

Applications and Challenges of Smart Technologies in Supply Chain Management

Xiaoyang Mao

Denison University, Granville, USA

The advent of intelligent technologies in supply chain management (SCM) through the use of artificial intelligence (AI), the Internet of Things (IoT), blockchain, big data analytics, and others is a game changer. These improvements increase clarity, effectiveness, and flexibility, allowing companies to quickly deal with market changes and interruptions. Nevertheless, adopting such technologies comes with difficulties, such as information security, compatibility, exorbitant prices, and employee opposition. The applications of intelligent technologies for SCM are examined in this article, as well as the importance of their implementation and solutions that provide a competitive advantage for businesses.

Keywords: supply chain management, innovative technologies, artificial intelligence, blockchain, Internet of Things, big data analytics, data security, interoperability

Introduction

The expansion of markets across national boundaries and the rapid technology revolution have brought about notable changes in supply chain management (SCM) practices. In this highly competitive business landscape, most modern supply chains are expected to be fast, transparent, and flexible (Iranmanesh et al., 2023). Advanced technologies like artificial intelligence (AI), blockchain, big data, and the Internet of Things (IoT) have become primary enablers in achieving this goal. While smart technologies proffer countless advantages, their application presents several challenges. More specifically, problems such as data security, the requirements of interoperability among various systems, expensive technology integration, and employee resistance to change are considerable obstacles. The paper will focus on the opportunities provided by intelligent technologies in SCM, investigate related challenges, and suggest how these challenges can be addressed in promoting efficient and effective supply chain management.

Applications of Smart Technologies in Supply Chain Management

Artificial Intelligence (AI)

AI allows companies to expedite their supply chain operations by automating processes, predicting future demand, and managing inventory more efficiently. This involves using AI-enhanced algorithms that examine past sales patterns and study market dynamics and other factors to project and model customer behavior and demand for goods and services (Toorajipour et al., 2021). This ability to predict customer demand is beneficial in helping to deal with the problems of overstocking and understocking goods.

Another area where AI is essential is the optimization of route planning and logistics (Hu, Wu, Cho, & Tseng, 2020). Studying traffic flow, weather, and fuel prices allows an AI system to determine the best route for making deliveries in a given timeframe. This minimizes the overall transportation costs and time taken to achieve the targets. Moreover, using AI robots or drones for storage and last-mile delivery is fast becoming the order of the day.

Internet of Things (IoT)

A collection of devices that are connected and communicate with each other in real time is called IoT. Tan and Sidhu (2022) posit that SCM also employs IoT devices in the form of sensors and RFID devices to enhance the tracking of goods movement across the supply chain and present the live status of those goods and their shipments. This allows companies to keep track of the transported items and meet the regulatory standards; for instance, if any food crop requires a specific temperature to be maintained, avoid potential problems like delays and damages. With the inclusion of the IoT, processes such as reordering can also be enhanced. For instance, sensor-embedded smart shelves detect if the stock is running out, and a replenishment order is raised without human intervention.

Blockchain

Supply chain process blockchain technology promotes transparency and confidence in all transactions by allowing for a distributed accounting of all transaction entries and a protected and rare descriptor to outlast any transaction. According to Dutta, Choi, Somani, and Butala (2020), each transaction is committed onto the blockchain, enabling all interested parties to check on its legitimacy and where the products came from. In this regard, it is vital, especially to the food and pharmaceutical industry, because traceability is essential in ensuring the safety and regulatory compliance. Again, by utilizing Smart Contracts, blockchain can help in the administration of contracts and payments even further by removing any human-dependent process (Prause, 2019). Such agreements are triggered once the required parameters are achieved, and self-fulfilling obligations like making payments eliminate the need for a third party for quicker payment processing.

Big Data Analytics

The use of big data analytics assists organizations in dealing with the enormous amount of data created at all levels of the supply chain and derive helpful knowledge (Seyedan & Mafakheri, 2020). Another example is that companies can analyze customer orders, market patterns, and supplier efficiency, among other elements, to make better decisions. Big data is significant in managing supply chains, especially in supplier selection. Analyzing supplier performance metrics (lead times, quality, cost, etc.) allows the organization to choose the most reliable and affordable suppliers (Sharma & Joshi, 2023). In addition, with the application of big data analytics, firms can forecast supply chain disruption events like supplier failures or in-transit delays and take necessary preemptive actions.

Challenges in Implementing Smart Technologies in Supply Chain Management

Data Security and Privacy

While technologies in supply chain management (SCM) systems have been embraced, worries have emerged regarding the safety and privacy of data (Kumar, Liu, & Shan, 2020). Since the introduction of IoT devices and blockchain technology, which have always led to the exchange of information, the chances of cyber-

attacks have escalated. Thus, businesses should implement robust cybersecurity frameworks since there is always a threat from data breaches or attacks by unauthorized persons. Moreover, firms that do business across borders face complexities because of the necessity to comply with laws governing information protection.

Interoperability

The supply chain is usually characterized by the engagement of many parties using different systems or technologies. The databases of such systems—not only the management systems—and how their interoperability or even their communication can be realized are a whole problem (Nižetić, Šolić, Gonzalez-De, & Patrono, 2020). The inability of Internet of Things components to work together produces “islands” of information, creating barriers to effective logistics management. Organizations must adopt similar technologies that ensure the movement of information across different platforms without challenges.

High Implementation Costs

The introduction of intelligent technologies in supply chains entails a substantial cost in capital assets, applications, and human resources. Small and medium-sized enterprises (SMEs) may find the expenses incurred in improving legacy systems, buying IoT devices, or creating AI algorithms too much. In addition, the running costs of these upgrades, especially for businesses with thin margins, can also prove to be burdensome on resources as they may be required to keep both the technology and the capital expenditure up to date for operational efficiency (Nižetić et al., 2020).

Workforce Resistance and Skill Gaps

It is very likely that employees, especially those who revert to traditional supply chain management, will resist the use of smart technologies. Reluctance could stem from fears of losing their jobs to machines or even from an inability to keep up with other developing technologies (Nižetić et al., 2020). A lack of relevant technology management or operation may also be experienced, among other issues. A solution to this is to retrain the workforce, which calls for training and development programs in organizations.

Conclusion

Intelligent technologies have numerous benefits concerning their impact on the efficiency, visibility, and sustainability of supply chain management. Using technologies such as AI, IoT, blockchain, and big data analytics enables organizations to provide automated systems and enhanced real-time control in a business process. Nevertheless, these technologies can only be adopted by overcoming the challenges related to data security, technology redundancy, capital investment, and people dynamics. By overcoming these challenges through strategic thinking, suppressed investment in appropriate technology, and training the employees at strategic positions on how to utilize these new intelligent technologies, the latest technologies will be put to full effective use and also give an upper hand in business competition in the markets that are complex and changing very fast.

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