Journal of Information Systems Engineering and Management
2025, 10(38s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Transforming Supply Chain Management with Next-Generation Technology (AI, Drones and Robots)- A Bibliographic Review

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ARTICLE INFO

Received: 15 Dec 2024

Revised: 21 Feb 2025

Accepted: 28 Feb 2025

ABSTRACT

The global supply chain is undergoing a radical transformation driven by emerging technologies such as robots, drones, and artificial intelligence (AI). These (modern technologies) are redefining supply chain management by enhancing efficiency, reducing operational costs, and improving resilience against disruptions such as natural disasters, geopolitical tensions, and pandemics. The integration of robots in warehouse automation has streamlined logistics processes, while drones are revolutionizing last-mile delivery, particularly in remote and hard-to-reach locations. AI-driven predictive analytics have significantly optimized demand forecasting, inventory management, and decision-making processes, leading to a more responsive and agile supply chain ecosystem. This paper explores the profound impact of these next-generation technologies, analysing their contributions to supply chain optimization, logistics enhancement, and real-time monitoring as well examine the critical challenges associated with their implementation, including cybersecurity risks, regulatory constraints, data privacy concerns, and ethical considerations related to workforce displacement. The study highlights the growing need for businesses to adapt to these advancements and the importance of policy frameworks to ensure a sustainable and ethical transition. The findings suggest that the adoption of robots, drones, and AI is not just a competitive advantage but a necessity for organizations striving for long-term sustainability and market leadership. While challenges remain, strategic implementation and regulatory alignment can help organizations maximize the benefits of these technologies, creating a more resilient and efficient global supply chain. This paper concludes with recommendations for businesses, policymakers, and supply chain professionals on how to navigate this technological evolution successfully.

Keywords: Supply Chain, Artificial Intelligence, Drones, Logistics, Automation, Technology Innovation.

INTRODUCTION

The global supply chain is the backbone of the modern economy, facilitating the seamless movement of goods from manufacturers to consumers. Efficient supply chain management is crucial for sustaining

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economic growth, ensuring product availability, and maintaining competitive advantage. However, traditional supply chains encounter significant challenges, including inefficiencies, delays, human errors, and rising operational costs (Christopher, 2016). The increasing complexity of supply chain networks, exacerbated by globalization, has further highlighted the need for innovative solutions to enhance resilience and efficiency (Ivanov, Dolgui, & Sokolov, 2019).

Recent advancements in robotics, drones, and artificial intelligence (AI) have presented transformative opportunities to address these inefficiencies. Robots are streamlining warehouse operations through automation, reducing manual labour dependency and increasing accuracy in inventory management (Waller & Fawcett, 2013). Drones, on the other hand, are revolutionizing logistics by expediting last-mile deliveries and reaching remote areas where traditional transportation methods may be impractical (Goodchild & Toy, 2018). AI-driven predictive analytics are improving demand forecasting, optimizing supply chain decision-making, and reducing waste by enhancing real-time visibility (Choi, Wallace, & Wang, 2018).

This paper explores how these next-generation technologies are reshaping supply chain operations and their implications for future business models. It analyses the benefits of integrating these technologies, as well as the challenges businesses may encounter during implementation, such as regulatory constraints, cybersecurity threats, and workforce displacement. By examining existing literature, this study aims to provide a comprehensive understanding of the bibliographic review on evolving supply chain landscape and offer strategic recommendations for organizations navigating this transformation.

REVIEW OF LITERATURE

The role of artificial intelligence (AI), robotics, and automation in supply chain management has been widely explored in academic and industry research. AI-driven predictive analytics, robotic process automation, and drone-based logistics have significantly altered traditional supply chain models.

Ivanov et al. (2020) discuss the use of AI-driven predictive analytics to enhance demand forecasting. Their study highlights how machine learning algorithms analyze vast datasets to identify demand trends, optimize inventory levels, and reduce stockouts or overstock situations. Similarly, Choi, Wallace, and Wang (2018) emphasize the role of big data analytics in improving supply chain efficiency, asserting that AI-powered decision-making leads to improved responsiveness to market fluctuations.

The impact of autonomous drones on logistics and last-mile delivery efficiency has been analysed by Kim and Lee (2021). Their study identifies key benefits, such as reduced delivery times, minimized labour costs, and enhanced accessibility to remote locations. Goodchild and Toy (2018) further evaluate the environmental impact of drone-based deliveries, concluding that drones have the potential to reduce CO_2 emissions compared to traditional delivery vehicles, particularly in urban areas.

Smith et al. (2019) explore the implementation of robotic process automation (RPA) in warehouse management. Their research demonstrates that automated systems improve order accuracy, optimize storage space utilization, and enhance overall productivity. Waller and Fawcett (2013) discuss the broader implications of data science and predictive analytics in warehouse automation, arguing that robotics and AI integration lead to more efficient supply chain operations.

Despite these benefits, challenges remain. Ivanov, Dolgui, and Sokolov (2019) highlight risks associated with AI and automation, such as cybersecurity threats, system vulnerabilities, and the high costs of technological implementation. Ethical concerns surrounding workforce displacement and job automation are also critical issues discussed by researchers.

This literature review synthesizes existing research to provide a comprehensive understanding of how emerging technologies are transforming supply chains. By reviewing multiple studies, it becomes evident that AI, robotics, and drones contribute significantly to enhancing supply chain competence, yet their adoption requires strategic planning, policy intervention, and risk mitigation measures.

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OBJECTIVES

1. To review the transforming supply chain management with next-Generation technology.
2. To examine policy implications, ethical concerns, and propose strategic recommendations for businesses adopting these technologies.

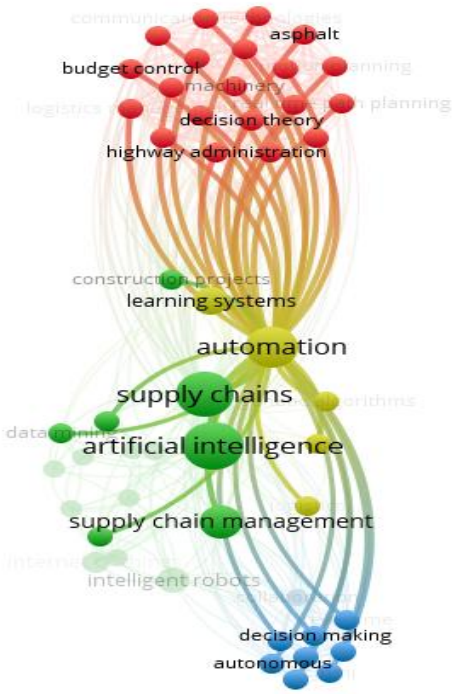
METHODOLOGY

This study employs a qualitative research methodology based on a systematic literature review. The research is primarily based on secondary data sources from scoups database and peer reviewed journals. The various keywords such as Supply Chain, Robotics, Artificial Intelligence, Drones, Logistics, Automation, Technology Innovation are used with multiple combinations to extract the research papers from Scopus database. A total of 24 relevant paper are selected without any filters from the database. The extracted sources of the papers are feed to VOSveiwer tool to understand the various associations between the authors, keywords, countries etc. These sources provide insights into current trends, technological advancements, and the broader implications of AI, robotics, and drones in supply chain management.

RESULTS AND DISCUSSION

1.Role of Automation in Supply Chain Management: This vertical co-occurrence network visualization elegantly captures the centrality and interconnectedness of artificial intelligence (AI), automation, and supply chains across various domains, including construction, decision sciences, and logistics. The diagram is organized with a visual flow from the bottom (technological enablers) to the top (application areas), highlighting how foundational technologies influence higher-level functions.

At the centre of the map, artificial intelligence, automation, and supply chains form the core nexus of the network suggesting these are not only heavily researched topics but also integrative concepts that link technological innovation with operational efficiency. Supply chain management and decision-making, connected through AI, emphasize the growing role of intelligent systems in managing complexity, improving responsiveness, and enabling real-time data-driven strategies.



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Surrounding this core, intelligent robots, Internet of Things (IoT), and data mining reflect enabling technologies that power the digital supply chain. These feed into broader applications such as learning systems and construction projects, revealing a trend toward smarter infrastructure and automated project execution.

Further up the diagram, the red cluster at the top (e.g., budget control, decision theory, asphalt, highway administration) represents public infrastructure and urban planning domains, which are increasingly benefiting from AI-driven automation and optimized supply chains. Their strong connections to the central AI node imply a deepening integration of smart technologies in construction planning, resource allocation, and administrative efficiency.

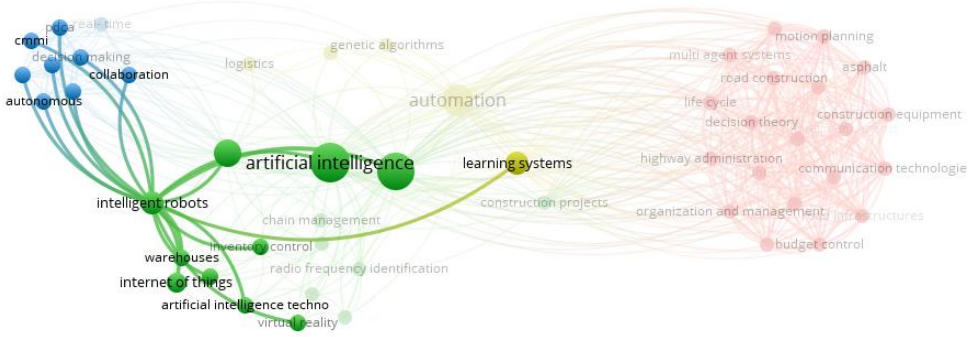
The above network illustrates a layered ecosystem that AI and supply chains act as technological pillars bridging operational tools like robotics and IoT with practical applications in construction and public systems. The flow of connections from technology to implementation domains underscores a key insight the digital transformation of industries is being powered by AI enabled supply chain intelligence and automation, creating smart, responsive systems that are reshaping how infrastructure and decision-making operate in practice.

2 AI Contribution to Supply Chain: The diagram illustrates a keyword co-occurrence network highlighting thematic areas in the intersection of artificial intelligence, supply chain management, and construction projects. Each node represents a keyword, with its size indicating the frequency of occurrence in the literature. The colors group keywords into clusters, representing distinct thematic areas, while the thickness and proximity of the connecting lines show the strength of co-occurrence between terms.

The red cluster centers around artificial intelligence and automation in supply chain management, with key terms such as artificial intelligence, automation, supply chain management, efficiency, and decision support systems. This indicates a strong research focus on the application of AI to optimize and automate supply chain operations. The keywords in this cluster are closely linked, suggesting a well-developed body of work exploring intelligent systems for improving efficiency and decision-making in supply chains.

The blue cluster represents themes related to digital transformation and decision-making, including keywords like digital transformation, digital tools, decision-making, and supply chain. This cluster highlights the growing role of digital technologies in enhancing supply chain visibility, agility, and strategic planning, particularly through AI-driven insights and data-supported decision-making processes.

3 Associations of Intelligent systems (Robots) and Supply Chain:



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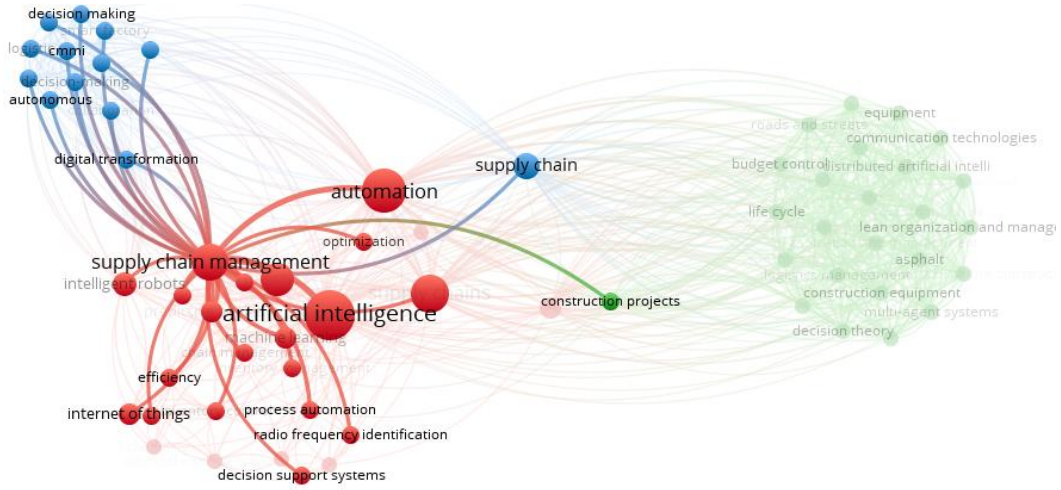
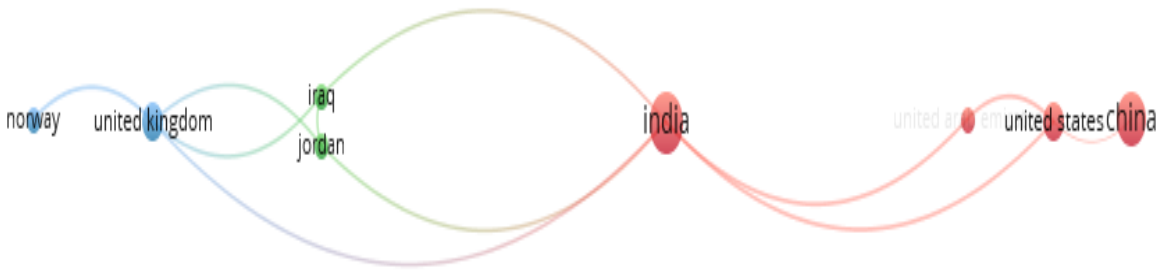


The diagram presents a rich co-occurrence network of keywords, mapping the evolving research terrain where artificial intelligence (AI), automation, intelligent systems, and supply chain management converge with growing influence on construction technologies. At the core, artificial intelligence stands out as a central hub, its large green node symbolizing its dominant role across disciplines. Closely connected are keywords such as intelligent robots, internet of things (IoT), warehouses, and virtual reality, indicating a strong focus on AI-enabled automation and smart operations within the supply chain ecosystem. The supply chain is further emphasized through links with chain management, control systems, and radio frequency identification, reflecting how AI is revolutionizing the way logistics, inventory, and warehousing are managed through intelligent decision-making and real-time data processing.

The term learning systems acts as a bridge, connecting AI to broader domains such as construction projects and automation, showcasing the integration of machine learning models into complex operational environments. In the blue cluster, keywords like autonomous, real-time, and collaboration underscore the shift toward decentralized, intelligent supply chain networks where robotics and AI collaborate in dynamic and adaptive ways. On the other end, the red cluster hints at the growing impact of these technologies on construction management, budget control, and multi criteria planning, suggesting an ongoing digital transformation within infrastructure projects.

This network visualization captures a vibrant, interconnected research field where AI and learning systems are not only optimizing supply chains but are also driving a broader technological shift across domains like manufacturing, logistics, and construction. The emerging synergies between AI, supply chain intelligence, and smart infrastructure point to a future where automation and connectivity redefine operational excellence and strategic decision-making.

4 Bibliographic coupling with countries:



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At the centre of the network is India, marked by the largest and darkest node, indicating its significant presence and high degree of shared references with other countries. India is strongly connected with countries like China and the United States, suggesting active international collaboration or alignment in research themes with these leading nations.

To the left, clusters like Norway–United Kingdom and Iraq–Jordan represent regional or thematic research linkages, with thinner lines suggesting moderate bibliographic connections. Notably, the United Kingdom acts as a bridge between European countries (like Norway) and Middle Eastern nations (like Iraq and Jordan), indicating its diverse international research engagement.

Challenges and Risks: Robots, Drones, and AI are generating breakthrough changes and advantages in supply chain but the road is not risk-free. With the increase of digitization of supply chain systems and their interdependencies, hacking in supply chains and the associated data breaches represent a major cybersecurity concern (Ivanov, Dolgui, & Sokolov, 2019). Another challenge is that these technologies typically have high start-up costs, which can be prohibitive for SMEs. Moreover, the ethical implications of job displacement through automation warrant consideration, emphasizing the need for a more holistic approach complemented by reskilling initiatives and workforce transition plans (Smith et al., 2019). The regulatory hurdles add another layer of complexity to the adoption process, as current stipulations erase the ramifications over drones and AI-powered judgment necessitating policymakers to develop guidelines for responsible implementation.

As promising as next-gen technologies are for the long-term evolution of supply chain management, it must be understood that to gain the full leverage of their pros, businesses must also find a way around multiple hurdles in adoption. Organisations can use these innovations for sustainable competitive advantage in the long term by utilising tactical implementation plans and mitigating the possible ethical, regulatory and cyber security risk.

Policy Implications: Governments need a broad-based regulatory framework concerning the incorporation of AI, robotics, and automation in supply chains. Governments also develop policies that handle key issues like data privacy, cybersecurity and ethics. With automation changing the landscape of supply chain processes, it becomes paramount for government institutions to provide these guidelines with the intention of creating a space that ensures transparency, sensitivity and safety of data, information and consumer rights respectively. They should promote investment in workforce development programs to help workers learn the skills they need to adapt to the changes created by automation.

Public/private partnerships will be key in establishing policy to achieve innovation with social accountability. To address the above shift across industries and further drive industry adoption and evolution, regulators, corporations, and technology developers must work towards establishing a unified set of standardized regulations to promote sustainable technology adoption. In addition, the global supply chains operate across various jurisdictions, making the international co-operation essential to align the regulations and to avoid conflicts in national trade policies.

Thus, one may think about presumptive regulation in a way that it aligns with technology development to unlock the AI and automation value to supply chains over other regulatory approaches focused solely on risk mitigation and social impacts.

LIMITATIONS OF THE STUDY

This research is more reliance on secondary data and direct empirical data that can provide a deeper insight into the effect that AI, drones, and robotics have in the field is not corroborated. Future researchers may corroborate with surveys, interviews, and case studies to confirm results that provide more specific insights into adoption of modern technologies and also look at greater time-series research that reflect how these technologies blend into supply chain effectiveness, cost reductions and labour impacts can take place.

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CONCLUSION

Robots, drones and AI would transform the operational aspects of supply chain management of the world. These technologies facilitate operations, establish logistics, and create inventory controls, providing companies with significant competitive advantages. While the advantages are huge, one should additionally clear up several regulatory, ethical and operational challenges to provide responsible and effective use. Having a strategic, policy led plan is needed to unlock the potential of these technologies, while mitigating their risks such as cyber security threats, job losses, regulatory pressures and more. Businesses must invest in the workforce to train and upskill them to deal with any automation related changes they are implementing.

In terms of future research, real world case studies, data collection, and cost-benefit analyses would strengthen organizational theory with tangible results. As the global supply chain continues to evolve, proactive adaptation, collaboration and regulation among stakeholders involved are essential to harness the full potential of AI, robotics, and drones.

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