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Innovative Logistics: Assessing AI's Impact on Supply Chain Excellence

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Abstract— Many facets of corporate operations could be revolutionized by artificial intelligence (AI). Artificial Intelligence (AI) has the potential to improve supply chain inefficiencies, optimize logistics and transportation routes, and forecast demand based on data analysis. This may result in shorter lead times, lower costs, and better response to variations in demand. Using the Scopus database, this study examines and evaluates the uses of artificial intelligence (AI) in supply chain management (SCM).
The goal is to close the existing research gap on the effects of AI on supply chain management (SCM) performance. This includes identifying AI techniques that can improve SCM performance, SCM subfields that have a high potential for AI enhancement, the effects of AI application on SCM performance, and how the performance can be explained from an agile-lean perspective. The Scopus database was used to list and categorize the current nations and areas involved in AI impact on SCM performance, document type, and subject area.
In addition to addressing the existing research gap, this study delves into the challenges and ethical considerations surrounding the integration of artificial intelligence (AI) in supply chain management (SCM). The lack of standardized application methods poses a challenge for cross-enterprise comparisons, making it crucial to explore the variations in outcomes and impacts across diverse industries. Furthermore, the study highlights the absence of standardized metrics for assessing the return on investment (ROI) of AI in SCM, hindering businesses in evaluating the true value of their AI investments.
An essential aspect examined in this research is the integration of AI systems with existing SCM frameworks, revealing potential limitations on data availability and accuracy. Ethical concerns, including issues of discrimination and the protection of sensitive data, emerge as critical considerations that demand greater attention in the context of AI-driven SCM solutions. This study aims to shed light on these ethical dimensions and emphasizes the necessity for a human-centric approach in developing AI solutions, with a focus on workforce development and training alongside process optimization and cost savings.

Introduction:

Supply chain management is being significantly impacted by AI. AI's capacity to track freight forwarding on a large scale and predict shipping requirements can be advantageous for supply chain management logistics companies (Rahimi & Alemtabriz, 2022). Supply chain managers may now see a more comprehensive view of the system thanks to artificial intelligence, which helps them make better decisions and provide better customer service. Expert systems and fuzzy logic helped to establish this trend, which peaked sometime after 2010. The advancements in big data, analytics, deep learning (DL), and graphics processing unit (GPU) applications have shaped today's cutting-edge AI (Li, 2020).

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The rise in popularity of AI applications since the early 2010s has caused both enthusiasm and anxiety about the future of labor and corporate administration (Li, 2020). Even though businesses are adopting AI and investing in AI solutions to better their end-to-end supply chain operations, the supply chain literature seems to be lagging behind some recent attempts to incorporate modern AI approaches inside its core research (Hartmann & Moeller, 2014). The need for a broadly acceptable and inclusive taxonomy that can help operations and supply chain researchers expand their knowledge of the past, present, and future scope of research into AI applications in supply chain management is highlighted by the significant fragmentation in AI research that our research also revealed.

The purpose of this literature review was to address the following queries. In terms of published research on AI's application to supply chain management, where are we at this point? In what kind of supply chain environments have the research on AI approaches been conducted? Where have they been conducted? What more studies on the application of AI to supply chain management may we expect? Which supply chain segments do you see using these tactics the most broadly? We conduct an extensive literature review utilizing a range of research techniques to address these questions (Nayak & Choudhary, 2022). Developing a new taxonomy of AI applications is the first step in our multi-method strategy to thoroughly assess the subject and related studies.

We will be able to identify the relationships and patterns already existing in this body of work through thorough co-citation and network analysis. This is the first attempt of its sort to examine this literature and identify research trends using a carefully constructed artificial intelligence taxonomy, an extensive bibliometric, a cluster analysis, and a thorough evaluation of future research directions. According to McKinsey, companies that have used AI-enabled supply-chain management have seen a 15% reduction in logistical costs, a 35% increase in inventory levels, and a 65% boost in service levels. These are preliminary results; narrower, more predictive outputs may hold the key to artificial intelligence's real promise in the supply chain (Camargo et al., 2020).

This article's goal is to close the existing research gap on the effects of AI on supply chain management (SCM) performance. It does this by identifying the AI techniques that can improve SCM performance, the SCM subfields that have the most potential for AI application, the effects of AI application on SCM performance, and how the performance can be explained from an agile-lean perspective. The paper is structured as follows: the first section provides an overview of how artificial intelligence (AI) is being used in supply chain management (SCM). The second section focuses on using AI technologies, in particular SCM applications, to enhance performance. The conclusion drawn from this section is that AI is being used more and more in SCM to improve performance from an Agile and Lean perspective.

Methodology:

Awuzie and McDermott (2017) state that after gathering data to investigate a phenomenon, the author can test the new or updated theory by gathering more data to further examine the themes and patterns that are identified. The exact same procedure was employed by the author in this study, and the impact of AI applications on SCM performance was examined using secondary data. Only peer-reviewed articles from the SCOPUS database were included in the secondary data. A robust search engine is offered by Scopus, which supports many search parameters for numerous domains, including "Article Title, Abstract, Keywords," "Source Title," "Year of Publication," and others.

These search parameters include "Document search," "Author search," "Affiliation search," and "Advanced search." For the purpose of this study, the search terms utilized in the document are "Artificial Intelligence" and "Artificial Intelligence in Supply Chain Management Performance." Findings were examined to include papers made between 2012 and 2023 in those study domains. The type of document, topic matter, source type, number of publications per country or region, and number of publications annually were all determined using the retrieved data.

Literature Review:

AI has grown and collapsed since its launch in 2012 for a variety of reasons. Due to the increased flow of data and complexity that has emerged in business contexts, the last 20 years have seen a renaissance in interest in and applications of AI across numerous industries (Scholten et al., 2014). In light of present requirements and long-term objectives, the potential of AI in numerous business operations is being investigated. A network of computers with artificial intelligence (AI) can mimic human intellect and make decisions about how to address a business problem (Huang & Rust, 2018). AI learns from data to obtain insights without the need for human input, which aids in business system design thinking.

Businesses can identify the weak points in their supply chain management and allocate resources appropriately by using artificial intelligence (FossoWamba & Akter, 2019). Artificial intelligence (AI) has the potential to assist businesses in producing the best products possible by quickly extracting customer expectations, sensing the market, utilizing failure modes, optimizing internal and external supply chains, and fostering a more creative workforce through the automation of repetitive tasks (Jabbour et al., 2020). AI has been steadily embraced by a variety of

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industries, including manufacturing and e-commerce, to address supply chain issues.

During COVID-19, the majority of supply chains underwent a new degree of resilience testing as they were required to manage ever more complex tasks (Zouari et al., 2021). In today's business environment, customers want supply chains to offer both dependability and personalized solutions. AI has been used to create a system that can identify customer profiles and offer customized products without jeopardizing security or privacy. In conclusion, supply chains and organizations that do not identify and leverage AI in their operations risk falling short of achieving the required supply chain resilience in the dynamic business market that may arise due to COVID-19-like scenarios.

This is because the application of AI is growing at a rapid rate. A branch of artificial intelligence called "expert systems," sometimes referred to as "knowledge-based systems," focuses on creating software that allows computers to carry out tasks that have traditionally been completed by humans with the help of specialized training and supply chain management knowledge (Pournader et al., 2021). According to Kusiak (2019), an expert system consists of the following parts: knowledge acquisition, which enables the system to gather information and knowledge for the purpose of solving supply chain management problems; knowledge reorientation, which is where knowledge is framed; and the interface engine, which explains the control strategy.

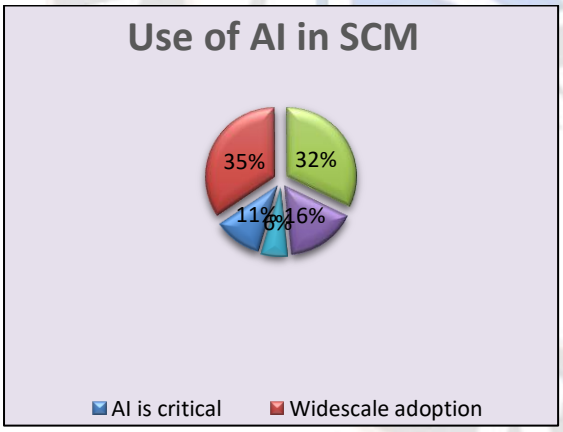

Figure 1: Global AI adoption rate in supply chain management in the year 2022 (Statista, 2022)

To get the best results from AI in supply chain management, expert system techniques such as rule-based, fuzzy, frame-based, and hybrid approaches can be used in combination with one another (Zarbakhshnia et al., 2018). Jakupović et al. (2014) found that expert systems function exceptionally effectively in domains where human intellect may be properly arranged. Expert systems' effectiveness may significantly decline if data is not formally recorded (Haenlein & Kaplan, 2019). When trying to use expert systems to solve cognitive disabilities, this problem becomes even more evident. In recent years, supply chain management practitioners have become more interested in using AI techniques to model and simulate complex systems (Chen et al., 2022).

By using artificial intelligence (AI) for modeling and simulation, people can gain a deeper understanding of how a system operates, which improves their capacity for making better judgments (Bennett & Hauser, 2013). In supply chain management, agent-based computing approaches may prove to be a useful instrument for characterizing the interplay of system elements and evaluating performance in practical situations (Zamani et al., 2022). Artificial Intelligence has been used more and more in supply chain management to enhance performance from an Agile and Lean standpoint. To improve their supply chain operations, many organizations are investing in digital technologies.

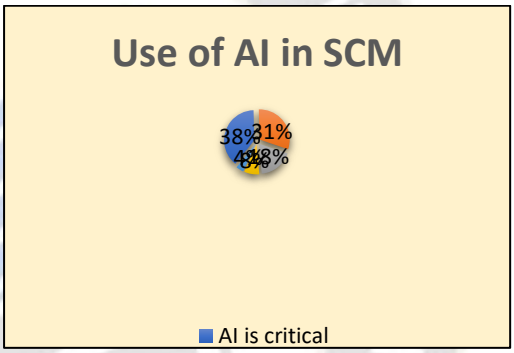

Figure 2: Expected global AI adoption rate in supply chain management in the year 2025 (Statista, 2022)

The phrase "artificial intelligence (AI) planning and scheduling in supply chain management" (Barták et al., 2010) describes a collection of techniques for intelligent system decision-making in the presence of constraints (e.g., the availability of resources at a manufacturing facility). Planning is the process of selecting choices to optimize the order in which activities occur, as opposed to scheduling, which is concerned with allocating tasks to resources within a given period of time (Kreipl & Pinedo, 2004).

Artificial intelligence has advanced recently, enabling managers to anticipate and identify disruptions that could interfere with regular system operations (like fraud detection, predictive maintenance, and system failures). These advancements have also made system recovery more agile and data-driven. Thanks to these developments, managers may now anticipate and identify disturbances that could interfere with regular system operations (Abedinnia et al., 2017).

Analysis:

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The literature review was intended to be analyzed using both quantitative and qualitative methods. The supply chain management-related industries that use artificial intelligence techniques and technology would make up the quantitative portion of the report (El Jaouhari et al., 2022). Furthermore, it will involve the processes of perceiving, engaging, and making decisions. The report analysis carried out by the organization will be taken into account when the organization makes decisions. The Rostami et al. (2022) quantitative literature evaluation would also include the purchasing operation, logistics, resource management, and information workflow.

Conversely, the assessment of the qualitative literature takes into account the limitations in the science surrounding the impact of AI on supply chain management performance. Speaking more specifically to this topic, the survey revealed that, among the eight business functions examined, the influence of AI in supply chain management ranked second and third in terms of the percentage of respondents who indicated the potential for cost reduction and revenue rise (Tirkolaee et al., 2022). While 61% of respondents reported lower expenses, 63% of respondents reported higher revenues. Supply chain management programs, including demand and sales forecasting, spending analytics, and network optimization, are most likely the ones that spurred these changes.

A 2019 summary of the potential impacts of AI on supply chain management was provided by McKinsey & Company. Regretfully, it looks like a while before that promise is matched by broad acceptance in the real world. Artificial intelligence (AI) is currently ranked eighth; robotics, prescriptive analytics, and the Internet of Things (IoT) are all ahead of AI. The good news is that over 25% of respondents to the survey said they planned to use AI in the next two years. The Scopus database was utilized to get and assess the state of AI applications in SCM and their influence on its performance. Excellent information on the research community, history, countries, affiliations, authors, published articles, abstracts, and multiple citations that can be exported and examined may be found in the Scopus database.

A vast amount of peer-reviewed literature, including conference proceedings, book chapters, and scientific journals, is available in the database. With many search parameters, including "Document search," "Author search," "Affiliation search," and "Advanced search" for several categories, including "Article Title, Abstract, Keywords," "Source Title," "Year of Publication," etc., Scopus offers a helpful and robust search engine. For the purpose of this study, the search terms utilized in the document are "Artificial Intelligence" and "Artificial Intelligence in Supply Chain Management Performance."

The results were filtered to include research publications from those domains from 2012 to 2023. The following information was obtained using the data that was retrieved:

a) Document type
b) Subject area
c) Source type
d) Number of publications by country or region

Impact of AI on Supply Chain Management Performance:

Performance evaluation is crucial because it teaches companies how to better serve their clients and meet their long-term goals. Assessing the degree to which demands are met, and resources are used efficiently is essential to achieving the intended level of customer satisfaction. A supply chain evaluation takes into account the interdependencies between all of the firms involved in the chain rather than concentrating on the performance of a single organization. It provides a framework for comprehending the entire system, influences human behavior, and demonstrates the effectiveness of supply chain participants and stakeholders.

The development and application of performance measurements is crucial to management. Using performance measuring tools promotes transparency and deep supply chain knowledge. The efficacy of the company's internal supply chain can be evaluated by monitoring important metrics, such as fill rate, lead time, and on-time performance (Yu et al., 2017). Since these criteria are internal, the entire supply chain is not taken into account. Anticipating the wants of your clients with artificial intelligence programs may help you cut down on unnecessary inventory expenses. Enhancing warehouse efficiency through automation is crucial for efficiently managing the supply chain. It would enable the prompt retrieval of goods from storage facilities and their easy distribution to clients.

The rate at which problems are resolved, the simplicity with which regular tasks can be finished, and the amount of time employees can devote to more crucial daily activities planning are just a few ways that the use of AI in warehouses may boost productivity (Ben-Daya et al., 2019). AI-powered warehouse process automation could cut costs and save time by eliminating the need for human labor. The integration of data, resources, and networks; automation through robotics technology; process automation; intelligent processes; and supply chain reconfiguration are the elements of digital supply chain management, chain networks, changes to the organizational structure, supply chains to boost productivity, supply chain analytics to ensure in-the-moment decision-making, process optimization, and sophisticated forecasting,

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and supply chain processes that repeat a plan, source, make, deliver, and return.

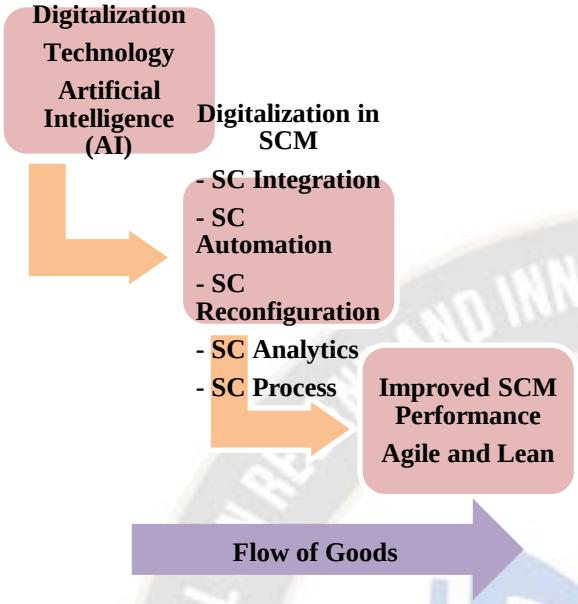

Figure 3: Framework for digitization of SCM (Ben-Daya et al., 2019)

According to Xie et al. (2020), the main goal of industry 4.0 and digitalization is to turn the supply chain into an intelligent supply chain, which will remove asymmetric information from the chain. From the perspectives of visibility, personalization, information governance, warning, sustainability, innovation and learning, agile and lean (leagality), and intelligent supply chain management, the performance of the system can be examined. Leagality is the result of combining lean, which maximizes profits and minimizes waste, with agility, which emphasizes adaptability and responsiveness. Lean and agile do not have to conflict in an intelligent supply chain, according to Xie et al. (2020). Furthermore, he came to the conclusion that supply chain management performance can be successfully enhanced by AI.

Mohsen (2023) noted that block chains, IoT, cloud computing, AI, and big data are all used in digital supply chains. Supply chain management is enhanced by block chain technology, which makes it easier to comply with regulations, facilitates better process monitoring, and produces more accurate reporting. Activities may be completed quickly, flexibly, at scale, and with complete visibility over all stakeholders thanks to the cloud. IoT gives supply chain experts—such as production managers, procurement managers, and inventory planners—more precise data and projections to use when making strategic decisions about the production, acquisition, and sale of goods. According to Mohsen (2022), big data is crucial to supply chain management in a number of areas, including inventory management, logistics, innovation and product design, network architecture, and the creation of market and product strategies.

An overview of the use of AI in supply chain management was given by Stoyanov (2021). According to his paper, AI gives businesses an autonomous supply chain that has the capacity to develop into a self-defining, self-aware, and self-managing system. According to Toorajipour et al. (2021), artificial intelligence has improved a number of supply chain management subfields. Distribution and transportation, sales, marketing, planning, production, logistics hub management, and supply chain demand forecasting are a few of these. According to a McKinsey & Company (2021) study, supply chain management can become more flexible and responsive when AI-enabled real-time monitoring and control of production and logistical activities is used. This can increase performance by enabling businesses to swiftly adjust to shifts in demand and other interruptions.

According to Gülen (2023), artificial intelligence (AI) can improve supply chain management transparency by giving real-time visibility into the logistics and production operations. This can save waste and boost productivity by enabling businesses to recognize issues and take action more swiftly. Additionally, studies have demonstrated that AI can enhance coordination amongst many supply chain participants, including manufacturers, suppliers, and retailers. Artificial Intelligence (AI) has the potential to enhance collaboration among firms by promoting communication and information sharing, ultimately leading to better performance. Artificial intelligence (AI)-driven catboats and virtual assistants have been proven to enhance customer service by promptly and accurately responding to client requests, resulting in increased client satisfaction levels.

Businesses may benefit from this in terms of client retention, sales growth, and performance enhancement. Wang et al. (2022) examined the effects of digital technology, artificial intelligence, and the Internet of Things on supply chain efficiency in the manufacturing sector. They said that a number of artificial intelligence (AI) technologies, such as artificial immune systems (AIS), genetic algorithms (GA), virtual reality (VR), and neural networks (ANN), have been used in supply chain management. According to reports, supply chain management can benefit from AI's ability to foresee and plan, which reduces resource waste and economic risk. In order to predict future demand and optimize inventory levels, artificial intelligence (AI) can be used to analyze vast amounts of data from a variety of sources, including sensor data, weather forecasts, and social media. This has the potential to significantly improve the performance of supply chain management.

It can be applied to optimize logistics, including delivery and production scheduling, transportation routes, and cost reduction. AI may be used to forecast equipment failure dates and plan maintenance appropriately, saving money and downtime. It can be applied to recognize and reduce supply chain risks, including those caused by political unrest, natural disasters, and shortages of supplies. Artificial intelligence (AI) can be used to monitor and inspect products during manufacture and shipping, guaranteeing quality and lowering the possibility of flaws or damage. It can be used to increase collaboration and communication amongst various supply chain players, including manufacturers, retailers, and suppliers, as well as to automate monotonous jobs like data entry, freeing up staff to concentrate on higher-value work. In general, AI may assist businesses in enhancing the efficiency of their supply chains by boosting productivity, cutting expenses, and raising the caliber of output.

Conclusion:

Examining supply chain management's usage of AI and how it affects performance is the paper's goal. Supply chain management is increasingly using AI. The application of artificial intelligence (AI) in supply chain management is commendable and benefits a number of supply chain management subfields, including demand forecasting, logistics hub management, distribution and transportation, sales, and marketing. AI has the ability to boost supply chain management efficiency from an Agile and Lean approach by enhancing customer satisfaction, collaborating better, cutting waste, and being more responsive and flexible.

Notwithstanding the possible advantages, it's critical to remember that integrating AI into supply chain management involves a substantial investment of time and resources in addition to raising serious ethical issues like data security and privacy. Thus, before using AI in supply chain management, businesses should thoroughly weigh the risks and viability. The literature study indicates that there is a research gap regarding the influence of artificial intelligence (AI) on supply chain management performance. This gap includes the following: the application of AI in supply chain management is not standardized, which makes it challenging to compare outcomes and impacts across various enterprises.

The absence of hard data makes it difficult for businesses to assess the value of their AI investments due to the lack of standards and techniques for calculating the return on investment (ROI) of AI in supply chain management. The integration of AI systems with current supply chain management systems presents a challenge that may result in restrictions on the availability and accuracy of data. The ethical and privacy issues of artificial intelligence (AI) in supply chain management, including the possibility of discrimination and the safeguarding of sensitive data, have not received much attention. The majority of AI-driven supply chain management solutions available today ignore the human element and the requirement for workforce development and training in favor of process optimization and cost savings.

There will probably be a number of trends in supply chain management using AI in the future. Supply chain management is anticipated to use AI more frequently as businesses realize how much it can save money and increase productivity. It is anticipated that artificial intelligence (AI) technologies will more smoothly integrate with current supply chain management systems, enabling more precise data analysis and decision-making. The application of AI in supply chain management will increase, and with it, the focus on ethical and privacy issues. Examples of these include making sure AI systems are impartial and safeguarding private information.

AI-driven supply chain management will take a more human-centered approach, emphasizing employee training and development and taking into account the effects automation and AI-driven procedures will have on people. Predictive analytics will use artificial intelligence (AI) more and more, giving businesses the ability to foresee supply chain problems, react to them, and better manage risk. It is anticipated that block chain and artificial intelligence (AI) will combine more and more to offer supply chain management solutions that are more transparent and safer.

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