Research Article

The Expected Contribution of Artificial Intelligence (AI) Adoption in Supply Chain Management

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Abstract

In today's rapidly evolving economy, the adoption of artificial intelligence (AI) within supply chain management (SCM) has emerged as a key area of study. The integration of AI technologies into SCM systems presents a transformative opportunity for organizations seeking to enhance operational efficiency, reduce costs, and establish a competitive advantage in a dynamic market. AI technologies—ranging from machine learning algorithms to predictive analytics—serve as pivotal tools in addressing these challenges. By automating routine tasks, forecasting demand with greater accuracy, and facilitating real-time decision-making, AI enhances responsiveness and agility within supply chains. The economic benefits of incorporating AI into SCM frameworks are substantial. Implementing AI-driven solutions can lead to significant cost savings through improved inventory management, reduced waste, and enhanced resource allocation. For instance, machine learning models can predict stock requirements more accurately, minimizing excessive inventory and associated holding costs. Additionally, AI enhances supplier relationship management by analyzing vendor performance data, leading to more informed selection processes and negotiation strategies. As the field continues to evolve, it is crucial for professionals to engage with emerging technologies, ensuring that they remain competitive and responsive to the demands of an ever-changing market landscape. This study reviews the literature to determine why supply chain management (SCM) needs to adopt artificial intelligence (AI) in terms of integrative tactical planning, resource utilization and cost reduction, risk management, data management and inventory management. The aim of this study was to encourage professionals to investigate the possibilities of AI technology to enhance several elements of the supply chain.

Keywords

Artificial Intelligence, Supply Chain Management, Economy, Industry 4.0, Risk Management, Data Management

1. Introduction

In today's interconnected global economy, supply chains face unprecedented challenges. The complexity of modern IT systems and disruptive global events like the COVID-19 pandemic have exposed critical vulnerabilities in traditional supply chain management approaches. A 2023 study by the World Economic Forum (WEF) found that 75% of companies reported supply chain disruptions in the previous year, with an average financial impact of $184 million per organization [1]. While the increasing prevalence of free trade policies has given supply chain managers the chance to grow their company internationally, numerous product/service providers are facing intense competition because of global production and logistics operations [6]. The current business climate is characterized by highly aware customers, customized products, short product life cycles, and short lead times [5]. Supply chains are essential to cost management, providing high-quality client experiences, and maintaining a company's flexibility in the face of changing market conditions [8]. Businesses priorities inventory optimization, deadlines, financial constraints, and speed, reliability, and traceability. In a highly competitive market, supply networks continue to change and are significantly different from those of only a few years ago [4]. Conventional supply chain economics is leveled in principles of cost minimization, efficiency, and value creation across the entire supply chain network [16]. It emphasizes optimizing the flow of information, goods, and finances from raw material suppliers to end customers while minimizing inventory holding costs, production lead times, and transportation expenses. Key concepts in conventional supply chain economics include economies of scope, economies of scale, the bullwhip effect, and inventory management techniques [17, 19]. These principles guide decision-making processes related to procurement, production planning, inventory management, transportation logistics, and distribution channel design. The integration of digital technologies revolutionizes conventional supply chain economics by enabling data-driven decision-making, real-time visibility, and process automation throughout the supply chain lifecycle. Digital technologies such as artificial intelligence, machine learning, big data analytics, blockchain, Internet of Things (IoT), and cloud computing empower supply chain stakeholders to overcome conventional restrictions and unlock new efficiencies. For example, advanced analytics algorithms can analyze large volumes of supply chain data to identify patterns, trends, and anomalies, enabling proactive demand forecasting and risk management [18]. Technological solutions for dynamic supply chain processes must be able to handle their growing complexity [9]. Customer expectations and competitive pressures have led to a surprising increase in transaction volumes and a corresponding decrease in acceptable response times. For example, since 2019, e-commerce order volumes have grown by 44%, and now 65% of customers expect same-day or next-day delivery. The need for faster response times to data requests has become essential. The percentage of supply chain leaders who say that real-time visibility is vital for their operations has increased from 45% in 2019 to 78% in 2023 [14]. Artificial Intelligence has emerged as a powerful tool, offering enhanced responsiveness and flexibility. The global AI in supply chain market size was valued at $4.8 billion in 2023 and is estimated to reach $14.3 billion by 2028, growing at a Compound Annual Growth Rate (CAGR) of 24.3% during the forecast period [13]. Several artificial intelligence (AI)-based functional supply chain applications have surfaced in recent years. Enhancing supply chain performance with artificial intelligence (AI) has a lot of potential advantages. Organizations improve their resilience in the supply chain, decrease costs, increase efficiency, improve forecast accuracy, improve customer service, and improve sustainability by utilizing AI technologies. Better profitability, operational efficiency, customer happiness, and environmental impact can result from these outcomes [10, 12]. Recent developments and studies in AI-driven SCM optimization showcases its growing impact and potential. Research has demonstrated significant improvements in demand forecasting accuracy through advanced ML models that can handle complex, non-linear patterns in data [15].

Advancements in artificial intelligence (AI), big data, blockchain, robotics, drones, 3D printing, Internet of Things (IoT), 5G, biometrics, and robotics are currently influencing the way individuals purchase and use products, the way businesses manufacture and deliver them, along with the way logistics networks interact with society at large. Industry 4.0, or the fourth industrial revolution, is centered around these technologies. Within this framework, business models, supply chain and logistics production systems must adjust to the changing production and consumption dynamics [2]. This paper identifies the need for AI adaptation in supply chain management with the help of literature review.

2. Literature Review

Over time, the world has been progressively moving toward a digital future, with artificial intelligence emerging as a pivotal technology that can significantly enhance supply chain capabilities. Organizations considering the adoption of AI in supply chain management (SCM) must understand the critical reasons for its implementation to ensure success. Typically, SCM academics focus primarily on the managerial aspects of AI, often overlooking the essential process perspective. A more comprehensive approach that includes the process perspective is essential, as it allows researchers to explore the various applications of AI across different supply chain processes such as Integrative tactical planning, Resource utilization and cost reduction, Risk Management, Data management, and Inventory Management. By integrating AI into these processes, organizations can reduce costs, enhance efficiency,

and improve responsiveness to market demands. This multi-faceted understanding of AI's role in SCM not only supports strategic objectives but also fosters innovation, ultimately connecting managerial insights with process-oriented analysis will enable organizations to fully leverage AI's potential, enabling a more resilient and agile supply chain ecosystem.

3. Benefits of AI Adoption in SCM

To add value, maximize profitability through efficiencies, and achieve customer satisfaction, the management of a network of relationships both within and between interdependent organizations and business units, including material suppliers, purchasing, production facilities, logistics, marketing, and related systems, is necessary to facilitate the forward and reverse flow of materials, services, finances, and information from the original producer to the final customer. Advances in computer power have made it possible for AI applications to expand and become more complicated.

a) Integrative tactical planning: Businesses can enhance process automation by integrating intelligent technology with their supply chain management (SCM) solutions. With improved visibility into both static and real-time data, organizations may lower costs, boost the agility of their digital supply network, make better planning decisions, and obtain more comprehensive and detailed insights into their supply chains [3].

b) Resource utilization and cost reduction: Tedious and labor-intensive activities in supply chain management, including order processing, inventory control, and warehouse operations, can be automated by AI. This can increase productivity, cut expenses, and free up human workers to concentrate on more strategic responsibilities [10]. SCM businesses rely on both digital and physical networks, which need to work together harmoniously in the face of high volume, budgetary constraints, tight margins, and pressing deadlines. Artificial intelligence (AI) makes it possible to optimize and enhance network orchestration in an effective way that is not possible for humans. By transforming operations from reactive to proactive, processes from manual to autonomous, services from standardized to personalized, and production planning from forecasting to prediction, AI can assist this industry reinvent its current practices using such technologies [11]. Increasing the rate of capacity utilization is a common goal for various planning initiatives. Artificial intelligence can do tasks that provide humans with nearly real-time recommendations on how to enhance the existing configuration. Practical use cases for this include anticipating future states and learning from the past [3].

c) Risk Management: Artificial Intelligence has the potential to detect and reduce supply chain hazards. This can enhance resilience and help businesses avoid disruptions. FedEx, for instance, utilizes AI to keep an eye out for dangers in its supply chain. This enables them to recog-

nize any issues before they become serious and to take action to reduce the risks. This aids in preventing supply chain interruptions and enhancing their general performance [10, 15]. AI facilitates the application of predictive methodologies that enable prompt evaluation and efficient mitigation of potential risks or disruptive events across the supply chain. Additionally, AI helps users identify patterns within the supply chain. AI can swiftly and accurately detect pertinent supply chain data using algorithms to create models that help managers find opportunities for improvement and gain a better understanding of how each process operates. It helps businesses to continuously learn about areas that need improvement, discover factors that affect performance, and anticipate performance in this new strategy of employing AI to optimize the supply chain [7].

d) Data management: The emergence of data mining as a new discipline can be attributed to its amalgamation of various previous fields, primarily to the proliferation of enormous datasets. The main driving force behind data mining is the fact that these large databases hold important information for database owners, since it offers useful insights into various processes, including decision-making. Data mining can be applied to supply chain management (SCM) in several ways, including managing and keeping an eye on warehouses, food supply chains, and sustainability in supply chains [11, 12]. AI can forecast demand in the future, spot possible hazards, and improve supply chain efficiency using data from the past. This can lower waste, prevent stockouts, and raise customer satisfaction for businesses [10].

e) Inventory Management: To estimate demand more precisely, artificial intelligence (AI) can be utilized to examine previous sales data and industry patterns. By doing this, businesses can minimize stockouts and maximize inventory levels. Walmart, for instance, forecasts product demand at the shop level using artificial intelligence. By doing this, they can make sure that the appropriate quantity of inventory is kept in the appropriate stores, which lowers out-of-stock and raises customer satisfaction [10]. Artificial intelligence software can help cut down on unnecessary inventory costs by predicting the demands of your clients. Enhancing warehouse productivity through automation is crucial for efficiently managing the supply chain. It would make it possible to quickly retrieve goods from storage facilities and easily transport them to clients [6].

4. Conclusion

Utilizing artificial intelligence (AI) to improve supply chain performance offers numerous influential advantages for organizations across various sectors. By leveraging AI technologies, companies can not only achieve improved productivity and significant cost savings but also refine their fore-

casting capabilities, leading to more accurate demand predictions. Additionally, AI enhances the resilience of supply chains, allowing businesses to predict potential disruptions, and allowing organizations to develop proactive strategies to mitigate uncertainties in the market. In customer service, AI-driven chatbots and personalized recommendations improve customer experiences, ultimately driving higher levels of customer satisfaction. The application of AI contributes to sustainability efforts, optimizing transportation routes, resource use, and reducing waste throughout the supply chain. The convergence of these benefits results in better profitability and operational efficiency, positioning organizations to thrive in a competitive environment. In conclusion, the integration of artificial intelligence into supply chain management presents a transformative opportunity for organizations striving to enhance their overall performance, marking a pivotal shift in how supply chains operate and adapt to meet the ever-evolving demands of the global marketplace.

Abbreviations

AI	Artificial Intelligence
SCM	Supply Chain Management
%	Percentage
IT	Information Technology
CAGR	Compound Annual Growth Rate
IOT	Internet of Things

Conflicts of Interest

The authors declare no conflicts of interest.

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