

# The role of artificial intelligence on supply chain resilience

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## Abstract

**Purpose** – Supply chains are facing several challenges due to disruptions and changing situations such as COVID-19 and the need for increased levels of resilience is more important than ever. This paper focuses on exploring the impact of artificial intelligence (AI) on supply chain resilience (SCR) through a review of the existing literature. To address the gap of AI on SCR, this study focused on answering the following two research questions: (1) What is the role of AI technologies in SCR? (2) What are the key ethical and social implications of AI that arise in the process of enhancing SCR?

**Design/methodology/approach** – This study collected relevant data available in the existing literature from peer-reviewed journals and articles on supply chain and AI. The study employed a systematic literature review (SLR) and qualitative thematic analysis to identify the key themes that generate relevant findings.

**Findings** – The study's findings highlight that AI's role in enhancing SCR is important in several areas, such as improved demand and supply forecasts, accurate problem-solving, increased efficiency of tasks and improved customer services, amongst others. However, AI does not come without limitations. Although it improves the resilience of supply chains, it also leads to ethical and social implications related to job displacement, privacy and security, biases and transparency.

**Research limitations/implications** – The study offers intriguing insights into closing the disparity between theory and practice, utilising a systematic approach to demonstrate how AI impacts the resilience level of supply chains.

**Originality/value** – This study presents the positive impact that AI technologies have on enhancing the resilience of supply chains. Although there are challenges and ethical and social implications because of AI implementations, supply chains benefit from the use of AI and big data.

**Keywords** Artificial intelligence, Supply chain, Resilience, Impact

**Paper type** Literature review

## Introduction

A supply chain has been defined as a set of three or more entities directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer (Fosso Wamba *et al.*, 2024). In recent years, supply chains have faced several challenges and become more difficult to manage. As a result, the need for flexibility and agility has grown, and organisations are highly focusing on SCR, which is being promoted in many areas as a remedy for challenging situations (Singh and Modgil, 2024). To improve SCR, organisations are developing their capacity to manage disruptive and unexpected events (Munir *et al.*, 2024). AI technologies are becoming increasingly accessible for organisations to improve the performance of supply chains and their resilience. AI techniques can support organisations to develop predictive and proactive capabilities and achieve intelligent decision-making solutions in the supply chain. Due to the ability of AI machines to think, react and behave similarly to humans, several AI techniques support supply chains to be highly agile, self-adaptive and show high levels of resilience during disruptive events (Singh and Modgil, 2024). Using AI tools to improve SCR has allowed organisations to improve inventory levels by 35%, logistics costs by 15% and service levels by 65% (Belhadi *et al.*, 2021).



Researchers and practitioners have shown significant interest in understanding the key issues that cause disruptions and how to bring resilience into the supply chain to minimise the risk of these disruptions (Singh *et al.*, 2021). Dolgui *et al.* (2020) argue that further research is needed to explore how organisations can build survival mechanisms to minimise the risk of challenges and disruptions by integrating their existing capabilities and resources. The current supply chain practices are not fully updated and prepared to address challenges; therefore, organisations should rethink their supply chain methods and tactics to achieve resilience.

Addressing the impact of AI on SCR in research is crucial for several reasons. The increasing complexity and globalisation of supply chains make them susceptible to various disruptions, such as natural disasters, geopolitical tensions, and pandemics, as evidenced by the COVID-19 crisis (Sun *et al.*, 2023). These disruptions can have significant economic consequences, affecting not only individual businesses but entire economies; therefore, enhancing SCR has become a strategic priority for organisations worldwide, although only 21% of global enterprises have established a resilient supply chain network (Yuan *et al.*, 2023).

Subsequently, the study evaluates the role of AI in enhancing SCR by assessing the positive and negative effects. The study investigates the main phases the SCR endures, and it anticipates the role of AI in each supply chain phase to ensure that resilience is achieved. Secondly, this study also considers the social and ethical implications of AI in enhancing SCR. Additionally, the study applies a thorough systematic review and thematic analysis to investigate the key role of AI in enhancing SCR, focusing on the following two research questions.

RQ1. What is the role of AI technologies in SCR?

RQ2. What are the key ethical and social implications of AI that arise in the process of enhancing SCR?

Researching the impact of AI on SCR is not only timely but also essential for informing business strategies and public policies. It provides insights into best practices and technological innovations that can enhance the robustness of supply chains against future disruptions. Thus, understanding and addressing this topic through research can lead to more resilient, efficient, and sustainable supply chain systems, benefiting businesses and society as a whole (Richey *et al.*, 2023).

The paper is organised as follows. In the next section, a thorough review of the existing literature has been conducted, specifically investigating the role of AI on SCR and the social and ethical implications of AI. This section is followed by a detailed methodology that guides the study. Next, a thorough thematic analysis and a discussion of the results have been completed, followed by a summary of the findings and implications for theory and practice. The paper concludes by highlighting the limitations and the recommendations for future research.

## Literature review

### *Resilience in supply chains*

A resilient supply chain during disruption is capable of sensing risks, recognising failure and trends, analysing realistic customer demand, reconfiguring automation, security threats and controls, and activating operations quickly (Singh and Modgil, 2024).

Subsequently, the three phases through which SCR is achieved have been discussed:

- (1) Anticipation phase
- (2) Resistance phase
- (3) Response and recovery phase.

In the anticipation phase, operations managers of the supply chain must anticipate and be prepared with contingency plans for any supply chain disruptions possible within their supply

chain. In the resistance phase, when disruptions occur, the operations must be able to resist the expansion of disruption and its effects with minimal impact on the continuity of operations. In the recovery and response phase, after disruptions have occurred, the operations must be able to come back to their pre-disruption position as soon as possible. A well-prepared supply chain might even be able to transcend to a higher-order position. [Table 1](#) shows the indicators identified as responsible for the first and third phases.

*The role of AI on SCR*

In contemporary SCM, the incorporation of AI signifies a crucial advancement. AI implementations transform procedures, allowing for predictive analysis, forecasting demand, and automating decision processes ([Eyo-Udo, 2024](#)).

One of the key advantages of AI on SCR is the ability to forecast demand and supply during times of uncertainty and misinformation. This can be completed using algorithms which analyse large amounts of data from several sources and make useful predictions ([Belhadi et al., 2021](#)). Other areas of the supply chain where AI technologies have a positive impact include labour scheduling, sourcing, capacity, and inventory. The ability of AI to analyse and process a large capacity of information is beneficial, as stated above; however, this alone does not guarantee effective crisis management ([Allioui et al., 2024](#)). To achieve an effective process of crisis preparedness and response, alongside the high-capacity information processing, firms should ensure that this aligns with the decision-making frameworks and strategies the organisation has; otherwise, this capacity could lead to delayed decision-making or misallocation of resources ([Belhadi et al., 2021](#)).

Coordination and knowledge sharing across the entire supply chain ([Zamani et al., 2022](#)) is another benefit of AI on SCR. Additionally, AI contributes to the improvement of communication, flexibility and the reduction of unnecessary fluctuations in the supply chain. Increased efficiency is another impact of AI on the supply chain. AI contributes to better real-time visibility into the supply chain by monitoring inventory levels across locations and tracking the movement of goods ([Lalmi et al., 2021](#)).

The impact of AI on SCR can be categorised into various dimensions of resilience:

(1) Visibility and real-time monitoring

Machine learning algorithms and IoT sensors collect and analyse data from every point in the supply chain, from raw material sourcing to product delivery. Machine learning is a subset of AI which allows systems to learn and improve from experience without being explicitly programmed, therefore identifying patterns and making better predictions and decisions ([Cohen, 2025](#)). This real-time visibility helps in quickly identifying and addressing issues such as delays, bottlenecks, or quality problems, ensuring smoother operations and quicker response times to disruptions ([Lalmi et al., 2021](#)). Although these new data streams have a positive impact on enhancing visibility, they are also complex, given that decision-makers should integrate and interpret diverse sources of information such as predictive analytics, real-

**Table 1.** Indicators responsible for SCR phases

Anticipation phase	Response and recovery phase
Visibility	Velocity
Awareness	Agility
Security	Public private relationship
Sustainability	Adaptability
Supply chain risk management	Market position
	Information sharing

**Source(s):** Adapted from [Singh et al. \(2019\)](#)

time market trends and IoT sensor data. This can hinder the process of decision-making and overwhelm stakeholders (Riad *et al.*, 2024). Predictive analytics have emerged as useful tools in understanding and forecasting market trends by leveraging historical data and advanced statistical models. Although they appear complex, they allow organisations to predict future demand and supply, and optimise inventory and productivity (Okeleke *et al.*, 2024).

AI-driven predictive analytics allow supply chain managers to anticipate disruptions before they occur. By analysing vast amounts of data from various sources, AI can identify patterns and trends that signal potential risks such as demand spikes, supplier failures, or logistical issues (Belhadi *et al.*, 2021). Although AI information provides valuable insights, the information overload in managing supply chains can overwhelm decision-makers with excessive data. The vast amount of information makes it difficult to identify actionable priorities. This can lead to delays in decision-making due to the increased uncertainty about the best course of action. Furthermore, large datasets or reports can be generated by AI, which may contain irrelevant information to the specific challenges or goals decision-makers are focusing on at the time (Dubey *et al.*, 2022).

## (2) Agility and flexibility

Supply chain agility is the ability of the SC to adapt to changes quickly and with minimal disruptions (Pasupuleti *et al.*, 2024). AI facilitates supply chain agility by enabling more flexible and adaptive supply chain models. For instance, AI can support dynamic rerouting and alternative supplier identification when primary sources are disrupted. This flexibility ensures that the supply chain can quickly adapt to changing conditions, maintaining continuity and minimising the impact of disruptions, thus increasing the level of resilience (Rane *et al.*, 2024). Although flexibility is beneficial for responding to uncertainty and disruptions, it can lead to inefficiencies in stable conditions. This may occur if overly flexible systems excessively analyse data and information during these stable conditions, leading to a wrong diversion of resources into redesigning or restructuring processes that do not need change (Rane *et al.*, 2024). The benefits of simplicity and predictability in stable environments can be easily eroded due to the complexity of managing overly flexible systems.

## (3) Inventory optimisation and logistics

AI tools refine stock quantities, improve shipping paths, and reduce operational obstacles. It also enhances logistics by optimising routing and scheduling, which reduces transportation costs and improves delivery times. These optimisations help maintain supply chain efficiency and responsiveness, crucial for resilience in the face of disruptions (Zamani *et al.*, 2022).

## (4) Risk management

Risk management in the supply chain is concerned with the identification, assessment and prioritisation of potential risks and disruptions that can impact supply chain operations from running efficiently and continually (Olawale *et al.*, 2024). AI improves risk management by assessing the likelihood and impact of different types of risks, from financial and operational to geopolitical and environmental. By providing a comprehensive risk assessment, AI helps companies develop robust risk mitigation strategies, thereby enhancing their ability to withstand and recover from disruptions (Lalmi *et al.*, 2021).

## (5) Enhanced decision-making

By processing and analysing data faster and more accurately than humans, AI systems can recommend the best course of action in various scenarios, from procurement to production to distribution. This enhances the overall strategic and operational decision-making process, contributing to a more resilient supply chain (Riad *et al.*, 2024). AI systems allow for a decentralised decision-making process which thrives in facilitating timely and localised actions; nevertheless, the highly interconnected systems it provides may lead to inconsistent

prioritisation, duplication of efforts and information silos (Hofmann *et al.*, 2019). On the other hand, a centralised decision-making process that is supported by AI offers an integrated view of the supply chain. During crisis and disruptions, this process allows for resources to be allocated efficiently and conflicts to be minimised. Generative AI, which is a subset of AI, creates original material based on learning from real-world data. This technology has the potential to transform SCM and positively impact resilience by improving operational workflows, achieving productivity and optimising decision-making (Khlie *et al.*, 2024).

#### *Ethical and social implications of AI on the SCR process*

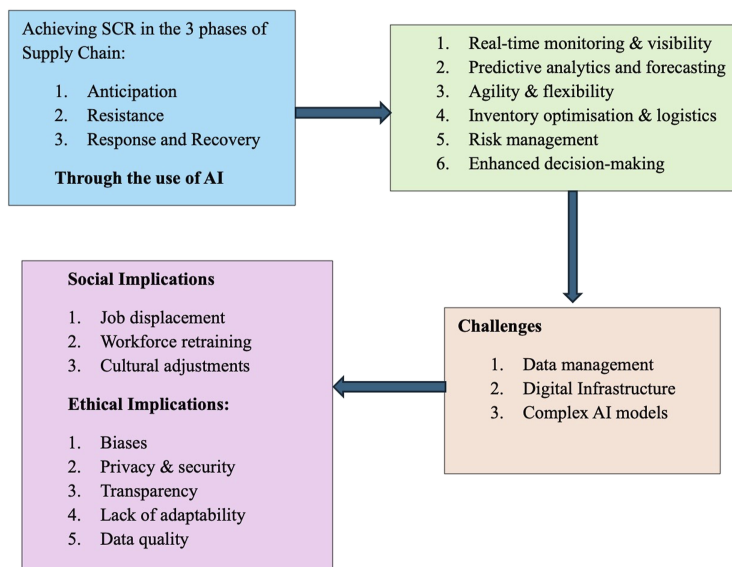
The implementation of AI in SCR leads to ethical and social implications. Although the impact of AI on SCR leads to its improvement, it also leads to risks and ethical implications for supply chains and the stakeholders involved in the processes (Riad *et al.*, 2024). Job displacement is one of the key issues brought on as a result of AI technologies and the automation of supply chain processes. It could affect employees who perform routine tasks, which can easily be automated through the use of AI tools and technologies (Khan *et al.*, 2022). Secondly, biases may arise while using AI technologies in the supply chain. Given that AI systems are designed by humans, biases are inherited, and they can have an impact on decisions made (Gray *et al.*, 2024). If algorithms are not trained properly and fed with data correctly, they can perpetuate biases and discrimination and result in incorrect or unfair solutions and treatment of individuals or groups (Manning *et al.*, 2022). Furthermore, when the systems have to consume a lot of data, their pace will inevitably decrease. Additionally, privacy and security of data is a major issue brought on as a result of AI implementation in the supply chain. The use of AI leads to the collection, storage and usage of a large amount of data related to employee information, supplier information, customer information and other important information regarding supply chain processes (Eyo-Udo, 2024). Transparency is another ethical implication as a result of AI on the supply chain. The use of AI may lead to a lack of transparency and confusion amongst stakeholders in a supply chain and a lack of understanding of how decisions are being made and who is responsible for them (Mir, 2024). A useful technology that can be used to enhance transparency and trust in SC is blockchain. Blockchain is a decentralised, distributed ledger, consisting of a chain of blocks of data which operates on a network of computers that reach consensus through algorithms (Arif *et al.*, 2024). In addition to enhancing transparency and trust, blockchain can also improve information sharing and visibility through publicly accessible information while ensuring data security (Liu *et al.*, 2024).

Furthermore, AI cannot become more proficient with time. Due to their design for repeated work conditions, these systems are unable to adapt to changing situations (Ekundayo, 2024). Consequently, whenever there is a change, the data within the AI system of supply chains must be reconstructed, retrained, reviewed and evaluated. For AI systems to produce insights and make predictions, precise, consistent, and current data is essential. It can be difficult to ensure data quality throughout the supply chain, particularly when working with several vendors, different locations, and different data formats. The use of low-quality, unreliable input data will result in incorrect predictions, which will lead to issues with the supply chain and, therefore, will make it less resilient.

The review of the literature allowed the researcher to design a conceptual framework that guided the rest of the research (Figure 1).

#### **Research design**

To explore the impact of AI on SCR, this study adopted a qualitative approach, assessing existing literature. According to Nassaji (2020), qualitative research seeks to understand and explore rather than explain and manipulate variables; therefore, this approach allows the researchers to explore the role that AI has in achieving the SCR and understanding the ethical and social implications associated with it. Furthermore, the qualitative approach offered



Source(s): Authors' own work

Figure 1. Conceptual framework (literature review)

contextual depth, and a holistic perspective of the topic researched. The approach allowed for the research to achieve credibility, dependability, conformability and transferability, thus making it trustworthy research (Stenfors *et al.*, 2020). The theories, research question, data collection and analysis and results align with each other, thus achieving credibility. Moreover, the methodology provides sufficient information for other researchers to replicate the research following the same steps. There is a clear link or relationship between the data and the findings, which can be transferred to another setting or context with caution.

A systematic literature review (SLR) has been conducted, which focuses on the most recent studies on AI and SCR. An SLR enables researchers to systematically gather, organise, and evaluate pre-existing academic works (Paul and Barari, 2022). It aims to present a thorough overview of the existing knowledge and suggest potential pathways for future research by methodically selecting and interpreting data. This method empowers researchers to achieve a more profound comprehension of the literature and the topic at hand, focusing on AI and SCR while pinpointing areas within the field where further research is needed (Paul and Criado, 2020). Bailey *et al.* (2017) argue that a well-executed systematic review should possess a distinct central theme and concentrate on the published evidence relevant to a specific topic or inquiry. In the case of this study, the key topic investigated focuses on the impact that AI has on SCR and, more specifically, investigating the role of AI in enhancing SCR, the effects of AI on SCR and the ethical and social implications of AI on the supply chain. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines were followed to understand the process of data mining. Reviewing existing literature based on the PRISMA guidelines allowed the study to extensively scan the articles/journals published related to the impact of AI and SCR and research questions. Through the application of several inclusion and exclusion criteria, the study identified the articles and journals used in the review (Selcuk, 2019).

The SLR was deployed following the below steps.

*Step 1: Search strategy*

The search strategy employed for this study involved specific keywords to conduct searches across various databases, including ProQuest and EBSCO, as well as within notable journals such as Emerald, IEEE, Elsevier, and Springer. The identical set of keywords was also utilized for searches conducted on Google Scholar, aiming to pinpoint significant journals and articles that have concentrated on investigating the repercussions of AI on the resilience of supply chains. The keywords encompassed terms like impact, AI, SCR, and ethical and social implications.

*Step 2: Inclusion and exclusion criteria*

Following a selective process that involved filtering out journals, articles, books, and professional publications, the initial search yielded a substantial result of over four hundred (400) articles. These results were further scrutinized using specific exclusion criteria, as detailed below (Table 2; Table 3).

Initially, the duplicate papers were identified and excluded as shown in Table 2. Further exclusion criteria were established which excluded any journals/articles, books, or publications before 2018, to focus on the most recent publications of the past 7 years due to the rapid development of the technology and rapid changes within supply chain management. A further analysis was conducted to exclude those articles/journals and publications with explicit or implicit discussions on or reference to the impact of AI on SCR, narrowing down the number of articles to 25.

Figure 2 is a visual representation of the PRISMA model which leads to a higher level of transparency and clarity in reporting and provides a better structured report with clear answers to the study question.

*Step 3: Screening, quality, appraisal and data synthesis*

After duplicate papers were removed across databases, the remaining papers were screened by title, abstracts, and keywords. After this exclusion process, the remaining papers were read and included or excluded based on the eligibility criteria highlighted above and the implicit or explicit discussion on reference to AI and/or SCR (Table 4).

Author 1 assessed the quality appraisal of all 25 papers, with authors 2 and 3 cross-checking a random sample of 12 papers. Within each paper category, the quality was evaluated using descriptive checklists derived from the Centre for Reviews and Dissemination of Research (2009), with adaptations by Duncan and Murray (2012). The quality appraisal included assessments based on five criteria: suitability of methods, clarity in data collection description, clarity in data analysis description, data quality, and sampling techniques. An assessment returning a nil value indicated that the article did not meet any of the five assessment criteria;

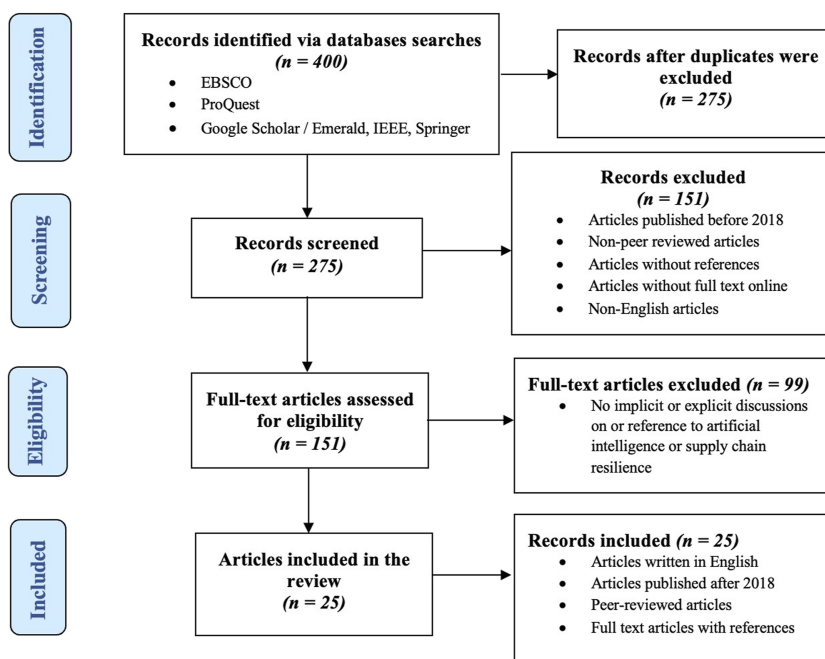
**Table 2.** Identified papers by database

Database	Search strings	Identified papers	Duplicate papers	Non-duplicate papers
EBSCO	("artificial intelligence")	156	62	94
ProQuest	AND ("supply chain")	137	38	99
	AND ("resilience") AND ("impact" OR "effect")			
	AND LANGUAGE: English			
Other – Manual Search (Emerald/IEEE/Springerlink)	Manual search using the same keywords	107	25	82
Total		400	125	275
<b>Source(s):</b> Authors' own work				

**Table 3.** Selection criteria

Inclusion/ Exclusion	Criteria	Description	Identified papers	
Exclusion	Duplication	Duplicated articles	125	
		Not relevant	The screened content demonstrates that the article is irrelevant to AI or SCR, no implicit or explicit discussion of AI and/or SCR	99
	Other exclusion	Publication year: before 2018		85
		Non-peer reviewed articles		7
		Articles without full text and/or references		5
		Publication language: not English		9
Inclusion	Quality check	Excluded by the quality check	45	
		The full text of the article provides a clear methodology The full text of the article provides results The article is relevant to the research questions		
Total identified articles		400		
Total excluded articles		375		
Total included articles		25		

**Source(s):** Authors' own work



**Source(s):** Authors' own work

**Figure 2.** PRISMA guidelines

however, none of the articles scored below 1. Scores of 1+ and 5+ signified that an article had fully met at least one or all five criteria, respectively. Articles that partially addressed the criteria were given a score of 0.5+ per criterion. Most papers received high scores in the

**Table 4.** Overview and comparison of included studies

Authors and year	Outlet	Paper category	Sample size and population	Reference to key themes	Key findings and contributions	Research gaps	Theoretical frameworks	Limitations
<a href="#">Belhadi et al. (2021)</a>	<i>Annals of Operations Research</i>	Empirical (Survey)	SC managers, industry practitioners	AI, Supply Chain, Resilience, Impact	AI enhances supply chain resilience and performance amid dynamism. Empirical findings provide practical insights	Limited real-world case studies, need for industry-specific models	Resource-based view (RBV), dynamic capabilities	Focused on one industry sector, lack of deeper implementation insights
<a href="#">Cheong (2024)</a>	<i>Frontiers in Human Dynamics</i>	Narrative literature review	AI system designers, policymakers	Legal and ethical challenges, AI, Transparency, Accountability	Ethical concerns in AI systems, transparency critical for accountability in decision-making	Lack of implementation framework for AI governance	Ethical decision-making, governance frameworks	Limited scope of empirical data on real-world applications
<a href="#">Dubey et al. (2022)</a>	<i>International Journal of Production Economics</i>	Empirical Quantitative	Humanitarian organisations, SC managers	AI, Big data analytics, Agility, Resilience, SC	AI-driven analytics fosters agility and resilience in humanitarian supply chains	Limited focus on cross-organizational collaboration in analytics	Big data analytics, resource dependency theory	Only focused on humanitarian sector, limited application to commercial supply chains
<a href="#">Ekundayo (2024)</a>	<i>International Journal of Research Publication and Reviews</i>	Conceptual study	Engineers, decision-makers	AI, DL, Reinforcement Learning, Complex System	AI optimizes decision-making processes in complex systems engineering	Lack of field-based validation of AI models in real systems	Decision theory, AI-driven decision intelligence	Small-scale focus, no real-life system validation in complex scenarios
<a href="#">Eyo-Udo (2024)</a>	<i>Journal of Multidisciplinary Studies</i>	Conceptual Review – Qualitative	SC managers, industry experts	AI, SCM, Benefits, Challenges	AI optimizes logistics, inventory management, and overall supply chain performance	Industry-specific challenges, lack of data on adoption barriers	Optimization theory, AI application models	No empirical data from diverse industries or regions
<a href="#">Fosso Wamba et al. (2024)</a>	<i>International Journal of Production Research</i>	Empirical – Quantitative	SC managers, researchers	Generative AI, Benefits, Challenges, SCM	Key benefits and challenges of generative AI in supply chain management	Limited to exploratory research, needs deeper case studies	Technology adoption models, innovation diffusion	Non-quantitative analysis, no clear performance metrics

*(continued)*

**Table 4.** Continued

Authors and year	Outlet	Paper category	Sample size and population	Reference to key themes	Key findings and contributions	Research gaps	Theoretical frameworks	Limitations
<a href="#">Gupta et al. (2021)</a>	<i>IEEE Transactions on Engineering Management</i>	Qualitative Empirical	SC leaders, IT managers	Supply Chain, AI, Resilience	AI enhances resilience through advanced data analytics and real-time decision-making	Limited focus on the cross-organization impact	Contingency theory, strategic alignment	Limited to AI-driven information systems, no comparison with other technologies
<a href="#">Hofmann et al. (2019)</a>	<i>International Journal of Physical Distribution and Logistics Management Sustainability</i>	Conceptual Review – Qualitative	Scholars, industry practitioners	Industry 4.0, Digital Transformation of SC, IoT	Industry 4.0 and digital technologies, including AI, drive transformation in SCM, improving efficiency and flexibility	Lack of focus on small-medium enterprises (SMEs)	Industry 4.0, technology adoption theory	Focus on general trends rather than specific supply chain sectors
<a href="#">Khan et al. (2022)</a>		Quantitative – Empirical	SC managers, transparency experts	Supply Chain, AI, Traceability, Transparency, Tracking	Technologies like blockchain improve traceability and transparency, enhancing supply chain performance	Limited understanding of implementation challenges in complex supply chains	Blockchain theory, transparency frameworks	Limited to theoretical and pilot case studies
<a href="#">Khlie et al. (2024)</a>	<i>Journal of Infrastructure, Policy and Development</i>	Conceptual Review – Qualitative	SC professionals, AI practitioners	GenAI, SCM, Predictive Maintenance	Generative AI models improve efficiency and strategic planning in supply chain management	Need for practical industry applications	Generative AI, technology adoption models	Non-empirical, focused on theoretical models without real-world validation
<a href="#">Liu et al. (2024)</a>	<i>Supply Chain Management: An International Journal</i>	Empirical – Quantitative	SC managers, blockchain adopters	Blockchain, SCR, Disruptions	Blockchain adoption improves resilience through transparent, secure supply chain processes	Further study needed on leadership's role in adoption and its practical integration	Transformational leadership theory	Limited research in non-blockchain contexts

(continued)

Table 4. Continued

Authors and year	Outlet	Paper category	Sample size and population	Reference to key themes	Key findings and contributions	Research gaps	Theoretical frameworks	Limitations
Manning <i>et al.</i> (2022)	<i>Trends in Food Science and Technology</i>	Conceptual Review – Qualitative	Food industry professionals, SC experts	AI, Ethical Considerations	AI's ethical challenges, focusing on fairness, transparency, and accountability in the food supply chain	Lack of cross-sector comparison of AI ethics	Ethics in AI, technology governance frameworks	Limited sectoral scope, focusing mainly on food supply chains
Modgil <i>et al.</i> (2022)	<i>The International Journal of Logistics Management</i>	Qualitative Empirical Research	SC managers, practitioners	Supply Chain, Resilience, Capabilities	AI's role in enhancing resilience during disruptions, with a focus on Covid-19 supply chain impacts	Lack of post-pandemic studies and real-world application data	Resilience theory, technological adaptation	No empirical data beyond the pandemic context
Munir <i>et al.</i> (2024)	<i>Technological Forecasting and Social Change</i>	Empirical – Quantitative	SC managers, risk managers	SC, Risk Management, SCR, Decision-making	AI, analytics, and ambidexterity contribute to building resilient supply chains amidst risks	Limited empirical evidence from different sectors	Ambidexterity theory, risk management frameworks	No industry-specific deep dives, limited focus on human aspects of resilience
Okeleke <i>et al.</i> (2024)	<i>International Journal of Engineering Research Updates</i>	Empirical – Quantitative	Consumers, marketers, SC managers	Predictive analytics, AI, Market trends	AI models predict consumer behavior trends, helping businesses optimize supply chain decisions	Lack of consumer diversity, limited focus on different market dynamics	Predictive analytics, consumer behavior theory	Limited geographical scope and sample diversity
Olawale <i>et al.</i> (2024)	<i>Magna Scientia Advanced Research and Reviews</i>	Empirical – Qualitative	HR professionals, risk managers	Risk management, SC, Resilience	Human resources practices help manage risks, ensuring smooth supply chain operations	Lack of deep dive into specific risk management techniques	HR management, risk management models	Small sample size, focus on HR practices without broader perspectives
Pasupuleti <i>et al.</i> (2024)	<i>Logistics</i>	Empirical – Quantitative	SC managers, data scientists	SC, Agility, Sustainability, Machine Learning	Machine learning enhances supply chain sustainability by optimizing logistics and inventory	Focused more on technology, less on organizational adoption challenges	Machine learning models, supply chain agility	Limited data on organizational readiness for AI adoption

(continued)

**Table 4.** Continued

Authors and year	Outlet	Paper category	Sample size and population	Reference to key themes	Key findings and contributions	Research gaps	Theoretical frameworks	Limitations
Rane <i>et al.</i> (2024)	SSRN	Empirical – Qualitative	SC professionals, logistics experts	AI, ML, Resilience, Sustainability, SCM	AI and machine learning improve resilience and sustainability in logistics and supply chain systems	Needs integration with existing non-AI systems, challenges with data privacy	Machine learning, AI in logistics theory	Small empirical sample, reliance on technology-centric views
Riad <i>et al.</i> (2024)	Logistics	Empirical – Qualitative	SC professionals, managers	AI, Sustainability, SC, Optimisation	AI fosters resilience through improved decision-making processes and enhanced supply chain optimization	Lack of in-depth case studies to understand barriers to AI adoption	AI adoption frameworks, resilience theory	Limited theoretical application in specific industries
Richey <i>et al.</i> (2023)	Journal of Business Logistics	Review	Academics, industry experts	AI, Supply Chain Management	AI's transformative role in logistics and supply chain management through automation, predictive analytics, and decision support	Need for more empirical research across various industries	Technology adoption, decision support systems	Focus on academic perspectives, lack of real-world application data
Singh <i>et al.</i> (2019)	Journal of Industrial Engineering International	Conceptual Review – Qualitative	SC professionals, academics	SCR, Risk management	Identified performance indicators that can measure and improve supply chain resilience	Lack of alignment with new-age technologies like AI	Performance measurement, resilience theory	Theoretical framework, no application to modern technologies like AI
Singh and Modgil (2024)	International Journal of Productivity and Performance Management	Empirical – Quantitative	SC managers, academics	Agility, Capacity, SCR	Agility and absorptive capacity improve resilience, especially in disruptive contexts	Limited application in specific industry contexts	Organizational theory, resilience models	No empirical research beyond the conceptual model

(continued)

**Table 4.** Continued

Authors and year	Outlet	Paper category	Sample size and population	Reference to key themes	Key findings and contributions	Research gaps	Theoretical frameworks	Limitations
<a href="#">Sun et al. (2023)</a>	<i>Journal of Enterprise Information Management</i>	Quantitative Empirical Research (Survey)	SMEs in various sectors	Supply Chain, Resilience, Risk, Disruption	Deep learning improves risk management for SMEs in the face of supply chain disruptions like Covid-19	Limited scope to SMEs only, need for broader sectoral research	Deep learning models, resilience theory	Limited to SMEs, no comparison with large enterprises
<a href="#">Yuan et al. (2023)</a>	<i>Journal of Enterprise Information Management</i>	Quantitative Empirical Research (Survey)	SC managers, digital transformation experts	Supply Chain, Resilience, Digital Transformation	Digital transformation enhances supply chain resilience through integration of new technologies	Need for empirical validation of the model in different sectors	Digital transformation models, resilience theory	Theoretical focus, lacking real-life testing across diverse industries
<a href="#">Zamani et al. (2022)</a>	<i>Annals of Operations Research</i>	Systematic Literature Review	SC managers, AI professionals	AI, Supply Chain, Resilience	AI and big data enhance supply chain resilience by optimizing decision-making and performance	More industry-specific case studies needed	Big data analytics, AI adoption theories	Theoretical review, no primary data or empirical case studies

**Source(s):** Authors' own work

quality appraisal (Table 5). Consequently, the findings from the current review were based on studies with appropriate designs, methods, detailed descriptions of data collection and analysis, and high-quality data according to our assessment criteria. The need for a third assessor was not required as no disagreement was present.

Finally, the included articles were critically analysed following a qualitative research strategy and thematic analysis, which allowed the researchers to extract codes through a meticulous examination of the text, leading to the emergence of salient themes inductively. The thematic analysis allowed for the clear identification of patterns and meanings from the data collected (Finlay, 2021). The steps followed to complete this process included: (1) becoming familiar with the data, (2) generating initial codes for each objective, (3) searching for themes, (4) reviewing the themes identified, (5) defining and naming the themes, and (6) presenting and writing up (Braun and Clarke, 2019). This technique contributed to an informative analysis process, which addressed the aims of the research and led to new findings and a fresh perspective in researching the role of AI in SCR.

### Findings and discussion

This section showcases the key findings of the research and discussion. To complete the thematic analysis, the researchers familiarised themselves with the data from the 25 papers selected, generated initial codes and searched for themes amongst the codes. Additionally, the themes were reviewed and refined to ensure an accurate representation of the data (Table 6).

Riad *et al.* (2024) argue that AI contributes to simpler operations in the supply chain, quicker and more accurate problem-solving and handling of a large amount of data simultaneously. Furthermore, AI can anticipate problems in the supply chain through smart and agile decision-making. It enhances the quality of service for customers through on-time and undamaged deliveries. This way, AI fosters stronger relationships and loyalty with customers due to the ability to tailor services and improve interaction and engagement. AI contributes to the efficient functioning of the value chain network and lowers costs through automated compliance (Arif *et al.*, 2024). Today's dynamic business environment makes demand forecasting more challenging for organisations, and AI can enhance the predictive capabilities required to forecast demand. Besides, AI bots can personalise interactions with customers, thus leading to a higher level of engagement (Modgil *et al.*, 2022). Optimisation of roots and deliveries, which leads to reduced time and costs, is another important role of AI in the supply chain and is achieved through the use of algorithms. The ability of AI to facilitate adaptability through predictive and prescriptive capabilities ensures that SCR is enhanced and able to navigate uncertainties.

By employing predictive analysis, AI processes extensive data volumes, enabling businesses to foresee changes in consumer demand, disruptions in the supply chain, and market fluctuations. AI-enabled automated decision-making reduces the impact of operational challenges (Kaviani *et al.*, 2020). This automation notably boosts the efficiency of tasks like managing inventory, tracking shipments, and processing orders. This streamlining minimizes errors, optimises resources, and elevates overall productivity (Belhadi *et al.*, 2021).

**Table 5.** Quality appraisal scoring

Quality appraisal score	N articles
1+	3
2+	4
3.5+	7
4+	6
5+	5

**Source(s):** Authors' own work

**Table 6.** Thematic analysis

	Codes	Themes	No. of papers themes were identified from
Role of AI in SCR	Simplified operations	Reduced operational obstacles	7
		Inventory management	
		Shipment tracking	
	Data handling	Order processing	5
		Large amount of data	
	Visibility and real-time monitoring	Easier to manage	6
		Identifying and addressing issues	
	Problem-solving	Quicker response to disruptions	4
		Higher accuracy	
	Facilitated communication	Ability to anticipate problems	6
		Quicker and easier communication between devices	
	Enhanced customer service	Better quality products	10
		On-time deliveries	
Predictive analysis	Undamaged products	9	
	Higher customer engagement		
Decision-making	Forecast demand and supply	7	
	Flexible reactions to market shifts		
Risk management	Automated decisions	8	
	Ability to withstand and recover from disruptions		
Ethical and social implications of AI in achieving SCR	Job displacement	3	
	Unemployment		
Biases	Risk of biased data when AI models are generated	4	
	Data management		
Data management	Data accuracy	5	
	Up-to-date information		
Privacy and security	Time consuming	7	
	Data protection		
Transparency	Access control	2	
	Data visibility		
Complexity	Accountability – who is making the decision	3	
	Lack of digital infrastructure		
Adaptation	Complex AI models	2	
	Inability of algorithms to adapt to changing situations		
		Cultural adjustments	

Source(s): Authors' own work

The integration of AI provides real-time insight into supply chain operations, offering a comprehensive overview that helps in identifying bottlenecks, evaluating performance, and adjusting strategies promptly (Lalmi *et al.*, 2021).

A great example of how AI tools have been incorporated to increase SCR involves Walmart. Amongst others, Walmart uses Everseen, an AI-driven visual recognition tool to optimise inventory by preventing overstocking and understocking and enhancing SCR. The tool uses real-time data to make decisions, such as customer behaviour, supplier operations and point-of-sale systems (Gupta, 2024).

The introduction of AI in supply chains raises ethical and social concerns that affect various aspects of operations. There is worry about job displacement as AI's automated processes might replace specific roles, potentially leading to employment challenges and job loss (George, 2024). Additionally, biases ingrained within AI algorithms, stemming from past data, could perpetuate inequalities and discrimination in decision-making, affecting job opportunities for certain groups. Providing incorrect data to AI algorithms can amplify biases and lead to errors in decision-making. The vast collection of data raises concerns about privacy, data ownership, protection, and potential misuse. If privacy and security issues arise due to the use of AI, data may be accessed externally and used for malicious purposes (Gupta *et al.*, 2021). In SC, this can lead to unfair treatment of customers, employees or suppliers. An example includes Amazon's recruitment AI tool, which selected men over women due to the biased information fed into the system. The AI tool was fed with CVs mainly from men, and the system learned that men were more appropriate than women for the job positions. Amazon tried to overcome the issue; however, due to the inability to produce unbiased results, the AI tool was abandoned (Davies, 2023). This highlights the critical need for ensuring AI systems are trained on accurate data that prevents the reinforcement of existing biases.

The transparency of AI decision-making is uncertain, making it difficult for stakeholders to understand who designs these algorithms and their criteria. Transparency in AI indicates openness and clarity on how the systems operate, how decisions are made and how the data are used (Cheong, 2024). The lack of transparency, often considered the "black box" of AI brings challenges for SC stakeholders to understand, trust and manage AI decisions (Marcus and Teuwen, 2024). Within Amazon, we can identify an issue of transparency in SC due to the use of AI. Amazon uses AI tools such as machine learning and predictive analytics to optimise demand forecasting and inventory management. It has been reported by sellers that Amazon's AI, on occasion, favours Amazon's own products, over third-party sellers' items. This lack of transparency raised concerns amongst stakeholders about algorithmic fairness and trustworthiness of AI systems (Krause, 2024).

Moreover, AI systems' inability to adapt to changing scenarios poses risks in dynamic supply chains. This could impact the accuracy of decisions when faced with unexpected situations or unknown issues. The development of AI will have a significant impact on many decisions, particularly those on sustainable supply chains, as they are increasingly used (Manning *et al.*, 2022). Developing and maintaining AI systems demand substantial time and resources, potentially creating technological gaps and limiting access for smaller businesses, further exacerbating societal inequalities. A great example of companies using AI to manage risk and supply chain disruptions is DHL. DHL, the global logistics company, uses Resilience360 AI-based risk management tool. This tool combines real-time data with predictive analytics to forecast potential risks and disruptions such as natural disasters, supplier failures and geopolitical issues and supports the adjustment of inventory levels in real-time (DHL, 2024).

## Conclusion

The supply chain environment is rapidly changing due to disruptions, the implementation of technologies and the need to become more resilient and overcome challenges. This study established that higher quality service for customers, better communication, and engagement due to the use of AI result in a more resilient supply chain due to the ability to understand customer needs and forecast demand and supply. Despite the benefits of AI on SCR, the implementation of these technologies has its limitations, mainly related to ethical and social issues such as privacy and security of data, transparency of decision-making, biased solutions and decisions and job displacement due to automation.

Based on the findings of this study, to achieve SCR using AI while addressing challenges and ethical and social implications, companies should employ the following strategies:

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*Enhance predictive analytics:* Companies should utilise AI to forecast demand and supply accurately, ensuring data privacy and security. AI tools suggested to achieve this include the following:

- (1) IBM Watson utilizes advanced machine learning algorithms for demand forecasting and data analysis.
- (2) Microsoft Azure Machine Learning provides robust tools for predictive analytics and real-time data processing.
- (3) Amazon Forecast uses machine learning to deliver accurate demand forecasts.

*Optimise inventory management:* Companies should deploy AI for dynamic inventory optimisation, reducing waste and ensuring fair working conditions. AI tools suggested to achieve this include the following:

- (1) SAP Integrated Business Planning is an AI-driven inventory optimization and demand sensing.
- (2) Oracle Cloud Inventory Management leverages AI to dynamically manage and optimize inventory levels.
- (3) Slimstock Slim4 is an AI-based inventory management tool focusing on stock optimization and waste reduction.

*Optimise logistics and route planning:* Companies should leverage AI to enhance transportation efficiency and sustainability, partnering with ethical logistics providers. AI tools suggested to achieve this include the following:

- (1) Descartes Route Planner uses AI for route optimization and logistics efficiency.
- (2) ClearMetal supports AI-driven supply chain visibility and predictive logistics.
- (3) FourKites provides real-time logistics tracking and AI-based route planning.

*Foster transparent AI deployment:* Companies should ensure AI systems are unbiased and transparent, addressing job displacement through reskilling programs and establishing ethical guidelines. AI tools suggested to achieve this include the following:

- (1) IBM AI Fairness 360 is a comprehensive toolkit to help detect and mitigate bias in AI models.
- (2) Google Cloud AI Explainability includes tools and frameworks to ensure AI transparency and interpretability.
- (3) Fairness Indicators by TensorFlow are a suite to evaluate the fairness of AI models.

*Enhance product lifecycle management:* Companies should implement AI to analyse and optimize the entire product lifecycle, from design to end-of-life, promoting circular economy principles and reducing environmental impact. AI tools suggested to achieve this include the following:

- (1) Siemens Teamcenter integrates AI to manage the entire product lifecycle efficiently.
- (2) PTC Windchill uses AI to optimize product lifecycle processes and sustainability.
- (3) Autodesk Fusion Lifecycle is an AI-driven product lifecycle management tool focusing on circular economy principles.

These strategies leverage AI to build resilient supply chains while promoting ethical practices and social responsibility.

Given below is a framework that can be useful for future studies to specifically address actions to enhance the positive outcomes and reduce negative social implications (Figure 3). The framework identifies the key benefits, ethical and social implications of AI, the strategies to enhance resilience using AI and the AI tools to successfully implement these strategies for each phase of the supply chain.

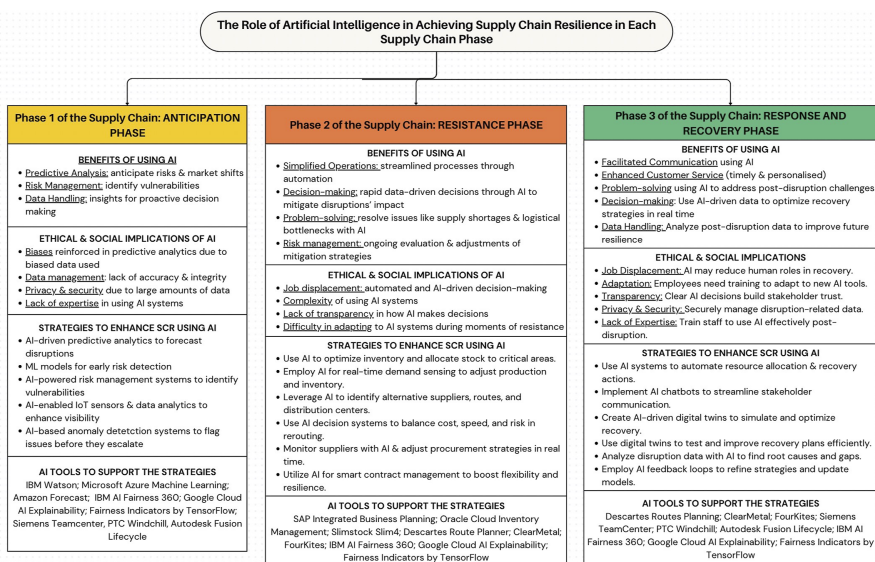
*Implications for theory*

In this study, we bring together the following research outcomes from studies conducted by authors:

- (1) Resilience in the supply chain
- (2) Phases and characteristics required for SCR
- (3) AI's characteristics
- (4) Complexities in integrating AI into the supply chain
- (5) Ethical/social implications due to AI solution outcomes

The study highlights how AI supports supply chain phases, including anticipation, resistance, response and recovery phases. The SCR indicators such as visibility, awareness (in the anticipation phase) and, agility, information sharing (in the response and recovery phase) can be improved by AI's intrusion considering its predictive and learning capabilities (Baryannis et al., 2019).

The study establishes the direct link between what is required for attaining resilience in supply chain systems and what AI can offer to enhance SCR. The study consolidates the important roles played by AI in SCR and the social and ethical implications created by AI. Finally, the study contributes to the theory by formulating a useful conceptual framework



Source(s): Authors' own work

Figure 3. Conceptual framework

which highlights the role of AI in SCR by investigating the benefits and implications and suggesting practical solutions to the issues highlighted.

#### *Implications for practice*

Organisations, large or small, need to work on making their supply chains more resilient, and the findings of this study can be used as guidelines to implement AI technologies that can be utilised for different processes of the supply chain and during different phases. Suggested applications based on each stage/phase are further explained. Considering that the anticipation phase aims to predict disruptions and mitigate potential risks, firms should use AI to leverage predictive analytics and forecasting to forecast demand and supply fluctuations, geopolitical issues or supplier risks. Furthermore, machine learning (ML) models can be used to analyse market trends, external factors, historical data etc. to detect risk early. During this phase, an AI-powered management system can be implemented which will help firms identify vulnerabilities across the supply chain. Finally, firms must monitor the visibility of the supply chain by utilising real-time data analytics and AI-enabled IoT (Internet of Things) sensors; and detect any anomalies before they escalate.

During the resistance phase, the aim is to minimise the impact of disruption whilst maintaining the supply chain operations. To achieve this, firms should use AI algorithms to optimise inventory management levels, reallocate resources to critical locations, reduce waste and maintain fair working conditions. Furthermore, AI can be used to optimise supply chain networks through the identification of alternative routes, suppliers and distribution centres when needed. AI systems can help balance costs, risk, and speed during the reallocation process. AI can also be used during this phase to adjust procurement strategies in real-time and implement smart contracts (developed using AI) to ensure resilience and flexibility in supplier agreements.

The response and recovery phase focuses on quickly restoring normal operations and enhancing future resilience by learning from the disruption. AI chatbots can be used to facilitate and speed communication with stakeholders during this phase. AI can support firms in developing digital twins of the supply chains (virtual replicas), which can simulate recovery scenarios and test and validate recovery plans. This could lead to minimised recovery time and cost and optimised recovery strategies when real disruptions occur. Finally, AI can be used during the third phase to analyse data from the disruption. It can support firms to identify root causes and areas for improvement and continuously enhance SCR strategies through continuous feedback.

Furthermore, the findings highlight the key benefits that AI brings in the process of creating a more resilient supply chain; however, it also considers some of the key challenges/implications. Those responsible for ensuring smooth supply chain operations should consider the application of new AI technologies to reduce the risks and make the supply chain more responsive towards challenges. Firms should ensure that predictive analytics do not compromise data integrity. They should implement tools that maintain transparency, avoid bias in AI deployment and use AI to optimise and promote circular economy principles.

Organisations should keep informed of the ethical and social implications that may arise due to the use of AI and ensure that policies and procedures are put in place. Training, knowledge sharing, and increased awareness should be part of the day-to-day activities and culture of any organisation. This would ensure all employees are aware and possess the right knowledge to deploy AI technologies to ensure smooth processes and a higher level of resilience within supply chains. They should develop platforms for sharing best practices and updates on AI advancements and they should embed AI awareness into the organisational culture.

Finally, the study provides 5 key strategies on how to use AI effectively to enhance resilience in supply chains by utilising practical AI tools for each strategy. The role of each suggested tool has been highlighted to ensure that organisations are aware of their function before implementing these new technologies.

While these implications apply broadly, their impact differs depending on the size of the organisation or industry. Larger organisations with extensive global supply chains can leverage AI at scale to optimise inventory, streamline complex logistics networks, and enhance predictive analytics. Although they have the resources to leverage AI extensively, it also comes with challenges in integrating AI across multiple locations and managing data across diverse systems due to their vast operations. On the other hand, small and medium-sized enterprises (SMEs) may lack the financial resources to invest extensively in AI; however, they can easily benefit from the ability of AI to enhance agility and resilience, including real-time analytics and automated decision-making. AI adoption is also shaped based on the type of industry. Whilst manufacturing firms should prioritise predictive maintenance and AI-driven robotics, retail companies should focus on AI systems that prioritise demand forecasting and customer insights. Instead, the healthcare and pharmaceutical industries should use AI for supply chain risk management, regulatory compliance and cold chain logistics to maintain product quality and safety. The automotive industry should focus on using AI to optimise just-in-time manufacturing processes, predict shortages and enhance collaboration between suppliers. In the agriculture and food sector, AI should be mainly used for demand forecasting, weather forecasting and ensuring food safety. These industry-specific applications of AI showcase AI's flexibility in enhancing SCR while addressing the unique challenges of the sectors.

Finally, it is important to highlight that although the role of AI supports SCR and organisations' activities and operations, its implementation poses several challenges. One significant barrier is the initial investment when implementing AI systems, especially for SMEs with limited financial resources. Resistance to change and lack of AI expertise can also pose challenges to AI adoption within organisations. Furthermore, given that AI requires a vast amount of data to operate, data availability and quality become an issue. Additionally, implementing AI into the existing supply chain infrastructures can be complex, specifically for companies with legacy systems that are not easily compatible with AI technologies. To address these issues, companies should adopt a phased approach to AI implementation, invest in workforce training, focus on cost-effective solutions, and establish partnerships with research institutions and AI vendors to receive technical support. By addressing these challenges, companies can maximise the benefits of AI while ensuring a smoother transition towards SCR.

### *Limitations*

This study provides valuable insights into the impact of AI in enhancing SCR; nonetheless, it does not come without limitations. Firstly, the study was based purely on the existing literature and research completed recently on similar topics. With technological advancements, the availability of data is not an issue; on the contrary, a vast amount of data is available which can be easily utilised and analysed. This supports the study, considering that it is purely based on available data and follows a systematic review process; however, it does come with its limitations. Researchers are not involved in the process of collecting the data; therefore, validity, reliability and errors may be an issue (Pederson *et al.*, 2020). Moreover, secondary data may not provide the researchers with all the data required, which is usually more achievable using primary data (Kumara, 2022). To mitigate the risks that may arise from the limitations of secondary data mentioned, the authors have considered only reliable, peer-reviewed journals and articles and followed a systematic literature review process to gather sufficient data.

### *Further research*

This study establishes the connection between resilience in the supply chain and AI, proving AI can enhance resilience in the supply chain greatly. This opens opportunities for further research into how AI can be implemented in supply chains and what challenges and phases are required to be handled. Researchers can explore the development of new AI algorithms

tailored to specific supply chain needs and investigate the socio-economic impacts of AI-driven supply chain transformations. Additionally, examining case studies of successful AI integrations can provide valuable insights and best practices for overcoming implementation hurdles.

Further research is needed to find how resilient supply chains driven by AI can overcome the negative ethical and social implications shown by this study. This includes developing frameworks for ensuring data privacy, mitigating algorithmic bias, and establishing transparent governance models to enhance trust and fairness. Additionally, studies should examine the long-term societal impacts of AI on employment and economic disparity within supply chain networks.

Furthermore, future empirical studies may conduct primary data collection with several large and small organisations, particularly with employees who are responsible for the smooth functioning of their supply chain, to further understand how AI technologies are making their supply chains more resilient. This empirical research can provide nuanced insights into the practical challenges and benefits experienced on the ground, offering a clearer picture of AI's real-world impact. Additionally, it can help identify best practices and areas for improvement in AI integration across diverse organisational contexts. Empirical research can support the process of confirming the effectiveness and generalisability of the proposed framework and strategies highlighted above.

Finally, future research should consider Generative AI more particularly and its impact in improving the resilience level of supply chains. Exploring how generative AI can create predictive models, optimize logistics, and generate innovative solutions during disruptions can provide deeper insights into its potential benefits. Additionally, examining real-world applications and outcomes of generative AI in diverse supply chain scenarios will be crucial in understanding its full impact.

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