

An Analysis of the Impact of Artificial Intelligence Technology on Supply Chains

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Abstract. Significant developments in artificial intelligence (AI) research in recent years have made people increasingly aware of its transformative impact on society. With the rapid development of AI, its applications are expanding across various fields. AI technology is now being increasingly used in supply chains, which can significantly improve their efficiency and performance. AI can not only accurately match the resource supply and demand in various links of the supply chain, but also dynamically avoid risks and optimize processes, thereby significantly improving the overall efficiency and comprehensive operational performance of the supply chain. To understand how AI technology specifically influences supply chains, this paper reviews existing investigation into how supply chains are affected by AI, summarizing the current research focus from different perspectives. It reveals that AI technology has been applied to multiple core links in the supply chain, benefiting various aspects of supply chain management. Furthermore, emerging technologies combining AI with other technologies are reshaping supply chain management in innovative ways. This paper also explores what should be focused on in this field.

Keywords: Artificial Intelligence Technology, Supply Chain Management, Chain Management.

1. Introduction

It is essential to have a healthy supply chain for every company. In the worldwide market of today, with the constantly evolving nature of supply chains, global supply chains face uncertainties such as geopolitical conflicts and climate change. Traditional linear supply chain models struggle to adapt to this dynamic environment, making flexible and sustainable supply chain management strategies increasingly important. Compared to conventional analytical methods, businesses urgently need more advanced approaches to better address challenges in their supply chains. In recent years, artificial intelligence (AI) has become an extension of the human brain, and AI technology will help us unleash our true creative potential. AI promises to revolutionize all aspects of operations of businesses and the supply chain, as a core element of any business, will be significantly impacted. Through its unique capabilities, such as analyzing data in real time and making decisions on its own, AI provides new approaches to building the supply chain's resiliency and effectively addresses the challenges of today's dynamic supply chains. AI has the ability to enhance transportation routes and logistics, forecast demand, and evaluate data. AI-powered models can achieve better results than traditional models, helping to improve responsiveness to demand changes, shorten delivery times, and reduce costs. In today's challenging environment for traditional supply chain models, integrating AI technology with supply chains to create new supply chain management models has become a key path to improving the efficiency and resilience of modern businesses.

Publications about AI used in supply chains have greatly increased in number within the last five years, demonstrating that AI can contribute to supply chain optimization across all key stages. Most studies focus on using AI for data processing in supply chains, especially for demand forecasting, as AI can improve prediction accuracy and thus enhance supply chain efficiency. Furthermore, the effects of AI on inventory and order management have been the subject of numerous studies, while some researchers have also explored its role in optimizing transportation and risk control. To support future research in this area, it is crucial to systematically review and summarize the rapidly growing body of literature. This paper synthesizes existing studies on how supply chains are affected by AI, summarizing its effects on various supply chain phases. It also identifies the emerging trend of



integrating AI with other technologies to address supply chain challenges. Finally, the paper points out the gaps and limitations in current research and offers perspectives on future research directions.

2. AI Implementation at Strategic Supply Chain Phases

The core components of a supply chain include procurement, inventory management, and logistics. To attain maximum profitability, supply chain management's main objective is to balance revenue and expenses. To this end, supply chain management needs to address issues such as how to replenish inventory on demand, how to coordinate the movement of goods, and how to improve transportation efficiency. A comprehensive supply chain management system also requires measures such as supplier management to reduce supply chain risks, enhance resilience, and achieve sustainable development. AI technology can be applied to these various stages to address these challenges, improving the precision of demand projections and optimizing transportation routes, consequently boosting the supply chain's resilience and effectiveness.

2.1. Demand Forecasting and Inventory Management

AI's application in supply chains can overcome the limitations of traditional models. In supply chain management, game theory models are often used to simulate the relationships between multiple stakeholders, aiming to optimize overall benefits by balancing gains and losses in a competitive environment. A major challenge in supply chain management is dealing with constantly fluctuating demand. Reducing inventory costs and stockout costs due to demand variability and uncertainty in a complex environment is a key problem that models aim to address. The application of AI has proven to notably increase the precision of demand projections, thus guiding the development and implementation of product and service procurement plans. By integrating AI technology with traditional models, it is possible to achieve results such as cost reduction, profit increase, risk reduction, and improved supplier performance.

From a technological perspective, machine learning is a core technology of AI and is widely used in demand prediction and stock control. It leverages analytical insights to enhance resource distribution and alleviate hazards linked to supply and demand variances. Accurately predicting customer demand and inventory levels using machine learning can provide companies a major edge over their competitors, effectively helping to minimize expenses, enhance income, and optimize the supply chain's use of assets [1]. Supply chain design, risk control, and advanced analytics all profit from the application of evolutionary algorithms and artificial neural networks, which provide ways to maximize decision-making in a variety of operational domains [2]. Additionally, making decisions dynamically in real-time operating situations is facilitated by reinforcement learning techniques, enhancing the flexibility and resilience of supply chain management practices [3].

2.2. Intelligent Logistics and Transportation Optimization

Logistics within a supply chain encompasses the movement of goods both within and outside a facility. Beyond demand forecasting and inventory management, AI technology has a profound impact on logistics management. Internal logistics involves receiving and shipping goods. Supply chain management must coordinate the flow of different products or commodities to ensure they reach their destinations at the right time. Companies can use AI technology to optimize internal receiving and shipping processes, improving efficiency. External logistics primarily involves distribution. Technologies like drone deliveries, driverless cars, and route optimization can enhance delivery timeliness, thus laying the foundation for other operational processes within the company. In theory, optimizing transportation, distribution, and inventory routing can be achieved by utilizing graph algorithms and network theory to maximize the supply chain network's dynamics and structure [2].

AI-driven warehouse automation systems, which use sophisticated algorithms, can optimize a number of warehouse activities in terms of management. Computer vision technology enhances the visual capabilities of robots, facilitating activities including quality control, picking and arranging, and item

recognition [3]. These developments greatly increase the precision, efficiency, and economy of warehouse operations. Autonomous mobile robots navigate the warehouse environment autonomously, maximizing pickup routes and making adjustments to the layout of the warehouse; AI-powered robotic arms achieve precise and adaptable material handling, improving efficiency in tasks such as packaging and palletizing; and automated guided vehicles ensure seamless material transport within the warehouse, enhancing overall operational flexibility.

2.3. Supplier Management and Risk Control

Due to factors such as geopolitical tensions, natural disasters, and technological disruptions, supply chains are increasingly vulnerable. Traditional risk management methods have proven inadequate to deal with these issues. Through the use of predictive analytics and autonomous systems, real-time risk detection and response are made possible. AI is revolutionizing supply chain risk management [4]. AI helps businesses proactively monitor and analyze digital data, allowing them to extract information related to the supply network, instantly identify potentially hazardous, unethical, or environmentally unsustainable actions, as well as supply chain participants and linkages. With the help of AI, businesses can now develop proactive supply chain risk management strategies. AI can mine various structured and unstructured data, categorize risk sources based on severity, predict the probability of risk occurrence, detect anomalies, and forecast the potential impact of risks [5]. AI and big data analytics contribute to building risk profiles, which guide decision-makers and risk managers in making faster and more effective decisions, reducing risks to the supply chain, and enhancing its resilience. They also help in selecting suppliers and determining the location of various elements within the supply chain to shorten delivery times [6].

3. Integration Trend of AI and New Technologies

With the rapid development of the times, breakthroughs have been made in the research of AI technology. Research in related fields is no longer simply focusing on AI itself, but is now focusing on new hybrid technologies that have emerged with the development of AI and are integrated with other technologies. For supply chains, these new technologies can help solve some complex supply chain problems.

3.1. Blockchain and AI

Combining blockchain and AI technologies has received widespread attention, especially in corporate settings that are marked by complexity, ambiguity, volatility, and uncertainty. The applications of the combined technologies in the supply chain sector have improved information flow, increasing the resilience of supply chain data and procedures, enabling quicker and more economical product delivery, and enhancing product traceability [7]. All participants in the supply chain can access their own data and acquire fresh perspectives by utilizing AI. Through blockchain, each participant can access data from other participants [8]. Customers may track product status and transaction history in just a few seconds using digital systems built on blockchain and AI. Supply chain management becomes more dependable when blockchain and AI are combined. This helps address issues like a lack of traceability, transparency of product sources, production process information, logistics information for consumer distribution, and information on raw materials needed for processing [9].

3.2. Artificial Intelligence Internet of Things (AIoT)

AI is combined with the Internet of Things (IoT) in order to enable intelligent tasks. AIoT facilitates the connection of IoT devices with AI-enabled sensors, all without human intervention. Innovative AIoT applications, such as data sensors, leverage AI analytics to provide information for tracking, real-time alerts, and other functions, thus improving decision-making [10]. AIoT breaks down static data flows and identifies previously unidentifiable patterns. Management, predictive, and monitoring applications help managers enhance the efficiency of their distribution operations and increase transparency in decision-making. Several frameworks have been developed for implementing this

hybrid intelligent technology to achieve sustainability. This technology contributes to sustainable and resilient supply chains [11]. Current research indicates that the two biggest issues facing AIoT-based supply chains are hacking and inadequate infrastructure [10].

4. Conclusion

This paper summarizes existing research on AI technology's effects on supply chains. Within domains including risk management, logistics management, and inventory management, AI-powered supply chain models can overcome the limitations of traditional models, offering new approaches to solving supply chain problems. Furthermore, this paper also investigates how supply chains are affected when AI and new technologies are integrated. Supply chain management procedures will be drastically changed by this new trend of combining AI with technologies like blockchain and IoT, which will enhance the supply chain's robustness and effectiveness.

As a rapidly developing emerging technology, while research on AI has surged in recent years, there are still many gaps and shortcomings in its application to the supply chain field. There are still a lot of untapped potential AI technologies and their supply chain applications. Furthermore, with technological advancements, new AI technologies and new supply chain challenges will inevitably emerge. The integration of AI with other technologies is another area that requires more research; currently, there is little research on this, yet technology integration is a trend for addressing complex supply chain problems and deserves further investigation. Additionally, investigation into the possible adverse effects is scarce. Using AI technologies inevitably raises issues such as data security, but only a few publications have briefly touched upon this problem.

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