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Adoption of Artificial Intelligence for Improved Supply Chain and Logistic Performance: A Conceptual Insight

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Abstract

In the evolving landscape of supply chain digitalization, integration, and globalization, there is a growing recognition of the potential of advanced information processing methods like Artificial Intelligence (AI) to enhance supply chain performance (SCP) and logistic performance (LP). Out of sixty articles reviewed, sourced from both conferences and journals, only twenty-four qualified for in-depth synthesis and analysis. This highlights a significant gap in the literature, especially when considering comprehensive reviews on the current and potential impacts of AI on SCP and LP, despite the increasing interest in this domain. Thus, this paper examines the nexus of AI application, SCP and LP. This paper consolidates and synthesize the current available research and provides the basis for further research on the connection between AI, SCP, and LP.

Keywords: Artificial Intelligence, Supply Chain Performance, Supply Chain Management, Logistic Performance, Fifth Industrial Revolution.

Introduction

Artificial intelligence (AI) is transforming supply chain management by improving operating efficiency, lowering costs, and streamlining decision-making processes. Modern information processing methods, like as artificial intelligence, are increasingly being recognised for their ability to improve supply chain performance (SCP) and logistics performance (LP). According to Eyo-Udo (2023), AI integration in supply chain and logistics is transforming the sector. As global supply chains become more complicated and interconnected, the demand for technology that improve efficiency, cut costs, and enable improved decision-making intensifies (Jackson et al., 2024). AI provides real-time insights, autonomous supply chains, predictive analytics, and automation capabilities that all improve SCP and LP (Madancian et al. 2024).

AI's ability to monitor large-scale commodities movement and estimate shipping demand benefits logistics organisations (Rahimi and Alemtabriz, 2022). The deployment of these advanced technologies is projected to improve industrial and service outcomes. The fourth industrial revolution, which includes digitalisation, automation, AI technologies, connected devices, data analytics, IoT, machine learning, robotics, smart systems, and virtualisation, has opened the path for these advances (Kumar et al. 2020).

Walter (2023) emphasises that supply chain management is highly information-intensive, which requires an understanding of complex, interconnected decision-making processes critical for collaborative problem solving, such as cooperative demand planning and forecasting involving multiple supply chain partners. AI improves analytics efficiency, delivers relevant simulations and notifications, increases supply chain efficiency, resource and energy efficiency, decreases emissions, and improves supply chain agility, providing supply network security and optimal risk management (Min, 2010). Despite the increased interest in using artificial intelligence to supply chain and logistics performance, the underlying framework, design, and possible implications for services productivity are not well documented in supply chain literature.

The study of AI in supply chain and logistics is vital since current supply chains are becoming more complicated and demanding. Globalisation brings issues such as shifting demand, supply chain interruptions, and the requirement for faster delivery times. AI tackles these difficulties by optimising processes, increasing demand forecasting accuracy, and improving overall supply chain resilience (Balfaqih, 2023; Madancian et al. 2024).

According to Adele (2022), the fifth Industrial Revolution, or Industry 5.0, would see humans collaborate with new technologies such as AI-powered robots to improve workplace operations. Industry 5.0 emphasises efficient and intelligent machinery, elevating the industrial industry to new heights while enhancing corporate efficiency (Chen et al., 2020).

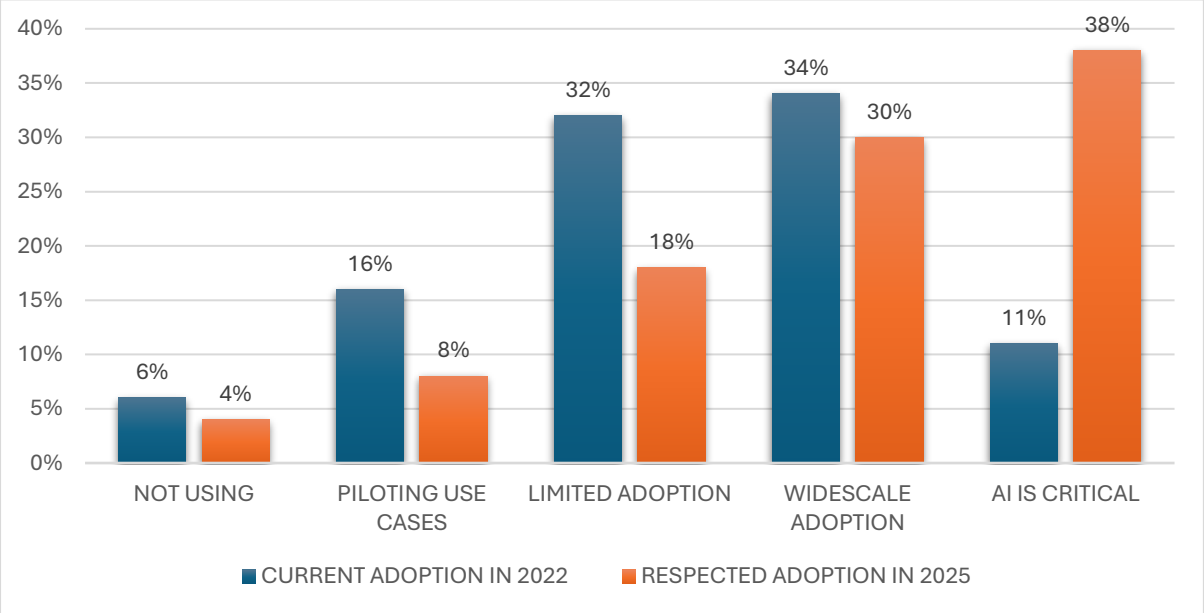
Given the growing interest in AI's overall impact on SCP and LP, many studies concentrate on specific applications or technology rather than providing a comprehensive evaluation. This paper seeks to close this gap by synthesising previous research and conducting a thorough analysis of AI's potential and actual impact on supply chain and logistics performance. This study is critical for industry practitioners, academics, policymakers, and technology developers (Doe and Smith, 2023) as it provides insights into how to use AI to improve

operational efficiency, lower costs, improve decision-making, drive economic growth, and develop tailored AI solutions, all while identifying research gaps and guiding future studies.

Problem statement

The efficiency and efficacy of various logistical operations and transportation networks can be enhanced by smart technology applications, such as artificial intelligence and data science technologies that use big data (Chung, 2021). AI has a significant impact on supply chain and logistics performance (Govindan et al., 2018), which requires new approaches for performance monitoring (Kamble and Gunasekaran, 2020). Many manufacturing process or supply chain company concepts are being developed for "factory of future". Thus, industrial problems could be solved swiftly by using machines, robots, collaborative robots (cobots), RFID, but also internet of thing (IoT), decision aided tools, etc (Eric-Dossou, 2019).

According to Mohsen (2023), AI application provides supply chain with a clearer picture of the complete system, resulting in smarter decisions and more attentive customer care. This trend began with the advent of expert systems and fuzzy logic and reached maturity sometime after 2010. According to the literature, AI enables businesses to adapt rapid changes in demand, minimise waste, and increase collaboration and customer satisfaction.



(Source: Statista, 2022)

Figure 1: AI adoption rate in manufacturing and supply chain globally: 2022 - 2025

Many firms are investing in digital technologies to improve the efficiency of their supply chain operations. Figure 1 Statista (2022) displays the global AI adoption rate in supply chain and industrial businesses. AI usage remained steady in 2022, with more than a third of businesses (34%) reporting the use of AI in their operations based on widescale adoption. Accessibility, which make AI easier to apply across the organisation, is a big driver of adoption, but businesses are also looking to AI to help them enhance the automation of operations and costs cutting.

The AI adoption gap between larger and smaller businesses has also grown dramatically. Larger organisations are now 100% more likely to have used AI in their organisation than smaller companies, compared to 69% in 2021 according to IBM Global AI Adoption Index

2022. The adoption rate of AI in product development from 2022- 2025 is widely employed in service operations, strategy, and corporate finance, with nearly all industries indicating that AI is used in these areas at a rate of around 20%. The application of AI's shows the use in product creation has grown in recent years. This mean adoption of AI in 2025 will be critically 38% expected to increase.

On top of that, AI machine learning integration into software application development frameworks allows developers to utilise AI capabilities to deliver intelligent features, automate tasks, and improve user experiences. The manufacturing industry will be seeing as the most use of AI in product development, with more than 30 % of respondents expected on planning and employ AI in 2025.

However, few publications have investigated the sustainable logistics and supply chain management from the perspectives of different supply chain network partners, such as suppliers, manufacturers, and customers. Moreover, the role of innovative and intelligent supply chain technologies, such as internet of things (IoT), big data, AI, and blockchain technology, has not been adequately explored (Jomthanachai et al., 2023). Thus, this paper is aimed to collate, summarise, synthesize, and critically evaluate the existing published literature on the nexus of AI, SCP and LP. Therefore, this study consolidates and synthesises current research on the relationship between AI, SCP, and LP, and it serves as a foundation for future research.

Research Objectives

This paper seeks to bridge the knowledge gap by exploring the relationship between AI application and SCP, as well as the link between AI and LP. The results of this study could offer valuable conceptual insights for future research and shed light on the current impact of AI on the performance of SCP and LP.

This paper is structured as follows. The methodology, framework, and sample identification are presented in the following section. Section 3 presents the finding from the selected studies, distinguishing the AI towards SCP, and LP. The discussion section synthesizes the findings and considers the implications in the context of AI application towards SCP and LP. Finally, the paper is ended with a brief conclusion and future research directions.

Literature Review

Artificial Intelligence

The fourth industrial revolution, driven by disruptive technologies like AI and robotics, is distorting the line between humans and machines. Over the past decade, there has been an increase in management paradigm shifts as the role of humans in supply chain operations has evolved (Sharma et al., 2022). According to Ben-Daya et al. (2019) this change improves supply chain management (SCM) efficiency, productivity, and visibility across all processes. Based on Brynjolfsson and Mcafee (2017), in 1955, a team of scientists led by Prof. John McCarthy invented the term artificial intelligence. Meanwhile, Min (2010) mentioned that AI is the use of computers for reasoning, pattern recognition, learning, knowledge acquisition, and inference to solve decision-making problems when optimal or exact solutions are too costly or difficult to produce. Therefore, machine learning and deep learning techniques are used to improve its task execution abilities. AI allows robots to replicate human intellect and helps them perceive, analyse, and do things in the same ways that humans do (Sharma et al., 2022).

Performance

The importance of supply chain performance is becoming more widely recognised in modern industrial organisations. Furthermore, the development of digital technology and supply chain globalisation has led to an increasing acknowledgment of the use of substantial information processing tactics such as artificial intelligence in improving performance. Therefore, artificial intelligence collaboration between supply chain can helps to bridge the gap of performance (Nwagwu et al., 2023). According to Richey Jr. et al. (2023), generative AI has the potential to significantly impact logistics and supply chain management. Furthermore, AI plays a beneficial role in supply chain management in a variety of subfields. Scholars are debating the possible benefits and downsides of this innovative approach. But limited study exists on the relationship between AI and logistics and supply chain management performance (LP and SCP). This paper aims to fill a gap by synthesising AI's prospective applications in LP and SCP and analysing their implementation across the industry. For logistics performance, generative AI can create efficient distribution methods and logistics, taking into account cost, service level, routing, weather, and environmental factors. AI system may build a route for a delivery truck with multiple stops within a city to reduce travel time and fuel usage. AI can provide textual reasons for selected routes, giving logistics managers more options and enabling better decision-making. Meanwhile for supply chain performance, AI technologies such as cobots, computer vision, speech recognition, deep learning, and natural language processing enable efficient and effective decision-making and operations (Pessot et al., 2023). The AI-powered capability helps organisations monitor and respond quickly to supply chain disturbances. When a danger is identified, the system generates an automated alert and sends it to relevant vendors (Richey Jr. et al., 2023).

Method

Systematic Mapping

In analysing and synthesizing previous published articles, a systematic mapping outlay a sequential process in projecting a research domain in terms of the quantity, types and research result. The steps of research in this study are presented in figure 1 below:

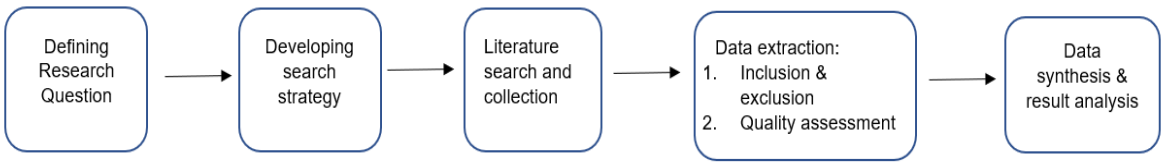


Figure 1: Systematic Mapping Process

The systematic mapping process employs in this study involves a sequential series of five steps, as represented in figure 1. The initial stage entails identifying the research question and followed by the development of search strategy. Subsequently, the literature searching, and collection are conducted and followed by data extraction. In the fourth stage, data extraction involves in filtering articles based on specific criteria of inclusion and exclusion. This step is crucial as to ensure articles collected relevant to this study. Then, quality assessment is conducted for evaluating the reliability and validity of the primary studies. The final step in this study involves a synthesis and result analysis.

This study applies the systematic analysis method via two online search databases: Scopus and Web of Science (WOS). The search process was done on published articles for 10 years

from the year 2023 until 2013. The purpose of this conceptual review is to provide an overview of the current state in manufacturing industry with the emergence of AI towards SCP and LP.

Research Question

Table 1
Research Question

RQ No.	Research Question
RQ 1	What is the extent of the relationship between Artificial Intelligence (AI) application and Supply Chain Performance (SCP)?
RQ 2	How does Artificial Intelligence (AI) application associated with Logistics Performance (LP)?

The aim of this paper is to collate, summarize, synthesize, and critically evaluate the existing published literature on the nexus of AI application to SCP and LP. The focus of this paper is on how and what AI may influence the performance of SCP and LP. Hence, this paper formulates two research questions as presented on Table 1.

Search Strategy

The initial phase of the review process involves identifying relevant databases and pinpointing pertinent research. This phase unfolds in two stages. The primary stage involves collating publications that align with the study's research objectives. Subsequently, the second stage focuses on selecting articles that meet specific inclusion and exclusion criteria. For this study, we have chosen to restrict our data collection to journal articles. Several literary databases, such as Scopus and Web of Science (WOS), are tapped into for this purpose. Moreover, the scope of articles is considered spanned to those articles that have been published between 2013 and 2023. To effectively locate relevant resources, it is crucial to employ suitable keywords. In this study, the chosen keyword for literature exploration were **"(artificial intelligence AND supply chain performance AND logistic performance)".**

Prior Literature Search and Collection

Research on AI, Supply Chain and Logistics performance is at the stage on increasing using technological developments drove by the Fourth Industrial Revolution (IR 4.0). Today's supply chain is under pressure to adapt the way it operates in order to manage supply chain efficiency. According to Min (2022), his study focussed on smart port architecture development due to COVID-19 pandemic and fourth industrial revolution. Every organisation must compel a new way of thinking and doing things. The new path involves technology innovation based on digital transformation, which may deliver enormous productivity benefits and eventual corporate success through better access to a multitude of real-time information. This digital transformation comprises the digitization (computerization) of physical resources as well as their connection with the global Internet network.

The following characteristics reflect such technology: IoT, Man and machine interface, Cyber physical system (CPS) which allow autonomous decision-making (Ślusarczyk 2018; Sisinni et al. 2018; Oztemel and Gursev 2020). Moreover, a study by Kamble et al. (2018, 2020) indicates that, 4.0 industry technologies, such as IoT, cloud computing, and augmented and virtual reality systems, enable remote sensing and monitoring of real-time systems, allow

effective device control, and create a Cyber physical environment with direct interaction, integration, and synchronisation between the virtual and real worlds.

Following the establishment of a search strategy, the next phase involved conducting keyword searches across various databases. Table 2 indicates a total of online scholar database that has been found from WOS and SCOPUS for this topic. This process yielded 60 articles. After a thorough review, 24 of these articles are selected for further analysis, as detailed in Table 2. The selected articles are presented strong evidence in relation to supply chain performance and logistics performance.

Table 2
Literature Collection

Online Database	Found	Candidate	Selected
WOS	34	20	14
SCOPUS	26	16	10
TOTAL	**60**	**36**	**24**

Data Extraction

After collecting 60 articles from multiple databases, each article was meticulously reviewed to determine its relevancy to those that were aligned with the research objectives. This review process was guided by predefined inclusion and exclusion criteria, detailed in Table 3, to select the most appropriate articles for the study.

Table 3
Inclusion and Exclusion Criteria

Inclusion	Exclusion
1. Studies that published between 2013 to the first quarter of 2023.	1. Abstract research or unpublished paper.
2. Articles with artificial intelligent as a central topic	2. Paper in language other than English
3. Articles that show well defined objective, research methodology, empirical result and able to provide substantial and contribution in this literature.	3. Articles were not published between 2013 and 2023.
4. Paper in English	4. Articles in progress

Upon reviewing the 60 articles using the inclusion and exclusion criteria aligned with our research objectives and questions, key inclusion criteria were established for this study. These criteria were specified that the selected research should be conducted in developing countries and clearly presented the factors of influencing the AI adoption in SCP and LP.

Quality assessment is a pivotal stage in evaluating the rigor and validity of primary studies. This assessment is underpinned by specific instruments, which serve as a checklist of essential criteria tailored for the study at hand. For the purpose of this investigation, four distinct questions were formulated to act as the benchmark for assessing the quality of sources. Following this rigorous evaluation, twelve (12) articles were excluded due to the lack of clarity in their research methodology and data collection processes.

Table 4
Quality Assessment

QA NO.	QA QUESTION
1.	Is the topic addressed in the paper related to AI, SCP or/ and LP?
2.	Does the research methodology described in the paper?
3.	Does the data collection method described in the paper?
4.	Are the data analysis steps clearly described in the paper?

Findings

Synthesis and Result Analysis

In the final stage, the study interpreted its findings through content analysis, which allows for the examination of data using quantitative, qualitative, and mixed methods. This approach facilitates the identification of trends in categorical data. Search through online scholar databases (WOS and SCOPUS) yielded 60 articles on AI, SCP and LP. A total of 24 articles met the inclusion and exclusion criteria and were selected for further analysis. As indicated in Table 5, the articles were categorized based on the research methodology employed. The table revealed that the quantitative method was the most commonly used, followed by qualitative and mixed methods.

Table 5
Number of Studies Based on Method

Method	No of study
Quantitative	13
Qualitative	9
Mixed	2

As tabulated in table 5, the data indicated on methods used based on 24 articles selected as a key prominent of this study. 13 reviewed articles had been used quantitative method to identify the performance of supply chain and logistics and 9 reviewed articles were used qualitative methods. The balance of 2 reviewed articles employed a mixed method.

Discussion and Conclusion

The growth of AI programmes as expert systems that occasionally required human-level intelligence resulted in substantial progress. AI can be used to analyse massive amounts of data and give actionable insights to improve corporate operations (Giovanni, 2020; Richardson, 2019). AI adoption can reduce operating expenses while increasing the market value of a company's brand, hence improving firm performance (Engelman et al., 2017; Irfan and Wang, 2019; Naseer et al., 2021; Silva et al., 2021). AI, which is developed from big data analytical capability (BDAC), is driving the fourth industrial revolution (Irfan and Wang, 2019; Liu et al., 2016; Yu et al., 2018). Big data applications are becoming increasingly beneficial, especially with the rise of big data smart environments and smart ecosystems (Chen and Chen, 2021).

Many developed countries, such as the United States, Japan, the United Kingdom, and those in the European Union, as well as emerging countries, such as China and South Korea, are promoting a variety of policies, including increased research and development of big data applications (BDA), in order to become the most successful nations in the world (Latif et al., 2019; 2018). Based on Sharma et al. (2021) automation equipped with AI and BDA will result

in numerous productive aspects such as reduced time consumption; less errors; increased cleanliness; improved food safety; cost reduction; decision making; sorting products; inventory management; waste reduction; toxicity prediction; improved supply chain and logistics; product development; and food delivery.

Moreover, for Li et al. (2022) addressed on issues of how logistics firms improve the supply chain performance in COVID-19 through big data and supply chain integration (SCI). This study collected a three-round survey of 323 logistics firms from 26 countries in Europe, America, and Asia by conducting in-depth interviews with 55 logistics firms which resulted on big data analytics technology capability (BDATC) and SC Integration that influenced the supply chain performance. BDATC and SCI, in particular, were two second-order capabilities that assisted firms in developing three first-order capabilities (i.e., proactive capabilities, reactive capabilities, and resource reconfiguration), which eventually led to an innovation capability and disaster immunity, by allowing firms to survive in COVID-19 and improving the supply chain performance. Study from Chen and Chen (2021), identified BDAC was able to assist firms to achieve a long-term growth on the IoT, social networks, and supply chains. BDAC was positively related to an internal integration but not to external integration. Furthermore, both internal integration and external integration were positively correlated with operational performance. As a result, BDAC was able to improve the supply chain efficiency and flexibility, as well as solution for a low efficiency in distribution channels caused by the bullwhip effect.

However, big data applications have yet to mature for many businesses for the following reasons (Srinivasan and Swink, 2018). First, little consideration is given to the mechanism and process of BDAC and there is a lack of BDAC on decision-making (Richey et al., 2016), second, many businesses continue to struggle with its adoption because they are lacking in the number of adequate data analysis skills workers (Ferraris et al., 2019). When firms want to acquire deep insights from big data, they must address the challenges of introducing the technology, particularly the expenditure of resources (Erevelles et al., 2016). As a result, there is little literature on the impact of BDAC on operational performance (Irfan and Wang, 2019; Yu et al., 2018) to support the efficiency of AI to SC and LP.

Another industry that uses AI in supply chain operation is food sector. This study is focused with the findings and researched of the established automation technology governing AI and BDA in the food business. Sharma et al., (2021) emphasises on machine learning, artificial neural networks (ANNs), and various algorithms as examples of AI and big data analytics in the food industry. Logistics, supply chain, marketing, and production patterns, as well as food sub-sector applications for artificial intelligence approaches, are all discussed. It has been discovered that the use of AI techniques and the intelligent optimisation algorithm leads to considerable process and production management.

Meanwhile, for electronics manufacturer, component distributors estimate demand for wide assortments of stock keeping units (SKUs) with separate dynamics for inventory control and supply chain management. A study from Fu and Chien (2019) intends to establish a UNISON data-driven analytics framework that blends machine learning technologies and a temporal aggregation mechanism to estimate the demands of intermittent electronics components in order to improve demand forecast performance. The results were demonstrated the practical viability of the proposed approach, outperforming traditional approaches and existing practise. The built solution was being used to assist the flexible decisions in order to enable agile logistics and supply chain resilience for smart production.

In term of logistics industry, Cross-docking (CD) operations were one of the warehouse operations for intelligent logistics network design that were used to minimise inventory levels

and increase responsiveness to meet the needs of consumers. The efficiency of supply chain logistics management and an immediate reaction to client needs were viewed as additional sources of profit (Lo and Chuang, 2023). The study created a two-phase approach, named sAIS, to solve the vehicle routing problem (VRP) with the CD facilities and systems in the logistical operations. The sAIS algorithm employed a clustering-first and routing-later strategy and optimising routing via the Artificial Immune System, the sweep approach is utilised to cluster vehicles. The proposed sAIS technique performed well, with average gains of 7.26% in pickup and delivery benchmark tasks.

Another study by Kamble et al. (2022) was focusing on digital twin that was virtual and physical system integration that employeds disruptive technologies. It is a way of constructing sustainable, intelligent manufacturing systems for achieving resilient quality, decreasing time, and creating customised goods using real-time information across the product life cycle. This is due to (Negri et al., 2017; Uhlemann et al., 2017) identified that manufacturing organisations can benefit from higher production and efficiency as a result of digitalization. This is due to the ability of manufacturing organisations can benefit from higher production and efficiency as a result of digitalization (Negri et al., 2017; Uhlemann et al., 2017). A digital twin is a virtual model and full representation of a system that is used to understand performance characteristics and efficiently boost value-added operations (Park et al., 2019; Rezaei et al., 2019). Result of the study had shown that, IoT, simulation modelling, cyberphysical systems, machine learning, and artificial intelligence were recognised as emerging technologies that can play a crucial role in achieving sustainability objectives (Kamble et al. 2022).

Another smart manufacturing study is based on Bhargava et al. (2022) using IoT development for smart manufacturing and smart logistics and become a key requirement to save logistic time and costs. This resulted in the creation of the industrial internet of things IIoT and industry 5.0. IIoT is an industry-focused Internet of Things in which industrial data, equipment, machines, and vehicles are interconnected over a large network. By utilising IIoT in logistics, it is possible to govern IIoT for smart and effective supply chain management (Wu et al. 2021; Zhang 2021).

Future Research and Limitations

In response to the dearth of research in identifying and validating performance indicators relevant to AI evaluation, this study employed a systematic mapping process as the foundation of this research methodology. This paper only provides an overview of the current literature on the application of artificial intelligence to improve supply chain and logistics performance in manufacturing and other industry sectors. The readiness of AI technology to support supply chain and logistics activities can be leveraged to achieve efficient performance in the industry 5.0. As a result, the study had few constraints, creating opportunity for future research. For this venture, additional study for this initiative can be performed to get insights from other value chain actors in combination with AI.

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