-2025-0656.

[9] C. Ratanacharoenchai and K. Jantapoon, “The mediating role of supply chain resilience in the relationship between AI capabilities and sustainability performance: evidence from manufacturing SMEs,” Sustain. Futur., vol. 11, 2026, doi: 10.1016/j.sftr.2026.101677.

[10] A. Ghadami, M. Abdsharafat, R. Rostamzadeh, and H. Isavi, “AI-Powered Supply Chains: Mapping the Future of Resilience and Sustainability,” Ind. Manag. J., vol. 18, no. 2, pp. 208–236, 2026.

[11] X. Guo, Y. Chen, J. Xie, H. Wang, and X. Lei, “Research on supply chain resilience mechanism of AI-Enabled manufacturing enterprises -based on organizational change perspective,” Sci. Rep., vol. 15, no. 1, pp. 1–18, 2025, doi: 10.1038/s41598-025-17138-3.

[12] M. A. K. Alsmairat, L. Jum’a, M. K. Al-Nawayseh, and E. Singhal, “Mapping the Intersection of Artificial Intelligence and Supply Chain Resilience: A Literature Review and Future Research Agenda,” Aug. 14, 2025, Emerald Publishing Limited. doi: 10.1108/S2754-58652025000004B007.

[13] J. Jones, “The Role of AI in Enhancing Supply Chain Resilience: Insights from Industry Experts,” Preprints, pp. 0–15, 2025, doi: 10.20944/preprints202504.0741.v1.

[14] C. Zhou, F. Gong, and X. Li, “The impact of artificial intelligence and group effects on supply chain resilience in enterprises,” Int. Rev. Econ. Financ., vol. 108, p. 105180, 2026, doi: 10.1016/j.iref.2026.105180.

[15] A. H. Gomaa, “AI-Driven Sustainable Procurement Management in Supply Chains: A Systematic Literature Review, Research Gap Analysis, and Future Directions,” Intell. Sustain. Manuf., 2026, doi: 10.70322/ism.2026.10025.

[16] V. Tathavadekar and D. N. R. Mahankale, “AI-Powered Sustainable Supply Chains: A Machine Learning Framework for Circular Economy Transitions by 2040,” Int. J. Sci. Technol., vol. 2, no. 2, pp. 171–204, 2025, doi: 10.70558/ijst.2025.v2.i2.241059.

[17] S. Wei and Y. Ma, “The Impact of Artificial Intelligence on Supply Chain Resilience in Manufacturing Firms: The Moderating Role of Internationalization Degre,” in Proceedings of 2025 2nd International Conference on Digital Economy and Computer Science, DECS 2025, Association for

Computing Machinery, 2025, pp. 587–596. doi: 10.1145/3785706.3785799.

[18] H. Allam, E. J. Lazaros, C. B. Davison, and A. D. Truell, “The AI-driven sustainability: transforming supply chains for a greener future,” Issues Inf. Syst., vol. 26, no. 2, pp. 258–266, 2025, doi: 10.48009/2_iis_120.

[19] I. Alsakhen, L. Buics, and E. Süle, “AI-driven resilience in revolutionizing supply chain management: A systematic literature review,” J. Infrastruct. Policy Dev., vol. 8, no. 16, p. 9474, 2024, doi: 10.24294/jipd9474.

[20] Rita Uchenna Attah, Baalah Matthew Patrick Garba, Ifechukwu Gil-Ozoudeh, and Obinna Iwuanyanwu, “Enhancing supply chain resilience through artificial intelligence: Analyzing problem-solving approaches in logistics management,” Int. J. Manag. Entrep. Res., vol. 6, no. 12, pp. 3883–3901, 2024, doi: 10.51594/ijmer.v6i12.1745.

[21] O. Stewart and P. V. Adams, “AI-Powered Supply Chain Optimization: Enhancing Resilience through Predictive Analytics,” Int. J. AI, BigData, Comput. Manag. Stud., vol. 4, no. 2, pp. 9–20, 2023, doi: 10.63282/3050-9416.ijaibdcms-v4i2p102.