W Company's Supply Chain Network Restructuring and Inventory Control Optimization Research

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Abstract: The paper analyzes and optimizes the supply chain network and inventory management of W Company, improves the operational efficiency and reduces costs, and provides reference for the supply chain network reconstruction and inventory control optimization under the complex economic environment. In the process of constructing the supply chain network optimization model of W Company, this paper integrated 2,316 shipping records and 100,645 customer order data to ensure that the fulfillment of each order can be accurately tracked. By matching the quantity of products and services in the shipping record with the demand in the customer order, the consistency of the total inflow and outflow of RDC was verified, thus ensuring the balance of supply chain flow. Further, this paper analyzed 5,091 types of transport matrix data to evaluate the transportation route, cost and time from the regional distribution center (RDC) to the customer. Analysis of these data is essential to optimize the logistics path and reduce transportation costs.

Keywords: Supply Chain Network; Inventory Optimization; Cost Control; Baseline Model; Logistics Efficiency

1. Introduction

W Company is a large-scale leisure food production enterprise in China, focusing on the production and sales of various kinds of leisure food. After years of operation, it has now risen to the top tier of the domestic leisure food industry. Among its dozens of products, the most popular are chocolate products, including dark chocolate, milk chocolate, and white chocolate. Additionally, chewing gum, mint candy, and milk candy are also among W Company's main products.

1.1 Analysis of Customer Orders of W Company

W Company has 6 production factories, 2 central warehouses and 8 regional distribution centers in China, offering 6 product varieties to 389 customers nationwide.

When analyzing the customer order data of W Company, it is found that the market performance of Class A products is particularly outstanding. According to statistics, there are 86907 ordering records of Class A products, accounting for 79.86% of the total ordering records of the Company; in terms of ordering quantity, the total ordering quantity of Class A products reaches 1,268,149, accounting for 81.25% of the total ordering quantity. By further observing the distribution of order quantity of Class A products, it is found that the maximum order quantity is 108 pieces, while the minimum order quantity is only 1 piece, which reflects that there is a significant difference in the demand of customers for Class A products. In particular, there are 5,022 order records showing a minimum order quantity of 1 piece, showing a large number of small orders from individual consumers or small businesses. From the statistical point of view, the average ordering value of Class A products is 14.59 pieces, and the standard deviation is 15.69 pieces, which indicates the central trend of ordering quantity and the relatively small range of demand fluctuation. This stability in demand has a positive impact on inventory management and production planning because it reduces the likelihood of forecasting errors, allowing W Company to implement more precise inventory control and production scheduling. In the context of supply chain management, this stability helps to lower inventory costs, improve operational efficiency, and ultimately enhance the company's market competitiveness.

The total number of order records for Class B and C products is 21,921, accounting for 20.14% of the total order records, while the total order quantity is 292,568, accounting for

18.75% of the total order quantity. In terms of order size, the maximum order quantity for B and C products is 12,012 pieces, while the minimum order quantity is 1 piece, indicating a wide distribution of order sizes. In particular, an order quantity of 1 with 18,522 orders indicates that small orders are more common among these products, and small-scale high-frequency orders place special requirements on the company's inventory management and logistics management. From a statistical point of view, the average order quantity for Class B and Class C was 13.35 pieces with a standard deviation of 200.96 pieces. This large standard deviation indicates significant fluctuations between ordered quantities.

1.2 Analysis of Supply Chain Operation Status of W Company

At present, W Company has 6 factories in China, among which the factories in Tianjin, Anhui, Zhejiang and Jiangsu produce chocolate, and the factories in Guangdong and Shanghai produce candy. Each factory can purchase raw materials from the company's 8 long-term suppliers. Chocolate products are delivered to Jiaxing Central Warehouse for storage, and candy products are transported to Guangzhou Central Warehouse for storage after leaving factory, and then transported to 8 regional distribution centers, which serve 389 customers nationwide, which are divided into distributors (DT) and large-scale supermarket (KA) [1-3]. The chocolate products are greatly affected by the temperature, and the normal temperature and constant temperature transportation modes are adopted according to different warehouse and customer positions, and the normal temperature transportation mode is adopted completely for the candy products.

2. Construction of Baseline Model

2.1 Baseline Model

In the baseline model, the total cost consists of transportation cost (TC), fixed operation cost (DCC), inventory holding cost (IC) and Manufacturing cost (MC) [4].

(1) Transportation Cost TC:

The transportation cost between stations is expressed as unit transportation cost (yuan/KM)×transportation distance (KM)×transportation quantity weight (KG) ÷ single batch transportation quantity (KG), and the transportation cost from stations to customers is expressed as fixed express parcel expense (yuan/piece) between regions transportation quantity [5]. The total transportation cost is expressed as:

$$TC = \sum_{j\in J}\sum_{n\in N}\frac{transP_{M,j}\cdot dist_{M,j}\cdot U_{M,j,n}\cdot Weight_n}{\bar{B}} + \sum_{j\in J}\sum_{k\in K}\sum_{n\in N} transW_{j,k}\cdot U_{j,k,n} \quad (1)$$

(2) Fixed Operating Cost DCC:

The total fixed operating costs are expressed as the sum of all RDCs and the fixed operating costs of the Shenzhen factory, expressed in terms of mathematical variables:

$$DCC = \sum_{j\in J} Fix_j + Fix_M \quad (2)$$

(3) Inventory holding cost IC: In network optimization, it is reflected as in transit inventory cost. The cost of in transit inventory from factory to RDC and RDC to customer is expressed as time in transit (in years) (distance ÷ speed of transport) ×inventory holding cost rate value per unit of product, expressed as:

$$IC = \sum_{j\in J}\sum_{n\in N} U_{M,j,n}\cdot\frac{dist_{M,j}}{f\cdot 24\cdot 360}\cdot\bar{h}\cdot p_n + \sum_{j\in J}\sum_{k\in K}\sum_{n\in N} U_{j,k,n}\cdot\frac{dist_{j,k}}{f\cdot 24\cdot 360}\cdot\bar{h}\cdot p_n \quad (3)$$

(4) Manufacturing cost MC: the Manufacturing cost per unit product is expressed as the unit product price×65% (if the Manufacturing cost accounts for 65% of the price).

2.2 Data Processing

In the process of constructing the supply chain network optimization model of W Company, this paper integrated 2,316 shipping records and 100,645 customer order data to ensure that the fulfillment of each order can be accurately tracked. By matching the quantity of products and services in the shipping record with the demand in the customer order, the consistency of the total inflow and outflow of RDC was verified, thus ensuring the balance of supply chain flow [6]. Further, this paper analyzed 5,091 types of transport matrix data to evaluate the transportation route, cost and time from the regional distribution center (RDC) to the customer. Analysis of these data is essential to optimize the logistics path and reduce transportation costs.

Based on the analysis of product flow and customer demand, this paper established reasonable inventory levels for each RDC. This step took into account factors such as safety stock, maximum inventory capacity, and replenishment cycles to ensure the efficient operation of the supply chain [7-9]. Additionally, based on assumed procurement and manufacturing cost rates (65% of unit price), this paper calculated the manufacturing costs for each product, providing a foundation for subsequent cost-benefit analysis.

2.3 Baseline Model Operation and Result Analysis

By running the baseline model, the supply chain network diagram is finished. By running the baseline model, the value contribution chart is finished.

After the optimization, the company's total profit increased by 2.16%, mainly due to the 1.14% reduction in total cost. Specifically, the optimization effect of transportation cost was the most significant, with a decrease of 14.41%, while the inventory holding cost increased slightly, increasing by 2.85%. Fixed operating costs remain unchanged as all stations remain operating.

In the current baseline model, all customer orders have been satisfied, so total revenue has not changed. In this case, profit growth is achieved entirely through cost reduction. In the optimization process, the transportation flow restriction between stations and between stations and customers is eliminated, so that the model can automatically select the transportation scheme with the lowest cost. Although this approach resulted in an increase in in-transit inventory, resulting in a slight increase in inventory holding costs, overall, this strategy still resulted in cost savings for the company and thus improved profits.

In the future optimization design, we will continue to remove the traffic flow restriction to re-optimize the product flow and pursue a more efficient and beneficial supply chain structure. The running results show that the product flow optimization model based on the current situation can effectively reduce the transportation cost of the supply chain network and improve the profit of the enterprise. However, this model is constructed based on the optimization of product flow according to current customer demand and does not account for the dynamic changes in market demand. Therefore, to some extent, this approach can be considered an idealized model that precisely meets current customer needs within the existing network structure.

Notably, the optimized product flow results reveal that the traffic at the RDC Changsha station is disproportionately high, leading to an imbalance in the entire supply chain network. This situation could result in the RDC Changsha station experiencing overload due to excessive use, while other sites may be underutilized due to lower traffic, potentially affecting the efficiency and stability of the entire supply chain network. Therefore, future optimization plans need to further consider how to balance the transportation among the various stations to ensure efficient and stable operations throughout the supply chain.

3. Design of Supply Chain Network

3.1 Scheme I

Assumptions for supply chain network design are as follows: (1) do not change the layout of supply chain facilities; (2) optimize product flow.

In the current dynamic market pattern, the optimization of supply chain management has become the key factor for the sustainable success of enterprises. As a leading leisure food manufacturer in China, W Company is facing the dual challenges of improving supply chain efficiency and improving customer service level. To effectively address these challenges, this study proposes an innovative product flow optimization scheme that does not rely on changes in the layout of supply chain facilities but rather enhances cost savings and service levels through meticulous management of product flows. The aim of this paper is to provide a detailed exposition of the design framework, implementation strategies, expected outcomes, and potential risks of this scheme, along with an in-depth analysis and evaluation of its comprehensive impact.

Firstly, this study identifies the key bottlenecks and inefficiencies in the supply chain by comprehensively mapping and analyzing the existing product flows of W Company. This step revealed issues such as over processing, long waiting times, and unreasonable inventory levels, providing data support for subsequent process improvements. Secondly, advanced forecasting algorithm is used to accurately forecast product demand, and the inventory management strategy is optimized by combining multi-dimensional information such as historical sales data, market trend, seasonal factors and promotion activities, so as to realize dynamic adjustment of inventory level, reduce inventory cost and improve inventory turnover efficiency.

Furthermore, this study uses logistics optimization software to re-plan the logistics route and transportation mode, and evaluate the efficiency and cost of different transportation modes to find the transportation scheme with the lowest cost and the highest efficiency. Furthermore, close cooperation between logistics service providers and suppliers, facilitated by the sharing of demand forecasts and inventory data, and has enhanced the responsiveness and flexibility of the supply chain, thereby reducing costs and risks associated with information asymmetry.

The deployment of information technology provides strong support for supply chain management. In this study, the advanced supply chain management information system realizes the real-time monitoring and data analysis of each link of the supply chain, so that W company can quickly adapt to the market change and adjust the production and distribution plan in time. At the same time, the application of big data analysis and artificial intelligence technology further improves the optimization of product flow and inventory level.

To ensure the stable operation of the supply chain, this study also establishes a continuous improvement mechanism and conducts risk assessment and management activities. Through these measures, significant reductions in transportation and inventory costs, shortened delivery times, increased customer satisfaction, and achievement of the service goal of "75% precise delivery" are realized. Partner collaboration and information technology support contribute to better supply chain risk management and resilience. The optimized product flow reduces resource waste, enhances transportation efficiency, and promotes the environmental sustainability of the supply chain.

In general, the product flow optimization scheme proposed in this study provides an effective way for W Company to improve the efficiency and service level based on the existing supply chain. This scheme not only achieves cost savings without altering facility layouts but also enhances the flexibility and resilience of the supply chain. Future research will further explore how to integrate these optimization strategies with the company's long-term strategies and market dynamics to achieve continuous improvement and innovation. Through this comprehensive approach, W Company will maintain its competitive edge in the fiercely competitive market and achieve sustainable business growth.

3.2 Scheme II

The premise assumptions for the supply chain network design are as follows: (1) the layout of the supply chain facilities is not changed, and (2) cross-level procurement is allowed to optimize the product flow.

To ensure W Company’s success in implementing a cross-level sourcing strategy and maximize its benefits, the Company needs to follow a series of detailed steps to ensure smooth implementation and continuous optimization of the strategy.

Demand analysis and forecasting is the cornerstone of the entire process. W Company initially needs to collect multidimensional information including historical sales data, inventory levels, market trends, and consumer behavior. By conducting in-depth analysis of these data, the company can more accurately predict future market demand, thereby devising more precise demand forecasting models. This model not only aids in guiding procurement decisions but also provides a scientific basis for inventory management.

In terms of cross-level procurement mechanism construction, W Company shall design a set of clear cross-level procurement process, and specify the key steps such as procurement application, approval and implementation. At the same time, establish corresponding rules and standards to ensure that each node of the supply chain can follow the unified operation process. In addition, establishing an effective coordination mechanism is crucial, as it facilitates information flow and ensures alignment of actions among all stakeholders, thereby enhancing the overall supply chain's collaborative efficiency.

Supplier negotiation and cooperation is a key link in the implementation of cross-level procurement strategy. W Company needs to conduct in-depth negotiations with suppliers to clarify the cooperation objectives and conditions of both parties, so as to ensure that suppliers can provide flexible supply services to meet the needs of cross-level procurement. By signing the cooperation agreement, both parties can define their respective rights, obligations and responsibilities, laying a solid foundation for a long-term and stable cooperative relationship.

Upgrading of information technology systems is essential to support the implementation of cross-level procurement strategy. W Company shall conduct a comprehensive assessment of existing systems, identify upgrade needs, and introduce or upgrade new information technology systems to support real-time data updates and sharing. The implementation of the new systems will greatly improve the efficiency and accuracy of data management and provide strong technical support for procurement decision-making. At the same time, relevant personnel shall be trained on systems operation to ensure that they can use the new systems skillfully, so as to ensure the smooth operation of the new systems.

Risk assessment and management are necessary to ensure the successful implementation of cross-level procurement strategy. W Company needs to identify and assess various risks that may be brought by cross-level procurement, such as supply chain interruption, inventory imbalance, etc., and establish corresponding risk assessment model to carry out quantitative analysis on the risks. Based on these analysis results, the Company shall formulate a series of risk control measures and emergency plans to reduce the impact of potential risks on the supply chain.

Finally, to achieve continuous optimization and innovation of cross-level procurement strategy, W Company shall establish a performance monitoring system to regularly assess the implementation and effectiveness of the strategy. By establishing a feedback mechanism and collecting opinions and suggestions from all participants in the supply chain, the company is able to continuously adjust and optimize the cross-level procurement process. Meanwhile, it shall integrate cross-level procurement strategies with the company's long-term strategy; explore new innovative opportunities to adapt to the ever-changing market environment.

4. Optimization of Inventory Control

The background of W Company's multi-stage inventory optimization scheme design encompasses the company's market leadership position, product diversity, supply chain complexity, technological advancements, market competition, and the demand for sustainability. As a leading enterprise in the domestic leisure food industry, W Company faces challenges in meeting constantly evolving consumer demands, managing complex supply chains, leveraging emerging technologies to improve efficiency, maintaining market competitiveness, and fulfilling social responsibilities.

4.1 Scheme I

Scheme I aims to reduce operating costs, improve service levels and ensure supply chain stability and reliability through accurate demand forecasting, efficient inventory control and transparent supply chain management. Additionally, considering the environmental and social impacts, the optimization scheme will also support the company in achieving its sustainability goals. Through this comprehensive strategy, W Company will be able to maintain its leading position in the competitive market and achieve long-term, sustainable business growth.

As the leading enterprise in the domestic leisure food industry, W Company has a rich product line and extensive customer base. In order to further improve supply chain efficiency and reduce inventory costs while maintaining high service levels, the company can take a series of multi-stage inventory optimization measures. Firstly, through in-depth analysis of historical sales data and forecasting market trends, W Company can more accurately forecast demand. Subsequently, the company can optimize factory production plans and supplier management to ensure stability in raw material supply and production flexibility. Furthermore, optimizing the layout and storage strategies of central warehouses and regional distribution centers can effectively enhance inventory turnover and logistics efficiency. The implementation of advanced inventory control model and dynamic replenishment system can further reduce the risk of overstock and out of stock. The upgrading of information technology system and the application of data analysis tools will provide strong support for inventory management and decision-making. Moreover, the company offers differentiated services for various customer segments and establishes a customer feedback mechanism to facilitate timely adjustments to inventory strategies, meeting customer demands. Lastly, W Company shall continuously monitor technological innovations in the supply chain domain and actively participate in supply chain modeling and design competitions to enhance its modeling and optimization capabilities. Through these comprehensive measures, W Company will be able to maintain its leading position in the fiercely competitive market and achieve sustainable business growth.

4.2 Scheme II

The implementation of service level sensitivity analysis at W Company is a key strategy to improve overall business performance. The core of this analysis is to assess the multidimensional impact of different service levels on company operational efficiency, cost control, and customer satisfaction in order to more precisely adjust and optimize inventory and supply chain management strategies.

Firstly, W Company builds a comprehensive data analysis platform by collecting and analyzing historical sales data, inventory change records and customer feedback information. The platform not only tracks the accuracy and timeliness of order fulfillment, but also monitors the relationship between inventory levels and demand fluctuations. Based on these data, the company has developed a mathematical model that simulates the effects of changes in service levels on sales, inventory costs, customer satisfaction, and profitability.

Through the model analysis, W Company has identified that even minor improvements in service levels can significantly increase customer repurchase rates and willingness to recommend, thus leading to sales growth. However, the company also acknowledges that excessively high service levels may result in unnecessary increases in inventory costs, necessitating the identification of a service level balance point that maximizes cost-effectiveness. To address this, W Company has implemented a series of measures, including dynamic inventory management, optimization of supply chain network layout, improvement of supplier collaboration models, and enhancement of logistics distribution efficiency. Additionally, sensitivity analysis on service levels has revealed a strong correlation between customer satisfaction and loyalty. By consistently providing high-quality service, W Company has successfully enhanced customer satisfaction, thereby increasing customer loyalty and brand reputation. This strategy not only helps solidify the existing customer base but also attracts new customers, expanding market share.

In terms of cost-benefit analysis, W Company ensures that any service level increase is economically justified by comparing the additional costs associated with the service level increase with the resulting benefits. This analysis allows the company to avoid over-investment and ensures that resources are used effectively. Furthermore, Service Level Sensitivity Analysis also provides W Company with a powerful risk management tool. By predicting potential supply chain disruptions and demand surges, the company can develop contingency plans to mitigate the negative impact of these events on service levels. This proactive risk management strategy ensures that W Company is able to maintain business continuity and stability in the face of market fluctuations and uncertainty.

5. Conclusion

Through in-depth analysis, reconstruction of W Company's supply chain network, and optimization of inventory control strategies, the following research conclusions are drawn.

5.1 The Reconfiguration of the Supply Chain Network Significantly Enhances the Efficiency of the Entire Supply Chain

By redesigning W Company’s supply chain network, including optimizing factory production planning, supplier management and logistics distribution routes, the company can significantly improve the efficiency and responsiveness of the overall supply chain. This reconstruction helps reduce shipping and storage costs while ensuring that products reach customers faster to meet market demands.

5.2 Multi-stage Inventory Control and Dynamic Replenishment Effectively Reduce Inventory Backlog and Lower Inventory Cost

The implementation of multi-stage inventory control and dynamic replenishment strategy enables W Company to effectively reduce inventory backlog and inventory cost while maintaining high service level. Through refined demand forecasting and inventory management, the company can better cope with demand fluctuations and reduce the risk of out-of-stock and excess inventory.

5.3 Key Role of Information Technology Systems

Upgrading supply chain management system and introducing advanced data analysis tools are crucial for achieving supply chain network reconstruction and inventory control optimization. The application of these technologies improves the transparency and accuracy of data, enabling decisions to be based on real-time information and scientific analysis.

5.4 Enhancement of Customer Service Levels

The optimized supply chain network and inventory control strategies enable W Company to provide more stable and efficient service, thereby enhancing customer satisfaction and loyalty. This is critical to the long-term growth and market competitiveness of the company.

5.5 Necessity of Continuous Improvement

Supply chain network reconstruction and inventory control optimization is a continuous process. W Company needs to constantly monitor supply chain performance and market dynamics and adjust its strategy to respond to changing external environment and internal demand.

As W Company progresses in supply chain network reconstruction and inventory control optimization, future research will focus on further integrating innovative technologies to improve the agility, resilience and sustainability of the supply chain. Exploring the application of technologies such as artificial intelligence, big data analytics, the Internet of Things and block chain will help improve the automation level, transparency and risk management capabilities of the supply chain. Moreover, research will emphasize building supply chain networks that can quickly adapt to market changes and respond to uncertainty factors to ensure business continuity and robustness. In addition, facing the growing personalized demands of consumers, research will focus on how to meet customer needs and maintain cost-effectiveness through flexible supply chain design.

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