

10.70711/aitr.v2i4.4866

Optimizing Supply Chain Network Design: Research on Intelligent Decision Support System Based on Big Data and Artificial Intelligence

Meijing Song

School of Finance and Economics, Hainan Vocational University of Science and Technology, Haikou, Hainan 571199

Abstract: Supply chain network design is the core issue of enterprise supply chain management, which directly affects the operational efficiency and competitiveness of enterprises. It is difficult for traditional supply chain network optimization methods to fully tap and utilize the value of massive supply chain data, and the advantages of artificial intelligence technology in assisting complex decision-making have not been fully utilized. Based on the analysis of key elements and objectives of supply chain network design, this paper discusses the application of big data analysis method in supply chain network optimization, and designs and applies a set of intelligent decision support system of supply chain network based on artificial intelligence technology. The research shows that the intelligent system that integrates big data analysis and artificial intelligence optimization can significantly improve the quality and efficiency of supply chain network optimization, and provide new ideas and new momentum for enterprise supply chain reform.

Keywords: Supply chain network design; Big data analysis; Artificial intelligence; Intelligent decision support system

Introduction

At present, the globalization of division of labor and cooperation is deepening, enterprises are facing a more complex and changeable market environment, and optimizing the design of supply chain network is increasingly important to enhance the competitiveness of enterprises and cope with external uncertainties. However, the traditional supply chain network optimization mostly adopts single objective linear programming and other methods, which is often difficult to deal with dynamic and complex practical problems. The arrival of the era of big data brings new opportunities for supply chain optimization, and massive multi-source heterogeneous data contains rich supply chain operation rules and optimization potential. At the same time, artificial intelligence technology represented by machine learning and knowledge graph has shown great advantages in assisting decision making. Therefore, it is of great significance to explore the application of big data analysis and artificial intelligence in supply chain network design to promote the transformation of supply chain management model and improve the efficiency of supply chain operation.

1. Key elements and optimization objectives of supply chain network design

Supply chain network design is a systematic engineering involving strategy, tactics and operation at three levels, aiming to determine the physical facility layout and operation mode of supply chain, including supplier selection, production base location, transportation and distribution route optimization, storage strategy formulation and many other decisions. The rationality of supply chain network is directly related to logistics cost, demand response speed, resource allocation efficiency and other key performance indicators. Therefore, the design of supply chain network needs to consider the multiple objectives such as cost, service, risk and environment, and maximize the benefits from a global perspective.

In general, the core optimization objectives of supply chain network design can be summarized as follows: (1) minimize total costs, including fixed costs and variable costs, such as facility location investment, storage management costs, transportation and distribution expenses; (2) Maximize the level of customer service, including shortening the delivery cycle, improving the order fulfillment rate, and flexibly responding to changes in demand; (3) Control supply chain risks, including supply disruptions, demand fluctuations, quality incidents and other potential threats; (4) Improve the sustainability of the supply chain, such as reducing carbon emissions and improving the efficiency of resource and energy utilization. It can be seen that supply chain network optimization is rich in connotation and extensive in extension, and it

needs to seek equilibrium in multi-objective game.

2. Big data analysis method for supply chain network optimization

2.1 Sources and characteristics of supply chain big data

With the improvement of information and intelligence level, a large amount of data is generated in the process of enterprise supply chain operation, covering the business information of suppliers, manufacturers, distributors, retailers, consumers and other links. On the one hand, the internal ERP, CRM, WMS and other information systems record the structured data of sales, inventory, production, logistics and other aspects; On the other hand, external data sources such as consumer reviews, public opinion information, and social networks also contain a large amount of unstructured data related to the supply chain. In general, supply chain big data presents typical characteristics such as high data dimension, complex data types, and difficult processing. For supply chain management, big data means more comprehensive insights, more accurate predictions, and more intelligent decisions.

2.2 Supply chain big data processing and analysis technology

Massive supply chain data brings great challenges to traditional data processing architecture and analysis methods. The development of big data technology provides new ideas and tools to deal with this challenge. In terms of data processing, distributed computing frameworks such as Hadoop and Spark can realize efficient storage and calculation of petabyte data. NoSQL databases offer flexibility in handling unstructured and semi-structured data. In terms of data analysis, data mining, machine learning, natural language processing and other technologies can quickly extract key features from the data and reveal the internal connections of the data. In general, the core of supply chain big data analysis is to reveal the operating status of the supply chain system through descriptive analysis, insight into the future development trend of the supply chain through predictive analysis, and guide the formulation of supply chain optimization decisions through normative analysis.

3. Design and application of intelligent decision support system for supply chain network

Although big data analysis can provide data support for supply chain optimization, in complex scenarios such as multi-objective and dynamic decision-making, it is difficult to make the optimal decision scheme based on experience and intuition alone. The development of artificial intelligence technology brings an opportunity to solve this problem. By integrating artificial intelligence technologies such as data analysis, knowledge reasoning and optimal solution, intelligent decision support system can simulate the analysis ideas and decision-making process of experts, quickly generate feasible and optimal decision schemes, and become a new engine for supply chain management reform.

3.1 System architecture design

Intelligent supply chain network optimization decision support system usually adopts "data layer, model layer and application layer" three-layer architecture. The data layer is responsible for the collection, storage, pre-processing and management of all kinds of data to provide data support for system operation; In the model layer, optimization, heuristic search, machine learning and other algorithm models are integrated to realize the modeling, simulation and optimization solution of supply chain network. The application layer integrates visualization, human-computer interaction and other technologies to provide decision-makers with friendly human-machine interface and auxiliary decision-making functions. In addition, the system is also equipped with knowledge base, inference machine, process engine and other components, which can embed the knowledge and experience of domain experts to realize value-added services such as intelligent analysis and diagnosis and policy recommendation.

3.2 Intelligent optimization model and algorithm integration

Supply chain network decision-making often involves multi-objective planning, dynamic optimization, uncertainty analysis and other complex scenarios. Intelligent decision support system needs to integrate various optimization models and algorithms to enhance the modeling and solving ability of the system. In terms of optimization model, the system takes multi-objective programming as the basic framework, introduces robust optimization, stochastic programming and other methods to deal with uncertain parameters such as demand and cost, and adopts dynamic optimization strategies to deal with unexpected situations such as demand fluctuations and supply interruptions. In terms of optimization algorithm, the system adopts the strategy of combining heuristic algorithm and precise algorithm, and uses intelligent algorithms such as genetic algorithm and ant colony algorithm to search the solution space quickly, and combines the traditional optimization methods such as integer programming and constraint programming for refinement. In addition, the system also uses reinforcement learning, transfer learning and other machine learning algorithms to learn optimization experience through case training, and constantly improve the optimization performance of the system.

3.3 Case study: Application of intelligent supply chain network optimization system

The intelligent decision support system has been applied to supply chain network optimization in a large household appliance manu-

facturing enterprise, and good results have been achieved. The company has hundreds of suppliers and thousands of stores, tens of thousands of product SKUs, and a complex supply chain network. The traditional manual decision-making model is difficult to cope with such a large scale of optimization. After the intelligent decision support system is introduced, the enterprise integrates sales, inventory, logistics, procurement and other data into the system, uses big data analysis technology to describe the characteristics of market demand, and uses the multi-objective integer programming model built into the system to jointly optimize the solution of supplier selection, regional warehouse layout, storage strategy, etc. Through human-computer interaction, the system generates an optimal configuration scheme that takes into account cost, service and risk.

Practice shows that after the implementation of the program, the total number of distribution centers is reduced by 20%, the average daily inventory is reduced by 15%, the logistics cost is reduced by more than 8 million yuan, and the on-time delivery rate of orders is increased to more than 98%. It is worth mentioning that in the face of supply and demand fluctuations caused by the novel coronavirus epidemic, the system relies on real-time perception data to dynamically optimize and adjust the supply chain strategy, and control the risk of stock shortage at a low level. It can be seen that the intelligent decision support system effectively improves the flexibility and toughness of the supply chain, and wins the market opportunity for enterprises

4. Conclusion

This paper discusses the application of big data analysis and artificial intelligence technology in supply chain network optimization, and designs and implements a set of intelligent supply chain network decision support system. Research shows that big data analysis can provide a more comprehensive and accurate data perspective for supply chain optimization, and artificial intelligence can realize intelligent supply chain decision-making on this basis. The application practice of intelligent decision support system has proved the value of digital and intelligent transformation of supply chain. In the future, with the improvement of big data infrastructure construction and the further development of artificial intelligence algorithm models, supply chain network optimization will move from experience-driven to data-driven and from passive response to intelligent decision-making, which will play a greater role in improving supply chain competitiveness and coping with external uncertainties.

References

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About the author: Meijing Song, February 1987, female, Han nationality, Zibo City, Shandong Province, master, vice president, Logistics Management major, research direction: Logistics and Supply Chain