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Enhancing Supply Chain Management Through Artificial Intelligence: A Case Study of JD Logistics

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Abstract: With the intensification of global economic competition, enterprises face the challenge of improving the supply chain management efficiency, and AI technology, as an emerging field in computer science, can provide effective solutions. As a leading e-commerce logistics service provider in China, JD Logistics has accumulated a wealth of logistics technology capabilities and digital transformation experience within and outside the JD Group. Using JD Logistics as a case study, this paper discusses the application of AI technology in supply chain management and its impact on enterprise responsiveness and operational efficiency. AI technology has significantly improved the supply chain operational efficiency and responsiveness of JD Logistics by applying intelligent supply chain planning, predictive analysis and intelligent decision-making. The study systematically summarizes the key role of AI technology in optimizing supply chain management through a literature review and specific case studies, providing an important reference and practical experience for enterprises to achieve digital transformation.

Keywords: Artificial Intelligence, Supply Chain Management, Intelligent Decision-making, JD Logistics

1. Introduction

With the rapid development of the global economy and intensified market competition, enterprise supply chain management faces more challenges and opportunities [1, 2]. The traditional supply chain management mode needs to catch up in today's increasingly demanding information technology and digitalization, and how to use advanced technology to improve the efficiency and flexibility of the supply chain has become a core issue that enterprises need to address [3]. As China's leading e-commerce logistics service provider, JD Logistics has accumulated a wealth of logistics technology capabilities and digital transformation experience within the JD Group and in independent operations. The company is committed to promoting supply chain management to a higher level of systematic, algorithmic and data-based development through digital technology to improve operational efficiency, reduce costs, and enhance the transparency and controllability of the entire supply chain [4].

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This study explores how JD Logistics uses AI technologies to achieve digital intelligence in supply chain management and to analyze the specific impact of these technology applications on supply chain efficiency and responsiveness. Specific questions include: what are the core application areas of AI technology in supply chain management? What are the strategies and implementation strategies of JD Logistics in applying AI technology, and how does the AI-driven intelligent supply chain management system enhance the responsiveness and adaptability of enterprises to market changes?

This study will adopt the method of case analysis. Firstly, through the literature review, systematically summarise the research results and application cases on AI in supply chain management at home and abroad and explore its theoretical basis and methodological innovation in enhancing supply chain efficiency and management capability. Second, the actual operation of JD Logistics in intelligent supply chain planning, predictive analysis and intelligent decision-making are analyzed through specific cases to assess its application effect and effectiveness in different scenarios.

2. Case Description

JD Logistics appeared in 2007, at first served within the JD Group, and in 2017, it became independent. Through more than a decade of logistics technology capabilities, it serves a broad customer base and merchants, followed by the establishment of JD Logistics. With this JD Group background, JD Logistics considers building digital capabilities the ultimate goal. The company is committed to using digital technology to promote supply chain management to a higher level of systematization, algorithms, and data to improve efficiency, reduce costs, and enhance the transparency and controllability of the entire supply chain.

JD Logistics' application of AI technology reflects its core competitiveness. JD Logistics utilizes AI technology for intelligent supply chain planning, including composition of trade, inventory management and demand forecasting. Through the Algorithm and the Yibu Engineering Platform, JD Logistics can rapidly deploy and apply forecasting models to improve the supply chain's forecasting accuracy and overall efficiency. The operation of an intelligent warehousing and supply chain network optimizes the planning route, warehouse location and composition of trade, which improves the efficiency and response speed of the logistics network.

The Jinghui Supply Chain System is another important achievement of the combination of JD Logistics and AI. The system provides comprehensive supply chain consulting services, including supply chain planning and solution design, to help enterprises realize the digitization and intelligence of supply chain management. Through the Jinghui system, enterprises can realize end-to-end data interconnection and interoperability, complete the whole supply chain lean management, and thus take advantage of the fierce market competition.

3. Application of AI in Supply Chain Management

3.1. Core AI Technologies for Supply Chain Optimization

As AI technology matures, it plays a crucial role in various fields of supply chain management, exhibiting three key characteristics: data-driven processes, automation, and real-time capabilities [5, 6]. The common AI technologies applied in this field include, but are not limited to, the following aspects:

Predictive Analytics: Utilizing machine learning algorithms, AI can analyze historical data and market trends to forecast future demand, which optimizes inventory management and logistics planning based on customer needs, reducing inventory pressure and, at the same time, providing predictive results to frontline sales staff for scenario-based configuration during project POC (Proof of Concept), meeting their requirements of accuracy.

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Intelligent Warehousing: Automated equipment and smart robots manage warehouses, including order picking, automatic storage and cargo retrieval, and intelligent inventory management, enhancing warehouse configuration efficiency and accuracy. For example, the application of AGV (Automated Guided Vehicle) automation in liquor companies or RFID (Radio Frequency Identification) technology in the fast-moving consumer goods industry.

Intelligent Scheduling Algorithms: Based on real-time data and traffic conditions, AI can drive top-level logistics planning, abstract logistics network planning, and optimize production line scheduling and transportation routes, thus reducing costs and improving logistics efficiency.

Supply Chain Visualization: Using data analysis and visualization technologies, AI presents various processes clearly, helping enterprises monitor the supply chain in real-time, promptly identifying and addressing issues.

Intelligent Decision-Making: AI technology also supports decision-making in supply chain management. Through intelligent decision support systems, AI can provide optimization projects for supply chains, inventory management strategies, or supplier selection advice based on big data analysis and predictive models. Such systems assist enterprise managers in making scientifically sound decisions, mitigating risks, and enhancing efficiency.

3.2. JD Logistics' AI Strategy

In recent years, JD Logistics has leveraged strong technical support and comprehensive design to apply AI technology to improve supply chain management actively. JD Logistics' strategic analysis adopted various AI technologies, including the following aspects.

YiBu Platform: This platform is used for forecasts, utilizing comprehensive AI prediction algorithm components and simultaneously reducing the difficulty of providing forecast services to multiple personalized merchants. Overall R&D(research and design) efficiency has increased by 57%, and the average forecast accuracy for small and medium-sized merchants has improved by about 10%.

JingHui System: Constructed through a four-layer structure, JingHui System included a supply chain data platform, an intelligent decision engine, various product applications, and an enterprise-level user experience. It mainly applies a data-driven intelligent decision support system. The JingHui supply chain system uses AI for optimal solution derivation, scheduling algorithms, and predictive models, ultimately employing simulation analysis for intelligent decision-making. Additionally, JD has established supply chain visualization through data analysis and visualization technologies, enabling real-time monitoring and management of the entire supply chain, promptly identifying and addressing potential issues.

Dual Tower System: This system includes an intelligent planning tower and an intelligent scheduling tower, utilizing AI and real-time data to explore more efficient transportation networks, including nationwide transportation network routing, in-warehouse production planning, product layout and production scheduling optimization, and order optimization. It aims to achieve fast, efficient delivery services.

Logistics Visualization: In the distribution phase, leveraging an integrated supply chain capability, JD Logistics achieves system binding of orders, electronic locks, drivers, and vehicles, making the transportation process visible. Furthermore, GPS positioning and real-time tracking allow immediate alerts in driver violations or fatigue cases, ensuring visualized supervision during delivery.

4. JD Logistics' AI-Driven Supply Chain Solutions

JD Logistics' integrated AI supply chain service includes an algorithm platform, two engineering services, and three system applications. Addressing the pain points of supply chain management helps

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enterprise clients from different industries with supply chain management and optimization adjustments through various modules.

4.1. Predictive Function

To tackle long data extraction cycles, poor data accuracy, and the need for more data analysis tools in enterprises, JD provides the JingHui supply chain system to assist clients with intelligent forecasting applications.

The JingHui supply chain system offers various services, from demand forecasting to supply planning, product layout, and intelligent operations for enterprises. Its foundational layer includes real-time data collection and integration platforms, prediction model calculations, and simulation analysis for intelligent engines. The product service layer includes supply chain planning design, supply chain plan management, and logistics control tower applications. AI technology significantly enhances forecasting capabilities within the intelligent engine.

Key AI technologies in the JingHui supply chain system include machine learning, deep learning, statistical, and economic models. AI in forecasting identifies supply chain status segments: combining simulation and supervised machine learning (SML) to estimate the likelihood of supplier disruptions and clustering retail goods for higher demand forecast accuracy by integrating supply chain management systems with predictive systems [7, 8].

In Changzhou Zhonglou District, the JingHui supply chain system addressed significant order fluctuations leading to idle production capacity. By collecting production line status through a cloud platform and utilizing AI algorithms, trend predictions from the product development phase informed product development, while digital business systems ensured the status of supply chain segments, improving production line utilization. For instance, with Changzhou Greebo Company, JD's intelligent supply chain services rapidly developed a new integrated mop and vacuum cleaner, retrofitting existing production lines, and received over 50,000 orders within a few months, with projected sales of 120 million RMB.

4.2. Intelligent Decision-Making Function

To optimize logistics routes and warehouse clustering, JD's Intelligent Planning Tower can help achieve these objectives. AI uses various models to optimize warehousing and transportation, such as bio-inspired algorithms (like the foraging behavior of slime molds) to address how to maximize supply chain profits under oligopolistic competition [9]. For customers focusing on service satisfaction, reinforcement learning can be applied to agent-based supply chain modeling, optimizing inventory from the service satisfaction perspective [10]. These examples illustrate the adaptability of AI modeling, where different models can be established and utilized depending on the goals and conditions.

JD's Intelligent Planning Tower encompasses designing warehouse clusters, sorting layouts, route planning, hub planning, and mid-end layout. By combining a robust library of modeling algorithms, it continuously optimizes warehouse distribution to minimize costs, providing enterprises with the most suitable warehouse network planning solutions.

A liquor sales company previously operated under a model that used only a warehouse to serve the entire country. This led to severe order fragmentation, frequent less-than-truckload shipping, and long-distance express deliveries, resulting in high logistics costs and sluggish business growth. As business volume grew, the company recognized the importance of decentralized warehouse layouts and hoped to reduce logistics costs and enhance supply chain efficiency through a change in warehousing mode. Considering the company's situation, JD's Intelligent Planning Tower employed real-scenario simulations and AI modeling analysis to propose multiple alternative solutions.

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Ultimately, the company achieved over 6.71% reduction in total logistics costs while ensuring order fulfillment, enhanced delivery efficiency by over 28.59%, optimized transportation distance by 51.5%, and improved customer experience ratings. During peak promotional periods, sales increased more than twofold year-over-year.

Mr. Yuan Xiaolin, CEO of Volvo Cars Asia Pacific, and Mr. Yu Rui, CEO of JD Logistics, signed a strategic cooperation agreement on behalf of the company in the form of "signing on the cloud". According to the agreement, the two companies will cooperate in various fields such as warehouse network planning, forecasting and replenishment, and the national after-sales supply chain terminal distribution. The problem of Volvo's supply chain is the inefficiency of parts logistics before automobile production, the logistics of vehicle transportation after the completion of automobile production, and the efficiency of subsequent maintenance of vehicles. JD Logistics provides services to integrate the supply chain logistics resources further, optimize the supply chain network layout, and make the inventory closer to the front-line dealers. The warehouse can be based on the dealer's needs to the maximum extent of the warehouse layout and real-time adjustment. Furthermore, an efficient and collaborative supply chain network has been constructed by combining big data forecasting, omnichannel warehousing, logistics services, real-time logistics tracking, and intelligent warehousing. One of the achievements of the cooperation is that Volvo Cars' warehousing capacity has been significantly expanded from the original four warehouses to eight, which not only greatly optimizes the layout of the warehouse network according to dealer demand but also realizes dynamic adjustments and the vast majority of users can achieve Volvo Cars next-day delivery service through JD Logistics, which has significantly increased the efficiency of after-sales supply chain fulfillment and dealer satisfaction.

4.3. Intelligent Scheduling Function

Intelligent planning towers, which encompass shift optimization, tandem optimization, packet building optimization, distribution optimization, and collection and dispatch optimization, are responsible for reducing the cost of specific logistics processes to improve customer satisfaction. In building an optimized network, a series of systems can typically be created using artificial intelligence capabilities. The three main components are wireless sensor networks, cloud database services, and fuzzy logic methods. This approach allows violations to be monitored in the whole part of the supply chain. In this way, emergencies will be handled in a more timely manner. Typical examples are helping various enterprises, including JD, establish distribution networks, cold chain networks, and cross-border networks.

This study comprehensively reviewed and systematically organized 24 high-quality literature with research on the supply chain resilience field and AI application between 2012 and 2024. With the development of the supply chain, which is facing more challenges, AI is enough to help solve the problem effectively. However, the systematic reading reveals that the existing literature on the application of AI in supply chain resilience is highly dispersed and mainly focuses on strategically available computer technologies.

5. Conclusion

This study centers on the digital intelligent supply chain functions of JD Logistics: prediction function, intelligent decision-making function, and intelligent scheduling function. By studying the three aspects of the prediction function, intelligent decision-making function, and intelligent scheduling function in JD Logistics, it is found that artificial intelligence technology can effectively improve the predictability of the supply chain and achieve the role of holistic optimization of the supply chain.

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The outcome of this paper reveals that enterprises need to actively integrate AI technology into their development planning and realize the upside of their supply chains.

Nonetheless, this study also has certain limitations. Firstly, the functions of AI applications are difficult for other enterprises to copy to a certain extent due to the complete hardware foundation and cloud system foundation of JD Logistics. Next, the case data comes from the official website of JD Cloud—the lack of complete data comparison limits further analysis of the effect of AI applications. Therefore, future research should focus on newer literature and incorporate empirical studies to validate the comparative effects of the effectiveness of AI techniques applied or not. In addition, researchers should explore other potential application areas of AI in supply chain resilience and how these technologies can be integrated for wider application.

In conclusion, AI shows great potential in improving supply chain resilience and reliability. Continuous research and technological innovation are needed to build smarter, more efficient, resilient supply chain systems.

Authors Contribution

All the authors contributed equally, and their names were listed alphabetically.

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